

(Reprint), C. C., C. N, et al. "Modelling the fate of sulphur-35 in crops. 1. Calibration data." ENVIRONMENTAL POLLUTION: <2005: <VO1>133: <IS1>N3: <IS2>FEB: <PG1>431-437: -.

Gas-cooled nuclear power plants in the uk release sulphur-35 during their routine operation. The gas is in the form of COS which can be readily assimilated by vegetation. It is therefore necessary to be able to model the uptake of such releases in order to quantify any potential contamination of the food chain. To develop such models experimental data are required. A series of experiments was undertaken to determine the rate of deposition, the partition and subsequent loss of sulphur-35 in crops exposed to (COS)-S-35. The mass normalised deposition rate was similar for the range of crops tested, while the partition of the S-35 paralleled the growth of crop components. There was no significant loss of radioactivity other than that expected from radioactive decay. (C) 2004 Elsevier Ltd. All rights reserved.

(Reprint), I. Y., I. Y, et al. "Vertical distributions of particles and sulfur gases (volatile sulfur compounds and SO₂) over east Asia: comparison with two aircraft-borne measurements under the Asian continental outflow in spring and winter." ATMOSPHERIC ENVIRONMENT: <2006: <VO1>40: <IS1>N3: <IS2>JAN: <PG1>430-444: -.

We have presented the vertical distributions, between 0.5 and 5.5 km, of particles, volatile sulfur compounds, sulfur dioxide, O₃, and fractions of sulfur over the Japan Sea coast, Wakasa Bay, on 23 April 1996 and 28 December 1995. Comparison of these measurements showed that free tropospheric concentrations of particles and short-lived sulfur gases (CS₂, H₂S, SO₂) on 23 April 1996 were significantly higher than those on 28 December 1995. Clustered isentropic backward trajectory analysis and meteorological data indicated that the difference was associated with air mass transport routes and meteorological conditions. On 23 April 1996, coarse size particles (mineral dust particles) were injected over the region associated with dust storms. During transport by westerly winds, these coarse size particles were mixed with short-lived sulfur gases injected by convection over an industrial region. The presence of DMS, confined to the boundary layer, indicated that Asian continental outflow can be modified during long-range transport through mixing with marine air in the boundary layer over the Japan Sea. On the other hand, on 28 December 1995, low concentrations of particles and short-lived sulfur gases, measured at altitudes above 3.0 km, were due to air mass subsidence. It is likely that some photochemical processing was also due to low concentrations (if short-lived sulfur gases. Vertical distributions of O₃ concentrations and values of sulfur fraction (SO₄²⁻/SO₄²⁻+SO₂) supported this interpretation. There was no significant difference in concentrations of long-lived COS, except for one sample on 23 April 1996. The low COS concentration coincided with significantly high concentrations of CS₂, suggesting rapid upward transport of COS depleted air masses from the surface. (C) 2005 Elsevier Ltd. All rights reserved.

(Reprint), U. G. and <Email>Guenther.uher@Ncl.ac.uk ESTUARINE COASTAL AND SHELF SCIENCE: <2006: <VO1>70: <IS1>N3: <IS2>NOV: <PG1>338-360: -.

Recent research work provided the basis for a much improved understanding of the open ocean sources of dimethylsulphide (DMS), carbonyl sulphide (COS), and carbon disulphide (CS₂) to the atmosphere.

Coastal ocean emissions remained less well constrained, arguably because of the inherently high variability of coastal and estuarine systems. This article presents a review of the spatial and seasonal distributions of dms, cos and cs₂ together with a preliminary assessment of their respective emissions from european coastal waters. Our data compilation considers winter/summer scenarios and explicitly distinguishes shelf waters and estuarine systems. For dms, our findings indicate similar emission rates for shelf waters and estuarine systems and an annual dms source of approximately 16 gmol a⁽⁻¹⁾. Our annual emission estimates for cos and cs₂ are 0.26 Gmol a⁽⁻¹⁾ and 0.16 Gmol a⁽⁻¹⁾, respectively, and suggest significant contributions from estuarine systems to total shelf emissions in both cases (cos: 27%; cs₂: 19%). On this basis we recommend that estuarine cos and cs₂ emissions should be considered in future global emission estimates. Comparisons of our emission estimates to previous estimates of global marine sulphur gas emissions indicate disproportionally high contributions from european coastal waters. Given that emission rates from european shelves may be similar to those of other coastal shelf areas, our findings suggest that the coastal marine sources of dms, cos and cs₂ may have been underestimated in previous work. (C) 2006 elsevier ltd. All rights reserved.

(Reprint), V. A., Z. Rg, et al. "Photochemical mineralization of dissolved organic nitrogen to ammonium in the baltic sea." ENVIRONMENTAL SCIENCE & TECHNOLOGY: <2005: <VO1>39: <IS1>N18: <IS2>SEP 15: <PG1>6985-6992: -.

Solar-radiation-induced photochemistry can be considered as a new source of nutrients when photochemical reactions release bioavailable nitrogen from biologically nonreactive dissolved organic nitrogen (don). Pretreatments of baltic sea waters in the dark indicated that > 72% of don was recalcitrant to biological mineralization. When this don (16-21.5 μM) was exposed to simulated solar radiation, the concentration of nh₄⁺ increased 0.5-2.5 μM more in irradiated waters than in the dark controls. The photochemical production of nh₄⁺ and the dose of absorbed photons were used to calculate the apparent quantum yield spectrum for photoammonification [$\text{mol nh}_4^+ (\text{mol photons})^{-1} \text{nm}^{-1}$] at wavelengths (λ) of 290-700 nm ($\phi_{\text{nh}_4^+, \lambda}$). The modeled mean rates of photoammonification based on $\phi_{\text{nh}_4^+, \lambda}$ were 143 and 53 $\mu\text{mol nh}_4^+ \text{m}^{-2} \text{d}^{-1}$ at the surface and in the whole water column, respectively, of baltic sea stations during summer. The results of this study indicate that the rate of photoammonification approximately equals and periodically exceeds the rate of atmospheric deposition of reactive inorganic nitrogen to the northern baltic sea. For these stratified surface waters beyond riverine input of labile nitrogen, photoammonification can periodically be the largest source of new bioavailable nitrogen.

(Reprint), Y. S., S.-S. L, et al. "Uptake of carbonyl sulfide (cos) and emission of dimethyl sulfide (dms) by plants." PHYTON-ANNALES REI BOTANICAE: <2005: <VO1>45: <IS1>N4,SI: <PG1>17-24: -.

Higher plants represent a significant sink for atmospheric carbonyl sulfide (cos) and a potential source of dimethyl sulfide (dms). In the present work, cos uptake was investigated on various plant species (quercus robur, juniperus excelso, hibiscus spec., Sorghum bicolor) differing in the activities of carbonic anhydrase (ca), the enzyme recognized responsible for cos consumption. Cos uptake was observed for all plant species, and the range of cos consumption was 1.5-25 $\text{pmol m}^{-2} \text{s}^{-1}$ (deposition velocity 1.2-10.6 Mm s^{-1}). The cos uptake was found to be light-independent, but was strongly under stomatal

control. For the c-3 plant species the uptake rates were well correlated with the inherent capacity of ca, a fact that may confer a comfortable tool to model cos uptake by plants, and ultimately may help to decrease the uncertainty in estimates of the global cos sink strength of vegetation. S. Bicolor, owing a c-4 metabolism and respective low ca activity, exhibited a relatively high cos uptake rate as compared to the c-3 plants. Potential reasons for this deviation are discussed. Emission of dms was species-specific and was only observed in case of hibiscus spec. Under light conditions.

Aberle, N. S., L. Burd, et al. (2004/9). "Acetaldehyde-induced cardiac contractile dysfunction may be alleviated by vitamin B1 but not by vitamins B6 or B12." Alcohol Alcohol **39**(5): 450-4.

AIMS: Chronic alcohol exposure leads to a deficiency of group B vitamins and increased risk of alcoholic cardiomyopathy characterized by impaired ventricular contractility. This study was designed to examine the effect of group B vitamin supplementation on short-term exposure of the main alcohol metabolite acetaldehyde (ACA)-induced cardiac contractile dysfunction in rat ventricular myocytes. **METHODS:** Mechanical contractile properties were evaluated by an IonOptix SoftEdge system. Protein damage and apoptosis were determined by protein carbonyl and caspase-3 assays, respectively. **RESULTS:** Short-term (4-6 h) culture of myocytes with ACA (10 microM) depressed peak shortening amplitude, maximal velocity of shortening/relengthening, shortened duration of shortening but not the duration of relengthening. ACA exposure also enhanced protein carbonyl formation and apoptosis in ventricular myocytes. The toxin-induced mechanical defects, protein damage and apoptosis were ablated by vitamin B1 (10 microM), an essential vitamin required for DNA synthesis and repair. Vitamin B6 (10 microM) attenuated ACA-induced impairment of shortening duration. Vitamin B12 (1 mM) attenuated ACA-induced reduction in maximal velocity of shortening/relengthening. Unlike vitamin B1, none of the other ACA-elicited alterations in myocyte mechanical function were affected by vitamin B6 or vitamin B12. Vitamin B6 and vitamin B12 partially, but significantly, attenuated the ACA-induced carbonyl formation without affecting ACA-induced apoptosis. **CONCLUSIONS:** These data provide evidence that vitamin B1 supplementation may be protective for ACA-induced cytotoxicity through protection against protein damage and apoptotic cell death in ventricular myocytes.

Ackerman, D. G., M. T. Haro, et al. (1980). "Health impacts, emissions, and emission factors for noncriteria pollutants subject to 'de minimis' guidelines and emitted from stationary conventional combustion processes." Govt Reports Announcements & Index (Gra&I), Issue 21, 1982: -.

TD3: Report presents a literature survey of the health and ecological effects associated with various air quality levels of noncriteria pollutants that are regulated under the Clean Air Act. These noncriteria pollutants include mercury, beryllium, asbestos, sulfuric acid mist, vinyl chloride, hydrogen sulfide, methyl mercaptan, dimethyl sulfide, carbon disulfide and carbonyl sulfide. Nationwide emissions are estimated for each noncriteria pollutant with particular emphasis on contributions from fossil fuel combustion at stationary sources. Factors for quantifying emissions from fossil fuel combustion processes are discussed for each noncriteria pollutant. Special rept. Prepared in cooperation with Battelle Columbus Div., OH.

Adams, D. F. and S. O. Farwell (1981). "Sulfur gas emissions from stored flue gas desulfurization sludges." J Air Pollut Control Assoc **31**(5): 557-564.

HEEP COPYRIGHT: BIOL ABS. Emissions of volatile S-containing compounds from 13 flue gas desulfurization (FGD) sludge field storage sites were characterized. S gas emissions from the sludge surfaces were determined by measuring S gas enhancement of S-free sweep air passing through a dynamic emission flux chamber placed over selected sampling sites. Samples of the enclosure sweep air were cryogenically concentrated in surface-deactivated Pyrex U traps. Analyses were conducted by wall-coated, open-tubular, capillary column, cryogenic gas chromatography using a S-selective, flame photometric detector. Several major variables associated with FGD sludge production processes were examined in relation to the measured range and variations in S fluxes including: SO₂ scrubbing reagent used, sludge sulfite oxidation, unfixed or fixed FGD sludge and ponding or landfill storage. The composition and concentration of the measured S gas emissions varied with the type of sludge, the effectiveness of rainwater drainage from the landfill surface, the method of impoundment and the sulfate/sulfite ratio of the sludge. H₂S, carbonyl sulfide, dimethyl sulfide, CS₂ and dimethyl disulfide were identified in varying concentrations and ratios in FGD sludge emissions. Up to 4 unidentified organo-S compounds were found in emissions from 4 FGD sludges. The S flux from 1 FGD storage pond was analyzed by gas chromatography-single ion monitoring mass spectrometry. In addition to the 4 identified S compounds, this flux contained large concentrations of benzene, toluene and alpha-pinene. The measured, total S emissions ranged < 0.01-0.3 kg S/day for an equivalent 100 acre (40.5 ha) sludge impoundment surface.

Adewuyi, Y. G. and G. R. Carmichael (1987). "Kinetics of hydrolysis and oxidation of carbon disulfide by hydrogen peroxide in alkaline medium and application to carbonyl sulfide." Environ Sci Technol **21** (2): 170-177.

RRM SULFATE WASTEWATER TREATMENT WATER POLLUTION

Ahearn, D. G., S. A. Crow, et al. (1997/11). "Fungal colonization of air filters and insulation in a multi-story office building: production of volatile organics." Curr Microbiol **35**(5): 305-8.

Secondary air filters in the air-handling units on four floors of a multi-story office building with a history of fungal colonization of insulation within the air distribution system were examined for the presence of growing fungi and production of volatile organic compounds. Fungal mycelium and conidia of *Cladosporium* and *Penicillium* spp. were observed on insulation from all floors and both sides of the air filters from one floor. Lower concentrations of volatile organics were released from air filter medium colonized with fungi as compared with noncolonized filter medium. However, the volatiles from the colonized filter medium included fungal metabolites such as acetone and a carbonyl sulfide-like compound that were not released from noncolonized filter medium. The growth of fungi in air distribution systems may affect the content of volatile organics in indoor air.

Ahearn, D. G., S. A. Crow, et al. (1997). "Fungal colonization of air filters and insulation in a multi-

story office building: production of volatile organics." Current Microbiology **35**(5): 305-308.

Secondary air filters in the air-handling units on four floors of a multi-story office building with a history of fungal colonization of insulation within the air distribution system were examined for the presence of growing fungi and production of volatile organic compounds. Fungal mycelium and conidia of *Cladosporium* and *Penicillium* spp. were observed on insulation from all floors and both sides of the air filters from one floor. Lower concentrations of volatile organics were released from air filter medium colonized with fungi as compared with noncolonized filter medium. However, the volatiles from the colonized filter medium included fungal metabolites such as acetone and a carbonyl sulfide-like compound that were not released from noncolonized filter medium. The growth of fungi in air distribution systems may affect the content of volatile organics in indoor air.

Aneja, V. P., A. P. Aneja, et al. (1982). "Biogenic sulfur compounds and the global sulfur cycle." J Air Pollut Control Assoc **32**(8): 803-807.

HEEP COPYRIGHT: BIOL ABS. REVIEW ACID RAIN AIR POLLUTION

Annis, P. C., Y. L. Ren, et al. (2000/8). "Fate of (14)C-labeled carbonyl sulfide on grains and grain fractions." J Agric Food Chem **48**(8): 3646-50.

¹⁴C-Labeled carbonyl sulfide (COS) was used to measure the amount of sorbed fumigant and alteration products on grains. Wheat, paddy rice, polished rice, mungbean, and safflower were exposed to a 60 mg L⁻¹ of (14)COS for 7 days and then aired for 5 days. Carbonyl sulfide and/or alteration products in sugars, protein, starch, amino acids, protopectines, and hemicelluloses were undetectable. The total uptakes of radioactivity determined after fractionation and also by extraction were in the range of 36-53 ng g⁻¹ COS equiv. The total radioactivity determined by autoradiography was below the detection limit of 70 ng g⁻¹ COS equiv. Radioactivity in the commodities was less than 0.003% of all the radioactivity applied. The amount of retained radiolabel was measured in three ways. First, biochemical fractions such as lipids and amino acids were separated by chromatography, and the activity was determined in each component. Second, commodities were crushed and extracted in aqueous acetone until the maximum amount of radiolabel was extracted. Third, autoradiography was carried out on commodity kernels.

Anon (1979). "Information profiles on potential occupational hazards. Volume i. Single chemicals. Carbon oxysulfide." Govt Reports Announcements & Index (Gra&I), Issue 11, 1981: -.

TD3: This information profile on carbon oxysulfide (463581) is part of a group of 46 such profiles that provide information about chemicals or industrial processes considered to be potential occupational hazards. Each profile contains summary data on known and suspected health effects, the extent of worker exposure and the industrial importance of either a single chemical, class of chemicals, or a particular industrial process. The report was developed for use by occupational safety and health professionals in industry, and labor and other areas, to provide them with a synopsis of information on

each subject and to identify potential hazards in their workplaces. Final rept.

Anon (1984). "High sulfur coal research at the siuc coal technology laboratory. Quarterly progress report." Govt Reports Announcements & Index (Gra&I), Issue 15, 1984: -.

TD3: The research effort addressed in this cooperative agreement includes the conduct of a high-sulfur coal research program and the establishment of a research facility, the Coal Technology Laboratory at the site of the former Carbondale Mining Technology Center. The associated research program is broadly based and directed toward high-sulfur coal, the goal being expand the technology to allow for the increased use of high-sulfur coal in an environmentally acceptable manner. Progress continues to be made on the research in the four areas of coal science, coal preparation, coal conversion, and coal utilization. In the Coal Science area, the maceral separation laboratory is about 90% operational. In the area of coal preparation, a mechanical auger feeder device for introducing material into an experimental hydrocyclone along its axis was constructed and incorporated. A froth flotation pilot plant has been acquired and renovated. Coal conversion studies included experiments to examine the effects of ch

Anon (1985). "Removing sulfur dioxide from flue gases: the process uses a regenerable molten salt supported on porous pellets." Govt Reports Announcements & Index (Gra&I), Issue 13, 1985: -.

TD3: This citation summarizes a one-page announcement of technology available for utilization. In situ removal of SO₂ in flue gases and fluidized-coal combustors, with no waste product, is possible using NaO₂ as a regenerable supported molten sorbent. Under the new method, SO₂ in the presence of O₂ is rapidly absorbed in the melt, forming sulfates; the sulfates are then reduced and desorbed as elemental sulfur and carbonyl sulfide. After removal of the elemental sulfur, the carbonyl sulfide is recycled to the reduction stage. For removal of SO₂ from coal combustion, the coal is burned in a fluidized bed of the sorbent....FOR ADDITIONAL INFORMATION: Contact NASA Technology Transfer Div., P.O. Box 8757, BWI Airport, MD 21240; (301) 621-0100 ext. 241. Refer to NPO-15758/TN. NTIS Tech Note.

Anonymous (1975). "Asphalt hot-mix emission study." Asphalt Institute, Research Series, College Park, Maryland, Research Report 75-1 (Rr-75-1), 103 Pages, 19751975: -.

Because of increasing interest in all matters affecting the environment, an investigation was undertaken to determine the composition of emissions, both visible and invisible, arising from hot asphalt (8052424) mixes. The findings are based on investigation of eight complete sets of emission samples taken at two hot mix facilities involving four asphalts from three refineries. The emission samples were taken following the discharge of the mix from the mixing chamber. In most of the samplings the immediate area was shrouded to concentrate the emissions, to exclude extraneous matter, and to provide more uniform sampling conditions. Most of the air contaminants found in the emissions were at extremely low concentrations and all fell well within currently applicable limits established by OSHA. Analysis of gaseous substances included carbon-monoxide (630080), nitrogen-dioxide (10102440), sulfur-dioxide (7446095), hydrogen-sulfide (7783064), carbonyl-sulfide (463581), mercaptans, ozone (10028156),

aldehydes, phenols, and C2 to C14 hydrocarbons. The threshold limit value for asphalt fumes of 5.0mg/m³ was considered the standard and found to be slightly exceeded in one of the samples. It is concluded that there is no serious air pollution or employee health problem resulting from the use of petroleum (8002059) derived asphalt in hot mixes.

Anonymous (1977). "Hygiene in foundry shops chemical nuisances." National Institute of Research and Safety for Prevention of Industrial Accidents and Occupational Diseases, Pages 1-19, 19 References, 19771977: -.

The hazards of chemicals used and vapors emitted in French foundry shops were discussed. Foundry activities, including older classic sand procedures and newer ones using synthetic resins, were reviewed. Analytic techniques for polyurethane-phenol, furon, and phenol (108952) resins, oils and sands were outlined, including processes of sample identification, core work, and coating and stripping. The vapors found in the foundry environment included isocyanates, phenols, dimethylethylamine (598561), ammonia (7664417), hydrocyanic-acid (74908), carbon-monoxide (630080), benzene (71432), furfuryl-alcohol (98000), formaldehyde (50000), methanol (67561), hydrogen-sulfide (7783064), sulfur-dioxide (7446095), carbonyl-sulfide (463581), acetaldehyde (75070), acetonitrile (75058), and acrolein (107028). (French).

Aung, L. H. R. A., J. G. Leesch, et al. "Effects of carbonyl sulfide, methyl iodide, and sulfuryl fluoride on fruit phytotoxicity and insect mortality." Annals of Applied Biology, (2001) Vol.139, No.1, pp.93-100.print.CODEN: AABIAV.ISSN: 0003-4746.: -.

Three potential chemical fumigants: carbonyl sulfide (COS), methyl iodide (MI) and sulfuryl fluoride (SF) were tested at selected dosages on lemons against California red scale (*Aonidiella aurantii*) and MI and COS were tested on nectarines against codling moth (*Cydia pomonella*). In nectarines, COS was tested at 0, 20, 40, 60 and 80 mg litre⁻¹, MI at 0, 10, 15, 20 and 25 mg litre⁻¹. Both fumigants intensified nectarine peel color, delayed fruit softening, but did not alter overall fruit quality. COS at 80 mg litre⁻¹ resulted in 87% codling moth mortality, but the fumigant dosage was insufficient to reach the desired probit 9 level (99.9968%). MI gave 100% codling moth mortality at 25 mg litre⁻¹. Lemons were treated with MI at 0, 10, 20, 40, 60 mg litre⁻¹, SF at 0, 10, 20, 40, 80 mg litre⁻¹ and COS at 0, 20, 40, 60 and 80 mg litre⁻¹. MI gave 100% red scale mortality at 40 mg litre⁻¹ but caused significant fruit injury. Conditioning lemons at 15°C for 3 days before MI fumigation lessened lemon phytotoxicity. Forced aeration at 3.5 standard litres per minute of lemons for 24 h following MI fumigation at 20 mg litre⁻¹ significantly reduced phytotoxicity compared to 2 h postfumigation aeration after MI treatment. SF at 40 mg litre⁻¹ gave 100% red scale mortality but resulted in commodity phytotoxicity. Lemons treated with the highest selected dose of 80 mg litre⁻¹ COS gave only 87% kill of red scale, but failed to reach the desired probit 9 level.

Badger, M. R. and G. D. Price (1990/9). "Carbon Oxysulfide Is an Inhibitor of Both CO₂ and HCO₃ Uptake in the Cyanobacterium *Synechococcus* PCC7942." Plant Physiol **94**(1): 35-39.

Carbon oxysulfide (COS) was reinvestigated as an inhibitor of active inorganic carbon transport in cells of *Synechococcus* PCC7942 adapted to growth at low inorganic carbon. COS inhibited both CO₂ and HCO₃⁻ transport processes in a reversible (in the short term) and mixed competitive manner. The inhibition of COS was established using both silicone oil centrifugation experiments and O₂-evolution studies. The K_i for COS inhibition was 29 micromolar for CO₂ transport and 110 micromolar for HCO₃⁻ transport. These results support a model of inorganic carbon transport with a central CO₂ pump and an inducible HCO₃⁻ utilizing accessory protein which supplies CO₂ to the primary pump.

Baker, D. C., W. V. Bush, et al. (1993). "Determination of the level of hazardous air pollutants and other trace constituents in the syngas from the shell coal gasification process." Chow, W. And K.K.Connor (Ed.).Managing Hazardous Air Pollutants: State of the Art First International Conference, Washington, D.c., Usa, November 4-6, 1991. Xix+582p. Lewis Publishers Inc.: Chelsea, Michigan, Usa. Isbn 0-87371-866-6.; 0(0): 126-137.

RRM MEETING PAPER BOOK CHAPTER ELEMENTAL ANALYSIS TRACE ORGANICS RADIONUCLIDES COMMERCIAL APPLICATION

Balazy, M., I. A. Abu-Yousef, et al. (2003/11/21). "Identification of carbonyl sulfide and sulfur dioxide in porcine coronary artery by gas chromatography/mass spectrometry, possible relevance to EDHF." Biochem Biophys Res Commun **311**(3): 728-34.

Incubation of porcine coronary artery rings and cardiac muscle tissue in Krebs buffer followed by GC/MS analysis of the headspace gas revealed two gases, carbonyl sulfide (COS) and sulfur dioxide (SO₂). The gases were identified by characteristic ions obtained by electron ionization, and by comparison of the retention time on a chromatographic column (GS GasPro) with standards of these gases. Stimulation of the arterial rings with acetylcholine and calcium ionophore A23187 increased the levels of SO₂ and COS in the vascular tissue. We also provide evidence that SO₂ could originate from disproportionation of a very unstable gas, sulfur monoxide (S=O). We suggest potential origins of these gases and discuss their relevance to endothelium-derived hyperpolarizing factor.

Baldocchi, D. D. (1993). "Deposition of gaseous sulfur compounds to vegetation." De Kok, L.J., Et Al. (Ed.).Sulfur Nutrition and Assimilation in Higher Plants: Regulatory Agricultural and Environmental Aspects Second Workshop on Sulfur Metabolism in Higher Plants, Garmisch-Partenkirchen, Germany, April 21-25, 1992. Xiv+326p. Spb Academic Publishing Bv: the Hague, Netherlands. Isbn 90-5103-084-3.; 0(0): 271-293.

RRM BOOK CHAPTER MEETING PAPER PLANT ATMOSPHERIC EMISSIONS POLLUTION METABOLISM

Banks, H. J. I. R. A., F. J. M. I. Desmarchelier, et al. "Carbonyl sulphide insecticide." Official Gazette of the United States Patent and Trademark Office Patents, (Mar.20, 2001) Vol.1244, No.3.e-file.CODEN:

The gaseous chemical compound, carbonyl sulphide, has hitherto been unknown as a fumigant for the control of insects and mites. Experiments have shown conclusively that carbonyl sulphide can be used as such a fumigant, with fumigation properties comparable to those of phosphine and methyl bromide. The effectiveness of carbonyl sulphide against insects (both adult and immature stages), mites, termites and moulds is demonstrated. In addition, its low absorption by grain, lower flammability than phosphine, lack of influence on seed germination, and apparent environmental safety make carbonyl sulphide particularly beneficial as a fumigant of stored grain. It may also be used to fumigate other stored produce (including perishable foodstuff), soil, timber and spaces (such as buildings) and any material likely to be infested by insects or mites, or act as a source of such infestation.

Banwart, W. C. and J. M. Brenner (1975). "Identification of sulfur gases evolved from animal manures." Journal of Environmental Quality, Vol.4, No.3, Pages 363-366, 17 References, 1975: -.

Sulfur gases evolved from animal manure were chromatographically analyzed. Manure samples were obtained from swine, poultry, sheep, and beef and dairy cattle. Analysis with gas chromatographic techniques was performed on atmosphere of fresh and air dried manure incubated for 40 days under aerobic conditions or for 30 days under anaerobic conditions. Percent of manure sulfur volatilized under anaerobic conditions was also calculated. Under aerobic incubation conditions, no sulfur gases were detected for air dried manure, and only trace amounts of dimethyl-sulfide (75183) were detected for fresh sheep and poultry manure. Under anaerobic incubation conditions, all manure samples released hydrogen-sulfide (7783064) and methyl-mercaptan (74931), and to a lesser extent dimethyl-sulfide. In addition, carbonyl-sulfide (463581) was found for some cattle and swine samples, carbon-disulfide (75150) was found for some cattle samples, and dimethyl-disulfide (624920) was found for all sheep and poultry samples and some swine and beef cattle samples. The sulfur volatilized in 30 days represented only 0.02 to 0.53 percent of the total sulfur in the manure samples. The authors conclude that sulfur gases evolved from manure are derived from microbial degradation of amino acids, but that there is no evidence to account for the evolution of carbonyl-sulfide.

Banwart, W. L. and J. M. Bremner (1975). "Identification of sulfur gases evolved from animal manures." J Environ Qual; 4 (3).1975 363-366: -.

HEEP COPYRIGHT: BIOL ABS. Evolution of volatile S compounds from animal manures (beef cattle (*Bos taurus*), dairy cattle (*B. taurus*), poultry (*Gallus domesticus*), sheep (*Ovis aries*), and swine (*Sus scrofa*) was studied by chromatographic techniques permitting detection and identification of trace (nanogram) amounts of S gases in the presence of nonsulfur gases known to be released through microbial decomposition of organic materials. All manures studied released hydrogen sulfide (H₂S), methyl mercaptan (CH₃SH) and dimethyl sulfide (CH₃SCH₃) when incubated under anaerobic conditions and some released dimethyl disulfide (CH₃SSCH₃), carbonyl sulfide (COS), and/or carbon disulfide (CS₂). Only trace amounts of 1 sulfur gas (dimethyl sulfide) were detected in the gaseous products of decomposition of manures under aerobic conditions, and no evidence was obtained that S

gases contribute to the odors of dried manures. Most of the S volatilized when manures were incubated under anaerobic conditions was in the form of hydrogen sulfide and methyl mercaptan, and the amount of sulfur volatilized in 1 mo. at 23 degrees C represented less than 1% of the total S in the manures studied.

Barker, J. F., R. V. Nicholson, et al. (1994). "Subsurface assessment handbook for contaminated sites." Govt Reports Announcements & Index (Gra&I), Issue 22, 1994: -.

TD3: The purpose of the handbook is to improve subsurface investigations at contaminated sites. Site investigations draw on many disciplines (e.g., geology, chemistry, mathematics, and biology) and therefore challenge both investigators and users of the results. This handbook helps those commissioning, conducting, and evaluating assessments of the subsurface at contaminated sites. Although presented simply, subsurface assessment techniques are often complex and at the leading edge of applied research and technological development. Therefore, some principles and basic concepts are presented to help in understanding the advice being offered, particularly in the specialized and very technical areas of geophysics and mathematical models. The handbook also provides a glossary of technical terms, highlighted at their first use. Sponsored by Canadian Council of Ministers of the Environment, Winnipeg (Manitoba). and Environment Canada, Ottawa (Ontario). Contaminated Sites Div.

Bartell, U., U. Hofmann, et al. (1993). "Cos and hydrogen sulfide fluxes over a wet meadow in relation to photosynthetic activity: analysis of measurements made on 6 september 1990." Atmos Environ Part a Gen Top **27**(12): 1851-1864.

Micrometeorological measurements of the fluxes of carbonyl sulfide (COS) and hydrogen sulfide (H₂S) were performed over wet meadow vegetation in southern Germany during September 1990. This experiment was conducted in order to verify that vegetation is an important sink for atmospheric COS. A cryo-sampling technique for continuously collecting these trace gases was applied at four different levels above the ground, combined with eddy correlation measurement of the meteorological fluxes and a micrometeorological profile technique. From these data the trace gas fluxes were determined, based on the assumption that chemical constituents are transported in a similar fashion to meteorological parameters. The observed diel variation of the COS and H₂S fluxes exhibits peak values of (-360|130) ngS(COS)m⁻² s⁻¹ (deposition) and (+6.7|2.4) ngS(H₂S)m⁻² s⁻¹ (emission). Using a modified budget model which includes horizontal advection, it is shown that the observed mean profile of C

Bartholomaeus, A. R. and V. S. Haritos (2005/12). "Review of the toxicology of carbonyl sulfide, a new grain fumigant." Food Chem Toxicol **43**(12): 1687-701.

Carbonyl sulfide (COS) is a new grain fumigant which has been developed to replace methyl bromide, being phased out due to its ozone depletion properties, and to supplement phosphine gas which is experiencing increased insect resistance. Treatment of commodities with COS, a highly effective fumigant, results in residues that are near or indistinguishable to natural background levels of this

compound. COS is a naturally occurring gas, being the predominant sulfur moiety in the atmosphere, occurs naturally in food and is a normal by-product of mammalian aerobic metabolism. COS has low acute inhalational toxicity but with a steep dose response curve; COS is neither genotoxic nor a developmental toxicant but does reversibly impair male fertility. Prolonged, repeated exposure to COS is likely to present similar neurotoxicity hazards to that of the structurally and toxicologically related compound carbon disulfide. Although the occupational risks presented by COS as a fumigant of bulk grain are significant, these are, as they have been for a considerable time for phosphine and methyl bromide, manageable by good occupational safety practices. Consideration may need to be given to scrubbing of ventilated COS and its breakdown product hydrogen sulfide, at the completion of fumigation to minimise worker and bystander exposure. In terms of classical regulatory toxicology studies, the available database for COS is deficient in many aspects and registration in most jurisdictions will depend on sound scientific argument built upon the totality of the existing scientific data as there are strong arguments supporting the registration of this compound.

Bascom, R., P. A. Bromberg, et al. (1996). "Health effects of outdoor air pollution." American Journal of Respiratory and Critical Care Medicine **153**(1): 3-50.

RRM LITERATURE REVIEW HUMAN ANIMAL OZONE NITROGEN OXIDES CARBON MONOXIDE METALS CHEMICALS CARCINOGENS GENOTOXICITY IMMUNOLOGIC EFFECTS ALTERED INFECTIVITY INFLAMMATION MORALITY MORBIDITY EPIDEMIOLOGY

Basu, R., K. T. Klasson, et al. (1994). "Removal of carbonyl sulfide and hydrogen sulfide from synthesis gas by chlorobium thiosulfatophilum." Applied Biochemistry and Biotechnology **45-46**(0): 787-797.

The anaerobic, photosynthetic bacterium *Chlorobium thiosulfatophilum* utilizes CO₂ as its carbon source and operates at the mesophilic temperature of 30°C. It requires incandescent light for growth and compounds such as H₂S, S₂O₃²⁻, or H₂ as a source of electrons. Of these compounds, H₂S as sulfide is the preferred electron donor, with other compounds utilized only when sulfide has been depleted from the medium. The organism is also capable of indirectly utilizing carbonyl sulfide (COS), since COS reacts with water to form CO₂ and H₂S. This work presents kinetic information on the rate of growth of *C. thiosulfatophilum*, as well as the rates of uptake of both H₂S and COS. The growth is dependent on light intensity according to a Monod type relationship.

Baxter, P. J. (1994). "Gases." Raffle, P.A.B., Et Al.(Ed.).Hunter's Diseases of Occupations, 8th Edition. Xi+804p.Edward Arnold: London, England, Uk **Little, Brown and Co.: Boston, Massachusetts, Usa.** **Isbn 0-340-55173-9;** 0(0): 213-267.

RRM BOOK CHAPTER HUMAN ACCIDENTS ASPHYXIANTS ANESTHETICS FIRES OCCUPATIONAL HEALTH

Bayer, C. W. and M. S. Black (1987). "Capillary chromatographic analysis of volatile organic

compounds in the indoor environment." J Chromatogr Sci **25**(2): 60-64.

RRM INDOOR AIR POLLUTION ENVIRONMENTAL QUALITY

Beard, W. E. and W. D. Guenzi (1983). "Volatile sulfur compounds from a redox-controlled cattle manure slurry." J Environ Qual **12**(1): 113-116.

HEEP COPYRIGHT: BIOL ABS. Volatile S compounds have been implicated as contributors to the odor problem from cattle-feedlots. This study was designed to evaluate the effects of oxidation-reduction potentials (Eh) on the type and amount of volatile S compounds released from cattle manure. The laboratory experiment utilized a manure slurry controlled at pH 7, 30°C and at preselected Eh levels. The Eh of the slurry was initially controlled at +300 mV, and subsequently decreased in increments of 100mV/wk through -200 mV. Effluent gases from the incubation flask were trapped, and the S gases analyzed by gas chromatography. Carbonyl sulfide (COS) and CS₂ production was low (0.07 mug/g manure per day) at all redox levels. Dimethyl sulfide (DMS) and dimethyl disulfide (DMDS) were highest at 0 mV, while H₂S and methanethiol (MeSH) were greatest at -100 mV. The total amount of S volatilized from the manure slurry as each compound was: H₂S, 155 mug; MeSH, 135 mug; DMS, 83 mug; DMDS, 27 mug; COS, 8 mug; and CS₂, 3 mug; representing 1.7% of the total manure S.

Belviso, S., N. Mihalopoulos, et al. (1987). "The supersaturation of carbonyl sulfide in rain waters." Atmos Environ **21**(6): 1363-1368.

RRM AIR POLLUTION

Berresheim, H. (1993). "Distribution of atmospheric sulphur species over various wetland regions in the southeastern USA." Atmos Environ Part a Gen Top **27**(2): 211-221.

Atmospheric dimethylsulphide (DMS), sulphur dioxide (SO₂), aerosol non-seasalt sulphate (nss-SO₄) and methanesulphonate (MSA) were measured periodically at Sapelo Island, Georgia, during March-April 1989 and April-May 1990. The spring 1990 measurements also included the sulphur gases hydrogen sulphide (H₂S), carbonyl sulphide (COS) and carbon disulphide (CS₂). In August 1989 single measurements of these compounds were also conducted in various natural environments of southern Louisiana (coastal waters, saltwater marsh, brackish/freshwater marsh, swamp). The median DMS concentrations over Sapelo Island was significantly higher in April-May 1990 (92 ppt) than in March-April 1989 (18 ppt) due to enhanced biogenic DMS emissions in spring. Atmospheric DMS levels increased sharply (up to 560 ppt) during advection of polluted air from paper mills located on the coastal mainland. Results obtained from measurements in Louisiana suggest that biogenic sulphur fluxes from soils and/

Berresheim, H. and V. D. Vulcan (1992). "Vertical distributions of carbonyl sulfide CS₂, DMS and other sulfur compounds in a loblolly pine forest." Atmos Environ Part a Gen Top **26**(11): 2031-2036.

Measurements of atmospheric COS, CS₂, DMS, SO₂ and aerosol sulfate and methanesulfonate (MSA) concentrations were conducted in a loblolly pine forest in central Georgia (USA) between July and September 1990. The daytime profiles obtained for the reduced sulfur gases (COS, CS₂, DMS) often showed significantly higher concentrations at the canopy level than above the forest canopy, indicating a net emission of these gases from the tree tops. No evidence was found for a net uptake of COS by the canopy during daytime. With one exception, all COS concentrations measured during the day were significantly higher than corresponding nighttime values. These results appear to be in conflict with recent studies suggesting a net uptake of atmospheric COS by plants during photosynthetic activity. Possible explanations for these different findings are discussed. Nighttime profiles indicated no major biosphere-atmosphere exchange of COS, CS₂ or DMS. Nighttime DMS concentrations were sign

Bertoni, G., A. Liberti, et al. (1986). "Identification by gas chromatography mass-spectrometry of the products obtained from thermal decomposition of azinphos-methyl guthion." Ann Chim **76**(1-2): 19-28.

RRM INSECTICIDE STORAGE TEMPERATURE UNPLEASANT ODOR

Boase, C. R. A. "Stored product insect control - post methyl bromide." International Pest Control, (May 2004) Vol.46, No.3, pp.133-135.print.ISSN: 0020-8256 (ISSN print). -.

Bodenbender, J., R. Wassmann, et al. (1999). "Temporal and spatial variation of sulfur-gas-transfer between coastal marine sediments and the atmosphere." Atmospheric Environment **33**(21): 3487-3502.

The spatial and temporal variability of sulfur gas fluxes (H₂S, COS, CH₃SH, DMS, and CS₂) at the sediment-air interface were studied in the intertidal Wadden Sea area of Sylt-Romo (Germany) during eight measuring campaigns between June 1991 and September 1994. Measurements were performed mainly at four sites in a sheltered intertidal bay of approximately 6 km² (Konigshafen) and discontinuously in a wider range of the 400 km² Sylt-Romo tidal flat area. In situ fluxes of the S-gases were determined between 0.07 and 9.95 μg S m⁻² h⁻¹. Both emission rates and relative contribution of H₂S were lowest from fine sand and highest from muddy sites. Diurnal variation of H₂S emission was evident in summer and fall with up to 10-fold higher rates during night than during the day. Distinct seasonal variation of H₂S-transfer between the sediment and the atmosphere was observed with higher emission rates in the summer than in spring or fall. The emission of H₂S to the atmosphere was sm

Bombaugh, K. J., K. W. Lee, et al. (1982). "Characterization of emissions from a large coal gasification system at Kosovo Yugoslavia." Keith, L.H.(Ed.).Energy and Environmental Chemistry, Vol.1.Fossil Fuels; Vol.2.Acid Rain.Xiv+450p (Vol 1); Xiv+304p (Vol 2) Ann Arbor Science Publishers Inc.: Ann Arbor, Mich., Usa.Illus.Maps.Isbn 0-250-40401-X; Isbn 0-250-40402-8.; 0 (0).1982 (Recd.1983).P343-362. -.

HEEP COPYRIGHT: BIOL ABS. AIR POLLUTION HYDRO CARBON ENERGY

Bottrell, S., D. Banks, et al. (1991). "A simple method for field determination of some reduced sulfur species in soil gases." Environ Technol **12**(5): 393-398.

A simple method is described for the measurement of the concentration of some volatile reduced sulphur compounds in soil gases and for assessing their rate of emission. Analysis is by a fluorometric technique which is sensitive to reduced sulphur as H₂S, carbonyl sulphide, carbon disulphide and dimethyl disulphide. The method is suitable for determination of sulphide in the range 0.5 to 100 ppb and can be used for soils of low sulphide productivity. In addition to determination of productivity of volatile sulphides from soils the technique has application to leakage of sulphide gases from landfill sites.

Braman, R. S. (1971). "Direct current discharge emission spectra for detection and identification of some air pollutant compounds." Atmos Environ; 5 (8).1971 669-675: -.

HEEP COPYRIGHT: BIOL ABS. A 4-channel d.c. discharge emission type detector was used in a study of the emission response of nitrogen oxides, CO, CO₂, COS, SO₂ and selected organic compounds. Limits of detection for the inorganic gases were determined and found to be in the 10⁻⁹ to 10⁻¹¹ range. Identification of compounds by a normalized relative response ratio technique was studied and found to be feasible. The structure and chain length of a homologous series of compounds influences the comparative response obtained at the emission wave lengths of the C₂, CH, CN bands and H line selected for study. The elemental composition of the inorganic gases was reflected in the relative responses obtained.

Brandon, R. W. and J. Trautwein (1992). "Application of fourier transform infrared remote sensing to air quality monitoring in the workplace." Clean Air at Work, New Trends in Assessment and Measurement for the 1990s, Proceedings of an International Symposium, Luxembourg, 9-13 September 1991, R.H. Brown, M.Curtis, K.J.Saunders and S.Vandendriessche, Editors; -Royal Society of, 1992: -.

The use of Fourier Transform Infrared remote sensing (FTIR) for monitoring air quality in various workplaces was discussed. The basic principles of FTIR/RS were summarized. Application of FTIR/RS to a medium sized electronics assembly area where a cleaning solvent and an aerosol propellant were present at low concentrations and an aluminum smelter was discussed as examples of its use. Methanol (67561) and Freon-12 (75718) vapors were detected in the electronics assembly area at concentrations of 0.135 and 2.107 parts per million (ppm), respectively. Hydrogen-fluoride (7664393) at a concentration of 5ppm was detected in the aluminum smelter. Carbon-tetrafluoride (75730), carbon-monoxide (630080), carbonyl-sulfide (463581), ammonia (7664417), and silicon-tetrafluoride (7783611) were also detected./ULTRASONOGRAPHY

Braun, T. and S. Zsindely (1991). "Some recent trends in instrumental analysis of environmental materials." Anal Proc **28**(9): 283-286.

RRM ORGANIC COMPOUND INORGANIC COMPOUND AIR WATER EFFLUENT CHEMICAL ANALYSIS METHODS

Bremner, J. M. and W. L. Banwart (1976). "Sorption of sulfur gases by soils." Soil Biol Biochem; 8 (2).1976 79-83: -.

HEEP COPYRIGHT: BIOL ABS. Gas chromatographic studies showed that air-dry moist soils have the capacity to sorb dimethyl sulfide (CH₃SCH₃), dimethyl disulfide (CH₃SSCH₃), carbonyl sulfide (COS) and carbon disulfide (CS₂), but do not sorb sulfur hexafluoride (SF₆). Moist soils sorb larger amounts of CH₃SCH₃, CH₃SSCH₃, COS or CS₂ than do air-dry soils, but the capacity of moist (or air-dry) soils for sorption of these gases is much smaller than their capacity for sorption of H₂S, SO₂ or CH₃SH. The ability of moist soils to sorb COS is considerably greater than their ability to sorb CH₃SCH₃, CH₃SSCH₃ or CS₂ and sorptions of COS by moist soils is accompanied by release of small amounts of CS₂. Experiments with sterilized (autoclaved) soils indicated that soil microorganisms are partly responsible for the sorption of CH₃SCH₃, CH₃SSCH₃, COS and CS₂ by moist soils. Support for this conclusion was obtained for experiments showing that the rate of sorption of these gases by moist soils increases with time. Soil is an important natural sink for gaseous atmospheric pollutants, but soils have little potential value for removal of CH₃SCH₃, CH₃SSCH₃, COS or CS₂ from industrial emissions polluted by these gases. The finding that soils have no capacity for sorption of SF₆ is significant in relation to use of this gas as a tracer for atmospheric research and as an internal standard for gas chromatographic studies of evolution and sorption of gases by soils.

Breuer, G. M. (1981). "Evaluation of a prototype portable microwave multi-gas analyzer." Govt Reports Announcements & Index (Gra&I), Issue 05, 1983: -.

TD3: An evaluation of a portable microwave multigas analyzer for its efficacy in measuring air contaminants in a workplace environment is presented. The evaluation focused on portability for field use; and versatility for several compounds including acetonitrile (75058), acetaldehyde (75070), acetone (67641), carbonyl-sulfide (468581), ethanol (64175), ethylene-oxide (75218), isopropanol (67630), methanol (67561), propylene-oxide (75569), and sulfur-dioxide (7446095) stability of measurement; simplicity of use. The authors conclude that versatility and simplicity of operation were adequate, but stability and portability were not. They suggest a program for improvement. Technical rept.,

Brewer, D. A. and J. Hall (1987). "A simulation model for the analysis of space station gas-phase trace contaminants." Acta Astronaut **15**(8): 527-544.

RRM HUMAN CABIN AIR ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM
NASA SPACE STATION REFERENCE CONFIGURATION CHEMICAL REACTIONS

Brown, K. A. and J. Bell (1986). "Vegetation: the missing sink in the global cycle of carbonyl sulfide." Atmos Environ **20**(3): 537-540.

It has been suggested that carbonyl sulphide (COS) represents the major form of atmospheric sulphur on a global scale, and that oxidation of COS in the stratosphere may affect the climate by influencing the formation of the sulphate aerosol layer. Despite the apparent importance of COS to the global

environment, considerable uncertainties remain as to its pathways in the atmosphere, particularly in regard to its sinks. In this paper, we review evidence from studies on deposition of COS to plants which provides preliminary confirmation of the hypothesis that uptake of COS by vegetation may be the major global sink for the gas, accounting for 2-5 Tg y⁻¹ (Tg = 10¹² g). In contrast, uptake by soil can account for a maximum of only 0.04 Tg y⁻¹. Confirmation of these estimates must await measurements of COS flux to vegetation representative of the major biomes of the world.

Bruner, F., P. Ciccioli, et al. (1976). "Analysis of sulphur compounds in environmental samples with specific detection and selective columns." Journal of Chromatography, Vol.120, No.1, Pages 200-202, 6 References, 1976: -.

Improvements in column technology and the use of a double detection system are briefly reported for the detection of carbonyl-sulfide (CoS), carbon-disulfide (75150) (CS₂), and sulfur-hexafluoride (SF₆). Improvements include coating of graphitized carbon (carbopack b) with various amounts of ortho-phosphoric-acid (H₃-PO₄) and Xe-60 to improve selectivity. The main use of H₃-PO₄ is to deactivate the adsorbent in order to obtain linear elution of sulfur-dioxide (7446095) (SO₂) and hydrogen-sulfide (7783064) (H₂S). Xe-60 acts as a deactivant of CH₃-SH and SO₂, but retains SF₆ and CoS, thus making possible the separation of H₂-S and SF₆. Both a flame ionization detector (FID) and a FPD (sulfur mode) detector are used. Improvements in previous methods, especially in the rapid identification of sulfur compounds in complex mixtures is shown in a chromatogram of a organic extract from lowland river water. Double detection of anthracene and phenanthrene with FID and dibenzothiophen with FPD is illustrated.

Bruner, F., P. Ciccioli, et al. (1974). "Use of graphitized carbon black in environmental analysis." Journal of Chromatography, Vol.99, Pages 661-672, 28 References, 1974: -.

Ab - the Use of Graphitized Carbon-Black (1333864) as a Gas Chromatographic Material and Air Sampling Adsorbent Was Examined. The Gas Chromatographic Column Used for the Analysis of Sulfur Containing Gases Was Packed With Graphitized Carbon-Black. Various Organic Compounds Were Analyzed in Air With a Column of Coated Carbopack. A New Type of Graphitized Carbon-Black Was Used for the Separation of High Boiling Compounds. By Using Carbopack a and Temperature Programming, Sulfur Compounds From Hydrogen-Sulfide (7783064), Carbonyl-Sulfide (463581), and Sulfur-Dioxide (7446095) up to Pentanethiol and Thiophenes Were Successfully Separated. Graphitized Carbon-Black Was Also Successfully Used as an Adsorbent to Determine Olefins in Air. Trapping Efficiency Was Near 100 Percent. The Authors Conclude That Graphitized Carbon-Black Has Many Applications in Environmental Analysis. Its Use as a General Stationary Phase Makes This Material Most Useful in the Analysis of Completely Unknown and Heterogenous Mixtures. Its Major Characteristics as a Sampling Adsorbent Are Blanks Are Practically Absent and, Owing to Its Thermal Stability, the Same Trap Can Be Used for an Unlimited Number of Sampling Operations.

Cao and Zhuang (1996). "Emission factors of trace ocs from crop residues burning and estimation its amount in china." Huanjing Kexue **17**(1): 34-36.

A method of sampling and analysis for trace carbonyl sulfide has been described. The sample is trapped and concentrated at temperature of liquid N₂ and liberated directly into a gas chromatographic column. The concentration of OCS in compressed air as determined as 2.94. The method accuracy expressed in term of standard deviation coefficient is | 0.72%. The emission factors of carbonyl sulfide, which were measured during the combustion of rice straws, maize stalks and wheat stalks in an enclosed combustion system, are 1.80, 2.75 and 2.05 g/t for rice straws, maize stalks, and wheat stalks, individual. Standard deviation coefficient are | 6.67%, | 8.36%, and 9.27% for rice straws, maize stalks, and wheat stalks, respectively. Distribution of the amount of crop residues burned in China is presented with a resolution 1° latitude 1° longitude. The amount of trace OCS could be calculated with their emission factors.

Chadwick, M. J., N. H. Highton, et al. (1987). "Environmental impacts of coal mining and utilization a complete revision of environmental implications of expanded coal utilization." Chadwick, M.J., N.H. Highton and N.Lindman (Ed.). Environmental Impacts of Coal Mining and Utilization: a Complete Revision of Environmental Implications of Expanded Coal Utilization. Xxv+332p. Pergamon Books, Inc.: Elmsford, New York, Usa **Pergamon Press: Oxford, England, Uk. Illus. Isbn 0-08-031427-9.; 0(0): Xxv+332p-**.

RRM BOOK ECONOMICS EMISSIONS LAND RECLAMATION COMBUSTION WASTE MANAGEMENT SOIL TREATMENT CONVERSION WATER REQUIREMENTS GEOGRAPHY TRACE ELEMENTS TRANSPORTATION CARCINOGENS MODELS POLYCYCLIC AROMATIC HYDROCARBONS

Chamberland, A. M. and J. M. Gauthier (1977). "Sensing sulfur oxides and other sulfur bearing pollutants with solid electrolyte pellets: i. Gas concentration cells." Atmos Environ; 11 (3).1977 257-262: -.

HEEP COPYRIGHT: BIOL ABS. A new sensing technique using a solid electrolyte was demonstrated for S-bearing pollutants. Based on potentiometric measurements across a pellet of potassium sulfate, this sensor allows concentrations of sulfur dioxides, sulfur trioxide, hydrogen sulfide, methyl mercaptan and carbonyl sulfide in air to be measured with accuracy. Its operational concentration range at the present time is 0.1 ppm up to at least 10,000 ppm. The presence of other common pollutants such as carbon dioxide, methane, nitric oxide and nitrogen dioxide does not interfere with the measurement of air samples containing S-bearing pollutants.

Chavez, C., C. D. Coufal, et al. (2004/6). "The impact of supplemental dietary methionine sources on volatile compound concentrations in broiler excreta." Poult Sci **83(6):** 901-10.

The impact of different Met sources on broiler fecal odor volatiles was determined by evaluating the types of sulfur compounds produced in broiler excreta. Two experiments were conducted using straight-run broiler chicks randomly distributed in battery cages, with 3 replicate pens of 16 birds each. The treatment groups were 1) dry Met hydroxy analogue (dry MetHA), 2) sodium methioninate aqueous solution (NaMet), 3) liquid Met hydroxy analogue (Liq MetHA), 4) D,L- Met, and 5) no supplemental

Met (control group). The Met activities of each Met source were 52, 45.9, 88, and 98%, respectively. All diets were formulated to contain either 0.8% (experiment 1) total Met activity or 0.5% Met activity in the starter and 0.38% Met activity in the grower (experiment 2) (except the control group, 0.35% Met activity), but otherwise met NRC nutrient requirements (NRC, 1994). Diets were fed ad libitum from d 1 to 6 wk of age. There were no significant differences in BW among the treatments. All excreta were collected in litter pans lined with aluminum foil. In experiment 1, at wk 6, broiler excreta were collected for a 24-h period, and 4.5 g of broiler excreta from each treatment group was collected into 15-mL headspace vials. Samples were analyzed by gas chromatography/mass spectrometry (GC/MS). The volatile sulfur compounds that were identified and quantified in the broiler excreta were H₂S, carbonyl sulfide (COS), methyl mercaptan (CH₃SH), dimethyl disulfide (CH₃SSCH₃), and dimethyl trisulfide (CH₃SSSCH₃). The NaMet treatment group had significantly higher concentrations of H₂S, COS, and CH₃SSCH₃ compared with all other treatment groups. The Liq MetHA group had significantly lower concentrations of H₂S, COS, CH₃SH, and CH₃SSCH₃ compared with the other treatment groups. The dry MetHA group significantly had the highest concentration of CH₄SH. The D,L-Met treatment group had the significantly highest concentration of CH₃SSSCH₃ and the lowest concentration of H₂S. The control group had the significantly lowest concentrations of CH₃SH, CH₃SSCH₃, and CH₃SSSCH₃ compared with the other treatment groups. In experiment 2, at wk 6, an electronic nose was used to evaluate 15 air samples per treatment group. In addition, 15 air samples (containing 6 to 8 L of air in a Tedlar bag, 3 samples per treatment group) were collected for odor evaluation by a sensory panel. Electronic nose sensor data revealed that volatile compounds in broiler excreta from the control group were significantly different from the other 4 treatment groups. Evaluation of the air samples by a sensory panel determined that there was a statistically significant difference in odor threshold detection between the control group and the other treatment groups. The dilutions to threshold of control group, NaMet, dry MetHA, Liq MetHA, and D,L-Met were 350, 492, 568, 496, and 526 odor units, respectively. These findings demonstrate that dietary Met sources significantly influenced odorous volatile concentrations in broiler excreta.

Chavez, C. R. A., C. D. R. A. Coufal, et al. "Influence of dietary methionine source on volatile sulfur compounds in broiler excreta." Poultry Science, (2002) Vol.81, No.Supplement 1, pp.53.print.Meeting Info.: 91st Annual Meeting of the Poultry Science Association.Newark, DE, USA.August 08-11, 2002. Southern Poultry Science Society.CODEN: POSCAL.ISSN: 0032-5791.: -.

Chemical, D. (1981). "[TSCATS] Initial Submission: Acute inhalation toxicity of carbon oxide sulfide in rats with cover letter dated 081092 (Old document number 8EHQ-0992-10971, New document number 88-920009259)." selected pages-.

Chen, L., T. R. Thompson, et al. (1996/9/20). "Synthetic, Mechanistic, and Structural Studies Related to 1,2,4-Dithiazolidine-3,5-dione." J Org Chem **61**(19): 6639-6645.

Reaction of O-ethyl thiocarbamate (4) with (chlorocarbonyl)sulfonyl chloride (5) gives 3-ethoxy-1,2,4-dithiazolin-5-one (2) and 3,5-diethoxy-1,2,4-thiadiazole (3), with the relative amounts of 2 and 3 formed depending very much on the solvent (e.g., diethyl ether favors 2; chloroform favors 3). The effects of added base, order of addition, concentration, and temperature were also studied. Mechanisms for the

observed transformations have been proposed and are supported by the characterization of relatively unstable acyclic intermediates, e.g., formimidoyl(chlorocarbonyl)disulfane 8, symmetrical bis (formimidoyl)disulfane 10, and ethoxythiocarbonyl imidate 11, which are obtained under alternative conditions. Compound 2 is converted with concentrated aqueous hydrochloric acid upon short reflux to 1,2,4-dithiazolidine-3,5-dione (1), rearranges upon prolonged melting to give principally N-ethyl-1,2,4-dithiazolidine-3,5-dione (13), and is desulfurized with various trivalent phosphorus compounds to yield O-ethyl cyanate (15) plus carbonyl sulfide. X-ray crystallographic structures of 1 and 2 have been solved; the planarity and aromatic character of these molecules help to explain some of their reactions.

Chen, Y. S. and J. E. Casida (1978). "Thiocarbamate herbicide metabolism: microsomal oxygenase metabolism of eptc involving mono- and dioxygenation at the sulfur and hydroxylation at each alkyl carbon." J.Agric.Food Chem.26(1): 263-267 1978 (11 References): -.

PESTAB. Metabolism of S-ethyl dipropylthiocarbamate (EPTC) by the mouse microsomal-NADPH system involves oxidative attack at the following sites in decreasing relative importance: sulfur alpha carbon of ethyl group alpha carbon of propyl group, beta carbon of propyl group, gamma carbon of propyl group, and beta carbon of ethyl group. The metabolites hydroxylated at the carbons alpha to the nitrogen and sulfur decompose at physiological pH, yielding S-ethyl N-propylthiocarbamate (N-depropyl-EPTC) in the former case and carbonyl sulfide and acetaldehyde from the latter compound. [14C]EPTC sulfoxide is further oxidized to [14C]EPTC sulfone which is most easily detected with microsomal preparations pretreated with unlabeled EPTC sulfone to block protein sites undergoing carbamoylation. These findings are consistent with previous studies on in vivo metabolism of EPTC in mammals which indicate major involvement of the sulfoxide intermediate and further suggest that hydroxylation of the carbon alpha to the sulfur is an important mechanism for thiocarbamate cleavage. (Author abstract reprinted by permission of the American Chemical Society)

Chen, Y. S., I. Schuphan, et al. (1979). "S-chloroallyl thiocarbamate herbicides: mouse hepatic microsomal oxygenase and rat metabolism of cis- and trans-[14C=O] diallate." J.Agric.Food Chem.27(4): 709-712 1979 (19 References): -.

PESTAB. Mouse hepatic microsomes metabolizes cis- and trans-[14C=O]diallate [S-(2,3-dichloroallyl) diisopropylthiocarbamate] in a NADPH-dependent reaction, yielding primarily 14CO₂ in the absence of glutathion (GSH) and 14CO₂ and S-(diisopropylcarbamoyl)-GSH in the presence of GSH. Although not detected, sulfoxides of the diallate isomers are likely intermediates in these reactions on analogy with previous studies on S-alkyl and S-benzyl thiocarbamates. Sulfoxides of the diallate isomers are more reactive and thermally unstable than other known thiocarbamate sulfoxides. The finding of carbonyl sulfide as an in vitro metabolite suggests that alpha-carbon hydroxylation of the 2,3-dichloroallyl group is an additional pathway for diallate degradation. Rats administered either diallate isomer excrete the S-diisopropylcarbamoyl derivatives of mercapturic acid (62%), cysteine (7%), and mercaptoacetic acid (1.5%) in addition to 14CO₂ (20%). The principal metabolic pathway in rats appears to involve sulfoxidation, nonenzymatic reaction of the sulfoxide with GSH, and mercapturic acid formation. (Author abstract reprinted by permission of the American Chemical Society).

Chengelis, C. P. and R. A. Neal (1979). "Carbon di sulfide and carbonyl sulfide metabolism in isolated hepatocytes." 18th Annual Meeting of the Society of Toxicology, New Orleans, La., Usa, Mar.11-15, 1979.Toxicol Appl Pharmacol **48**(1 Part 2): A11-.

HEEP COPYRIGHT: BIOL ABS. ABSTRACT RAT HEPATO TOXICITY

Chengelis, C. P. and R. A. Neal (1980). "Carbonyl sulfide toxicity: metabolism by carbonic anhydrase." Toxicol Appl Pharmacol **55**(1): 198-202.

HEEP COPYRIGHT: BIOL ABS. Carbonyl sulfide (COS) (an industrial by-product) is acutely toxic to rats, with an LD50 of 22.5 mg/kg, i.p. COS is partly metabolized in vivo to H₂S. Pretreatment of rats with acetazolamide, an inhibitor of carbonic anhydrase, reduced the blood levels of H₂S and, concomitantly, decreased the toxicity of COS. NaNO₂ pretreatment also protected animals against COS toxicity. Acetazolamide had no effect on H₂S toxicity per se. COS is evidently metabolized to H₂S by carbonic anhydrase. It is the H₂S produced that is responsible for COS toxicity.

Chengelis, C. P. and R. A. Neal (1979/10/12). "Hepatic carbonyl sulfide metabolism." Biochem Biophys Res Commun **90**(3): 993-9.

Chengelis, C. P. and R. A. Neal (1979). "Hepatic carbonyl sulfide metabolism." Biochemical and Biophysical Research Communications, Vol.90, No.3, Pages 993-999, 17 References, 1979: -.

Hepatic carbonyl-sulfide (463581) metabolism was studied in-vitro. Hepatocytes prepared from adult male Sprague-Dawley-rats were incubated with carbon-14 or sulfur-35 labeled carbonyl-sulfide in the presence or absence of 2-diethylaminoethyl-2,2-diphenylvalerate (62680) (SKF-525A), 4-methylpyrazole (7554656), metyrapone (54364), acetazolamine, or carbon-disulfide (75150). The rate of metabolism was measured by determining the rate of disappearance of carbonyl-sulfide before or after acidification with trichloroacetic-acid. Rat hepatocytes were fractionated and the fractions were incubated with sulfur-35 labeled carbonyl-sulfide. The rate of metabolism was measured by determining the rate of formation of radioactive nonvolatile sulfur compounds. Carbonyl-sulfide was rapidly metabolized by rat hepatocytes. The rate of carbonyl-sulfide disappearance after acidification was nearly equal to the rate of formation of radiolabeled carbon-dioxide from carbon-14 labeled carbonyl-sulfide plus the rate of formation of nonvolatile sulfur from sulfur-35 labeled carbonyl-sulfide. Carbonyl-sulfide metabolism was inhibited by acetazolamine, but not by SKF-525A, 4-methylpyrazole, metyrapone, or carbon-disulfide. Most of the hepatic carbonyl-sulfide metabolizing activity was found in the cytosol. The metabolism of carbonyl-sulfide by bovine erythrocyte carbonic-anhydrase in the presence or absence of acetazolamine and before or after heating was also investigated. Carbonyl-sulfide was metabolized by carbonic-anhydrase producing hydrogen-sulfide (7783064) and thiosulfate (26041178). Acetazolamine and heat significantly inhibited carbonyl-sulfide metabolism. The authors propose that carbonic-anhydrase is the enzyme primarily responsible for rat hepatic carbonyl-sulfide metabolism.

Chengelis, C. P. and R. A. Neal (1979). "Hepatic carbonyl sulfide metabolism." Biochem Biophys Res

HEEP COPYRIGHT: BIOL ABS. Carbonyl sulfide (COS) (an industrial waste gas) is rapidly metabolized by isolated rat hepatocytes, as determined by COS disappearance. Upon termination of the reaction by acidification much of the metabolized COS reappears in the headspace of the reaction vessel. The COS disappearance when determined after acidification is equal to the formation of CO₂ and an inorganic S-containing compound(s). The metabolism of COS by hepatocytes is inhibited by acetazolamine but not by CS₂ or inhibitors of the cytochrome P-450 containing monooxygenase system. Upon subcellular fractionation, the majority of hepatic COS metabolizing activity is found in the cytosol. Additional experiments with a partially purified enzyme indicate that COS is a substrate for hepatic carbonic anhydrase.

Chengelis, C. P. and R. A. Neal (1987). "Oxidative metabolism of carbon disulfide by isolated rat hepatocytes and microsomes." Biochem Pharmacol **36**(3): 363-368.

RRM HEPATOTOXICITY CARBON DIOXIDE HYDROGEN SULFIDE CARBONYL SULFIDE MONOTHIOCARBONATE CYTOCHROME P-450-CONTAINING MONOOXYGENASE

Chengelis, C. P. and R. A. Neal (1987). "Oxidative metabolism of carbon disulfide by isolated rat hepatocytes and microsomes." Biochemical Pharmacology, Vol.36, No.3, Pages 363-368, 23
References, 1987: -.

In an attempt to further define the mechanisms involved in carbon-disulfide (75150) (CS₂) metabolism, the relationship between CS₂ and carbonyl-sulfide (463581) (COS) metabolism was explored in male Sprague-Dawley-rat hepatocytes and liver microsomes. Pretreatment of animals with cobaltous-chloride (7646799) or phenobarbital (50066) decreased or increased, respectively, the extent of CS₂ metabolism by hepatic microsomes, as determined by the formation of COS and nonvolatile sulfur compounds. The effects on carbon-dioxide (CO₂) formation followed the same trend, but were not as marked. Microsomal cytochrome-P-450 concentrations of 0.47 and 2.1 nanomoles/milligram protein were observed following cobaltous-chloride and phenobarbital treatments, respectively, compared to control concentrations of 1.2 nanomoles/milligram protein. CS₂ metabolism in microsomes was biphasic in that there was an initial period of rapid metabolite formation followed by a period of slower metabolism. CS₂ metabolism in hepatocytes was biphasic as well. In microsomal incubations, the quantities of nonvolatile sulfur products were always less than the quantities of volatile products. SKF-525A significantly inhibited CS₂ metabolism in hepatocytes and microsomes from phenobarbital treated rats. Acetazolamide did not significantly inhibit CS₂ metabolism regardless of the metabolite studied. The addition of dialyzed cytosol to microsomal incubations containing CS₂ led to an increase in CO₂ formation at the expense of COS. The authors conclude that CS₂ is oxidized in rat liver predominantly by the cytochrome-P-450 containing monooxygenase system, and the product of this reaction is an unstable intermediate which reacts with water to form monothiocarbonate and a reactive sulfur species. In solution, monothiocarbonate exists in equilibrium with and can be dehydrated to form COS. However, in intact hepatocytes, monothiocarbonate is further metabolized to CO₂ and hydrogen-

disulfide, and subsequently to thiosulfate and sulfate. Evidence indicates that the two sulfur atoms of CS₂ are oxidized to sulfate by two distinct pathways.

Chhonkar, P. K. and D. Rao (1996). "Soil biology and biochemistry in relation to land degradation and environmental pollution." Biswas, T.D. And G.Narayanasamy (Ed.). Indian Society of Soil Science Bulletin, No.17. Soil Management in Relation to Land Degradation and Environment Symposium, Dehradun, India, October 8-9, 1993. Ii+167p. Indian Society of Soil Science: New Delhi, India.; 0 (0): 133-147.

RRM BOOK CHAPTER MEETING PAPER RICE BACTERIA ORGANISMS SOIL CONTAMINATION POLLUTION PESTICIDES BIOLOGICAL DEGRADATION CHEMICAL DEGRADATION ACID MINE SPOILS BIOREMEDIATION GASEOUS EMISSIONS NITROUS OXIDE METHANE INDIA

Chin, M. and D. D. Davis (1993). "Global sources and sinks of carbonyl sulfide and carbon disulfide and their distributions." Global Biogeochem Cycles 7(2): 321-337.

This study investigates the distribution and magnitudes of the global sources and sinks of OCS and CS₂. From an analysis of the correlations between measured emission rates and environmental parameters, the sources of OCS and CS₂ are estimated to be 1.23 (0.83-1.71) Tg(OCS) yr⁻¹ and 0.57 (0.34-0.82) Tg (CS₂) yr⁻¹, respectively. Our results indicate that 30% of the atmospheric OCS source is derived from the oxidation of CS₂, while emissions from the ocean and other natural terrestrial sources contribute 28% and 24%, respectively. In the case of CS₂, the major source is from chemical industrial emissions (58%) while the ocean contributes about 34% to the total CS₂ source. Our estimate of the OCS and CS₂ emission rates suggests that anthropogenic activities contribute approximately 32% to the total OCS source. The major sink for CS₂ is oxidation by tropospheric OH, whereas, that for OCS appears to be uptake by vegetation.

Chu, S. and S. Elliott (2000). "Eddy resolving nutrient ecodynamics in the global parallel ocean program and connections with trace gases in the sulfur, halogen and nmhc cycles." Govt Reports Announcements & Index (Gra&I), Issue 25, 2001: -.

Ecodynamics and the sea-air transfer of climate relevant trace gases are intimately coupled in the oceanic mixed layer. Ventilation of species such as dimethyl sulfide and methyl bromide constitutes a key linkage within the earth system. We are creating a research tool for the study of marine trace gas distributions by implementing coupled ecology-gas chemistry in the high resolution Parallel Ocean Program (POP). The fundamental circulation model is eddy resolving, with cell sizes averaging 0.15 degree (lat/long). Here we describe ecochemistry integration. Density dependent mortality and iron geochemistry have enhanced agreement with chlorophyll measurements. Indications are that dimethyl sulfide production rates must be adjusted for latitude dependence to match recent compilations. This may reflect the need for phytoplankton to conserve nitrogen by favoring sulfurous osmolytes. Global simulations are also available for carbonyl sulfide, the methyl halides and for nonmethane hydrocarbons.

We discuss futur

Cm, G., M. Y. (Reprint), et al. "Carbonyl sulfide and dimethyl sulfide exchange between trees and the atmosphere." ATMOSPHERIC ENVIRONMENT: <2006: <VO1>40: <IS1>N7: <IS2>MAR: <PG1>1373-1383: -.

The exchange rates of carbonyl sulfide (cos) and dimethyl sulfide (dms) between 19 tree species and the atmosphere were investigated under natural field conditions using a static enclosure. Most of the investigated trees acted as sinks for atmospheric cos and a few trees, such as salix matsudana koidz. And ulmus pumila l. Could emit cos. The distinct diurnal variations of cos uptake for the investigated trees indicated that cos uptake strongly depended on photosynthetically active radiation (par). The average cos uptake rates for most species were much higher in summer than in autumn, indicating leaf age and temperature also might be the important influencing factors for cos uptake. Platanus orientalis l., Sophara japonica var. P. Loud., Magnolia denudata desr. And sophora japonica l. Were capable of continuously absorbing cos in daytime as well as in nighttime. For platanus orientalis l., The maximal cos uptake rate and dms emission rate on a single leaf area basis were -15.29 And 0.42 Pmol m⁽⁻¹⁾ s⁽⁻¹⁾, respectively. The cos exchange fluxes for the investigated tree species depended strongly on the ambient cos mixing ratios. Significant correlation between dms emissions and temperature was observed in summer. (C) 2005 elsevier ltd. All rights reserved.

Co., M. (1985). "[TSCATS] Initial Submission: Two week study with carbonyl sulfide administered by inhalation to rats with cover letter dated 052892 [Old document number 8EHQ-0692-4757; New document number 88-920003400]." selected pages-.

Co., M. A. (1985). "[TSCATS] Initial Submission: Acute toxicity of carbon oxysulfide administered by inhalation to male and female Sprague-Dawley rats (final report) with attachments and letter dated 112791 [Old document number 8EHQ-1291-1723; New document number 88-920000368]." selected pages-.

Colon, M., W. A. McClenny, et al. (1995). "Field study results for vocs with the perkin-elmer sequential tube sampler." Govt Reports Announcements & Index (Gra&I), Issue 22, 1995: -.

TD3: Two Perkin-Elmer Sequential Tube Samplers (Model STS-25) were evaluated for their performance, portability, and convenience of operation. Results obtained from both samplers and from a collocated Summa-polished stainless steel canister were compared for seven 3-h periods at three sites. Special attention was given to the monitoring of carbonyl sulfide and carbon disulfide. Advantages for the use of the STS-25 are low cost, portability, ease of use, and a design suitable for obtaining sub-part-per billion detection limits with a standard analytical finish. Disadvantages are that it is a one-shot technique and no universal solid absorbent material exists. Interim rept. Prepared in cooperation with ManTech Environmental Technology, Inc., Research Triangle Park, NC.

Confer, R. G. and R. S. Brief (1975/11). "A simple method for the measurement of carbonyl sulfide in

the presence of hydrogen sulphide." Am Ind Hyg Assoc J **36**(11): 843-4.

Conrad, R. (1996/12). "Soil microorganisms as controllers of atmospheric trace gases (H₂, CO, CH₄, OCS, N₂O, and NO)." Microbiol Rev **60**(4): 609-40.

Production and consumption processes in soils contribute to the global cycles of many trace gases (CH₄, CO, OCS, H₂, N₂O, and NO) that are relevant for atmospheric chemistry and climate. Soil microbial processes contribute substantially to the budgets of atmospheric trace gases. The flux of trace gases between soil and atmosphere is usually the result of simultaneously operating production and consumption processes in soil: The relevant processes are not yet proven with absolute certainty, but the following are likely for trace gas consumption: H₂ oxidation by abiotic soil enzymes; CO cooxidation by the ammonium monooxygenase of nitrifying bacteria; CH₄ oxidation by unknown methanotrophic bacteria that utilize CH₄ for growth; OCS hydrolysis by bacteria containing carbonic anhydrase; N₂O reduction to N₂ by denitrifying bacteria; NO consumption by either reduction to N₂O in denitrifiers or oxidation to nitrate in heterotrophic bacteria. Wetland soils, in contrast to upland soils are generally anoxic and thus support the production of trace gases (H₂, CO, CH₄, N₂O, and NO) by anaerobic bacteria such as fermenters, methanogens, acetogens, sulfate reducers, and denitrifiers. Methane is the dominant gaseous product of anaerobic degradation of organic matter and is released into the atmosphere, whereas the other trace gases are only intermediates, which are mostly cycled within the anoxic habitat. A significant percentage of the produced methane is oxidized by methanotrophic bacteria at anoxic-oxic interfaces such as the soil surface and the root surface of aquatic plants that serve as conduits for O₂ transport into and CH₄ transport out of the wetland soils. The dominant production processes in upland soils are different from those in wetland soils and include H₂ production by biological N₂ fixation, CO production by chemical decomposition of soil organic matter, and NO and N₂O production by nitrification and denitrification. The processes responsible for CH₄ production in upland soils are completely unclear, as are the OCS production processes in general. A problem for future research is the attribution of trace gas metabolic processes not only to functional groups of microorganisms but also to particular taxa. Thus, it is completely unclear how important microbial diversity is for the control of trace gas flux at the ecosystem level. However, different microbial communities may be part of the reason for differences in trace gas metabolism, e.g., effects of nitrogen fertilizers on CH₄ uptake by soil; decrease of CH₄ production with decreasing temperature; or different rates and modes of NO and N₂O production in different soils and under different conditions.

Cox, R. A. (1997). "Atmospheric sulphur and climate-what have we learned?" Philosophical Transactions of the Royal Society of London B Biological Sciences **352**(1350): 251-254.

RRM MEETING REPORT SULFUR ATMOSPHERIC CLIMATOLOGY GLOBAL CLIMATE CHANGE CARBON DIOXIDE CLOUD CONDENSATION NUCLEI GLOBAL WARMING

Cox, R. A. and D. Sheppard (1980). "Reactions of hydroxyl radicals with gaseous sulfur compounds." Nature (Lond) **284**(5754): 330-331.

Cronn, D. R. and W. Nutmagul (1982). "Volcanic gases in the april 1979 soufriere (volcano, st vincent, west indies) eruption." Science (Wash D C) **216**(4550): 1121-1123.

HEEP COPYRIGHT: BIOL ABS. Six gas samples from the April 17, 1979 Soufriere eruption plume were analyzed for carbonyl sulfide, CS₂, CO, CO₂, CH₄, N₂O, fluorocarbon-11, fluorocarbon-12, methyl chloroform and CCl₄. Only CO, CO₂, carbonyl sulfide and CS₂ had increased mixing ratios as compared with those in clean tropospheric air, but the increases were not sufficient to contribute greatly to the global budgets of these 4 components.

Crookes, M. J., J. Diment, et al. (1993). "Environmental hazard assessment: carbon disulphide." Toxic Substances Division. Department of the Environment, London Vol:Tsd/14 (1993) 41 P: -.

Properties: Carbon disulphide is a highly volatile, highly flammable, colourless liquid. The main use of carbon disulphide is in the manufacture of viscose fibres and cellophane film from cellulose. It is also used as an intermediate in the rubber industry. Environmental fate: The major sink for carbon disulphide appears to be the atmosphere. The oceans and soils tend to act as biogenic sources of carbon disulphide to the atmosphere. Degradation of carbon disulphide occurs in the troposphere due to a combination of photooxidation reactions of carbon disulphide and the reactions of carbon disulphide with hydroxyl radicals. The lifetime of carbon disulphide in the atmosphere is estimated to be around 2 weeks. This value is consistent with the measured atmospheric levels of carbon disulphide, from which Bandy et al (1981) estimated an atmospheric residence time of around 10 days. The products from the atmospheric degradation reactions include carbonyl sulphide and sulphur dioxide. Carbon disulphide, on a global scale, is thought to be a significant source of carbonyl sulphide. Very little information is available on the biodegradation of carbon disulphide. A strain of *Thiobacillus thioparus* has been shown to oxidise carbon disulphide under aerobic conditions. No experimental data are available on the bioaccumulation of carbon disulphide. The low octanol- water partition coefficient for carbon disulphide ($\log K_{ow}=1.84$) indicates that carbon disulphide is unlikely to biomagnify through the aquatic food chain. Aquatic toxicity: Little information appears to be available regarding the toxicity of carbon disulfide to aquatic organisms. The results available indicate that carbon disulphide is of low to moderate toxicity to fish. The lowest value reported was a 96h LC₅₀ of 4 mg/l for the guppy (*Poecilia reticulata*). The lowest acute toxicity value found for other aquatic organism was a 48h LC₅₀ value of 2,1 mg/l for *Daphnia magna*. The 96h EC₅₀ for the green alga (*Chlorella pyrenoidosa*) was determined as 21 mg/l. An EC₅₀ value of 341 mg/l was determined for *Photobacterium phosphoreum* in a 3 hour Microtox test. Due to the high volatility of carbon disulphide, care must be taken in interpreting the results of the aquatic toxicity tests. (Shortened)

Crutzen, P. J. and G. R. Carmichael (1993). "Modeling the influence of fires on atmospheric chemistry." Crutzen, P.J. And J.G. Goldammer (Ed.). Environmental Sciences Research Report, 13. Fire in the Environment: the Ecological, Atmospheric, and Climatic Importance of Vegetation Fires. Xv+400p. John Wiley and Sons, Inc.: New York, New York, Usa Chichester, England, Uk. Isbn 0-471-93604-9; 0(0):

RRM BOOK CHAPTER BIOMASS CARBON MONOXIDE METHANE HYDROGEN METHYL CHLORIDE NITRIC OXIDE HYDROGEN CYANIDE METHYL CYANIDE PHOTOCHEMISTRY HYDROXIDE OZONE PEROXIDES ALDEHYDES ORGANIC ACIDS

Crutzen, P. J., M. T. Coffey, et al. (1985). "Observations of air composition in Brazil between the equator and 20 degrees south during the dry season." *Acta Amazonica* **15**(1-2): 77-120.

RRM CERRADO FOREST GAS POLLUTION EMISSION BURNING CLIMATE OZONE HYDROCARBON CONCENTRATION

Crutzen, P. J., L. E. Heidt, et al. (1979). "Biomass burning as a source of atmospheric gases carbon monoxide, hydrogen, nitrous oxide, nitric oxide, methyl chloride and carbonyl sulfide." *Nature (Lond)* **282**(5736): 253-256.

HEEP COPYRIGHT: BIOL ABS. Forest burning can contribute extensively to the budgets of several important atmospheric gases: CO, H₂, N₂O, NO, CH₃Cl and COS. In several cases the emission is comparable to the technological source. Most burning takes place in the tropics in the dry season and is caused by man's activities.

Culcasi, M. R. A., A. Muller, et al. "Early specific free radical-related cytotoxicity of gas phase cigarette smoke and its paradoxical temporary inhibition by tar - an electron paramagnetic resonance study with the spin trap depmpo." *Chemico-Biological Interactions*, (DEC 15 2006) Vol.164, No.3, pp.215-231. CODEN: CBINA8.ISSN: 0009-2797.: -.

Electron paramagnetic resonance (EPR) spin trapping studies demonstrated aqueous tar particulate matter (TPM) and gas phase cigarette smoke (GPCS) to behave as different sources of free radicals in cigarette smoke (CS) but their cytotoxic implications have been only assessed in CS due to its relevance to the natural smoking process. Using a sensitive spin trapping detection with 5-(diethoxyphosphoryl)-5-methyl-1-pyrroline-N-oxide (DEPMPO), this study compared the respective roles of CS- and GPCS-derived free radicals on smoke-induced cytotoxicity and lipid peroxidation of filtered and unfiltered, machine-smoked experimental and reference cigarettes yielding a wide range of TPM yields. In buffer bubbled with CS the DEPMPO/superoxide spin adduct was the major detected nitroxide. Use of appropriate control experiments with nitric oxide radical (NO center dot) or carbonyl sulfide, and a computer analysis of spin adduct diastereoisomery showed that the hydroxyl radical (HO center dot) adduct of DEPMPO seen in GPCS-bubbled was rather related to metal-catalyzed nucleophilic synthesis than to direct HO center dot trapping. Unexpectedly a protective effect of TPM on murine 3T3 fibroblasts was observed in early (< 3 h) free radical-, GPCS-induced cell death, and carbon filtering decreased free radical formation, toxicity and lipid peroxidation in three cell lines (including human epithelial lung cells) challenged with GPCS. These results highlight an acute, free radical-dependent, harmful mechanism specific to the GPCS phase, possibly involving NO center dot chemistry, whose

physical or chemical control may be of great interest with the aim of reducing the toxicity of smoke. (c) 2006 Elsevier Ireland Ltd. All rights reserved.

Dalvi, R. R., A. L. HUNTER, et al. (1975/5). "Toxicological implications of the mixed-function oxidase catalyzed metabolism of carbon disulfide." Chem Biol Interact **10**(5): 347-61.

The results of these studies have indicated that the decrease in the activity of the hepatic mixed-function oxidase enzyme system and the concentration of cytochrome P-450 seen on incubation of carbon disulfide (CS₂) with rat liver microsomes in the presence of NADPH is the result of the binding of the sulfur atom released in the mixed-function oxidase catalyzed metabolism of CS₂ to carbonyl sulfide (COS). Moreover, it appears that COS is further metabolized by the mixed-function oxidase enzyme system to CO₂ and that, analogous to the metabolism of CS₂ to COS, the sulfur atom released in this reaction also binds to the microsomes and inhibits benzphetamine metabolism and decreases the concentration of cytochrome P-450 detectable as its carbon monoxide complex. The results of these studies also suggest that the decrease in the concentration of cytochrome P-450 and the liver damage seen on in vivo administration of CS₂ to phenobarbital pretreated rats, is due to the mixed-function oxidase catalyzed release and binding of the sulfur atoms of CS₂. The decrease in the concentration of cytochrome P-450 seen on incubation of CS₂ with rat liver microsomes in the presence of NADPH does not appear to be the result of destruction of the heme group or its dissociation from the apoenzyme since the total amount of protoheme is unchanged in microsomes which have been incubated with CS₂ and NADPH as compared to those not incubated with these compounds.

Dalvi, R. R. and R. A. Neal (1978). "Metabolism in vivo of carbon disulfide to carbonyl sulfide and carbon dioxide in the rat." Biochem Pharmacol; 27 (11).1978 1608-1610: -.

HEEP COPYRIGHT: BIOL ABS. CS₂ is metabolized to carbonyl sulfide (COS) by rat hepatic microsomes. The present studies determined if (14C)CS₂, administered in vivo to rats, was also excreted in the breath as (14C)COS. CS₂ is metabolized to COS in vivo. In untreated rats it is the predominant metabolite excreted in the expired air. After treatment with phenobarbital, more of the administered CS₂ is metabolized to COS and CO₂ being the predominant metabolite. This increased rate of metabolism in vivo of CS₂ in phenobarbital-pretreated rats is in agreement with in vitro data showing an increased rate of metabolism of CS₂ to COS using microsomes from phenobarbital-pretreated rats. The in vitro data indicate that the metabolism of CS₂ to CO₂ involves, first, the cytochrome P-450 mono-oxygenase-catalyzed metabolism of CS₂ to COS, followed by metabolism of COS to CO₂ by these same enzyme systems. The present experiments suggest that the same sequence of reactions is operative in vivo.

Dalvi, R. R., R. E. Poore, et al. (1974). "Studies of the metabolism of carbon disulfide by the rat liver microsomes. Au - dalvi rr." Life Sci; 14 (9).1974 1785-1796: -.

HEEP COPYRIGHT: BIOL ABS. Carbon disulfide was studied as a substrate for the hepatic mixed function oxidase enzyme system. These studies showed that carbonyl sulfide was formed when carbon disulfide was incubated with rat liver microsomes in the presence of NADPH. No carbonyl sulfide was

formed in the absence of NADPH. The formation of carbonyl sulfide was inhibited when the reaction was carried out in an atmosphere containing CO. The other product of the reaction leading to carbonyl sulfide formation is probably a highly reactive form of S which binds covalently to the microsomal membrane. A chemical mechanism for the mixed function oxidase catalyzed metabolism of carbon disulfide to carbonyl sulfide was proposed.

Davidovits, P., D. R. Worsnop, et al. (1998). "Measurement of heterogeneous chemical processes relevant to aerosol surfaces and trace gases active in the marine environment. Final report, august 1, 1991 to june 30, 1998." Govt Reports Announcements && Index (Gra&I), Issue 24, 2001: -.

Ocean produced reduced sulfur compounds including dimethylsulfide (DMS), hydrogen sulfide (H₂S), carbon disulfide (CS₂), methyl mercaptan (CH₃SH) and carbonyl sulfide (OCS) deliver a sulfur burden to the atmosphere which is roughly equal to sulfur oxides produced by fossil fuel combustion. These species and their oxidation products dimethyl sulfoxide (DMSO), dimethyl sulfone (DMSO₂) and methane sulfonic acid (MSA) dominate aerosol and CCN production in clean marine air. Furthermore, oxidation of reduced sulfur species will be strongly influenced by NO_x/O₃ chemistry as well as halogen and ammonia chemistry in marine atmospheres. The multiphase chemical processes for these species must be understood in order to study the evolving role of combustion produced sulfur oxides over the oceans.

Davidovits, P., D. W. Worsnop, et al. (1992). "Measurement of gas/water uptake coefficients for trace gases active in the marine environment. (Annual report)." Govt Reports Announcements && Index (Gra&I), Issue 18, 1992: -.

TD3: Ocean produced reduced sulfur compounds including dimethylsulfide (DMS), hydrogen sulfide (H₂S), carbon disulfide (CS₂), methyl mercaptan (CH₃SH) and carbonyl sulfide (OCS) deliver a sulfur burden to the atmosphere which is roughly equal to sulfur oxides produced by fossil fuel combustion. These species and their oxidation products dimethyl sulfoxide (DMSO), dimethyl sulfone (DMSO₂) and methane sulfonic acid (MSA) dominate aerosol and CCN production in clean marine air. Furthermore, oxidation of reduced sulfur species will be strongly influenced by NO_x/O₃ chemistry in marine atmospheres. The multiphase chemical processes for these species must be understood in order to study the evolving role of combustion produced sulfur oxides over the oceans. We have measured the chemical and physical parameters affecting the uptake of reduced sulfur compounds, their oxidation products, ozone, and nitrogen oxides by the ocean's surface, and marine clouds, fogs, and aerosols.

De (1984). "Supelpak-s: the gas chromatographic separating column for sulfur gases." J Chromatogr Sci **22**(10): 470-472.

HEEP COPYRIGHT: BIOL ABS. A gas separating column for resolving a mixture of highly reactive S compounds with a gas chromatographic technique using a flame photometric detector (FPD) was

described. This proven column of specially treated Porapak QS polymer, available as Supelpak-S, is very short and does not have a liquid stationary phase, hence no bleed and no tailing. The column provides high resolution power that enables it to separate more than 14 commonly encountered S compounds, including separation of hydrogen sulfide from carbonyl sulfide. Supelpak-S is unaffected by moisture and other polar molecules usually encountered in stack flue gases, such as those from Kraft pulp and paper manufacture, ore roasting in metallurgy, petroleum refining, natural gas sweetening and wastewater and sewage treatment.

De (1987). "Dedicated automatic gas chromatograph for monitoring sulfur gases." 16th International Symposium on Chromatography, Paris, France, September 21-26, 1986. *J Chromatogr* **395**(0): 413-422.

RRM TOTAL REDUCED SULFUR COMPOUNDS PAPER MANUFACTURE INSTRUMENT DESIGN MICROCOMPUTER

De (1991). "Application of the sorption theory to eliminate heavy metals from waste waters and contaminated soils." Bolt, G.H., Et Al.(Ed.).Nato Asi (Advanced Science Institute) Series Series E Applied Sciences, Vol.190.Interactions at the Soil Colloid - Soil Solution Interface.Xv+603p.Kluwer Academic Publishers: Dordrecht, Netherlands (Dist. In the Usa and Canada by Kluwer Academic Publishers: Norwell, Massachusetts, Usa). Illus. Isbn 0-7923-1066-7.; 0(0): 293-320.

RRM REVIEW WASTEWATER SORBENT PRECIPITATION ALUMINOSILICATES ADSORPTION

De Souza, T. L. C. (1987). "Dedicated, automatic gas chromatograph for monitoring sulphur gases." Journal of Chromatography, Vol.395, Pages 413-422, 13 References, 19871987: -.

A newly developed automated gas chromatographic determination of total reduced sulfur (TRS) in flue gases set up in connection with a gas sampling train was described. The author states that the main components of TRS in paper pulp making are hydrogen-sulfide (7783064), methyl-mercaptan (74931), dimethyl-sulfide (75183), and dimethyl-disulfide (624920), and under certain conditions sulfur-dioxide (7446095) and carbonyl-sulfide (463581) may be produced as well. The operation of the commercial model 800 TRS analyzer was controlled by a microcomputer, and detection was by flame photometry. The gas chromatograph used a sample volume of 0.5 to 2.5 milliliters with a detector temperature of 130 degrees-C. The instrument printout contained the following information: date, time of analysis, automatic calibration change (if any), sample identity, precipitator outlet, number of unidentified peaks, concentration of each gas, concentration of TRS as hydrogen-sulfide and a continuous 24 hour average TRS value. Laboratory tests indicated minimal column deterioration and no more than 10 percent change by calibration curves after 4000 hours of operation and 1200 hours of exposure to sulfur gases representing flue gases. Detection maximum was 100 parts per million, but this could be increased by reducing sample volume. During 1 year of operation at a pulp mill, downtime was only 5 percent and calibration error from a permeation tube was less than 5 percent over a range of hydrogen-sulfide of up to 100 parts per million. The author concludes that the monitor assures that only the chemicals that

require control are in fact measured as TRS.

Del, J. Remoy, et al. (1994). "Monitoring for selected degradation products following a spill of vapam into the sacramento river." Journal of Environmental Quality **23**(2): 279-286.

Following a rail accident that spilled the soil fumigant VAPAM into the Sacramento River on 14 July 1991, a special study was carried out to assess the extent of contamination in Lake Shasta. A total of 32 river water samples collected on 18 July and another 316 samples collected from 22 July through 30 August were analyzed. Data obtained clearly showed the presence of the degradation products of Metham, namely, methyl isothiocyanate, carbonyl sulfide, methyl sulfide, and traces of methylamine. However, due to the emergency nature of the incident that required quick analytical turnaround times, as well as the unavailability of a satisfactory analytical method, the presence of Metham could not be demonstrated with certainty initially. Nonetheless, the laboratory's timely response to the crisis assisted public health officials in assessing the extent of the contamination and assuring the community-at-large that their drinking water was safe to consume. None of the degrada

Demello, W. Z., M. E. Hines, et al. (1992). "Factors controlling sulfur gas exchange in sphagnum-dominated wetlands." Govt Reports Announcements && Index (Gra&Amp;I), Issue 02, 1994: -.

TD3: Atmosphere-peatland exchange of reduced sulfur gases was determined seasonally in fen in NH, and in an artificially-acidified fen at the Experimental Lakes Area (ELA) in Canada. Dimethyl sulfide (DMS) dominated gas fluxes at rates as high as 400 nmol/m(sup -2)hr(sup -1). DMS fluxes measured using enclosures were much higher than those calculated using a stagnant-film model, suggesting that Sphagnum regulated efflux. Temperature controlled diel and seasonal variability in DMS emissions. Use of differing enclosure techniques indicated that vegetated peatlands consume atmospheric carbonyl sulfide. Sulfate amendments caused DMS and methane thiol concentrations in near-surface pore waters to increase rapidly, but fluxes of these gases to the atmosphere were not affected. However, emission data from sites experiencing large differences in rates of sulfate deposition from the atmosphere suggested that chronic elevated sulfate inputs enhance DMS emissions from northern wetlands. In Its Terminal Decompo

Denchfield, J. R., R. M. Dille, et al. (1982). "Coal gasification environmental baseline studies. Final report." Govt Reports Announcements && Index (Gra&Amp;I), Issue 02, 1983: -.

TD3: In conjunction with the commercial development of the Texaco Coal Gasification Process, environmental baseline studies were considered necessary. Accordingly, tests on oxygen and enriched air gasification of a water slurry of Illinois No. 6 coal were conducted at Texaco's Montebello Research Laboratory pilot plant. During the test runs, various solid, liquid, and gaseous streams were sampled. The samples were then analyzed, and the results compared with standards when applicable. The tests demonstrated that the Texaco Coal Gasification Process is an environmentally sound method of utilizing coal, in either electric power generation or for synthesis gas production. Essentially all sulfur

compounds in the coal are converted to hydrogen sulfide or carbonyl sulfide, which can then be removed from the raw gas to very low concentrations by commercially proven acid gas removal technology. This feature eliminates the need for stack gas scrubbing to meet SO₂ limits if the treated gas is used as a boiler

Deng, C., Q. G. Li, et al. (2007/7/30). "A comprehensive theoretical study on the hydrolysis of carbonyl sulfide in the neutral water." J Comput Chem: -.

The detailed hydration mechanism of carbonyl sulfide (COS) in the presence of up to five water molecules has been investigated at the level of HF and MP2 with the basis set of 6-311++G(d, p). The nucleophilic addition of water molecule occurs in a concerted way across the C=S bond of COS rather than across the C=O bond. This preferential reaction mechanism could be rationalized in terms of Fukui functions for the both nucleophilic and electrophilic attacks. The activation barriers, ΔH^\ddagger (not equal) (298), for the rate-determining steps of one up to five-water hydrolyses of COS across the C=S bond are 199.4, 144.4, 123.0, 115.5, and 107.9 kJ/mol in the gas phase, respectively. The most favorable hydrolysis path of COS involves a sort of eight-membered ring transition structure and other two water molecules near to the nonreactive oxygen atom but not involved in the proton transfer, suggesting that the hydrolysis of COS can be significantly mediated by the water molecule(s) and the cooperative effects of the water molecule(s) in the nonreactive region. The catalytic effect of water molecule(s) due to the alleviation of ring strain in the proton transfer process may result from the synergistic effects of rehybridization and charge reorganization from the precoordination complex to the rate-determining transition state structure induced by water molecule. The studies on the effect of temperature on the hydrolysis of COS show that the higher temperature is unfavorable for the hydrolysis of COS. PCM solvation models almost do not modify the calculated energy barriers in a significant way. (c) 2007 Wiley Periodicals, Inc. J Comput Chem, 2007.

Derikx, P., D. E. N. Op, et al. (1990). "Odorous sulfur compounds emitted during production of compost used as a substrate in mushroom cultivation." Appl Environ Microbiol **56**(1): 176-180.

Large-scale composting facilities are known to cause environmental problems, mainly through pungent air emitted by composting material. In air samples taken above stacks set up to prepare compost used as a substrate in mushroom cultivation, several volatile compounds were identified by means of the coupled techniques of gas chromatography and mass spectrography. Among the compounds identified, sulfur-containing compounds (H₂S, COS, CH₃SH, CS₂, (CH₃)₂S, (CH₃)₂S₂, and (CH₃)₂S₃) are the most conspicuous in causing a nuisance. Quantification of these compounds was performed by concentrating a relatively small air sample on Tenax GC. The sampling method appeared to be very useful under field conditions. During the composting process, the concentration of the volatile sulfur compounds in emitted air ranged from 1 to 35 $\mu\text{mol}/\text{m}^3$. The highest concentrations were obtained at the end of the outdoor process. Total sulfur emission amounted to 8.3 mg of sulfur per kg (fresh weight) of substrate.

o MH - BIOLOGY/METHODS

Derikx, P., F. Simons, et al. (1991). "Evolution of volatile sulfur compounds during laboratory-scale

incubations and indoor preparation of compost used as a substrate in mushroom cultivation." Appl Environ Microbiol **57**(2): 563-567.

Volatile sulfur compounds are known to be produced during the preparation of compost used as a substrate in mushroom cultivation. Because they cause odor problems, attempts have been made to reduce the production of these compounds. The influences of temperature and various additions on the production of volatile sulfur compounds from composting material were tested on laboratory-scale preparations. The production of H₂S, COS, CH₃SH, and (CH₃)₂S was proven to be a biological process with an optimal temperature that coincides with the optimal temperature for biological activity. The formation of CS₂ and (CH₃)₂S₂ was shown to be a nonbiological process. The emission of volatile sulfur compounds during the indoor preparation of mushroom compost appeared to be remarkably reduced (about 90%) as compared with the emission during the conventional outdoor process. Introduction of this indoor composting process would result in a significant reduction in environmental pollution.

Desmarchelier, J. M., S. E. Allen, et al. (1998). "Modifications of a method for determining multifumigant residues." Journal of Aoac International **81**(3): 638-644.

Phosphine (PH₃) and methyl bromide (CH₃Br) are the main fumigants used on stored grains. Published multiresidue methods, including those based on solvent extraction and on purge-and-trap techniques, give poor recoveries of CH₃Br and, in our hands, close to zero recovery of PH₃ and carbonyl sulfide (COS), a potential fumigant. We examined factors influencing fumigant analysis, including stability of chemicals in leachates and partitioning of fumigant between leachate and air. The partition ratio, defined as the ratio of fumigant concentration in leachate to that in the headspace, varied between 1.1 for PH₃ and > 100 for ethylene dibromide (EDB). An official procedure involving solvent extraction followed by partitioning was modified by being performed in sealed flasks. This change raised the recovery of CH₃Br from 28 to 85%. Volatile fumigants, including PH₃ and COS, were determined from concentrations in the headspace over the leachate (aqueous acidified acetone). Reco

Devai, I. and R. D. Delaune (1997). "Trapping efficiency of various solid adsorbents for sampling and quantitative gas chromatographic analysis of carbonyl sulfide." Analytical Letters **30**(1): 187-198.

The trapping efficiency of fourteen solid adsorbent tubes for sampling trace level of carbonyl sulfide was quantified. A thermal desorption gas chromatographic method for the accurate separation of carbonyl sulfide from other simultaneously collected reduced volatile sulfur gases was developed. Results demonstrated that Silica Gel and Carbotrap 301 were the best solid adsorbent material for trapping carbonyl sulfide if the sweep gas or the sampled atmosphere is dry. Molecular Sieve and Carbosieve SIII (along with calcium chloride in a drying tube) were the best solid adsorbent for trapping carbonyl sulfide if the sweep gas contains moisture (i.e., normal field sampling conditions).

Devai, I., R. D. Delaune, et al. (1998). "Environmental significance of atmospheric emission resulting from in situ burning of oiled salt marsh." Marine Environmental Research **45**(2): 157-167.

The environmental significance of atmospheric emissions resulting from in-situ burning used as remediation technique for removal of petroleum hydrocarbons entering Louisiana coastal salt marshes was quantified. Research conducted documented atmospheric pollutants produced and emitted to the atmosphere as the result of burning of oil contaminated wetlands. Samples collected from the smoke plume contained a variety of gaseous sulfur and carbon compounds. Carbonyl sulfide and carbon disulfide were the main volatile sulfur compounds. In contrast, concentrations of sulfur dioxide were almost negligible. Concentrations of methane and carbon dioxide in the smoke plume increased compared to ambient levels. Air samples collected for aromatic hydrocarbons in the smoke plume were dominated by pyrogenic or combustion derived aromatic hydrocarbons. The particulate fraction was dominated by phenanthrene and the C-1 and C-2 alkylated phenanthrene homologues. The vapor fraction was dom

Devai, I. and R. D. Lelaune (1994). "Changes in reduced gaseous sulfur compounds collected in glass gas sampling bulbs." Analytical Letters **27**(12): 2403-2411.

RRM RESEARCH ARTICLE AIR QUALITY ENVIRONMENTAL SAMPLING TOXICITY ANALYTICAL METHOD

Dickinson, R. E. (1996). "Climate engineering, a review of aerosol approaches to changing the global energy balance." Climatic Change **33**(3): 279-290.

As global greenhouse warming continues to intensify, it is likely that demands to employ technologies of climate engineering will become increasingly insistent. This paper addresses the possibility of 'canceling' the radiative effects of the increasing greenhouse gases through solar reflectors. Two promising approaches, according to COSEPUP (1992), are the employment of aerosols in the stratosphere, directly as reflectors, or in the troposphere, for the 'seeding' of clouds to increase cloud amounts and brightness. Besides technological and economic feasibility, such schemes could be relatively reversible, and describing their impact may be within the reach of future scientific study. The climate system is not yet sufficiently understood for such actions to be warranted. However, there is considerable potential for an increased understanding of what such actions might do through the study of the role of similar aerosols already added to the climate system. In particular,

Donati, E. R. and P. H. Tedesco (1990). "A preliminary discussion on some physicochemical aspects of bacterial leaching of sulfide minerals." Biorecovery **1**(4): 303-312.

Bioleaching of sulfide and ferrous ions in ores or more simple systems by *Thiobacillus ferrooxidans* has been studied by many authors. However much controversy remains whether the action of the bacteria is on the surface of the solid or on the dissolved ions. There are publications which dismiss the first or the second mechanism. In this paper some data obtained in this laboratory and those obtained by other workers are discussed to obtain clearer points on view and to point out the state of the problem at the present.

DuPont (1990). "[TSCATS] Initial Submission: Letter from E I Dupont De Nemours & Co to USEPA regarding toxicity studies with cover letter dated 09/01//92 [Old document number 8EHQ-0892-9921; New document number 88-920008223]." selected pages-.

Elliott, L. F. and T. A. Travis (1973). "Detection of carbonyl sulfide and other gases emanating from beef cattle manure." Soil Science, Society of American Proceedings, Vol.37, No, 5, Pages 700-702, 8 References, 1973: -.

Sulfur compounds and gases emanating from anaerobically incubated bovine manure were identified. Samples of fresh manure and composted manure, which consisted of manure at various stages of decomposition plus soil, were incubated for 5 weeks. Periodically, a sample was removed from the headspace in the incubating column and examined using gas chromatography and mass spectrometry. Carbonyl-sulfide (463581) appeared in the headspace above the fresh manure during the first 24 hours. On day 2, it rose to above 8 nanograms sulfur per milliliter (ng/ml). It remained that high for 4 days and gradually declined over the remainder of the experiment. Hydrogen-sulfide (7783064) followed a similar pattern initially, rising to 10ng/ml, but it declined more rapidly. By day 8 and thereafter, no more than 2ng/ml was produced. Hydrogen-sulfide was not detected above the compost during the first 5 days; thereafter, it was detectable at low concentrations. Traces of carbonyl-sulfide were detected above the compost near the end of the experiment. Carbon-dioxide (124389) was higher above the manure (up to 70 percent by volume) than above the compost. Oxygen was consistently higher above the manure. Methane (74828) appeared more quickly above the manure but never rose above 7.5 percent; however, it exceeded 36 percent above the compost. The authors suggest that carbonyl-sulfide may be an intermediate in bacterial sulfur reduction and a precursor to hydrogen-sulfide. The pH of fresh manure may be too low for optimum methane production.

Elliott, L. F. and T. A. Travis (1973). "Detection of carbonyl sulfide and other gases emanating from beef cattle manure." Soil Sci Soc Am Proc; 37 (5).1973 700-702: -.

HEEP COPYRIGHT: BIOL ABS. (Attempts to control odors and gases from beef cattle feedlots and other beef confinement areas have been mostly unsuccessful. Accordingly, a more basic approach to the problem must be taken. This involves identification, quantification, and source delineation before control measures can be devised.) Carbonyl sulfide (COS) was detected in the headspace above anaerobic columns of fresh manure and feedlot compost. One tenth mg S/ml of the compound was detected in gases from a debris basin and soil profile of a feedlot also. COS has not been reported from these sources previously. During the 1st 24 hr of anaerobic incubation, COS appeared above the manure. The concentration exceeded 8 ng S/ml the 2nd day and began to decline after 5 days. H₂S followed a similar pattern except that it persisted for 16 days. Only traces of COS were found above some of the replications of the anaerobically incubated compost. H₂S appeared above the compost after 5 days and persisted throughout the 37-day incupation. Methane appeared more quickly above the manure than above the compost. However, CH₄ never exceeded 7.5% above the manure whereas it exceeded 36% above the compost.

Ensign, S. A. (1995/4/25). "Reactivity of carbon monoxide dehydrogenase from *Rhodospirillum rubrum* with carbon dioxide, carbonyl sulfide, and carbon disulfide." Biochemistry **34**(16): 5372-8.

The reactivities of CO₂ and the related compounds COS and CS₂ with the nickel- and iron- sulfur-containing carbon monoxide dehydrogenase (CODH) from *Rhodospirillum rubrum* have been investigated. Both CO₂ and COS were substrates for CODH in a reductant-dependent reaction resulting in the formation of CO. CO₂ was reduced to CO and H₂O, while COS was reduced to CO and H₂S. CO was a potent inhibitor of CO₂ reduction at dissolved concentrations as low as 1 microM, but this inhibition could be prevented by quantitatively trapping CO as it was formed by including reduced hemoglobin in the assays. The addition of hemoglobin to the assays also allowed the formation of CO to be monitored in real time by following the decrease in absorbance at 433 nm resulting from carboxyhemoglobin formation. A variety of low-potential reductants, including dithionite, titanium(III) citrate, and dithionite-reduced viologens (methyl and benzyl), were suitable electron donors for the reduction of CO₂ and COS. Dithionite-reduced methyl viologen supported the highest rates of CO₂ and COS reduction, and the stimulation of CO₂ reduction (170-fold increased rate over dithionite alone) was much more dramatic than the stimulation of COS reduction (2.6-fold increased rate over dithionite alone). CO₂ was reduced to CO with a K_m for CO₂ of 190 microM and a V_{max} of 44 mumol of CO formed min⁻¹ (mg of protein)⁻¹, while COS was reduced with a K_m for COS of 2.2 microM and a V_{max} of 0.51 mumol of CO formed min⁻¹ (mg of protein)⁻¹.(ABSTRACT TRUNCATED AT 250 WORDS)

Eskilson, M. and M. Huber (1998). "Screening of volatile sulfur compounds in waste paper based corrugated boards for food packaging using a sulfur sensitive chemiluminescence detector." Hrc Journal of High Resolution Chromatography **21**(11): 623-624.

RRM RESEARCH ARTICLE METHODOLOGY CHEMISTRY VOLATILE SULFUR COMPOUNDS FOOD PACKAGING WASTE PAPER BASED CORRUGATED BOARDS SCREENING ANALYSIS GAS CHROMATOGRAPHY CHEMILUMINESCENCE DETECTION WASTE MANAGEMENT VARIAN MODEL 3700 GAS CHROMATOGRAPH CHROMATOGRAPHIC TECHNIQUES ANALYTICAL METHOD EQUIPMENT

Fall, R., W. C. Kuster, et al. (1987). "The uptake of cos by growing vegetation and the cos tropospheric lifetime." 194th American Chemical Society National Meeting, New Orleans, Louisiana, Usa, August 30-September 4, 1987. Abstr Pap Am Chem Soc **194**(0): Envr 270-.

RRM ABSTRACT CORN ALFALFA SOYBEAN WHEAT CARBONYL SULFIDE

Feng, Z. and P. G. Hartel (1996). "Factors affecting production of cos and cs₂ in leucaena and mimosa species." Plant and Soil **178**(2): 215-222.

Carbon disulfide (CS₂) and carbonyl sulfide (COS) are colorless, foul-smelling, volatile sulfur compounds with biocidal properties. Some plants produce CS₂ or COS or both. When used as an

intercrop or forecrop, these plants may have agronomic potential in protecting other plants. Most of the factors which affect production of these plant-generated organic sulfides are unknown. We determined the effects of sulfate concentration, plant age, nitrogen fixation, drought stress, root injury (through cutting), and undisturbed growth on COS production in *Leucaena retusa* or *Leucaena leucocephala* and the effect of some of these factors on CS₂ production in *Mimosa pudica*. In addition, we determined if organic sulfides were produced in all *Leucaena* species. When *L. retusa* and *M. pudica* seedlings were grown in a plant nutrient medium with different sulfate concentrations (50 to 450 mg S L⁻¹), COS or CS₂ from crushed roots generally increased with increasing sulfate concentration. C

Fichoux, H., E. Rusinek, et al. (1998/6). "Saturation Sideband CO₂ Laser Spectroscopy of the Overtone Band 2ν₂ and Its Hot Band 3ν₂-ν₂ of Carbonyl Sulfide." J Mol Spectrosc **189**(2): 249-53.

The saturation spectra of the 2ν₂ and the 3ν₂-ν₂ bands of carbonyl sulfide have been studied using a CO₂ laser sideband spectrometer. The frequency of 20 absorption lines has been determined with an accuracy of 20 kHz. These data have been included in a global rovibrational analysis including all the other data available on 16O12C32S. We list an improved set of standard frequencies at the 10⁽⁻⁶⁾ cm⁻¹ level. Copyright 1998 Academic Press.

Floeck, O. R., M. O. Andreae, et al. (1997). "Environmentally relevant precursors of carbonyl sulfide in aquatic systems." Marine Chemistry **59**(1-2): 71-85.

Seawater solutions of environmentally relevant organosulfur compounds, commercial humic acid (HA), and natural dissolved organic matter (DOM) were incubated with and without UV light in order to determine the carbonyl sulfide (COS) producing capabilities of these compounds. COS dark- and photo-production rate constants were determined for dilute solutions of the organosulfur compounds (μmol l⁻¹) and HA (mg l⁻¹). Dissolved COS was determined using a purge and cryogenic trap method followed by GC/FPD detection. COS was produced in considerable amounts both non-photochemically and photochemically from the reduced form of free acid of glutathione (GSH) and photochemically from cysteine (CYS). Other organosulfur compounds yielded little or no COS. Photosensitizers, such as commercial HA and natural DOM, photo-catalyzed COS production from several of the chemicals tested and from unknown COS precursors in the seawater samples. HA itself was found to contain COS precursors. W

Forrest, V. J., D. L. Geiger, et al. (1992). "Combustion toxicity of a carbon composite." Proceedings of the Conference on Advanced Composites, American Conference of Governmental Industrial Hygienists, Inc., Cincinnati, Ohio, Pages 69-74, 4 References, 1992: -.

The combustion toxicity of a carbon composite was evaluated. The composite (3501-6-4), consisted of polyacrylonitrile based carbon fibers that were embedded in a proprietary five component epoxy matrix. Fischer-344-rats were exposed to smoke generated by the nonflaming combustion of 10.7 to 19.0 grams (g) of the composite for 30 minutes in a specially designed combustion/exposure system. The concentrations of carbon-monoxide (630080), hydrogen-cyanide (74908), sulfur-dioxide (7446095),

nitrogen-dioxide (10102440), and carbonyl-sulfide (463581) in the chamber were measured. Blood samples were collected and analyzed for carboxyhemoglobin (COHb). Changes in the respiration rate were monitored through exposure and up to 90 minutes post exposure. Rats were observed for mortality for 14 days. The median lethal concentration (LC50) of the smoke was computed from the mortality data. The LC50 of the smoke was 16.49 to 82.0 milligrams per liter (mg/l). Exposure to the smoke decreased respiration rates by 46 to 74%. Some of the smoke exposed rats were observed to be in a narcotic state after exposure. When these rats regained consciousness they appeared to be in good condition. The authors conclude that the combustion toxicity of the composite is less than or equal to that associated with various woods. The observed deaths were probably due to an additive effect of carbon-monoxide and hydrogen-cyanide, since their maximum concentrations were less than their LC50s. Combustion of the composite also causes narcosis and sensory irritation, as indicated by the decreases in respiration rate.

Fradkin, B. I. and B. A. Petrov (1978). "Gas chromatography in determining sulfur containing gases in the air of manufacturing facilities." Gig Tr Prof Zabol **0**(6): 53-54.

HEEP COPYRIGHT: BIOL ABS. HUMAN SULFUR DI OXIDE HYDROGEN SULFIDE CARBON DI SULFIDE CARBONYL SULFIDE

Fraser, P. J., R. Harriss, et al. (1991). "Source gases: concentrations, emissions, and trends." Govt Reports Announcements & Index (Gra&I), Issue 05, 1993: -.

TD3: Source gases are defined as those gases that influence levels of stratospheric ozone (O₃) by transporting species containing halogen, hydrogen, and nitrogen to the stratosphere. Examples are the CFC's, methane (CH₄), and nitrous oxide (N₂O). Other source gases that also come under consideration in an atmospheric O₃ context are those that are involved in the O₃ or hydroxyl (OH) radical chemistry of the troposphere. Examples are CH₄, carbon monoxide (CO), and nonmethane hydrocarbons (NMHC's). Most of the source gases, along with carbon dioxide (CO₂) and water vapor (H₂O), are climatically significant and thus affect stratospheric O₃ levels by their influence on stratospheric temperatures. Carbonyl sulphide (COS) could affect stratospheric O₃ through maintenance of the stratospheric sulphate aerosol layer, which may be involved in heterogeneous chlorine-catalyzed O₃ destruction. The previous reviews of trends and emissions of source gases, either from the context of their influence on atmospheric

Frech, B., M. Murtz, et al. (1998/7). "Sub-Doppler Heterodyne Frequency Measurements on OCS Near 2900 cm⁻¹ Using a CO Overtone Sideband Spectrometer." J Mol Spectrosc **190**(1): 91-100.

We present sub-Doppler heterodyne frequency measurements on 10 rovibrational transitions of carbonyl sulfide (OCS) between 2894 and 2910 cm⁻¹. The measurements were made using a CO overtone laser which had limited tuneability through the generation of microwave sidebands in a CdTe crystal. With this technique the laser frequencies were shifted to the desired OCS transition frequencies. The transition frequencies could be measured with uncertainties less than 30 kHz ($\Delta\nu/\nu = 3 \times 10^{-10}$) by

frequency offset-locking the CO overtone laser to combination frequencies of two saturation-stabilized CO₂ laser standards. The measured transition frequencies of OCS were combined with previous sub-Doppler, Fourier transform, and microwave measurements to recalculate improved calibration tables for the 10(0)1-00(0)0, 11(1e)1-01(1e)0, and 11(1f)1-01(1f)0 bands. These tables are suitable for the calibration of infrared spectrometers in the 87 THz region (near 2900 cm⁻¹). Copyright 1998 Academic Press.

G, D., B. L., et al. "The peptide formation mediated by cyanate revisited. N-carboxyanhydrides as accessible intermediates in the decomposition of n-carbamoylamino acids." JOURNAL OF THE AMERICAN CHEMICAL SOCIETY: <2006: <VO1>128: <IS1>N23: <IS2>JUN 14: <PG1>7412-7413: -.

Gallay, A., F. Van Loock, et al. (2002/1/15). "Belgian coca-cola-related outbreak: intoxication, mass sociogenic illness, or both?" Am J Epidemiol **155**(2): 140-7.

An epidemic of health complaints occurred in five Belgian schools in June 1999. A qualitative investigation described the scenario. The role of soft drinks was assessed by using a case-control study. Cases were students complaining of headache, dizziness, nausea, vomiting, abdominal pain, diarrhea, or trembling. Controls were students present at school on the day of the outbreak but not taken ill. An analysis was performed separately for school A, where the outbreak started, and was pooled for schools B-E. In school A, the attack rate (13.2%) was higher than in schools B-E (3.6%, relative risk = 3.6, 95% confidence interval (CI): 2.5, 5.3). Exclusive consumption of regular Coca-Cola (school A: odds ratio (OR) = 29.7, 95% CI: 1.32, 663.6; schools B-E: OR = 7.3, 95% CI: 2.9, 18.0) and low mental health score (school A: OR = 16.1, 95% CI: 1.3, 201.9; schools B-E: OR = 3.1, 95% CI: 1.5, 6.6) were independently associated with the illness. In schools B-E, consumption of Fanta, consumption of Coca-Cola light, and female gender were also associated with the illness. It seems reasonable to attribute the first cases of illness in school A to regular Coca-Cola consumption. However, mass sociogenic illness could explain the majority of the other cases.

Galloway, J. N., H. Levy, et al. (1994). "Year 2020 consequences of population growth and development on deposition of oxidized nitrogen." Ambio **23**(2): 120-123.

RRM RESEARCH ARTICLE FOSSIL FUEL LIGHTNING BIOGENIC SOIL EMISSIONS
FERTILIZATION CARBON SEQUESTRATION NITRIC OXIDE NITROUS OXIDE CARBONYL
SULFIDE METHANE OZONE

Gamankov, P. I., E. V. Gafurova, et al. (1979/7). "[Data for setting the MAC for carbon oxysulfide in the air of work zones]." Gig Tr Prof Zabol(7): 52-4.

Geddes, J. D., G. C. Miller, et al. (1994). "Gas phase photolysis of methyl isothiocyanate." 208th National Meeting of the American Chemical Society, Washington, D.c., Usa, August 21-25, 1994. Abstracts of Papers American Chemical Society **208**(1-2): Envr 159-.

RRM MEETING ABSTRACT HUMAN HEALTH HAZARD METAM SODIUM METHYL ISOCYANATE METHYL ISOCYANIDE SULFUR DIOXIDE HYDROGEN SULFIDE CARBONYL SULFIDE N-METHYL FORMAMIDE METHYL AMINE ECOLOGICAL RISK ASSESSMENT

Geddes, J. D., G. C. Miller, et al. (1995). "Gas phase photolysis of methyl isothiocyanate." Environmental Science & Technology **29**(10): 2590-2594.

Methyl isothiocyanate (MITC) is the major volatile transformation product of the fumigant metam sodium. The objectives of these studies were to determine both the products and the kinetics of photolysis of MITC in the gas phase in order to better understand its transformation in the atmosphere. The gas phase photolysis of MITC was examined using Tedlar, borosilicate, and quartz chambers. Since sorption of MITC on the walls of the reactors is potentially important, these studies used a ratioing technique that relates sorption of MITC to two other photostable compounds of similar vapor pressure. These experiments showed that MITC undergoes photolysis in the gas phase with a half-life of 10 | 3 h under xenon arc irradiation and slightly greater than 1 day of late summer sunlight. Photolysis products were determined using GC-NPD and GC/MS. Products observed include methyl isocyanate, methyl isocyanide, sulfur dioxide, hydrogen sulfide, carbonyl sulfide, N-methylformamide, a

Georgii, H., S. Buergermeister, et al. (1987). "Untersuchung des atmosphaerischen kreislaufes biogener schwefelverbindungen und ihrer reaktionen. (Studies on the atmospheric cycle of biogenic sulfur compounds and their reactions)." Govt Reports Announcements & Index (Gra&I), Issue 21, 1991: -.

TD3: This report describes field measurements to gain information about the atmospheric cycle of biogenic sulfur compounds and their reactions. The studies concentrated on dimethyl sulfide (DMS), carbonyl sulfide (COS) and carbon disulfide (CS₂), which are the most important biogenic sulfur compounds for the atmospheric sulfur budget besides hydrogen sulfide (H₂S). As reaction products of these compounds sulfur dioxide (SO₂) and sulfate (SO₄) were also included in the measurements. Gas- and ion-chromatographic techniques were used for the detection of DMS, COS, CS₂ and SO₄, while SO₂ and H₂S were measured by chemiluminescence and fluorescence methods. (orig.). (Copyright (c) 1991 by FIZ. Citation no. 91:000982.) In German. Berichte des Instituts fuer Meteorologie und Geophysik der Universitaet Frankfurtain, no. 68.

Germida, J. J., M. Wainwright, et al. (1992). "Biochemistry of sulfur cycling in soil." Stotzky, G. And J.-M. Bollag (Ed.). Soil Biochemistry, Vol.7. Soils, Plants, and the Environment. Xi+418p. Marcel Dekker, Inc.: New York, New York, Usa **Basel, Switzerland. Illus. Isbn 0-8247-8575-4.; 0(0): 1-54.**

RRM CHEMICAL FORMS DEPOSITION PARTICULATES ACID RAIN MICROBES OXIDATION REDUCTION VOLATILIZATION

Gestrich, W. (1987). "Reductive flue gas desulfurization. Final report." Govt Reports Announcements & Index (Gra&I), Issue 17, 1989: -.

TD3: The desulfurization (removal of SO₂) of oxygen-free flue gases can take place in a two-stage process by addition of reducing gases (carbon monoxide, hydrogen, methane, town gas, partially burnt fuel oil); in the first stage, the reducing process to sulfur vapor and hydrogen sulfide takes place at the Co-Mo contact (or at one of the other investigated catalysts); in the second stage, a polyethylene glycol scrubbing process, the hydrogen sulfide reacts with the residual SO₂ to sulfur and this - as well as the sulfur vapor formed beforehand - is removed as individual heavy liquid phase. The reaction can be carried out in such a way that the secondary pollutant carbonyl sulfide (COS) remains under the detection limit of 50 ppm and thus can be regarded as innocuous. The flue gases, which normally contain up to 3-5% by volume of oxygen, cannot be treated in such a way because all known and analyzed catalysts either lose their effectiveness or the processes had to take place at uneconomical

Gestrich, W. (1987). "Reduzierende rauchgasentschwefelung. Schlussbericht. (Reductive flue gas desulfurization. Final report)." Govt Reports Announcements & Index (Gra&I), Issue 15, 1989: -.

TD3: The desulfurization (removal of SO₂) of oxygen-free flue gases can take place in a two-stage process by addition of reducing gases (carbon monoxide, hydrogen, methane, town gas, partially burnt fuel oil); in the first stage, the reducing process to sulfur vapor and hydrogen sulfide takes place at the Co-Mo contact (or at one of the other investigated catalysts); in the second stage, a polyethylene glycol scrubbing process, the hydrogen sulfide reacts with the residual SO₂ to sulfur and this - as well as the sulfur vapour formed beforehand - is removed as individual heavy liquid phase. The reaction can be carried out in such a way that the secondary pollutant carbonyl sulfide (COS) remains under the detection limit of 50 ppm and thus can be regarded as innocuous. The flue gases, which normally contain up to 3-5% by volume of oxygen, cannot be treated in such a way because all known and analyzed catalysts either lose their effectiveness or the processes had to take place at uneconomically high tem

Giddings, G. G. (1992). "Chemical safety of irradiated foods." Finley, J.W., S.F.Robinson and D.J. Armstrong (Ed.).Acs (American Chemical Society) Symposium Series, 484.Food Safety Assessment 200th National Meeting of the American Chemical Society, Washington, D.c., Usa, August 26-31, 1990. Ix+478p. American Chemical Society: Washington, D.c., Usa. Illus. Isbn 0-8412-2198-7.; 0 (0): 332-345.

RRM TOXICOLOGY FOOD PROCESSING FDA

Gluck, S. (1982). "Performance of the tracor model 700a hall electrolytic conductivity detector as a sulfur-selective detector." J Chromatogr Sci **20**(3): 103-108.

HEEP COPYRIGHT: BIOL ABS. The Model 700A Hall electrolytic conductivity detector (HECD) was evaluated for its use as a S-selective detector (for natural gas or pesticide analysis). The effects of different operating parameters were characterized in terms of a signal-to-noise ratio. Selectivity ratios of S:C and S:Cl were calculated for a few model compounds. The overall minimum selectivity found was

5.5ctor was linear for 2-4 orders of magnitude and the dynamic range was 6 orders of magnitude. The sensitivity ranged from 0.21-1.3 pg S/s for different compounds on different days. In comparison to the S-selective flame photometric detector, the HECD had lower detection limits, a linear response and similar selectivity ratios.

Goldhaber, S. B. and R. L. Chessin (1997). "Comparison of hazardous air pollutant health risk benchmarks." Environmental Science & Technology **31**(12): 568a-572a.

RRM JOURNAL ARTICLE POLLUTION GOVERNMENT AND LAW CLEAN AIR ACT AMENDMENTS OF 1990 AIR POLLUTION TOXIC CHEMICALS RELEASE REDUCTIONS POLLUTANT EMISSION SOURCES HEALTH RISK BENCHMARKS RISK ASSESSMENT GUIDELINES EPA TOXICOLOGY GOVERNMENT AGENCY

Goodings, J. M., D. K. Bohme, et al. (1986). "Sulfur anion chemistry in hydrocarbon flames with hydrogen sulfide carbonyl sulfide and sulfur dioxide additives." Can J Chem **64**(4): 689-694.

RRM ENVIRONMENTAL HAZARD FUEL COMBUSTION EMISSIONS CONTROL REGULATION

Gosselin, R. E., R. P. Smith, et al. (1984). [Carbonyl Sulfide]. Baltimore, Williams & Wilkins. **5th**: II-118-.

Gosselin, R. E., R. P. Smith, et al. (1984). [Hydrogen Sulfide. Baltimore, Williams & Wilkins. **5th**: III-198-III-202 ?-.

Goyal, A., Y. Shiraiwa, et al. (1992/2). "Carbon Oxysulfide Inhibition of the CO(2)-Concentrating Process of Unicellular Green Algae." Plant Physiol **98**(2): 578-583.

Carbonyl sulfide (COS), a substrate for carbonic anhydrase, inhibited alkalization of the medium, O(2) evolution, dissolved inorganic carbon accumulation, and photosynthetic CO(2) fixation at pH 7 or higher by five species of unicellular green algae that had been air-adapted for forming a CO(2)-concentrating process. This COS inhibition can be attributed to inhibition of external HCO(3) (-) conversion to CO(2) and OH(-) by the carbonic anhydrase component of an active CO(2) pump. At a low pH of 5 to 6, COS stimulated O(2) evolution during photosynthesis by algae with low CO(2) in the media without alkalization of the media. This is attributed to some COS hydrolysis by carbonic anhydrase to CO(2). Although COS had less effect on HCO(3) (-) accumulation at pH 9 by a HCO(3) (-) pump in *Scenedesmus*, COS reduced O(2) evolution probably by inhibiting internal carbonic anhydrases. Because COS is hydrolyzed to CO(2) and H(2)S, its inhibition of the CO(2) pump activity and photosynthesis is not accurate, when measured by O(2) evolution, by NaH(14)CO(3) accumulation, or by (14)CO(2) fixation.

Graedel, T. E. and R. McGill (1986). "Degradation of materials in the atmosphere common materials are

vulnerable to atmospheric attack." Environ Sci Technol **20**(11): 1093-1100.

RRM ROAD SURFACE BUILDING MATERIAL MACHINERY ACID RAIN METAL POLLUTION AIR POLLUTION

Grant, W. B., R. H. Kagann, et al. (1992). "Optical remote measurement of toxic gases." J Air Waste Manage Assoc **42**(1): 18-30.

Enactment of the Clean Air Act Amendments (CAAA) of 1990 has resulted in increased ambient air monitoring needs for industry, some of which may be met efficiently using open-patch optical remote sensing techniques. These techniques include Fourier transform spectroscopy, differential optical absorption spectroscopy, laser long-path absorption, differential absorption lidar, and gas cell correlation spectroscopy. With this regulatory impetus, it is an opportune time to consider applying these technologies to the remote and/or path-averaged measurement and monitoring of toxic gases covered by the CAAA. This article reviews the optical remote sensing technology and literature for that application.

Grebenev, S., B. Sartakov, et al. (2000/9/1). "Evidence for Superfluidity in Para-Hydrogen Clusters Inside Helium-4 Droplets at 0.15 Kelvin." Science **289**(5484): 1532-1535.

A linear carbonyl sulfide (OCS) molecule surrounded by 14 to 16 para-hydrogen (pH(2)) molecules, or similar numbers of ortho-deuterium (oD(2)) molecules, within large helium-4 ((4)He) droplets and inside mixed (4)He/(3)He droplets was investigated by infrared spectroscopy. In the pure (4)He droplets (0.38 kelvin), both systems exhibited spectral features that indicate the excitation of angular momentum around the OCS axis. In the colder (4)He/(3)He droplets (0.15 kelvin), these features remained in the oD(2) cluster spectra but disappeared in the pH(2) spectra, indicating that the angular momentum is no longer excited. These results are consistent with the onset of superfluidity, thereby providing the first evidence for superfluidity in a liquid other than helium.

Grosjean, E., R. A. Rasmussen, et al. (1998). "Ambient levels of gas phase pollutants in porto alegre, brazil." Atmospheric Environment **32**(20): 3371-3379.

Air samples have been collected using electropolished canisters in downtown Porto Alegre, Brazil, where ethanol is used as a vehicle fuel and methyl-tert-butyl ether (MTBE) is used as a vehicle fuel additive. The 150 volatile organic compounds (VOC) identified by GC-FID and GC-MS included 46 alkanes, 30 alkenes, 22 aromatics, 17 carbonyls, 3 alcohols, 8 bicyclic aromatics, 11 halogenated hydrocarbons and 13 other compounds. The most abundant VOC on a mass concentration basis (after CO₂, CH₄ and CO) included acetylene, MTBE, ethanol, the alkanes propane, n-butane, n-pentane, isopentane, n-hexane, 2-methylpentane and indane, the alkenes ethylene and propene, and the aromatics benzene, toluene, ethylbenzene and (m + p) xylene. During the ca. one-year period studied, 20 March, 1996-16 April, 1997, ambient concentrations of VOC correlated well with those of carbon monoxide, for which vehicle exhaust emissions account for ca. 99% of total emissions in Porto Alegre. Two VOC ph

Gupta, R., S. Gangwal, et al. (1994). "Fluidized-bed testing of z-sorb iii sorbent." Govt Reports Announcements & Index (Gra&I), Issue 23, 1995: -.

TD3: Phillips Petroleum Company (PPCo) successfully developed a fluidizable version of their proprietary Z-SORB sorbent. Z-SORB sorbent is a ZnO-based regenerable sorbent for removing hydrogen sulfide (H_2S) and carbonyl sulfide (COS). RTI conducted a life-cycle test on this sorbent in the high-temperature, high-pressure (HTHP) semi-batch fluidized-bed reactor. This test consisted of 50 cycles of sulfidation and regeneration to demonstrate the long-term chemical reactivity and mechanical strength of the Z-SORB sorbent. A simulated air-blown gasifier coal gas was used at 20 atm and 538 (degree)C (1,000(degree)F). The Z-SORB sorbent exhibited excellent sulfur removal capability; the prebreakthrough H_2S levels were below the detection limit of the analyzer (<10 ppmv). The sulfur capacity of the sorbent at breakthrough (500 ppM H_2S in reactor exit gas) was 20.2 g S/100 g sorbent in Cycle 1 and was 10 g S/100 g sorbent in Cycle 50. The sorbent loss from the reactor due to fines generat

Hanson, R. L. and A. R. Dahl (1985). "Chemical and biological characterization of volatile components of environmental samples after fractionation by vacuum line cryogenic distillation." Archives of Environmental Contamination and Toxicology 14(3):289-297; 1985.: -.

HMTC Scientists using vacuum desorption and distillation apparatus successfully identified carbon dioxide, sulfur dioxide, alkanes, aldehydes, ammonia, carbonyl sulfide, two ring hydrocarbons, and phenols that were emitted from coal gasification plants and diesel engines. Vacuum desorption with cryogenic distillation is a way to separate volatile components of emissions in order to characterize their chemical and biological components. Biological characterization was determined by mutagenicity and cytotoxicity assays conducted on chinese hamster ovary (CHO) cells. All the compounds in vapor phase except diesel particulate extracts were cytotoxic but not mutagenic to CHO cells. Diesel particulate extracts were cytotoxic as well as mutagenic to CHO cells. Nitrogen dioxide, however, did not change the activity of the lower molecular weight hydrocarbons. (40 ref.)

Hanson, R. L., A. R. Dahl, et al. (1985). "Chemical and biological characterization of volatile components of environmental samples after fractionation by vacuum line cryogenic distillation." Archives of Environmental Contamination and Toxicology, Vol.14, No.3, Pages 289-297, 41 References, 1985: -.

Volatile organic compounds from combustion were analyzed. Samples of diesel engine exhaust and condensate of process gas from coal gasification facilities were processed by cryogenic distillation fractionation, infrared spectroscopy, and gas chromatography/mass spectroscopy (GC). With sufficiently large samples, mutagenicity and cytotoxicity assays were performed on Chinese-hamster ovary cells. The infrared spectra of the diesel exhaust showed that nitric-oxide (7697372), nitrogen-dioxide (10102440), carbon-dioxide (124389), and sulfur-dioxide (7446095) were adsorbed to the particles. Dinitrogen-trioxide (10544737) and aromatic and aliphatic hydrocarbons were also identified. Analysis by GC/MS showed over 30 compounds. Infrared spectroscopy on the volatile material desorbed from the

gasifier condensate indicated that it contained primarily ammonia (7664417), carbonyl-sulfide (463581), carbon-dioxide, and both aliphatic and aromatic compounds. More detailed analysis by GC/MS showed over 40 compounds. Diesel particles were not mutagenic or cytotoxic up to 100 micrograms per milliliter (microg/ml). When tested without liver microsomal fraction, the gasifier samples were cytotoxic and produced 50 percent cell killing at concentrations between 50 and 75microg/ml. With liver microsomal fractions, the cytotoxicity decreased to 75 to 100microg/ml. Fractions collected at minus 24 degrees-C were found to be more cytotoxic (50 percent at 25 to 50microg/ml) than those collected at zero degrees. The authors conclude that interactions in nitrogen compounds that may occur on diesel exhaust particles do not increase the mutagenic activity of the lower molecular weight hydrocarbons present in the soot. However, the ability of the gas phase materials (probably phenolic compounds) to produce cell killing could have biological significance. Infrared spectroscopy and GC/MS analysis provide complimentary data for sample analysis./TRANSPLANTATION

Hanst, P. L., L. L. Spiller, et al. (1975). "Infrared measurement of fluorocarbons, carbon tetrachloride, carbonyl sulfide, and other atmospheric trace gases." Journal of the Air Pollution Control Association, Vol.25, No.12, Pages 1220-1226, 18 References, 19751975: -.

A method for detecting the concentration of trace gases in the atmosphere for infrared (IR) analysis was tested. The sampled air was pumped into a 3.5 liter condenser immersed in liquid nitrogen. After condensation, the oxygen and nitrogen were pumped out of the vessel, leaving a residue of ice, solid carbon-dioxide (CO₂), and trace gases. This procedure was repeated 16 times. The condenser was then removed from the liquid nitrogen and allowed to warm to room temperature. As the residue vaporized, it was allowed to flow into an after trap, from which it was transferred to a long path IR absorption cell for analysis. CO₂ was removed by distributing watch glasses containing 100 grams of sodium-hydroxide pellets along the bottom of the IR absorption cell. Air samples obtained from Research Triangle Park and Atlantic Beach, North Carolina, and Queens Botanical Garden, New York City, were analyzed. Fluorocarbons were detected in concentrations of 0.12 to 0.99 parts per billion (ppb), carbon-tetrachloride (56235) in concentrations of 0.07 to 0.11ppb, carbonyl-sulfide (463581) in concentrations of 0.20 to 0.24ppb, acetylene (74862) in concentrations of 1.6 to 4.2ppb, and hydrocarbons in concentrations of 20 to 200ppb.

Hanst, P. L., L. L. Spiller, et al. (1975). "Infrared measurement of fluorocarbons, carbon tetrachloride, carbonyl sulfide, and other atmospheric trace gases." J Air Pollut Control Assoc; 25 (12).1975 1220-1226: -.

HEEP COPYRIGHT: BIOL ABS. A cryogenic procedure for concentrating atmospheric trace gases was developed and applied to the ambient air at Research Triangle Park, North Carolina, Atlantic Beach, North Carolina and New York City (USA). The concentrated gases were analyzed by long path IR absorption spectroscopy, with a detectability down to partial pressures of 10⁻¹¹ atm. Carbonyl sulfide was detected at partial pressures in the range 1 x 10⁻¹⁰ to 3 x 10⁻¹⁰ atm. Carbon tetrachloride was always detected with a rather narrow partial pressure range of 0.7 x 10⁻¹⁰ to 1.1 x 10⁻¹⁰ atm. Fluorocarbon-11 values ranged from about 1.3 x 10⁻¹⁰ atm. at Research Triangle Park to 8 x 10⁻¹⁰ atm. at New York City. Fluorocarbon-12 covered the range 1.8 x 10⁻¹⁰ to 1.0 x 10⁻⁹ atm.

Hydrocarbon pollutants varied widely in concentration, but were always detected, even in the clean rural air.

Haritos, V. S. and G. Dojchinov (2005/1). "Carbonic anhydrase metabolism is a key factor in the toxicity of CO₂ and COS but not CS₂ toward the flour beetle *Tribolium castaneum*." Comp Biochem Physiol C Toxicol Pharmacol **140**(1): 139-47.

The analogues carbon dioxide (CO₂), carbonyl sulfide (COS) and carbon disulfide (CS₂) have been useful as substrate probes for enzyme activities. Here we explored the affinity of the enzyme carbonic anhydrase for its natural substrate CO₂, as well as COS and CS₂ (1) by in vitro kinetic metabolism studies using pure enzyme and (2) through mortality bioassay of insects exposed to toxic levels of each of the gases during carbonic anhydrase inhibition. Hydrolysis of COS to form hydrogen sulfide was catalysed rapidly showing parameters K_m 1.86 mM and K_{cat} 41 s⁻¹ at 25 degrees C; however, the specificity constant (K_{cat}/K_m) was 4000-fold lower than the reported value for carbonic anhydrase-catalysed hydration of CO₂. Carbonic anhydrase-mediated CS₂ metabolism was a further 65,000-fold lower than COS. Both results demonstrate the deactivating effect toward the enzyme of sulfur substitution for oxygen in the molecule. We also investigated the role of carbonic anhydrases in CO₂, COS and CS₂ toxicity using a specific inhibitor, acetazolamide, administered to *Tribolium castaneum* (Herbst) larvae via the diet. CO₂ toxicity was greatly enhanced by up to seven-fold in acetazolamide-treated larvae indicating that carbonic anhydrases are a key protective enzyme in elevated CO₂ concentrations. Conversely, mortality was reduced by up to 12-fold in acetazolamide-treated larvae exposed to COS due to reduced formation of toxic hydrogen sulfide. CS₂ toxicity was unaffected by acetazolamide. These results show that carbonic anhydrase has a key role in toxicity of the substrates CO₂ and COS but not CS₂, despite minor differences in chemical formulae.

Harnisch, J., R. Borchers, et al. (1995). "Cos, cs₂ and so₂ in aluminium smelter exhaust: the contribution of aluminium production to the global cos budget." -.

Measurements of carbonyl sulfide (COS) and carbondisulfide (CS₂) were carried out on samples drawn from a smoke stack of an aluminium smelter. Volume mixing ratios of 6 ppm COS and 0.1 ppm CS₂ were measured for gases from the electrolysis unit that had previously passed an Al₂O₃ fluid bed reactor and electrostatic precipitators. Specific emissions of 1.6 kg COS and 0.03 kg CS₂ per ton of primary aluminium were found. Extrapolating from this particular smelter's conditions to a world mix specific COS emissions of about 4 kg/t(Al) are calculated resulting in emissions of annually 0.08 Tg COS into the atmosphere due to electrolytic aluminium production in 1995. Besides the photochemical conversion of anthropogenic CS₂ aluminium production is established to be the second major industrial source of COS probably exceeding automotive tire wear's and coal combustion's contributions.

Harnisch, J., R. Borchers, et al. (1995). "Aluminium production as a source of atmospheric carbonyl sulfide (cos)." Environmental Science and Pollution Research International **2**(3): 161-162.

Carbonyl sulfide is found as a major sulfur compound in anodic gases of commercial aluminium

electrolysis. Recent spectroscopic measurements on industrial aluminium smelters found typical CO ratios between 80 and 200. This results in specific COS emissions of between 1 and 7 kg/t(Al) if all COS is released into the atmosphere. In 1993 aluminium production would have been responsible for between 0.02 and 0.14 Tg of COS emissions. Currently, aluminium production does not seem to influence the total atmospheric COS budget to an extent beyond its natural variability. If recent growth rates of global aluminium production are sustained, however, COS emissions would quadruple until 2030. Together with increasing aircraft emissions into the stratosphere, an increase of the sulfate background aerosol is to be expected that could significantly enhance ozone depletion. The use of inert anodes is recommended to reduce aluminium production emissions of COS and CF₄, C₂F₆, CO₂ and CO

Harrison, R. M., D. B. Nedwell, et al. (1992). "Factors influencing the atmospheric flux of reduced sulphur compounds from north sea inter-tidal areas." Atmos Environ Part a Gen Top **26**(13): 2381-2387.

Measurements of the fluxes of reduced sulphur compounds to the atmosphere, from three types of inter-tidal site, representing saltmarsh creek, saltmarsh pan and saltmarsh vegetated surface, have been made using an enclosure method. The major S gases released were DMS, H₂S and COS. Their fluxes showed a strong seasonal variation with a summer maximum apparently related to elevated sediment temperature. Laboratory experiments revealed no influence of illumination upon the fluxes. In summer, a net export of DMS in estuarine water exiting from the marsh was demonstrated but there was no export during winter. The average fluxes of gases from sediments to the atmosphere in summer from these three sites were all of similar magnitude, although less than those reported from the North Sea water column. When the area of inter-tidal sediments was taken into account it was concluded that inter-tidal areas did not make a significant direct contribution to the regional atmospheric sulph

He, H., J. Liu, et al. (2005/12/15). "Heterogeneous oxidation of carbonyl sulfide on atmospheric particles and alumina." Environ Sci Technol **39**(24): 9637-42.

Heterogeneous oxidation of carbonyl sulfide (OCS) on atmospheric particles and alumina (Al₂O₃) was investigated in a closed system and a flowed system using in situ diffuse reflectance infrared Fourier transform spectroscopy (DRIFTS). At room temperature, OCS could be catalytically oxidized on the surface of atmospheric particles and Al₂O₃ to form gas-phase CO₂ and surface sulfate (SO₄(²⁻)), sulfite (HSO₃⁻), and hydrogen carbonate (HCO₃⁻) species. The real atmospheric particles were characterized using X-ray fluorescence (XRF) and the Brunauer-Emmett-Teller (BET) method. As a simplified model, Al₂O₃ was used to study the reaction mechanism of heterogeneous oxidation of OCS. The hydrogen thiocarbonate surface (HSCO₂⁻) species, an intermediate formed in the reaction of OCS with surface hydroxyl (OH), could only be observed on the prereduced Al₂O₃ sample. The experimental results also indicate that surface oxygen containing species on the atmospheric particle sample and the Al₂O₃ sample might be the key reactant for OCS oxidation. A reaction mechanism of heterogeneous oxidation of OCS on Al₂O₃ surface is discussed.

Helmig, D. (1997). "Ozone removal techniques in the sampling of atmospheric volatile organic trace

gases." Atmospheric Environment **31**(21): 3635-3651.

Some of the most detrimental interferences in the atmospheric analysis of volatile organic compounds (VOCs) are reactions between ozone and the analytes occurring during the sampling and enrichment process. This paper provides a review of typical interferences observed and techniques to circumvent this problem by the selective removal of ozone from the air sample.

Henke, K. R. (1998). "Chemistry of heavy metal precipitates resulting from reactions with thio-red." Water Environment Research **70**(6): 1178-1185.

Thio-Red is a commercial product that is widely used to precipitate divalent heavy metal contaminants from water. To gain a better understanding of how Thio-Red reacts with dissolved divalent metals, the product was added to laboratory aqueous solutions, each of which contained one of several dissolved copper, lead, mercury, and zinc compounds. In all of the solutions, precipitates rapidly formed after adding Thio-Red. X-ray diffraction analyses of the precipitates detected ordinary metal sulfides rather than metal thiocarbonates. Further investigations identified reactions that may be responsible for the formation of the precipitates.

Herr, D. W., J. E. Graff, et al. (2005). "Ten-day exposure to carbonyl sulfide produce brainstem lesions and changes in brainstem auditory evoked responses in fischer 344n rats." Toxicol Sci 2005 Mar;**84**(1-S):223: -.

Carbonyl sulfide (COS) is an intermediate in the production of pesticides and herbicides, a metabolite of carbon disulfide, a byproduct of combustion of organic material, and occurs naturally. COS was included in a Toxic Substances Control Act data request, and was listed as a Clean Air Act hazardous air pollutant. We have reported that 12-week exposure to 400 ppm COS produces brainstem lesions and altered brainstem auditory evoked responses (BAERs). To determine if shorter duration exposures produce similar effects, and to examine additional behavioral endpoints, male Fischer 344N rats were exposed by inhalation to 0, 300, or 400 ppm COS for 6 h/day, 5 days/week, for 2 weeks. Animals were tested 5-11 days after the last exposure using a functional observational battery and white noise prepulse inhibition (PPI) of the startle response. About 19 days after COS exposure, subjects were implanted with electrodes over the cerebellum and visual cortex and were allowed to recover for 1 week. Animals were presented with auditory stimuli consisting of rarefaction clicks (50, 65, 80 dB SPL), tone pips (4 and 16 kHz at 80 dB SPL), and flash stimuli (15 and 146 lux-s). Rats exposed to 400 ppm COS had lower motor activity and grip strengths, a slightly altered gait, and a few animals lacked the forelimb proprioceptive placing response. No changes were observed in sensory responses. White noise PPI of the startle response was not altered in COS-treated animals. Exposure to COS decreased BAER amplitudes (peak P4 region). Histopathology confirmed brainstem lesions in the anterior olivary complex and posterior colliculus. Flash evoked responses were not altered by COS exposure. We have shown that short-term exposure to COS produces mild motor deficits, brainstem lesions, and alters BAERs (without changes in PPI of the startle response), with no change in visual evoked responses.

Herr, D. W., J. E. Graff, et al. (2007/1). "Inhalational exposure to carbonyl sulfide produces altered brainstem auditory and somatosensory-evoked potentials in Fischer 344N rats." Toxicol Sci **95**(1): 118-35.

Carbonyl sulfide (COS), a chemical listed by the original Clean Air Act, was tested for neurotoxicity by a National Institute of Environmental Health Sciences/National Toxicology Program and U.S. Environmental Protection Agency collaborative investigation. Previous studies demonstrated that COS produced cortical and brainstem lesions and altered auditory neurophysiological responses to click stimuli. This paper reports the results of expanded neurophysiological examinations that were an integral part of the previously published experiments (Morgan et al., 2004, *Toxicol. Appl. Pharmacol.* 200, 131-145; Sills et al., 2004, *Toxicol. Pathol.* 32, 1-10). Fisher 334N rats were exposed to 0, 200, 300, or 400 ppm COS for 6 h/day, 5 days/week for 12 weeks, or to 0, 300, or 400 ppm COS for 2 weeks using whole-body inhalation chambers. After treatment, the animals were studied using neurophysiological tests to examine: peripheral nerve function, somatosensory-evoked potentials (SEPs) (tail/hindlimb and facial cortical regions), brainstem auditory-evoked responses (BAERs), and visual flash-evoked potentials (2-week study). Additionally, the animals exposed for 2 weeks were examined using a functional observational battery (FOB) and response modification audiometry (RMA). Peripheral nerve function was not altered for any exposure scenario. Likewise, amplitudes of SEPs recorded from the cerebellum were not altered by treatment with COS. In contrast, amplitudes and latencies of SEPs recorded from cortical areas were altered after 12-week exposure to 400 ppm COS. The SEP waveforms were changed to a greater extent after forelimb stimulation than tail stimulation in the 2-week study. The most consistent findings were decreased amplitudes of BAER peaks associated with brainstem regions after exposure to 400 ppm COS. Additional BAER peaks were affected after 12 weeks, compared to 2 weeks of treatment, indicating that additional regions of the brainstem were damaged with longer exposures. The changes in BAERs were observed in the absence of altered auditory responsiveness in FOB or RMA. This series of experiments demonstrates that COS produces changes in brainstem auditory and cortical somatosensory neurophysiological responses that correlate with previously described histopathological damage.

Herr, D. W. R. A., J. E. R. A. Graff, et al. (2003). "12 week exposure to carbonyl sulfide produces brain lesions and changes in brainstem auditory (baer) and somatosensory (sep) evoked potentials in fischer 344n rats." Toxicological Sciences, (March 2003) Vol.72, No.S-1, pp.72.print.Meeting Info.: 42nd Annual Meeting of the Society of Toxicology.Salt Lake City, Utah, USA.March 09-13, 2003.Society of Toxicology.ISSN: 1096-6080 (ISSN print). -.

Hines, M. E. (1992). "Gas exchange in wetlands: controls and remote sensing." Govt Reports Announcements & Index (Gra&I), Issue 01, 1995: -.

TD3: This project was directed toward the quantification of fluxes of gaseous biogenic sulfur compounds from freshwater wetlands. These compounds (primarily hydrogen sulfide (H₂S), dimethyl sulfide (DMS), and carbonyl sulfide (OCS)) have been implicated in the regulation of planetary albedo by the formation of microscopic atmospheric aerosols when they oxidize, and the further role of these aerosols as cloud condensation nuclei (CCN). The role of continental sources and sinks for these

compounds is poorly understood. The present study was undertaken to quantify the source and sink strength of high latitude wetlands, and to delineate factors that regulate this flux. Final Technical Report, 1 Oct. 1991 - 30 Sep. 1992.

Hines, M. E., R. E. Pelletier, et al. (1992). "Emissions of sulfur gases from marine and freshwater wetlands of the Florida Everglades: rates and extrapolation using remote sensing." Govt Reports Announcements & Index (GRA&I), Issue 02, 1994: -.

TD3: Rates of emissions of the biogenic sulfur (S) gases carbonyl sulfide (COS), methyl mercaptan (MSH), dimethyl sulfide (DMS), and carbon disulfide (CS₂) were measured in a variety of marine and freshwater wetland habitats in the Florida Everglades during a short duration period in October using dynamic chambers, cryotrapping techniques, and gas chromatography. The most rapid emissions of greater than 500 nmol/m²h occurred in red mangrove-dominated sites that were adjacent to open seawater and contained numerous crab burrows. Poorly drained red mangrove sites exhibited lower fluxes of approximately 60 nmol/m²h which were similar to fluxes from the black mangrove areas which dominated the marine-influenced wetland sites in the Everglades. DMS was the dominant organo-S gas emitted especially in the freshwater areas. Spectral data from a scene from the Landsat thematic mapper were used to map habitats in the Everglades. Six vegetation categories were delineated using geo

Hiraoka, K., K. Fujita, et al. (2005/11). "Thermochemical stabilities and structures of the cluster ions OCS⁺, S₂⁺, H⁺(OCS), and C₂H₅⁺ with OCS molecules in the gas phase." J Am Soc Mass Spectrom **16** (11): 1760-71.

The gas-phase clustering reactions of OCS⁺, S₂⁺, H⁺(OCS), and C₂H₅⁺ ions with carbonyl sulfide (OCS) molecules were studied using a pulsed electron-beam high-pressure mass spectrometer and applying density functional theory (DFT) calculations. In the cluster ions OCS⁺(OCS)_n and H⁺(OCS)_n, a moderately strong, here referred to as "semi-covalent", bond was formed with n = 1. However, the nature of bonding changed from semi-covalent to electrostatic with n = 1 → 2. The bond energy of S₂⁺(OCS) was determined experimentally to be 12.9 ± 1 kcal/mol, which is significantly smaller than that of the isovalent S₂⁺(CS₂) complex (30.9 ± 1.5 kcal/mol). DFT based calculations predicted the presence of several isomeric structures for H⁺(OCS)_n complexes. The bond energies in the C₂H₅⁺(OCS)_n clusters showed an irregular decrease for n = 1 → 2 and 7 → 8. The nonclassical bridge structure for the free C₂H₅⁺ isomerized to form a semi-covalent bond with one OCS ligand, [H₃CCH₂...SCO]⁺, i.e., reverted to classical structure. However, the nonclassical bridge structure of C₂H₅⁺ was preserved in the cluster ions C₂H₅⁺(OCS)_n below 140 K attributable to the lack of thermal energy for the isomerization. DFT calculations revealed that stability orders of the geometric isomers of H⁺(OCS)_n and C₂H₅⁺(OCS)_n changed with increasing n values.

Hofmann, D. J. (1990). "Increase in the stratospheric background sulfuric acid aerosol mass in the past 10 years." Science (Washington D C) **248**(4958): 996-1000.

Data obtained from measurements of the stratospheric aerosol at Laramie, Wyoming (41° N), indicate that the background or nonvolcanic stratospheric sulfuric acid aerosol mass at northern mid-latitudes has increased by about 5 ± 2 percent per year during the past 10 years. Whether this increase is natural or anthropogenic could not be determined at this time because of inadequate information on sulfur sources, in particular, carbonyl sulfide, which is thought to be the dominant nonvolcanic source of stratospheric sulfuric acid vapor. An increase in stratospheric sulfate levels has important climatic implications as well as heterogeneous chemical effect that may alter the concentration of stratospheric ozone.

Hofmann, U., G. Protoschill-Krebs, et al. (1990). "Uptake and emission of gaseous sulfur components by vegetation." 7th Congress of the Federation of European Societies of Plant Physiology, Umea, Sweden, August 5-10, 1990. *Physiol Plant*; 79 (2 Part 2).1990.A123.Ab - Biosis Copyright: Biol Abs. Rrm Abstract Ribulose Bisphosphate Carboxylase Phosphoenolpyruvate Carboxylase Carbonic Anhydrase Carbonyl Sulfide Diurnal Variations: -.

Honma, M. (1961). "Manned space vehicle toxicological problems caused by gases evolved from thermal degradation of polysulfide polymers." Institute of Environmental Sciences, Annual Technical Meeting Proceedings, Pages 321-324, 3 References, 19611961: -.

The thermal pyrolysis of polysulfide polymers used in space capsule construction was investigated with regard to the evolution of toxic materials. An epoxy polysulfide formulation cured for over 30 days, was pyrolyzed in air flowing at 85 milliliters (ml) per minute; the same sample was subjected to 100 degrees-C for 89.5 hours, 200 degrees for 99.0 hours, 300 degrees for 94.0 hours, and 600 degrees for 1 hour. Evolved gases were condensed in a series of traps cooled to 0 to minus 196 degrees, or were trapped on activated charcoal; gases were analyzed by calibrated gas/solid chromatography. The rate at which gases were generated was determined by pyrolyzing another sample at 450 degrees. At intervals up to 208 minutes, gases trapped by condensers were quantitatively analyzed by expansion into evacuated calibrated volumes and correction of pressure. At 100 degrees-C, only hydrogen (1333740), carbon-monoxide (630080), carbon-dioxide (124389), and water were evolved. At 200 degrees, sulfur-dioxide (7446095), and ethylene (74851) appeared, followed by methane (74828), ethane (74840), hydrogen-sulfide (7783064), carbonyl-sulfide (463581), methyl-mercaptan (74931), and propylene (115071) at 300 degrees. No new gases were evolved at 600 degrees. Total gas output peaked at 20 minutes at a rate of 20.68ml per minute. Of the principal products evolved, carbon-dioxide, ethylene, and sulfur-dioxide peaked at 20 minutes, while hydrogen-sulfide and ethane peaked at 30 and 40 minutes, respectively. Over the span of the pyrolysis, 0.209 grams (g) of sulfur-dioxide were obtained from a 13.007g sample; sulfur-dioxide concentrations in air reached 4520 parts per million. The author concludes that a 900 times dilution of sulfur-dioxide would be required to meet industrial safety standards, and a much greater attenuation would be needed in a space vehicle atmosphere.

Hopson, R. F. (1991). "Potential impact on water resources from future volcanic eruptions at long valley mono county california usa." *Environ Geol Water Sci* 18(1): 49-56.

RRM MICROORGANISM ACCUMULATION GEOTHERMAL ACTIVITY WATER QUALITY

Horton, A. D. and M. R. Guerin (1974). "Quantitative determination of sulfur compounds in the gas phase of cigarette smoke." J Chromatogr; 90 (1).1974 63-70: -.

HEEP COPYRIGHT: BIOL ABS. Flame photometric detection gas chromatography affords a reliable approach for the determination of sulfur compounds in smokes. Reliable quantitative data can only be generated if the analytical system allows a minimum of time to elapse between smoke generation and the onset of analyses. Contact with stainless-steel surfaces must be minimized and the chromatographic column must be conditioned to avoid irreversible adsorption. Typical cigarettes deliver approximately 85 mug of H₂S, 35 mug of CS₂, and 3 mug of SO₂ when smoked under standard conditions. The gas phases of smokes contain at least 28 sulfur components. Quantitative distribution of these components is highly sensitive to sampling methodologies.

Hoyt, S. D. and M. Khalil (1982). "Atmospheric carbonyl sulfide: techniques for measurement in air and water. Au - rasmussen ra." Chemosphere 11(9): 869-876.

HEEP COPYRIGHT: BIOL ABS. Experiments showed that the oceans released a significant fraction of the yearly global emissions of carbonyl sulfide (OCS) to the atmosphere. The experimental methods used to obtain, store and analyze air and water samples for OCS measurements were discussed and measurements of the Henry's constant in seawater at 0°-30° C were reported. The results were applied to oceanic flux models, and the global yearly emissions of OCS from oceans to the atmosphere were calculated to be 8

Hugod, C. (1981). "Myocardial morphology in rabbits exposed to various gas-phase constituents of tobacco smoke: an ultrastructural study." Atherosclerosis 40(2): 181-190.

HEEP COPYRIGHT: BIOL ABS. Rabbits were continuously exposed to 200 ppm CO. Using the same criteria as applied in earlier investigations for morphological myocardial damage, no histotoxic effect on myocardial damage, no histotoxic effect on myocardial morphology could be demonstrated when EM investigations were performed blindly. Similarly, exposure to 0.5 ppm HCN, 0.5 ppm HCN + 200 ppm CO, 0.5 ppm HCN + 200 ppm CO + 5 ppm nitric oxide and to 50 ppm carbonyl sulfide for 1-7 wk had no significant effect on myocardial ultrastructure.

Hugod, C. (1981/10). "Myocardial morphology in rabbits exposed to various gas-phase constituents of tobacco smoke--an ultrastructural study." Atherosclerosis 40(2): 181-90.

Rabbits were continuously exposed to 200 ppm carbon monoxide. Using the same criteria as applied by earlier investigators for morphological myocardial damage, no histotoxic effect on myocardial morphology could be demonstrated when electron-microscopic investigations were performed blindly. Similarly, exposure to 0.5 ppm hydrogen cyanide, 0.5 ppm hydrogen cyanide + 200 ppm carbon monoxide, 0.5 ppm hydrogen cyanide + 200 ppm carbon monoxide + 5 ppm nitric oxide and to 50 ppm carbonyl sulphide for 1-7 weeks had no significant effect on myocardial ultrastructure.

Hugod, C. and P. Astrup (1980/2/20). "Exposure of rabbits to carbon monoxide and other gas phase constituents of tobacco smoke." MMW Munch Med Wochenschr **122 Suppl 1**: 18-24.

Non cholesterol-fed rabbits were exposed to carbon monoxide at concentrations in air of either 200, 2000, or 4000 ppm (= 0.02, 0.2, or 0.4% vol/vol). Further, exposure was performed to 0.5 ppm hydrogen cyanide alone or in combination with 200 ppm carbon monoxide or with 200 ppm carbon monoxide and 5 ppm nitric oxide and eventually to 50 ppm carbonyl sulphide. Duration of the continuous exposures were between 1/2 week and 12 weeks. Using the same criteria for intimal damage as in earlier morphological studies, no histotoxic effect on intimal/subintimal morphology of coronary arteries or the aorta could be demonstrated, when light-microscopic evaluation was performed blindly.

Hyman, M. R., S. A. Ensign, et al. (1989/8/22). "Carbonyl sulfide inhibition of CO dehydrogenase from *Rhodospirillum rubrum*." Biochemistry **28**(17): 6821-6.

Carbonyl sulfide (COS) has been investigated as a rapid-equilibrium inhibitor of CO oxidation by the CO dehydrogenase purified from *Rhodospirillum rubrum*. The kinetic evidence suggests that the inhibition by COS is largely competitive versus CO ($K_i = 2.3 \text{ microM}$) and uncompetitive versus methylviologen as electron acceptor ($K_i = 15.8 \text{ microM}$). The data are compatible with a ping-pong mechanism for CO oxidation and COS inhibition. Unlike the substrate CO, COS does not reduce the iron-sulfur centers of dye-oxidized CO dehydrogenase and thus is not an alternative substrate for the enzyme. However, like CO, COS is capable of protecting CO dehydrogenase from slow-binding inhibition by cyanide. A true binding constant (K_D) of 2.2 microM for COS has been derived on the basis of the saturable nature of COS protection against cyanide inhibition. The ability of CO, CO₂, COS, and related CO/CO₂ analogues to reverse cyanide inhibition of CO dehydrogenase is also demonstrated. The kinetic results are interpreted in terms of two binding sites for CO on CO dehydrogenase from *R. rubrum*.

Idso, S. B. (1992). "The dms-cloud albedo feedback effect greatly underestimated?" Clim Change **21**(4): 429-433.

RRM GLOBAL WARMING CARBON DIOXIDE

Inomata, Y., K. Matsunaga, et al. (1999/12/9). "Simultaneous measurement of volatile sulfur compounds using ascorbic acid for oxidant removal and gas chromatography-flame photometric detection." J Chromatogr A **864**(1): 111-9.

A method for the simultaneous measurement of volatile sulfur compounds (COS, H₂S, CS₂, CH₃SH, DMS) is established with preconcentration and GC-flame photometric detection (FPD). Prior to preconcentration of ambient air, it was necessary to remove SO₂, water vapor and atmospheric oxidant. SO₂ and water vapor were removed using a glass fiber filter and a cooled PTFE water trap loop, respectively. In order to remove atmospheric oxidant, the efficiency of an ascorbic acid scrubber was examined. It was found that an ascorbic acid scrubber enabled measurement of volatile sulfur

compounds without adsorption and reaction loss. The detection limits for COS, H₂S, CS₂, CH₃SH and DMS were 20, 34, 35, 263 and 44 pg of S, respectively.

Ito, T. (1993). "Size distribution of antarctic submicron aerosols." Tellus Ser B Chem Phys Meteorol **45** (2): 145-159.

The method and results of the observation of the size distribution of submicron aerosols carried out at Syowa (Antarctica) station (69°00'S, 39°35'E) in the sunlit months from August to December in 1978 are described. The most important finding in this series of observations is that the bimodal size distribution with a trough at around 10-6 cm in radius is seen in almost all observations. The prevalence of the bimodal size distribution observed at Syowa station in the sunlit months gives evidence of new particle formation in the Antarctic troposphere. Based on simplified theoretical calculations, it is concluded that the production rate of new particles is about 4 instance could be yielded by homogeneous conversion of an SO₂ concentration of 1 mug m⁻³ at a rate of 0.5% hr⁻¹. The most plausible precursors of SO₂ involved in this process seem to be rather inert gases such as COS, CS₂, etc. DMS plays a small role in this new particle formation process, although it does play

Jensen, N. R., J. Hjorth, et al. (1991). "Products and mechanism of the reaction between nitrate and dimethylsulfide in air." International Conference on the Generation of Oxidants on Regional and Global Scales, Norwich, England, Uk, July 3-7, 1989. Atmos Environ Part a Gen Top **25**(9): 1897-1904.

RRM TROPOSPHERE GAS PHASE AIR POLLUTION ENVIRONMENTAL TOXICOLOGY NIGHT CHEMISTRY

Johansson, B. (1989/5). "Carbonyl sulfide: a copper chelating metabolite of disulfiram." Drug Metab Dispos **17**(3): 351-3.

Johnson, J. E., J. E. Lovelock, et al. (1987). "The ecd-sulfur detector oceanographic sulfur species measurement at the femtomole level." 194th American Chemical Society National Meeting, New Orleans, Louisiana, Usa, August 30-September 4, 1987. Abstr Pap Am Chem Soc **194**(0): Envr 90-.

RRM ABSTRACT HYDROGEN SULFIDE CARBONYL SULFIDE DIMETHYL SULFIDE METHANETHIOL CARBON DISULFIDE ELECTRON CAPTURE DETECTOR

JS, B. (1985). "The relationship of carbon disulfide metabolism to development of toxicity." Neurotoxicology, Vol.6, No.4, Pages 73-80, 40 References, 19851985: -.

The relationship between carbon-disulfide (75150) (CS₂) disposition and development of CS₂ neurotoxicity is reviewed. Animal studies have indicated that approximately 8 to 30 percent of the CS₂ retained after inhalation exposure is excreted by the lung; amounts less than 0.5 percent of retained CS₂ are excreted by the kidney. Free CS₂ reaches steady state concentrations in various tissues within 4 to 5 hours after initiation of exposure. CS₂ is metabolized by two distinctly different pathways: ability of

CS₂ to spontaneously react with free amine and sulfhydryl groups of amino acids and polypeptides, and microsomal metabolism of CS₂ to reactive intermediates capable of covalently binding to tissue macromolecules. Dithiocarbamates are formed during in-vitro incubations of CS₂ with blood; treatment of the dithiocarbamate products with acid and heat liberates CS₂. Tissue concentrations of acid labile metabolites exceed those of free CS₂ at the end of an 8 hour, 2 milligram per liter (mg/l) CS₂ inhalation exposure. Acid labile metabolites may also accumulate in the body after repeated CS₂ exposure. Administration of high doses of CS₂ to rats may markedly decrease hepatic cytochrome-P-450 content and associated microsomal mixed function oxidase (MFO) activity. Pretreatment of rats with phenobarbital (50066), an inducer of MFO activity, produces more severe CS₂ hepatotoxicity characterized by hydropic degeneration and necrosis. In-vivo studies in rats confirm exhalation of carbon-dioxide and carbonyl-sulfide (463581) following intraperitoneal administration of CS₂. CS₂ induced neuropathy may induce vitamin-B6 deficiency by reacting with the free amine group of pyridoxamine. The author suggests that the metabolism of CS₂ proceeds by direct reaction with amine or thiol functions of cellular constituents and microsomal oxidation to reactive intermediates that covalently bind to cell macromolecules. Formation of reactive intermediates catalyzed by microsomal metabolism is important in mediating CS₂ induced hepatotoxicity.

Kaiser, R. I., C. Ochsenfeld, et al. (1998/2/20). "The formation of HCS and HCSH molecules and their role in the collision of comet Shoemaker-Levy 9 with Jupiter." Science **279**(5354): 1181-4.

The reaction of hydrogen sulfide with ground-state atomic carbon was examined with crossed molecular beams experiments and ab initio calculations. The thiohydroxycarbene molecule, HCSH, was the reactive intermediate, which fragmented into atomic hydrogen and the thioformyl radical HCS. This finding may account for the unassigned HCS source and an unidentified HCSH radical needed to match observed CS abundances from the collision of comet Shoemaker-Levy 9 into Jupiter. In the shocked jovian atmosphere, HCS could further decompose to H and CS, and CS could react with SH and OH to yield the observed CS₂ and COS.

Kamboores, M. A., D. R. Blake, et al. (2005/11/1). "Breath sulfides and pulmonary function in cystic fibrosis." Proc Natl Acad Sci U S A **102**(44): 15762-7.

We have determined the concentrations of carbonyl sulfide (OCS), dimethylsulfide, and carbon disulfide (CS₂) in the breath of a group of cystic fibrosis (CF) patients and one of healthy controls. At the detection sensitivity in these experiments, room air always contained measurable quantities of these three gases. For each subject the inhaled room concentrations were subtracted from the time-coincident concentrations in exhaled breath air. The most significant differences between the CF and control cohorts in these breath-minus-room values were found for OCS. The control group demonstrated a net uptake of 250 +/- 20 parts-per-trillion-by-volume (pptv), whereas the CF cohort had a net uptake of 110 +/- 60 pptv (P = 0.00003). Three CF patients exhaled more OCS than they inhaled from the room. The OCS concentrations in the CF cohort were strongly correlated with pulmonary function. The dimethylsulfide concentrations in breath were greatly enhanced over ambient, but no significant difference was observed between the CF and healthy control groups. The net (breath minus room) CS₂ concentrations for individuals ranged between +180 and -100 pptv. They were slightly greater in the CF

cohort (+26 +/- 38 pptv) vs. the control group (-17 +/- 15 pptv; P = 0.04). Lung disease in CF is accompanied by the subsistence of chronic bacterial infections. Sulfides are known to be produced by bacteria in various systems and were therefore the special target for this investigation. Our results suggest that breath sulfide content deserves attention as a noninvasive marker of respiratory colonization.

Kamstrup, O. and C. Hugod (1979). "Exposure of rabbits to 50 parts per million carbonyl sulfide: a biochemical and histomorphological study." Int Arch Occup Environ Health **44**(2): 109-116.

HEEP COPYRIGHT: BIOL ABS. Continuous exposure of rabbits to approximately 50 ppm carbonyl sulfide (COS) for 7 wk slightly elevated the mean serum cholesterol concentration. The mean serum triglyceride concentration was largely unaffected during exposure, although a trend to increase was observed. There was a small increase in the concentration of free cholesterol in aorta most likely caused by the difference in serum cholesterol concentrations between experimental and control animals. No significant difference in arterial uptake of labeled cholesterol between exposed animals and controls could be demonstrated. By light microscopic investigation, no histopathological changes in lungs or atherosclerosis-like intimal changes in coronary arteries, aorta or pulmonary arteries were found. Viscose rayon workers are professionally exposed to COS and are reportedly at an increased death risk due to coronary heart disease.

Kamstrup, O. and C. Hugod (1979/9). "Exposure of rabbits to 50 ppm carbonyl sulfide. A biochemical and histomorphological study." Int Arch Occup Environ Health **44**(2): 109-16.

Kamstrup, O., C. Hugod, et al. (1981). "Measurements of low concentrations of carbonyl sulfide." Beitr Tabakforsch Int **11**(1): 33-38.

HEEP COPYRIGHT: BIOL ABS. Methods (3) described for measuring carbonyl sulfide at low concentration levels (1-120 ppm) were mass spectrometry, gas chromatography with an electron capture detector and Beckman CO IR analyzer. When results obtained by mass spectrometry were used as reference values, the 2 other methods gave linear responses. The practical applicability for gas chromatography with an electron capture detector for measurements of the carbonyl sulfide content of mainstream and sidestream cigarette smoke was demonstrated. Values revealed higher concentration of carbonyl sulfide in mainstream than in sidestream cigarette smoke.

Kamyshny, A., A. Goifman, et al. (2003/5/1). "Formation of carbonyl sulfide by the reaction of carbon monoxide and inorganic polysulfides." Environ Sci Technol **37**(9): 1865-72.

OCS formation by the reaction of inorganic polysulfides with carbon monoxide, which are both abundant in natural aquatic systems, was studied as a model abiotic route for OCS formation in the dark. The net OCS accumulation rate was a function of a bimolecular formation reaction and simultaneous OCS hydrolysis kinetics. The reaction of polysulfides with CO in the dark was found to be first order with respect to CO concentration and first order with respect to the molar sum of the polysulfide species generated by the disproportionation of the dissolved polysulfide precursors. The pH dependence of the

OCS production rate was controlled by the pH-dependent disproportionation of polysulfide precursors. Lower temperatures, intermediate redox potentials, and moderately basic pH conditions increase the steady-state concentration of OCS. The speciation of polysulfides in aqueous solutions is still disputed. Some authors claim that hexasulfide is one of the dominant species while others believe that pentasulfide is the largest sulfide species in aqueous systems. Despite the disagreement between different models for speciation of polysulfides, the proposed rate law agreed very well with the thermodynamic data based on four and on five polysulfide species, with only minor differences in the preexponential kinetic coefficients.

Kanda, K. I., H. Tsuruta, et al. (1992). "Emission of dimethyl sulfide, carbonyl sulfide and carbon disulfide from paddy fields." Soil Sci Plant Nutr **38**(4): 709-716.

Emission rates of dimethyl sulfide (DMS), carbonyl sulfide (COS), and carbon disulfide (CS₂) to the atmosphere from paddy fields at Ryugasaki, Ibaraki Prefecture, Japan were measured by using the closed chamber method. DMS was emitted mainly through the rice plant and its emission rate was much higher than those of COS and CS₂. During a cropping period COS was slightly absorbed by the rice plant. Significant diurnal and seasonal variations of DMS fluxes were observed. The highest DMS flux was observed immediately after the heading day of rice plant. The annual DMS emission rate was in the order of mineral plot > straw plot > no-N plot, ranging from 4.5 to 6.9 mg S m⁻² yr⁻¹. The annual COS emission rate was in the order of straw plot > non-N plot > mineral plot, ranging from -0.2 to 1.8 mg S m⁻² yr⁻¹. The annual CS₂ emission rate was slightly higher in the straw plot, ranging from 0.9 to 2.0 mg S m⁻² yr⁻¹.

Kanda, K. I., H. Tsuruta, et al. (1995). "Emissions of biogenic sulfur gases from maize and wheat fields." Soil Science and Plant Nutrition **41**(1): 1-8.

Emission rates of dimethyl sulfide (DMS), carbonyl sulfide (COS), and carbon disulfide (CS₂) to the atmosphere from maize and wheat fields were measured by using the closed chamber method. DMS was a predominant sulfur gas emitted from these fields mainly through the plants. The highest DMS fluxes occurred just before the harvest of maize plants from plots treated with nitrogen fertilizer. Annual DMS emission rates were also higher in the plots treated with nitrogen fertilizer than in the plots without nitrogen fertilizer application. Annual emission rates of CS₂ were higher than those of COS, because COS was absorbed by the plants. Annual sulfur emission rates from the fields were in the range of 5.6 to 17.0 mg S m⁻² yr⁻¹.

Karellas, N. S. and J. M. Goodings (1986). "Comparative sulfur cation chemistry in a hydrocarbon flame with hydrogen sulfide carbonyl sulfide and sulfur dioxide additives." Can J Chem; **64** (12).1986 (Recd.1987).2412-2417.: -.

RRM EMISSIONS INDUSTRIAL WASTE

Karellas, N. S. and J. M. Goodings (1986). "Sulfur cation chemistry in a fuel-rich methane-oxygen

flame with carbonyl sulfide additive." Can J Chem **64**(9): 1733-1742.

RRM AIR POLLUTION

Katayama, Y., T. Kanagawa, et al. (1993). "Emission of carbonyl sulfide by thiobacillus thioparus grown with thiocyanate in pure and mixed cultures." Fems (Federation of European Microbiological Societies) Microbiology Letters **114**(2): 223-228.

When grown in the presence of thiocyanate, a pure culture of Thiobacillus thioparus THI 115 was found to hydrolyse thiocyanate to carbonyl sulfide (COS). The maximum amount of COS detected in the head space of a sealed flask was 2.2 μmol which represented 0.2% of total thiocyanate. COS was incorporated into the cells during further incubation, and could not be detected in the head space. Activated sludge for the treatment of thiocyanate, which contained T thioparus as a thiocyanate-degrading bacterium, also showed emission followed by disappearance of COS in the head space when incubated with thiocyanate. These results provide evidence for the biogenic origin of COS which may play an important role in acid rain precipitation and the greenhouse effect.

Katayama, Y., Y. Narahara, et al. (1992/5/5). "A thiocyanate hydrolase of Thiobacillus thioparus. A novel enzyme catalyzing the formation of carbonyl sulfide from thiocyanate." J Biol Chem **267**(13): 9170-5.

A thiocyanate hydrolase that catalyzes the first step in thiocyanate degradation was purified to homogeneity from Thiobacillus thioparus, an obligate chemolithotrophic eubacterium metabolizing thiocyanate to sulfate as an energy source. The thiocyanate hydrolase was purified 52-fold by steps involving ammonium sulfate precipitation, DEAE-Sephacel column chromatography, and hydroxylapatite column chromatography. The enzyme hydrolyzed 1 mol of thiocyanate to form 1 mol of carbonyl sulfide and 1 mol of ammonia as follows: $\text{SCN}^- + 2\text{H}_2\text{O} \rightarrow \text{COS} + \text{NH}_3 + \text{OH}^-$. This is the first report describing the hydrolysis of thiocyanate to carbonyl sulfide by an enzyme. The enzyme had a molecular mass of 126 kDa and was composed of three different subunits: alpha (19 kDa), beta (23 kDa), and gamma (32 kDa). The enzyme exhibited optimal activities at pH 7.5-8.0 and at temperatures ranging from 30 to 40 degrees C. The K_m value for thiocyanate was approximately 11 mM. Immunoblot analysis with polyclonal antibodies against the purified enzyme suggested that it was induced in T. thioparus cells when the cells were grown with thiocyanate.

Keller, M., J. Melillo, et al. (1997). "Trace gas emissions from ecosystems of the amazon basin." Ciencia E Cultura (Sao Paulo) **49**(1-2): 87-97.

Tropical forests of Amazonia play a major role in controlling the composition of the earth's atmosphere. Natural ecosystems of Amazonia contribute significant portions to the global budgets of the greenhouse gases methane and nitrous oxide. Amazon forest vegetation contributes to regional atmospheric chemistry as an important source of reduced gases such as volatile organics and carbon monoxide. The forest soils produce nitric oxide. Recent trends in land use change have led to increases in the sources of

nitrous oxide and methane. The ozone precursor nitric oxide is internally recycled under forest conditions while deforestation leads to larger net emissions. We have limited knowledge of biosphere-atmosphere exchange of trace gases in Amazonia. However, recent advances in instrumentation approaches and the evolution in the design of interdisciplinary field campaigns enhance the prospects for successful study of this area in earth system science.

Kelly, D. P. and S. C. Baker (1990). "The organosulfur cycle aerobic and anaerobic processes leading to turnover of c-1 sulfur compounds." 6th International Symposium on Microbial Growth on C1-Compounds, Goettingen, West Germany, August 20-25, 1989. *Fems (Fed Eur Microbiol Soc) Microbiol Rev* **87**(3-4): 241-246.

RRM REVIEW THIOBACILLI METHYLOTROPH METHANOGEN SULFATE-REDUCING BACTERIA ECOLOGY METHYLATED SULFIDE METHANE SULFONATE CARBON DISULFIDE CARBONYL SULFIDE ACID RAIN

Kelly, D. P., A. P. Wood, et al. (1994/11). "Biological production and consumption of gaseous organic sulphur compounds." *Biochem Soc Trans* **22**(4): 1011-5.

Kelly, T. J. and M. W. Holdren (1995). "Applicability of canisters for sample storage in the determination of hazardous air pollutants." *Atmospheric Environment* **29**(19): 2595-2608.

RRM RESEARCH ARTICLE VOLATILE ORGANIC COMPOUND ANALYTICAL METHOD

Kennes, C. and F. Thalasso (1998). "Waste gas biotreatment technology." *Journal of Chemical Technology and Biotechnology* **72**(4): 303-319.

This paper presents fundamental and theoretical aspects of biological waste gas treatment technologies as well as examples of applications to different compounds. The three most widely used technologies are described, namely biofiltration, bioscrubbing and trickling biofiltration, focusing more extensively on biofiltration which is the most studied and most extensively used process. A description of the different technologies from technological and economic points of view, including an analysis of models used in waste gas biotreatment is given. Results presented in the literature concerning the removal of aliphatic, aromatic and mixtures of contaminants are reviewed. Carrier materials, inocula selected and alternatives proposed for regulating moisture content, pH values or for controlling pressure drop are considered. New technologies and reactor design studied at laboratory-scale are mentioned. MH - BIOCHEMISTRY/METHODS

Khalil, M. (1992). "A statistical method for estimating uncertainties in the total global budgets of atmospheric trace gases." *J Environ Sci Health Part a Environ Sci Eng* **27**(3): 755-770.

The global cycles of trace gases are described by a balance between the atmospheric distributions and the annual emission and removal rates. Often for each source a range of possible annual emissions is

consistent with experimental observations. When these ranges are added together to produce a total annual emission rate, a range is usually quoted with a lower limit consisting of the sum of the lower limits of emissions from each source and an upper limit as the sum of the upper limits of emissions from each source. This process often leads to an unrealistically large range for the total source even though the uncertainties in emissions from individual sources are justified. This paper deals with a method by which the uncertainties in the total emissions can be interpreted statistically. When applied to 11 global budgets of CH₄, two budgets of CO, and a budget of carbonyl sulfide (OCS), the 95% confidence limits of total global emissions are about half as big as the rang

Khalil, M. and R. A. Rasmussen (1984). "Global sources lifetimes and mass balances of carbonyl sulfide and carbon disulfide in the earths atmosphere." Symposium on Tropospheric Chemistry With Emphasis on Sulphur and Nitrogen Cycles and the Chemistry of Clouds and Precipitation Held at the 5th International Conference of the Commission on Atmospheric Chemistry and Global Pollution of the International Association for Meteorology and Atmospheric Physics (Iamap), Oxford, England, Aug.28-Sept.3, 1983. *Atmos Environ* **18**(9): 1805-1814.

HEEP COPYRIGHT: BIOL ABS. RRM AUTOMOBILE EXHAUST BIOMASS BURNING OCEAN-AIR EXCHANGE INDUSTRIAL POLLUTION

Kilburn, K. H. and R. H. Warshaw (1995). "Hydrogen sulfide and reduced-sulfur gases adversely affect neurophysiological functions." Toxicology and Industrial Health, Vol.11, No.2, Pages 185-197 37
References, 1995: -.

The effects of low level chronic exposure to hydrogen-sulfide (7783064) (H₂S) and reduced sulfur gases were measured in 13 former refinery workers and 22 residents downwind of a refinery. Workers had been employed in the desulfurization unit of the California coastal refinery for 1.5 to 3 years. The residents lived within 2,400 meters of, and at a lower elevation than, the sulfur facility and coking units. Air monitoring near the subjects' homes gave readings of 10 parts per billion (ppb), with peaks of 100ppb, H₂S, 4ppb dimethyl-sulfide, and 2ppb mercaptans. Outside the desulfurization unit, 24 hour averages were 0.1 to 21.1 parts per million (ppm) mercaptans, 0 to 8.8ppm H₂S, 2.6 to 52.1ppm carbon-oxide-sulfide (463581), and 2.6 to 52.1ppm total reduced sulfur. Subjects were tested before and after filing suit against the refinery. Healthy controls were nominated by the subjects. Subjects completed occupational and medical history questionnaires and were tested on neurophysiological and neuropsychological functions. As there were no statistically significant differences between groups, workers and residents mean test scores were pooled. Three out of four neurological functions were significantly different from the control group. Simple reaction time was slower, sway speed with eyes open and shut was faster, and color discrimination was reduced. Of the neuropsychological functions, trail making times were significantly longer and mean profile of mood states (POMS) scores significantly exceeded controls' scores. Scores significantly elevated included anger, confusion, depression, tension/anxiety, and fatigue. Significantly higher average frequencies for 31 of 33 complaints were calculated by t-test. These complaints included respiratory and mucous membrane irritation, neurological symptoms, sleep disturbances and general symptoms including headache and skin complaints. The authors conclude that neurophysiological abnormalities were associated with exposure

to reduced sulfur gases.

Kindermann, G., K. Hueve, et al. (1995). "Emission of hydrogen sulfide by twigs of conifers: a comparison of norway spruce (*picea abies* (l.) Karst.), Scotch pine (*pinus sylvestris* l.) And blue spruce (*picea pungens* engelm.)." Plant and Soil **168-169**(0): 421-423.

The emission of reduced volatile sulfur compounds from twigs of Norway spruce (*Picea abies* (L.) Karst.) was measured in the field by cryosampling and gas chromatographic analysis. Trees were growing in the Erzgebirge (E-Germany) at Oberbarenburg and at the Kahleberg and at a third stand in NW-Bavaria (S-Germany). Emission rates were also measured for Scotch pine (*Pinus sylvestris* L.) and Blue spruce (*Picea pungens* Engelm.) at the Kahleberg. Twigs still attached to the trees were enclosed in a flow-through gas exchange cuvette. H₂S was detected as the predominant reduced sulfur compound emitted from the twigs. The mean H₂S emission rate from twigs of Norway spruce varied between 0.04 pmol kg⁻¹ dw s⁻¹ at Wurzburg and 6.21 pmol kg⁻¹ dw s⁻¹ at the Kahleberg. Comparing different species at the Kahlebera, the mean H₂S emission rate was almost the same from twigs of Norway spruce (6.2 pmol kg⁻¹ dw s⁻¹) and Blue Spruce trees (5.9 pmol kg⁻¹ dw s⁻¹) but it was approximately 18 ti

Kindermann, G., K. Hueve, et al. (1995). "Is emission of hydrogen sulfide a dominant factor of so₂ detoxification? A comparison of norway spruce (*picea abies* (l.) Karst.), Scots pine (*pinus sylvestris* l.) And blue spruce (*picea pungens* engelm.,) In the ore mountains." Phyton (Horn) **35**(2): 255-267.

The emission of reduced volatile sulfur compounds from Norway spruce (*Picea abies* (L.) Karst.), Scots pine (*Pinus sylvestris* L.) and Blue spruce (*Picea pungens* Engelm.) growing at high elevation in the Ore mountains (Kahleberg, Germany, altitude 907 m) was measured in the field by cryosampling and gaschromatographic analysis. Twigs still attached to the trees were enclosed in a flow-through gas exchange cuvette and H₂S was detected as the predominant reduced sulfur compound in the effluent gas stream. Carbonylsulfide (COS) and, in a portion of the samples, dimethylsulfide were also detected. The mean H₂S emission rate was almost the same from twigs of Norway spruce (6.2 pmol kg⁻¹ dw s⁻¹) and Blue spruce trees (5.9 pmol kg⁻¹ dw s⁻¹) but it was approximately 18 times higher for Scots pine (110 pmol kg⁻¹ dw s⁻¹). The percentage of SO₂ detoxification via H₂S emission was calculated on the basis of data on SO₂ fluxes. It is only about 1% for Norway spruce and Blue spruce bu

Klemp, M., A. Peters, et al. (1994). "High-speed gc analysis of vocs sample collection and inlet systems." Environmental Science & Technology **28**(8): 369a-376a.

RRM JOURNAL ARTICLE VOLATILE ORGANIC COMPOUNDS AIR POLLUTION SOIL POLLUTION CRYOFOCUSING SAMPLE COLLECTION HIGH-SPEED GAS CHROMATOGRAPHY ANALYTICAL METHOD

Kluczewski, S. M., K. A. Brown, et al. (1985). "Deposition of carbonyl sulfide to soils." Atmos Environ **19**(8): 1295-1300.

RRM MICROFLORA SULFUR-35 RADIOLOGICAL DOSE MODEL

Kluczewski, S. M., K. A. Brown, et al. (1984). "Preparation of high purity sulfur-35-labeled carbonylsulfide." J Labelled Compd Radiopharm **21**(5): 485-488.

HEEP COPYRIGHT: BIOL ABS. The title compound (COS; of interest as an atmospheric pollutant and as a fungicide) was synthesized (for use in studies of uptake and metabolism by plants and soils) by the reaction between elementary ³⁵S and CO at 300° C, and purified by passage over Porapak QS. The only detectable S-impurity in the purified production was CS₂ at < 0.05% (vol/vol) of the COS concentration.

Kluge, M. and G. Proy (1984). "Desulphurization of hot reducing gas by means of metal oxides in a fixed bed reactor." Govt Reports Announcements & Index (Gra&I), Issue 23, 1984: -.

TD3: The calculation of thermodynamic equilibria for reducing gases in the temperature range of 950 to 1550 K shows that sulfur exists only as hydrogen sulfide and carbon oxysulfide. Theoretical investigations of the reactions of these sulfur compounds with metallic oxides leads to the result that reducing gases with a water content of 5% can be cleaned to sulfur contents less than 50 ppm. Zinc oxide and manganese oxide can be used till about 1050 K, calcium oxides till about 1120 K and barium oxide in the entire temperature range. Experiments were carried out in the fixed bed reactor with barium, zinc and calcium oxide as well as dolomite with particle sizes of 0,8 to 8 mm within the temperature range of 960 to 1300 K. Total sulfur concentrations between 10 and 35 ppm in the gas could be achieved. A mathematical model was developed with which the velocity of sulfur acceptance can be calculated by desulfurization with limestone at 1150 K. The calculation of a reactor scale-up is therefore possible fo

Kodama, M., M. Kaneko, et al. (1997). "Free radical chemistry of cigarette smoke and its implication in human cancer." Anticancer Research **17**(1a): 433-437.

Multiple components in cigarette smoke were analyzed for their ability to form active oxygen species using a spin trapping agent, 5,5-dimethyl-1-pyrroline-N-oxide. The main source of O₂·- and H₂O₂ was ascribed to polyphenols in a particulate phase, whereas a synergistic effect was also observed between these polyphenols and nicotine. The vapor phase contained a factor which produced ·OH from H₂O₂ which was identified as carbonyl sulfide. Nitric oxide in the vapor phase did not show such reactivity. The formation of an active oxygen species in cigarette smoke could provide an important clue to elucidate the mechanism of tobacco carcinogenesis, since they show genotoxic effects to induce DNA strand breaks as well as epigenetic effects to act as cell proliferation signals.

Kolbe, W. F. and B. Leskovar (1983). "Millimeter and submillimeter wave absorption by atmospheric pollutants and constituents." J Quan Spectrosc Radiat Transfer **30**(5): 463-478.

HEEP COPYRIGHT: BIOL ABS. RRM MICROWAVE ROTATIONAL SPECTROSCOPY
SAMPLING RN - 14280-30-9

Krasnopolsky, V. A. and J. B. Pollack (1994/5). "H₂O-H₂SO₄ system in Venus' clouds and OCS, CO, and H₂SO₄ profiles in Venus' troposphere." *Icarus* **109**(1): 58-78.

A coupled problem of diffusion and condensation is solved for the H₂SO₄-H₂O system in Venus' cloud layer. The position of the lower cloud boundary and profiles of the H₂O and H₂SO₄ vapor mixing ratios and of the H₂O/H₂SO₄ ratio of sulfuric acid aerosol and its flux are calculated as functions of the column photochemical production rate of sulfuric acid, $\phi_{\text{H}_2\text{SO}_4}$. Variations of the lower cloud boundary are considered. Our basic model, which is constrained to yield $f_{\text{H}_2\text{O}}(30 \text{ km}) = 30 \text{ ppm}$ (Pollack et al. 1993), predicts the position of the lower cloud boundary at 48.4 km coinciding with the mean Pioneer Venus value, the peak H₂SO₄ mixing ratio of 5.4 ppm, and the H₂SO₄ production rate $\phi_{\text{H}_2\text{SO}_4} = 2.2 \times 10^{12} \text{ cm}^{-2} \text{ sec}^{-1}$. The sulfur to sulfuric acid mass flux ratio in the clouds is 1 : 27 in this model, and the mass loading ratio may be larger than this value if sulfur particles are smaller than those of sulfuric acid. The model suggests that the extinction coefficient of sulfuric acid particles with radius 3.7 micrometers (mode 3) is equal to 0.3 km⁻¹ in the middle cloud layer. The downward flux of CO is equal to $1.7 \times 10^{12} \text{ cm}^{-2} \text{ sec}^{-1}$ in this model. Our second model, which is constrained to yield $f_{\text{H}_2\text{SO}_4} = 10 \text{ ppm}$ at the lower cloud boundary, close to the value measured by the Magellan radiooccultations, predicts the position of this boundary to be at 46.5 km, which agrees with the Magellan data; $f_{\text{H}_2\text{O}}(30 \text{ km}) = 90 \text{ ppm}$, close to the data of Moroz et al. (1983) at this altitude; $\phi_{\text{H}_2\text{SO}_4} = 6.4 \times 10^{12} \text{ cm}^{-2} \text{ sec}^{-1}$; and $\phi_{\text{CO}} = 4.2 \times 10^{12} \text{ cm}^{-2} \text{ sec}^{-1}$. The S/H₂SO₄ flux mass ratio is 1 : 18, and the extinction coefficient of the mode 3 sulfuric acid particles is equal to 0.9 km⁻¹ in the middle cloud layer. A strong gradient of the H₂SO₄ vapor mixing ratio near the bottom of the cloud layer drives a large upward flux of H₂SO₄, which condenses and forms the excessive downward flux of liquid sulfuric acid, which is larger by a factor of 4-7 than the flux in the middle cloud layer. This is the mechanism of formation of the lower cloud layer. Variations of the lower cloud layer are discussed. Our modeling of the OCS and CO profiles in the lower atmosphere measured by Pollack et al. (1993) provides a reasonable explanation of these data and shows that the rate coefficient of the reaction $\text{SO}_3 + \text{CO} \rightarrow \text{CO}_2 + \text{SO}_2$ is equal to $10^{(-11)} \exp(-13,100 \pm 1000/T) \text{ cm}^3/\text{s}$. The main channel of the reaction between SO₃ and OCS is $\text{CO}_2 + (\text{SO})_2$, and its rate coefficient is equal to $10^{(-11)} \exp(-8900 \pm 500/T) \text{ cm}^3/\text{s}$. In the conditions of Venus' lower atmosphere, (SO)₂ is removed by the reaction $(\text{SO})_2 + \text{OCS} \rightarrow \text{CO} + \text{S}_2 + \text{SO}_2$. The model predicts an OCS mixing ratio of 28 ppm near the surface.

Krupa, S. V. (1997). "Air pollution people and plants an introduction." Krupa, S.V. Air Pollution, People, and Plants: an Introduction. Ix+197p. American Phytopathological Society (Aps) Press: St. Paul, Minnesota, Usa. Isbn 0-89054-175-2. 0(0): Ix+197p-

RRM BOOK TEXTBOOK CLIMATOLOGY GLOBAL CLIMATE CHANGE AIR QUALITY ECOLOGY HUMAN HEALTH CROPS FOREST AIR POLLUTION CONTROL POLLUTION CONTAMINANT TRANSPORT ATMOSPHERIC CHEMISTRY

Kuhn, U., C. Ammann, et al. (1999). "Carbonyl sulfide exchange on an ecosystem scale: soil represents a dominant sink for atmospheric cos." *Atmospheric Environment* **33**(6): 995-1008.

The soil/plant/atmosphere exchange of carbonyl sulfide (COS) was investigated in an open oak woodland ecosystem at a rural site in northern California. Measurements of atmospheric concentrations of COS were made in June and in December 1994. We found a significant diel cycle with a drop of COS levels by approximately 150 ppt during the night in both seasons. The mean COS daytime background mixing ratios showed a distinct seasonal difference with 465 ± 77 ppt in summer and 375 ± 56 ppt in winter, due to high stomatal resistance. Results from soil chamber measurements indicate that the soil can act as a dominant sink for atmospheric COS.

Kuster, W. C. and P. D. Goldan (1987). "Quantitation of the losses of gaseous sulfur compounds to enclosure walls." Environ Sci Technol **21**(8): 810-815.

RRM AIR POLLUTION

L, S.-S., S. M., et al. "Global uptake of carbonyl sulfide (cos) by terrestrial vegetation: estimates corrected by deposition velocities normalized to the uptake of carbon dioxide (co2)."

BIOGEOSCIENCES: <2005: <VO1>2: <IS1>N2: <PG1>125-132: -.

Cos uptake by trees, as observed under dark/light changes and under application of the plant hormone abscisic acid, exhibited a strong correlation with the co2 assimilation rate and the stomatal conductance. As the uptake of cos occurred exclusively through the stomata we compared experimentally derived and re-evaluated deposition velocities (v_d ; related to stomatal conductance) for cos and co2. We show that v_d of cos is generally significantly larger than that of co2. We therefore introduced this attribute into a new global estimate of cos fluxes into vegetation. The new global estimate of the cos uptake based on available net primary productivity data (npp) ranges between 0.69-1.40 Tg a⁻¹. However, as a cos molecule is irreversibly split in contrast to co2 which is released again by respiration processes, we took into account the gross primary productivity (gpp) representing the true co2 leaf flux the cos uptake has to be related to. Such a gpp based deposition estimate ranged between 1.4-2.8 Tg a⁻¹ (0.73-1.50 Tg s a⁻¹). We believe that in order to obtain accurate global cos sink estimates such a gpp-based estimate corrected by the different deposition velocities of cos and co2 must be taken into account.

Langhorst, M. L. and L. B. Coyne (1987). "Industrial hygiene." Anal Chem **59**(12): 1r-17r.

RRM REVIEW DIISOCYANATES FORMALDEHYDE HAZARDOUS MATERIALS AIR POLLUTION ENVIRONMENTAL SURVEILLANCE WORK ENVIRONMENT

Lau, Y. K. (1989). "Measurement of sulfur gases in ambient air." Environ Monit Assess **13**(1): 69-74.

RRM GAS CHROMATOGRAPH AIR POLLUTION ENVIRONMENTAL QUALITY

Laura Lipciuc, M. and M. H. Janssen (2006/7/7). "Slice imaging of quantum state-to-state photodissociation dynamics of OCS." Phys Chem Chem Phys **8**(25): 3007-16.

Slice imaging experiments are reported for the quantum state-to-state photodissociation dynamics of OCS. Both one-laser and two-laser experiments are presented detecting CO(J) or S((1)D(2)) photofragments from the dissociation of hexapole state-selected OCS($v(2) = 0,1,2 / J = 1,2$) molecules. We present data using our recently developed large frame CCD centroiding detector and have implemented a new high speed MCP high voltage pulser with an effective slice width of only 6 ns. Slice images are presented for quantum state-to-state photolysis, near 230 nm, of vibrationally excited OCS($v(2) = 0,1,2$). Two-laser pump-probe experiments detecting CO(J = 63 or 64) show a dramatic change in the beta parameter for the same final state of CO(J) when the photolysis energy is reduced by about 1000 cm^{-1} . We attribute the observed change from large positive to large negative beta to a large increase of the molecular frame deflection angle at very slow recoil velocity, due to a breakdown of the axial recoil. Two-laser experiments on the S((1)D(2)) fragment reveal single well-separated rings in the slice images correlating with individual CO(J) states. Strong polarization effects of the probe laser are observed, both in the angular distribution of the intensity of single S((1)D(2)) rings and in the resolution of the radial velocity distribution. It is shown how the broadening of the velocity distribution can be reduced by a directed ejection of the electron in the ionization process perpendicular to the slice imaging plane. The dissociation energy of OCS($v(2) = 0, J = 0$) \rightarrow CO(J = 0) + S((1)D(2)) is determined with high accuracy $D(0) = (34\,608 \pm 24) \text{ cm}^{-1}$.

Leahy, T. E. (1969). "Determination of gases from viscose regeneration." Tappi, Vol.52, No.1, Pages 115-117, 3 References, 1969: -.

A method for qualitatively and quantitatively determining the gases formed during the regeneration of viscose was developed. A series of viscose samples were analyzed for carbon-disulfide (75150) (CS₂), hydrogen-sulfide (7783064) (H₂S), carbon-dioxide (124389) (CO₂), and carbonyl-sulfide (463581) (COS). For carbon-disulfide, a sample of viscose was acidified with sulfuric-acid and allowed to stand until regeneration was complete. The CS₂ evolved was purged into isooctane, diluted to volume, and determined either in the infrared or ultraviolet range, depending on sample size and quantity of CS₂ evolved. For hydrogen-sulfide, a sample of viscose was placed in the evolution flask and acidified with sulfuric-acid. After allowing time for regeneration, the flask was heated to boiling and a stream of nitrogen was passed through. The evolved H₂S was absorbed in copper-(II)-acetate, and after dilution to volume and filtration, the excess copper-(II) was determined iodometrically. For carbon-dioxide and carbonyl-sulfide, a sample of viscose was placed in the evolution flask with nitrogen inlet blocked off, and the flask was partially evacuated. The flask exit was connected to a highly evacuated gas collection bulb. The apparatus was allowed to come to atmospheric pressure by opening the funnel stopcock. A sample of the gases in the collection bulb was injected into the chromatograph. The gases were eluted in the order: air, CO₂, COS, and H₂S. From the weight percent of H₂S and the volume percent of each of the gases as determined from a calibration curve, the amounts of CO₂ and COS by weight were calculated. Recoveries were 98.7 to 99.5 percent for CS₂, and 99 to 100.3 percent for H₂S. Results were valid to about 2 percent for CO and COS. The methods were tested in determining the effect of pre and post xanthation conditions on the amounts and types of gases evolved during viscose regeneration. The author suggests that the method, when used in conjunction with other routine analyses normally applied to viscose, might then be used to follow the changes in viscose composition during ripening, and to predict the behavior of viscose during spinning.

Leboiteux, S. (1984). "Stratospheric concentration of nitric acid, ozone and carbonyl sulfide: measurement of nitric acid absorption in the q branch of the v4 band as a function of temperature." Govt Reports Announcements & Index (Gra&I), Issue 12, 1985: -.

TD3: Ten stratospheric species (O₃, NO₂, OCS, NO, CH₄, N₂O, HCl, HF, CO, HNO₃, and H₂O) were simultaneously measured and infrared absorption measurements by HNO₃ were recorded by instruments on an aircraft and from a balloon platform. The spectra obtained are presented and an attempt is made to evaluate a temperature dependence correction for the atmospheric spectra. Transl. into English of "Dosage de l'Acide Nitrique de l'Ozone et du Carbonyl Sulfureux dans la Stratosphere, Mesure de l'Absorption de l'Acide Nitrique dans la Branche Q de la Bande V4 en Fonction de la Temp." Rept. Onera-NT-1982-7 Onera, Paris, 1982. Original Language Document Announced as N84-27336.

Lee, S. C., M. J. Snodgrass, et al. (2001/6/1). "Kinetics of removal of carbonyl sulfide by aqueous monoethanolamine." Environ Sci Technol **35**(11): 2352-7.

The kinetics of the reaction between carbonyl sulfide and aqueous monoethanolamine (MEA) were studied over a range in temperature (298-348 K) and amine concentrations (5-20 wt%) using a wetted-sphere absorber. The experimental data were interpreted using a zwitterion mechanism. The key physicochemical properties needed to interpret the data are the solubility and diffusivity of COS in the aqueous amine solution. These properties were estimated using the N₂O analogy method. Experimental values of N₂O solubility were correlated using an extended scaled-particle model, and the measured N₂O diffusion coefficients were correlated using a modified Stokes-Einstein equation. Solution densities and viscosities were also measured and correlated in this work. On the basis of the zwitterion mechanism whose rate-limiting step was the deprotonation of a zwitterion, the Arrhenius relationship between the third-order rate constant and the temperature was well correlated with an absolute mean deviation of 0.3%. It could be thus concluded that the overall reaction rate was first-order in the COS concentration and second-order in the MEA concentration.

Leiber, M. A. and H. C. Berk (1985). "Determination of carbonyl sulfide in air by derivatization with 1,3-diaminopropane and capillary gas chromatographic analysis." Anal Chem **57**(14): 2792-2796.

RRM HUMAN HERBICIDE MANUFACTURE HAZARDOUS MATERIALS ENVIRONMENTAL SURVEILLANCE PERSONAL EXPOSURE INDUSTRIAL LOCATION FIELD TEST

Leiber, M. A. and H. C. Berk (1985). "A selective method for the personal monitoring of carbonyl sulfide derivatization with 1,3-diaminopropane and capillary gas chromatographic analysis." 190th American Chemical Society National Meeting, Chicago, Ill., Usa, Sept.8-13, 1985. Abstr Pap Am Chem Soc; 190 (0).1985 (Recd.1986).No Pagination.: -.

RRM ABSTRACT WORKROOM AIR

Lellouch, E., G. Paubert, et al. (1995/2/16). "Chemical and thermal response of Jupiter's atmosphere following the impact of comet Shoemaker-Levy 9." Nature **373**(6515): 592-5.

In July 1994, the collisions of the fragments of comet Shoemaker-Levy 9 with Jupiter resulted in dramatic changes in the planet's atmosphere. Observations of the events suggest that the composition and thermal properties of the atmosphere were considerably modified at the impact sites, with the changes persisting for times lasting from minutes to weeks (see, for example, refs 1-4). Here we report observations of the impact sites at millimetre wave-lengths, which reveal strong emission lines associated with carbon monoxide, carbonyl sulphide and carbon monosulphide. The abundance of carbon monoxide in the jovian atmosphere is normally very low; carbonyl sulphide and carbon monosulphide, on the other hand, have not hitherto been detected. We find that the largest fragments (G and K) each produced approximately 10^{14} g of carbon monoxide, 3×10^{12} g of carbonyl sulphide and 3×10^{11} g of carbon monosulphide, most probably by shock-induced chemical reactions. Our observations also place firm constraints on the thermal response of Jupiter's stratosphere to the impacts.

Leman, L., L. Orgel, et al. (2004/10/8). "Carbonyl sulfide-mediated prebiotic formation of peptides." Science **306**(5694): 283-6.

Almost all discussions of prebiotic chemistry assume that amino acids, nucleotides, and possibly other monomers were first formed on the Earth or brought to it in comets and meteorites, and then condensed nonenzymatically to form oligomeric products. However, attempts to demonstrate plausibly prebiotic polymerization reactions have met with limited success. We show that carbonyl sulfide (COS), a simple volcanic gas, brings about the formation of peptides from amino acids under mild conditions in aqueous solution. Depending on the reaction conditions and additives used, exposure of alpha-amino acids to COS generates peptides in yields of up to 80% in minutes to hours at room temperature.

Leman, L. J., L. E. Orgel, et al. (2006/1/11). "Amino acid dependent formation of phosphate anhydrides in water mediated by carbonyl sulfide." J Am Chem Soc **128**(1): 20-1.

Liesivuori, J. and K. Savolainen (1994). "Health surveillance of pesticide workers a manual for occupational health professionals dithiocarbamates." Toxicology **91**(1): 37-42.

RRM JOURNAL ARTICLE HUMAN FUNGICIDE

Lindgren, E. R., D. W. Pershing, et al. (1991). "Near-continuous measurement of hydrogen sulfide and carbonyl sulfide by an automatic gas chromatograph." Govt Reports Announcements & Index (Gra&I), Issue 11, 1992: -.

TD3: The article describes an automatic gas chromatograph with a flame photometric detector (GC-FPD) that samples and analyzes hydrogen sulfide (H₂S) and carbonyl sulfide (COS) at 30-sec intervals. Temperature programming was used to elute trace amounts of carbon disulfide (CS₂) present in each injection from a Supelpak-S column in a single peak at the end of 15 min runs. The system was used to

study the high-temperature fuel-rich sulfur capture reactions of H₂S and COS with injected calcium oxide (CaO) sorbent, necessitating the near continuous measurement of these gaseous sulfur species. The H₂S concentration ranged from 300 to 3000 ppm, and the COS from 30 to 300 ppm. The system was also used to monitor sulfur dioxide (SO₂) levels under fuel-lean conditions: results compared very closely with SO₂ measurements made simultaneously with continuous ultraviolet (UV) SO₂ instrumentation. Journal article Mar 89-Mar 90. Pub. in Jnl. of Chromatography, v585 p353-358 1991. Prepared in cooperation with Uta

Lindgren, E. R., D. W. Pershing, et al. (1992). "Fuel rich sulfur capture in a combustion environment." Govt Reports Announcements & Index (Gra&I), Issue 20, 1992: -.

TD3: The paper discusses the use of a refractory-lined, natural gas furnace to study the fuel-rich sulfur capture reactions of calcium sorbents under typical combustion conditions. The fuel-rich sulfur species hydrogen sulfide and carbonyl sulfide were monitored in a nearly continuous fashion using a gas chromatograph equipped with a flame photometric detector and an automatic system that sampled every 30 seconds. Below the fuel-rich zone, 25% excess air was added, and the ultimate fuel-lean capture was simultaneously measured using a continuous sulfur dioxide monitor. Under fuel-rich conditions, high levels of sulfur capture were obtained, and calcium utilization increased with sulfur concentration. The ultimate lean capture was found to be weakly dependent on sulfur concentration and independent of the sulfur capture level obtained in the fuel-rich zone. Journal article. Pub. in Environmental Science and Technology, v26 n7 p1427-1433 Jul 92. Sponsored by Environmental Protection Agency, Research Tr

Liu, W., M. Flytzani-Stephanopoulos, et al. (1992). "Selective catalytic reduction of sulfur dioxide to elemental sulfur. Quarterly technical progress report no. 2, october--december 1992." Govt Reports Announcements & Index (Gra&I), Issue 18, 1993: -.

TD3: Elemental sulfur recovery from SO₂-containing gas streams is highly attractive as it produces a saleable product and no waste to dispose of. However, commercially available schemes are complex and involve multi-stage reactors, such as, most notably in the Resox (reduction of SO₂ with coke) and Claus plants (reaction of SO₂ with H₂S over catalyst). This project will investigate a cerium oxide catalyst for the single-stage selective reduction SO₂ to elemental sulfur by a reductant, such as carbon monoxide. Cerium oxide has been identified as a superior catalyst for SO₂ reduction by CO to elemental sulfur because of its high activity and high selectivity to sulfur over COS over a wide temperature range (400--650°C). Kinetic and parametric studies of SO₂ reduction planned over various CeO₂-formulations will provide the necessary basis for development of a simplified process, a single-stage elemental sulfur recovery scheme from variable concentration gas streams

Logan, J. A., M. B. Mcelroy, et al. (1979). "Oxidation of carbon disulfide and carbon oxysulfide: sources for atmospheric sulfur dioxide." Nature (Lond) **281**(5728): 185-188.

HEEP COPYRIGHT: BIOL ABS. Oxidation of CS₂ and COS initiated by reaction with OH can provide

a source of atmospheric SO₂ as large as 12 Mtons S yr⁻¹ and may represent the dominant source of SO₂ in remote regions of the marine troposphere.

Lorimer, G. H. and J. Pierce (1989/2/15). "Carbonyl sulfide: an alternate substrate for but not an activator of ribulose-1,5-bisphosphate carboxylase." J Biol Chem **264**(5): 2764-72.

Carbonyl sulfide, a competitive inhibitor of ribulose-bisphosphate carboxylase with respect to CO₂ (Laing, W. A., and Christeller, J. T. (1980) Arch. Biochem. Biophys. 202, 592-600), is an alternate substrate. Thiocarboxylation was monitored by mass spectrometry as the stoichiometric consumption of carbonyl sulfide. The product, 1-thio-3-phosphoglycerate, was identified by ¹³C NMR and UV absorption spectroscopy and measured by enzymic conversion to thiolactate, coupled to the oxidation of NADH. The expected stoichiometry of thiocarboxylation was confirmed. The maximal rates of thiocarboxylation for the spinach and *Rhodospirillum rubrum* enzymes were close to the maximal rates of carboxylation for these two enzymes. Both enzymes favored CO₂ over carbonyl sulfide (with Mg²⁺ as metal ion) by a factor of about 110. Thiocarboxylation could only be demonstrated with enzymes carbamylated with CO₂. Incubation of the carbamylated E.ACO₂.Mg complex with excess carbonyl sulfide caused the displacement of the activator carbamate. The thiocarbamylated enzyme was catalytically incompetent and did not form a stable quaternary complex with 2'-carboxyarabinitol bisphosphate. Incubation of the thiocarbamylated enzyme with excess CO₂ resulted in the displacement of the thiocarbamate, the re-formation of the carbamylated E.ACO₂.Mg complex and the restoration of catalytic competence. Computergraphic simulation of the thiocarbamylated quaternary complex indicated unfavorable van der Waals interactions associated with the thiocarbamate.

Luo, D. (1989). "Abatement of pollution in process of synthesizing carbon oxysulfide by using a new catalyst." Chin J Environ Sci (Beijing) **10**(3): 42-45.

This paper deals with a waste-free technology. In the process of synthesizing carbon oxysulfide (COS), a new catalyst has been used to replace 13X molecular sieve, so that the yield of COS can rise from 65% to 90%. Because of enhancement of synthetic gas quality and reduction of hazardous gas, the system of gas purification would be removed in the process, by which environmental contaminant is eliminated. The catalyst process is simple, the cost is low and life span of the catalyst is long. Annually, taking count of output of COS 7000 NM³, 1500 tons of waste lye and 45 tons of waste CS₂ will be decreased.

Luria, M. and C. C. Van Valin (1986). "Contribution of gulf area natural sulfur to the north american sulfur budget." Environmental Science Technology **20**(1): 91-95; 1986.: -.

HMTC The contribution of natural sulfur emissions from the Gulf of Mexico to the total North American sulfur budget and the potential influence of this flux on precipitation acidification were examined. The Gulf area contribution to the total sulfur budget was minimal, ranging from 1.5% to 0.25%. Data were collected on dimethyl sulfide (DMS) and carbonyl sulfide (COS) through a series of air sampling flights over the Gulf of Mexico. DMS was the major source for atmospheric sulfate aerosols and therefore for acidification of precipitation. COS concentration was constant at 440 +/- 35

ppt. DMS levels varied significantly. DMS was not detected above the boundary layer. The average DMS concentration changed from 27 +/- 30 ppt during southerly airflows to 7 +/- 3 ppt when airflow was offshore. A negative correlation between DMS levels and trace atmospheric pollutants was demonstrated. To obtain a more accurate evaluation of natural sulfur contributions, additional sulfate measurements must be carried out during strong southerly airflows.

Lyke, S. E. (1984). "Development of a hot gas cleanup system for integrated coal gasification/molten carbonate fuel cell power plants. Quarterly technical progress report, august-november 1984." Govt Reports Announcements & Index (Gra&I), Issue 19, 1985: -.

TD3: The program to develop a hot gas cleanup system for integrated coal gasification/molten carbonate fuel cell power plants is divided into the following six tasks: Project Plan and Design of Experiments; Exploratory and Supporting Studies; Design of Bench-Scale Development Reactor and Associated Equipment; Ordering of Equipment and Construction of Reactor and Associated Equipment; Bench-Scale H₂S, COS, and HCl Absorption and Sorbent Regeneration Tests; and Engineering and Economic Assessment of the Process. Removal of H₂S, COS and HCl was demonstrated at multiple levels of space velocity, temperature, pressure and steam-carbon dioxide back pressure. Data from regeneration experiments should allow projection of requirements for continued removal to less than 1 ppM H₂S under a variety of operating conditions. 6 refs., 3 figs., 4 tabs. (ERA citation 10:027832)

Lyke, S. E., R. S. Butner, et al. (1986). "Development of a solid absorption model and improved sorbent for solid supported molten salt hot gas cleanup process: final report." Govt Reports Announcements & Index (Gra&I), Issue 24, 1987: -.

TD3: Previous work at Pacific Northwest Laboratory (PNL) demonstrated that solid supported molten salt (SSMS) can remove H₂S, COS and HCl to less than 1 ppM from gasified coal to meet molten carbonate fuel cell feed specifications while allowing recovery of elemental sulfur. Stable performance through at least 16 absorption and regeneration cycles was also demonstrated. Although PNL's previous work demonstrated technical advantages of SSMS, low equilibrium capacity and mass transfer limitations made cost effectiveness questionable and difficult to evaluate. The objective of this project was to develop the basis for accurate evaluation of the potential system design advantages of SSMS cleanup and test the effect of increased surface area on performance. The scope of work included computer modeling and laboratory experimentation. A model of the SSMS absorption-regeneration process was developed in BASIC computer language and experiments performed to test the model and to demonstrate potential red

Lyke, S. E., L. J. Sealock, et al. (1985). "Development of a hot gas cleanup system for integrated coal gasification/molten carbonate fuel cell power plants. Final report." Govt Reports Announcements & Index (Gra&I), Issue 18, 1985: -.

TD3: Battelle, Pacific Northwest Laboratories has developed a solid supported molten salt (SSMS) hot

gas cleanup process for integrated coal gasification/molten carbonate fuel cell (MCFC) power plants. In bench scale experiments the process simultaneously removed hydrogen sulfide (H₂S), carbonyl sulfide (COS) and hydrogen chloride (HCl) from MCFC anode feed gas at 1375 to 1475 °F and up to 180 psig. Regeneration produced a H₂S-rich gas from which elemental sulfur could be efficiently recovered. Through 16 absorption/regeneration cycles at each of two absorber sizes, conditions for continuous removal of H₂S to less than 1 ppm were well established. Further study would be required to assure removal of COS and HCl to that degree in a commercial design and to develop a practical means for chloride regeneration. A dynamic model was developed that uses measured equilibrium data and the two film theory to represent mass transfer resistance. The model can accurately simulate absorption

Maarouf, A. and J. Smith (1997). "Interactions amongst policies designed to resolve individual air issues." Environmental Monitoring and Assessment **46**(1-2): 5-21.

Six air issues are currently on science and policy agendas in Canada and elsewhere. These are climate change, stratospheric ozone depletion (increased UV-B radiation), acidic deposition, SMOG (increased ground-level ozone), suspended particulate matter, and hazardous air pollutants. Atmospheric scientists and decision makers have largely addressed these issues individually resulting in single-issue policies. However, it is now recognized that these issues are inter-related, and they may interact to cause negative as well as some beneficial effects, not only on the state of the atmosphere but also on societal and ecological systems. This paper illustrates through several examples the atmospheric dysfunction caused by the linkages among the six air issues. It also points to potentially conflicting policies arising from the single-issue approach, and it emphasizes the need for better integration of air issues. The linkages are summarized qualitatively in Table I.

Macdonald, O. C. and K. A. Mills (1994). "Plant quarantine treatments are there alternatives to methyl bromide?" British Crop Protection Council. Brighton Crop Protection Conference: Pests and Diseases, 1994 Vol.1-3 Proceedings of an International Conference, Brighton, England, Uk, November 21-24, 1994. Xxvi+498p.(Vol. 1); Xxvi+454p.(Vol. 2); Xxvi+466p.(Vol. 3) British Crop Protection Council(Bcpc): Farnham, England, Uk. Isbn 0-948404-80-9(Set); Isbn 0-948404-81-7(Vol. 1); Isbn 0-948404-82-5(Vol. 2); Isbn 0-948404-83-3(Vol. 3).; 0 (0): 183-190.

RRM BOOK CHAPTER MEETING PAPER PEST CONTROL

Mactaggart, D. L., S. O. Farwell, et al. (1999). "A continuous monitor-sulfur chemiluminescence detector (cm-scd) system for the measurement of total gaseous sulfur species in air." Atmospheric Environment **33**(4): 625-632.

A continuous monitor-sulfur chemiluminescence detector (CM-SCD) system with a flameless, temperature-controlled furnace combustion source was developed for real-time measurement of total sulfur gases in air. This measurement system demonstrated a linear dynamic range exceeding five orders of magnitude and equimolar sensitivity to the most prevalent atmospheric sulfur gases. A detection limit

of 10 pptv was obtained using 10 min signal averages. On a real-time basis, detection in the 20-50 pptv range was demonstrated. After modification of its sample inlet system, the CM-SCD showed no appreciable interference effects from the addition of H₂O vapor, NO₂ or O₃ to the sample matrix. In the recent Gas-Phase Sulfur Intercomparison Experiment (GASIE), the CM-SCD compared favorably with SO₂ measurement methods.

Margeson, J. H., J. E. Knoll, et al. (1985). "A manual method for measurement of reduced sulfur compounds." J Air Pollut Control Assoc **35**(12): 1280-1285.

RRM THIOPHENE

Maronpot, R. R., R. C. Sills, et al. (2004/7). "Applications of magnetic resonance microscopy." Toxicol Pathol **32 Suppl 2**: 42-8.

Magnetic resonance imaging (MRI) has enjoyed enormous clinical success since the first demonstration of the method more than 30 years ago. An increasing number of pharmaceutical manufacturers seeking new biomarkers for assessing drug efficacy and toxicity are turning to MRI. A specific application of MRI promises to revolutionize pathology for the basic scientist in the same way MRI has forever altered the standard of care in the clinical domain. More specifically, this application is the use of magnetic resonance microscopy (MRM) in conjunction with new staining methodologies that now make MRM routinely available to the widest range of investigators.

Martin, H. L., A. W. Nutt, et al. (1994). "Unknown plant de-construction hazard -- toxic cos and cs(sub 2) gas from torch cutting of pipe." Govt Reports Announcements & Index (Gra&I), Issue 09, 1995: -.

TD3: An employee exhibited signs of illness after apparently inhaling fumes generated from a pipe that had been cut with a cutting torch. Identification and quantification of the hazardous air emission for reduction of risk via the Department of Energy Class B Investigation are described in this case study. The old hydrogen sulfide gas flare pipe in the heavy water plant of the Savannah River Site has been abandoned with one end open to atmosphere for almost twenty years. The pipe was being removed and cut into sections for disposal during an asbestos abatement project. It contained ash like corrosion deposits that smolder after torch cutting. Investigation revealed that burning of carbon and sulfur in the oxygen deficient atmosphere in the ash generated carbonyl sulfide (COS) and carbon disulfide (CS(sub 2)) gas, which vented when the pipe was moved by the injured construction rigger. This is believed to be the first well documented exposure and response of a human to high concentration COS gas. Sul

Martin, W. and M. J. Russell (2006/11/3). "Review. On the origin of biochemistry at an alkaline hydrothermal vent." Philos Trans R Soc Lond B Biol Sci: -.

A model for the origin of biochemistry at an alkaline hydrothermal vent has been developed that focuses on the acetyl-CoA (Wood-Ljungdahl) pathway of CO₂ fixation and central intermediary metabolism

leading to the synthesis of the constituents of purines and pyrimidines. The idea that acetogenesis and methanogenesis were the ancestral forms of energy metabolism among the first free-living eubacteria and archaeobacteria, respectively, stands in the foreground. The synthesis of formyl pterins, which are essential intermediates of the Wood-Ljungdahl pathway and purine biosynthesis, is found to confront early metabolic systems with steep bioenergetic demands that would appear to link some, but not all, steps of CO₂ reduction to geochemical processes in or on the Earth's crust. Inorganically catalysed prebiotic analogues of the core biochemical reactions involved in pterin-dependent methyl synthesis of the modern acetyl-CoA pathway are considered. The following compounds appear as probable candidates for central involvement in prebiotic chemistry: metal sulphides, formate, carbon monoxide, methyl sulphide, acetate, formyl phosphate, carboxy phosphate, carbamate, carbamoyl phosphate, acetyl thioesters, acetyl phosphate, possibly carbonyl sulphide and eventually pterins. Carbon might have entered early metabolism via reactions hardly different from those in the modern Wood-Ljungdahl pathway, the pyruvate synthase reaction and the incomplete reverse citric acid cycle. The key energy-rich intermediates were perhaps acetyl thioesters, with acetyl phosphate possibly serving as the universal metabolic energy currency prior to the origin of genes. Nitrogen might have entered metabolism as geochemical NH₃ via two routes: the synthesis of carbamoyl phosphate and reductive transaminations of alpha-keto acids. Together with intermediates of methyl synthesis, these two routes of nitrogen assimilation would directly supply all intermediates of modern purine and pyrimidine biosynthesis. Thermodynamic considerations related to formyl pterin synthesis suggest that the ability to harness a naturally pre-existing proton gradient at the vent-ocean interface via an ATPase is older than the ability to generate a proton gradient with chemistry that is specified by genes.

Masuoka, T. and H. Doi (1993/1). "Single-, double-, and triple-photoionization cross sections of carbonyl sulfide (OCS) and ionic fragmentation of OCS⁺, OCS²⁺, and OCS³⁺." Phys Rev A **47**(1): 278-288.

Matthews, H. E., J. M. MacLeod, et al. (1987/4/15). "Observations of OCS and a search for OC₃S in the interstellar medium." Astrophys J **315**(2): 646-53.

Observations of OCS and a search for OC₃S are reported, with particular reference to cold dust clouds. OCS has been detected for the first time in dark clouds with a mean fractional abundance relative to hydrogen of approximately 3×10^{-9} ; this is approximately 4 times greater than that observed for giant molecular clouds. This results is discussed in the context of molecule formation mechanisms. Observations of the $J = 1 \rightarrow 0$ transition of OCS indicate that this transition is amplifying the background continuum radiation in the direction of Sgr B2.

Matthiessen, J. N., J. M. Desmarchelier, et al. (1996). "Comparative efficacy of fumigants against hatchling whitefringed beetle (coleoptera: curculionidae) larvae and their sorption by soil." Journal of Economic Entomology **89**(6): 1372-1378.

The toxicity of the fumigants methyl isothiocyanate, carbonyl sulfide, carbon bisulfide, and methyl bromide (control) was assessed against 1st instars of the soil-dwelling pest whitefringed beetle,

Graphognathus leucoloma (Boheman), by injection into sealed glass jars containing the insects. Methyl isothiocyanate was the most toxic compound, with a steep dose-response relationship, followed by methyl bromide, carbonyl sulfide, and carbon bisulfide, all of which had flatter response lines. Sorption of the fumigants by 3 contrasting soil types was determined by injecting them into the headspace of sealed glass jars containing soil at different temperatures and moisture contents, and sequentially analyzing subsequent headspace concentrations over 24 h by using gas chromatography. Methyl isothiocyanate was rapidly and strongly sorbed by all sods, with. Carbonyl sulfide was the next most sorbed fumigant (its sorption increased with time), whereas methyl bromide was sorbed 1

Mcbee, J. (1996). "Atmospheric sulfur cycle effects of carbonyl sulfide (ocs)." Govt Reports Announcements & Index (Gra&I), Issue 19, 1997: -.

TD3: Carbonyl Sulfide(OCS) is considered to be one of the major sources of sulfur appearing in the stratosphere due to its relative inertness, about 1 to 10 years. The ability of OCS to penetrate into the stratosphere makes it an excellent tracer for study of the role of the sulfur cycle in stratospheric chemistry. With molecular spectroscopy, it has been found that the tunable diode laser absorption spectrometer (TDL) provides a very rapid and accurate method of measuring OCS and other trace gases. Final Report.

McElroy, M. B., S. C. Wofsy, et al. (1980). "Photochemical sources for atmospheric hydrogen sulfide." Atmos Environ **14**(2): 159-164.

HEEP COPYRIGHT: BIOL ABS. REVIEW CARBONYL SULFIDE TROPOSPHERE

Mcquaker, N. R., G. E. Rajala, et al. (1986). "Measurement of total reduced sulfur compounds in ambient air." Environmental Science and Technology **20**(5): 517-520; 1986.: -.

HMTC Two reference methods for total reduced sulfur (TRS) measurement were compared. They were compared to assess the potential for measurement bias stemming from changes in the composition of TRS compounds that could potentially interfere with the process. These compounds include terpenes and carbonyl sulfide (COS). Both methods, coulometric detection and thermal oxidation with fluorescence detection, are susceptible to interference by terpenes and COS. Interference, however, is too low to lead to a significant measurement bias. Shifts in TRS composition would lead to a measurement bias in coulometric detection but not in thermal oxidation/ fluorescence detection. Comparison data obtained from coulometric analysis was collected at a single site in the vicinity of three operating kraft pulp mills to confirm laboratory analytical assessments. (8 ref.)

Medcalf, B. D., S. E. Mananhan, et al. (1998). "Gasification as an alternative method for the destruction of sulfur containing waste (chemchar process)." Waste Management **18**(3): 197-201.

The behavior of a non-incinerative reductive thermal concurrent flow gasification process (ChemChar Process) when used to treat representative sulfur compounds is reported. Gasification of 1,3-

benzenedisulfonic acid, thiomorpholine, and sulfuric acid converts the sulfur in these compounds to H₂S, OCS, and elemental sulfur. The H₂S and OCS are released in the synthesis with the gas product from which they can be scrubbed, with the elemental sulfur being deposited on the char matrix. No production of sulfur dioxide was detected. Gasified sulfur products recovered amounted to 89-114% of the total sulfur present in the sulfur compounds gasified, although exact mass balances could not be obtained due to the sulfur present in the char. rights reserved.

Mihalopoulos, N., B. C. Nguyen, et al. (1992). "The oceanic source of carbonyl sulfide (cos)." Atmos Environ Part a Gen Top **26**(8): 1383-1394.

Carbonyl sulfide (COS) concentrations both in sea water and in the marine atmospheric boundary layer has been measured for 2 years at Amsterdam Island, as well as during oceanographic cruises in regions of different productivity (coastal areas, upwelling areas and open ocean) in the Indian Ocean and Mediterranean Sea. Surface waters of the Indian Ocean and Mediterranean Sea were found to be supersaturated with respect to the atmosphere. The supersaturation of surface coastal sea water in COS displays a diurnal cycle with a midday/midnight ratio of approximately 4, and in addition of seasonal cycle with maximum values during summer and a summer/winter ratio of 2. The supersaturation of open ocean surface sea water is 3 times lower than that of the coastal areas. Taking into account the diurnal, seasonal and geographical variations of the sea water supersaturation in COS, along with the seasonal variation of the sea-air exchange coefficient and the Henry's law coefficient

Miller, A. G., G. S. Espie, et al. (1989/7). "Use of Carbon Oxysulfide, a Structural Analog of CO₂, to Study Active CO₂ Transport in the Cyanobacterium *Synechococcus* UTEX 625." Plant Physiol **90**(3): 1221-1231.

Carbon oxysulfide (carbonyl sulfide, COS) is a close structural analog of CO₂. Although hydrolysis of COS (to CO₂ and H₂S) does occur at alkaline pH (>9), at pH 8.0 the rate of hydrolysis is slow enough to allow investigation of COS as a possible substrate and inhibitor of the active CO₂ transport system of *Synechococcus* UTEX 625. A light-dependent uptake of COS was observed that was inhibited by CO₂ and the ATPase inhibitor diethylstilbestrol. The COS taken up by the cells could not be recovered when the lights were turned off or when acid was added. It was concluded that most of the COS taken up was hydrolyzed by intracellular carbonic anhydrase. The production of H₂S was observed and COS removal from the medium was inhibited by ethoxymolamide. Bovine erythrocyte carbonic anhydrase catalysed the stoichiometric hydrolysis of COS to H₂S. The active transport of CO₂ was inhibited by COS in an apparently competitive manner. When Na⁽⁺⁾-dependent HCO₃⁽⁻⁾ transport was allowed in the presence of COS, the extracellular [CO₂] rose considerably above the equilibrium level. This CO₂ appearing in the medium was derived from the dehydration of transported HCO₃⁽⁻⁾ and was leaked from the cells. In the presence of COS the return to the cells of this leaked CO₂ was inhibited. These results showed that the Na⁽⁺⁾-dependent HCO₃⁽⁻⁾ transport was not inhibited by COS, whereas active CO₂ transport was inhibited. When COS was removed by gassing with N₂, a normal pattern of CO₂ uptake was observed. The silicone fluid centrifugation method showed that COS (100 micromolar) had little effect upon the initial rate of HCO₃⁽⁻⁾ transport or CO₂ fixation. The steady state rate of CO₂ fixation was, however, inhibited about 50% in the presence

of COS. This inhibition can be at least partially explained by the significant leakage of CO(2) from the cells that occurred when CO(2) uptake was inhibited by COS. Neither CS(2) nor N(2)O acted like COS. It is concluded that COS is an effective and selective inhibitor of active CO(2) transport.

Mizuno, T., I. Nishiguchi, et al. (1993). "Reactions of unstable dialkylcarbamoyl lithiums with sulfur compounds." Tetrahedron **49**(12): 2403-2412.

Unstable dialkylcarbamoyl lithiums, generated from the reaction of lithium dialkylamides with carbon monoxide, were successfully trapped by sulfur compounds (elemental sulfur, disulfides, carbon disulfide, and carbonyl sulfide) at low temperature, through their potent affinity with a sulfur atom. These efficient reactions were also applied to development of a facile synthetic method for thiocarbamates useful herbicides, and thiooxamates.

Morandini, V. L. and D. Kroepfl (1985). "Total reduced sulfur emission monitoring of a kraft recovery boiler scrubber using the western research model 800 analyzer." Canadian Pulp and Paper Association. Conference Sur L'environnement 1985 Environment Conference, Toronto, Ont., Canada, Sept. 24-26, 1985. Iii+157p. Technical Section, Canadian Pulp and Paper Association: Montreal, Que., Canada. Illus. Paper. Isbn 0-919893-25-2.; 0(0): 143-148.

RRM AIR POLLUTION CARBONYL SULFIDE KRAFT WASTE

Morgan, D. L., P. B. Little, et al. (2004/10/15). "Neurotoxicity of carbonyl sulfide in F344 rats following inhalation exposure for up to 12 weeks." Toxicol Appl Pharmacol **200**(2): 131-45.

Carbonyl sulfide (COS), a high-priority Clean Air Act chemical, was evaluated for neurotoxicity in short-term studies. F344 rats were exposed to 75-600 ppm COS 6 h per day, 5 days per week for up to 12 weeks. In rats exposed to 500 or 600 ppm for up to 4 days, malacia and microgliosis were detected in numerous neuroanatomical regions of the brain by conventional optical microscopy and magnetic resonance microscopy (MRM). After a 2-week exposure to 400 ppm, rats were evaluated using a functional observational battery. Slight gait abnormality was detected in 50% of the rats and hypotonia was present in all rats exposed to COS. Decreases in motor activity, and forelimb and hindlimb grip strength were also detected. In rats exposed to 400 ppm for 12 weeks, predominant lesions were in the parietal cortex area 1 (necrosis) and posterior colliculus (neuronal loss, microgliosis, hemorrhage), and occasional necrosis was present in the putamen, thalamus, and anterior olivary nucleus. Carbonyl sulfide specifically targeted the auditory system including the olivary nucleus, nucleus of the lateral lemniscus, and posterior colliculus. Consistent with these findings were alterations in the amplitude of the brainstem auditory evoked responses (BAER) for peaks N3, P4, N4, and N5 that represented changes in auditory transmission between the anterior olivary nucleus to the medial geniculate nucleus in animals after exposure for 2 weeks to 400 ppm COS. A concentration-related decrease in cytochrome oxidase activity was detected in the posterior colliculus and parietal cortex of exposed rats as early as 3 weeks. Cytochrome oxidase activity was significantly decreased at COS concentrations that did not cause detectable lesions, suggesting that disruption of the mitochondrial respiratory chain may precede these

brain lesions. Our studies demonstrate that this environmental air contaminant has the potential to cause a wide spectrum of brain lesions that are dependent on the degree and duration of exposure.

Morimoto, T., K. I. Takeyama, et al. (1976). "Composition of gaseous combustion products of polymers." Journal of Applied Polymer Science, Vol.20, Pages 1967-1976, 13 References, 1976: -.

A study of the composition of gaseous combustion products of polymers was conducted. Samples, 0.1 or 0.05 gram, of polyethylene, polystyrene, nylon-66 (nylon), polyacrylamide, polyacrylonitrile, polyurethane, poly(phenylene-sulfide) (PPS), and epoxy, urea, and melamine resins were combusted in air or pyrolyzed in nitrogen at 700 degrees-C. Gaseous products were collected and analyzed for carbon-dioxide (124389), carbon-monoxide (630080), carbonyl-sulfide (463581), sulfur-dioxide (7446095), nitrous-oxide (10024972), nitrogen-dioxide (10102440), nitric-oxide (10102439), ammonia (7664417), hydrogen-cyanide (74908), methane (74828), ethylene (74851), and acetylene (74862) by infrared spectrophotometry, gas chromatography, and colorimetry. A sample of cedar wood was also combusted and analyzed for comparison. Combustion in air of polymers primarily produced methane, ethylene, and acetylene. Major sources of acetylene were methane and ethylene flames produced early during burning. The amount of acetylene increased when the amount of air was increased. Hydrogen-cyanide was produced by all nitrogen containing polymers and the resins during air combustion. Polyurethanes did not produce cyanide under nitrogen pyrolysis. Only nylon, polyacrylamide, and melamine resin formed ammonia during combustion in air. Nitrous-oxide was formed only by melamine and urea resins when combusted in air. Small amounts of nitric-oxide and nitrogen-dioxide were formed by combustion of nylon, polyacrylamide, polyurethane, and melamine resin. Nitrogen (7727379) gas was produced from about 70 percent of nitrogen in nylon and polyacrylamide under air combustion. Combustion of PPS in air yielded a large amount of sulfur-dioxide and a small amount of carbonyl-sulfide. When pyrolyzed in nitrogen, PPS formed a trace of carbonyl-sulfide. All samples produced large amounts of carbon-dioxide and carbon-monoxide when burned in air, with carbon-dioxide formed in larger amounts. Besides carbon-dioxide and carbon-monoxide, combustion of cedar wood yielded traces of methane, ethylene, and acetylene.

Morrison, M. C. and M. E. Hines (1990). "The variability of biogenic sulfur flux from a temperate salt marsh on short time and space." Atmos Environ Part a Gen Top **24**(7): 1771-1780.

Three emission chambers were deployed simultaneously to measure rates of emission of dimethyl sulfide, methane thiol and carbonyl sulfide within or across vegetative zones in a New Hampshire (USA) salt marsh. Short term (a few hours) variation in fluxes of all S gases from replicate sites were small within a monospecific stand of either *Spartina alterniflora* or *S. patens*. The quantity of emergent biomass and the type of vegetation present were the primary factors regulating the rate of emission. Dimethyl sulfide fluxes from the *S. alterniflora* soils ranged from 800 to 18,000 nmol m⁻² h⁻¹ compared to emissions of 25-120 nmol m⁻² h⁻¹ from *S. patens*. This difference was probably due to the presence of the dimethyl-sulfide precursor dimethylsulfoniopropionate which is an osmoregulator in *S. alterniflora* but not in *S. patens*. Methane thiol emissions from *S. alterniflora* were 20-280 nmol m⁻² h⁻¹ and they displayed a similar diel trend as dimethyl sulfide, although at much low

Moyers, J., A. C. Stanton, et al. (1987). "Very high sensitivity spectrometer for atmospheric measurements." Govt Reports Announcements && Index (Gra&I), Issue 03, 1993: -.

TD3: The research evaluated new optical designs and measurement techniques using liquid nitrogen-cooled lead-salt diode lasers to extend the sensitivity and simplify the design of atmospheric research instrumentation based on these devices. Techniques for minimizing optical fringe noise effects were studied, and the sensitivity limits of high frequency FM detection and low frequency harmonic detection were compared. Application of a new multiple pass absorption cell design combined with the development of a reliable method for elimination of optical interference fringes has resulted in a tenfold improvement in the sensitivity routinely attained with lead-salt diode laser instrumentation. At these sensitivity levels, no laser noise effects were observed either for high frequency FM detection or for low frequency harmonic detection. The sensitivity permits the accurate rapid-response measurement of several important atmospheric species (e.g., ammonia, hydrogen peroxide, carbonyl sulfide, and others) wh

Mroz, E. J., A. S. Mason, et al. (1984). "Stratospheric impact of el chichon,." Govt Reports Announcements && Index (Gra&I), Issue 19, 1985: -.

TD3: Stratospheric aerosols and gases were collected by high-altitude aircraft and balloons to assess the effect of the 1982 El Chichon volcanic eruption on the stratosphere. El Chichon injected sulfurous compounds that resulted in the production of about 7.6 + or - 2.3 Tg sulfate in the global stratosphere. Considerable uncertainty arises from balloon sampling being available at only one latitude. No significant amounts of carbonyl sulfide were detected in portion of the stratospheric plume of the volcano which was at aircraft altitudes. This eruption had the largest impact on the stratosphere of any volcanic eruption since 1971. (Reprints) Pub. in *Geofisica International*, v23 n3 p321-333 1984.

Mu, Y. J., H. Wu, et al. (2004). "Vertical distributions of COS and CS₂ in Beijing City." J Environ Sci (China) **16**(2): 226-9.

Vertical distributions of COS and CS₂ were measured at a meteorological tower in Beijing City. The mixing ratios of COS and CS₂ are in the range of 371-1681 pptv and 246-1222 pptv, respectively. The significant high mixing ratios of the two compounds at ground level and distinct vertical distributions indicated the existence of strong anthropogenic sources of COS and CS₂ in Beijing City. Domestic stoves and central heaters are important sources of COS during winter season. Cesspools may play significant role on COS over whole seasons. Chemical productions may be responsible for the observed high mixing ratios of CS₂ in Beijing City.

Muller, J., B. Herve-Bazin, et al. (1979). "Environmental control in foundries, chemical nuisances." Cahiers De Notes Documentaires, 3rd Quarter, 1979, No.96, Pages 415-423, 33 References (Translated by Health and Safety Executive Translation Services, United Kingdom, Dec.1979), 19791979: -.

Chemical hazards associated with foundry work in France are discussed. Principal moulding and core

production processes, including cold and hot processes, are described. Thermal degradation tests were performed on resin or coated sand samples, and gas and vapor products were analyzed by gas phase chromatography and infrared spectrophotometry. Air sampling was performed for most of the moulding processes. Compounds identified as being likely to be released during sand coating included isocyanates (MDI), phenol (108952), and solvents such as isophorone (78591). Combustion products included ammonia (7664417), hydrocyanic-gas (74908), carbon-monoxide (630080), carbon-dioxide (124389), methane (74828), light aliphatic hydrocarbons, benzene hydrocarbons, phenol, and traces of aldehydes and nitriles. Air pollution concentrations in connection with sand coating were low. Other industrial processes studied included cold setting, hot processes, core production with oils, involves subsequent drying, and conventional processes. Major chemical contaminants identified for these processes includes: isocyanates, furfuryl-alcohol (98000), formol (5000) and methyl-alcohol (67561), sulphur-dioxide (7446095), and carbonyl-sulphide (463581), phenol, various aldehydes and benzenehydrocarbons, and carbon-monoxide. The authors make several recommendations for worker safety during these processes, such as proper resin storage procedures protective clothing examination of alternate transport procedures for coated sand avoidance of direct contact between coated sands and skin and use of effective ventilation systems. (French). KW - DCN-182452

Naim, S., A. Fayt, et al. (1998/11). "Fourier Transform Spectroscopy of Carbonyl Sulfide from 3700 to 4800 cm^{-1} and Selection of a Line-Pointing Program." *J Mol Spectrosc* **192**(1): 91-101.

We have measured the Fourier transform spectrum of natural OCS from 3700 to 4800 cm^{-1} with a near Doppler resolution and a line-position accuracy between 4 and 8×10^{-5} cm^{-1} . For the normal isotopic species, 37 vibrational transitions have been analyzed for both frequencies and intensities. We also report 15 bands of OC34S, eight bands of O13CS, nine bands of OC33S, and two bands of 18OCS. Important effective Herman-Wallis terms are explained on the basis of eigenvectors. A comparison of different line-pointing programs is also presented. Copyright 1998 Academic Press.

Navas, M. J. and A. M. Jimenez (1999). "Chemiluminescent methods in alcoholic beverage analysis." *Journal of Agricultural and Food Chemistry* **47**(1): 183-189.

Chemiluminescent (CL) techniques employed in alcoholic beverage analysis are summarized. Specific applications to wine, beer, brandy, and tequila are described, and the determination of sulfur compounds, phosphate, L-malate, glycerol, fatty acids, phenolic compounds, and urate is included. Possibilities and limitations of the various CL detection systems are evaluated.

Nguyen, B. C., N. Mihalopoulos, et al. (1989). "Study of dimethyl sulfide and carbonyl sulfide at amsterdam island in the indian ocean." Laubier, L.(Ed.).Actes Du Colloque Sur La Recherche Francaise Dans Les Terres Australes (Kerguelen, Crozet, Saint-Paul Et Amsterdam) Et a Partir Des Navires Qui Les Desservent (Proceedings of the Colloquium on French Research in the Southern Territories (Kerguelen, Crozet, Saint-Paul and Amsterdam Islands) and Research Conducted From Ships) **Strasbourg, France, September 14-17, 1987. 562p. Comite National Francais Des Recherches Antarctiques: Territoire Des Terres Australes Et Antarctiques Francaises. Illus. Maps. Paper.; 0**

(0): 439-444.

RRM ATMOSPHERE OCEAN

Nie, Y., J. Zhang, et al. (2001/7). "[Emissions of biogenic sulfur gases from wheat fields]." Huan Jing Ke Xue **22**(4): 25-8.

Emission rates of carbonyl sulfide (COS), carbon disulfide (CS₂) and dimethyl sulfide (DMS) to the atmosphere from wheat fields treated with different fertilizers were measured by using the closed chamber method. The results showed that the emission rate of COS, CS₂ and DMS was affected by wheat growth and COS was absorbed by the plants. DMS and CS₂ were the predominant sulfur gases emitted from these fields. The diurnal variations of emission rates of COS and CS₂ were obvious. The sulfur flux in the plot treated with organic fertilizer was higher than that in the other plots. The sulfur fluxes from different plots were in the range of -1.40 to 0.79 mg.m⁻².

Noggle, J. C., J. F. Meagher, et al. (1986). "Sulfur in the atmosphere and its effects on plant growth." Tabatabai, M.A.(Ed.).Agronomy: a Series of Monographs, 27.Sulfur in Agriculture.Xviii+668p. American Society of Agronomy, Inc., Crops Science Society of America, Inc., Soils Science Society of America, Inc., Publishers: Madison, Wisconsin, Usa.Illus.Isbn 0-89118-089-3.; 0 (0).1986 (Recd.1987).251-278.: -.

RRM CROP INDUSTRY SULFUR DIOXIDE AEROSOLS HYDROGEN SULFIDE CARBONYLSULFIDE DIMETHYLSULFIDE CARBON DISULFIDE AIR POLLUTION DAMAGE FERTILIZER EFFECT

Notni, J., S. Schenk, et al. (2007/3/26). "The missing link in COS metabolism: a model study on the reactivation of carbonic anhydrase from its hydrosulfide analogue." Chembiochem **8**(5): 530-6.

Carbonic anhydrase (CA) is known to react with carbonyl sulfide, an atmospheric trace gas, whereby H₂S is formed. It has been shown that, in the course of this reaction, the active catalyst, the His(3)ZnOH structural motif, is converted to its hydrosulfide form: His(3)ZnOH+COS-->His(3)ZnSH+CO(2). In this study, we elucidate the mechanism of reactivation of carbonic anhydrase (CA) from its hydrosulfide analogue by using density functional calculations, a model reaction and in vivo experimental investigation. The desulfuration occurs according to the overall equation His(3)ZnSH+H(2)O right harpoon over left harpoon His(3)ZnOH+H(2)S. The initial step is a protonation equilibrium at the zinc-bound hydrosulfide. The hydrogen sulfide ligand thus formed is then replaced by a water molecule, which is subsequently deprotonated to yield the reactivated catalytic centre of CA. Such a mechanism is thought to enable a plant cell to expel H₂S or rapidly metabolise it to cysteine via the cysteine synthase complex. The proposed mechanism of desulfuration of the hydrosulfide analogue of CA can thus be regarded as the missing link between COS consumption of plants and their sulfur metabolism.

NTP (2003). "[Carbonyl sulfide Salmonella Study]." -.

Obenland, D. M., E. B. Jang, et al. (1998). "Tolerance of lemons and the mediterranean fruit fly to carbonyl sulfide quarantine fumigation." Crop Protection **17**(3): 219-224.

Lemons (*Citrus limon* Burm.) were evaluated for their tolerance to carbonyl sulfide (COS) fumigation and the influence of COS on market quality. At 70 mg l⁻¹ no significant deleterious changes occurred in market quality up to a fumigation duration of 8 h and only a slight amount of peel injury was observed after 12 h. Longer fumigations lead to the presence of an offensive off-odor in the juice as well as to increasing rind injury. A test of the sensitivity of the Mediterranean fruit fly (*Ceratitis capitata* Wiedemann) to COS indicated that long fumigation times (more than 8 h) will likely be required to achieve a degree of mortality sufficient for quarantine purposes for this insect. The tolerance of lemons to COS observed in this study suggests that COS is suitable for use as a quarantine treatment for this commodity. Its adoption, however, for this purpose will be hampered by the relatively long fumigation times needed and the odor that temporarily accompanies the fruit

O'Brien, W. S. and R. P. Gupta (1992). "Desulfurization of hot fuel gas produced from high-chlorine illinois coals. Technical report, march 1, 1992--may 31, 1992." Govt Reports Announcements & Index (Gra&I), Issue 07, 1993: -.

TD3: New coal gasification processes are now being developed which can generate electricity with high thermal efficiency either in an integrated gasification combined cycle (IGCC) or in a fuel cell (MCFC). Both of these new coal-to-electricity pathways require that the coal-derived fuel gas be at a high temperature and be free of potential pollutants, such as sulfur compounds. Unfortunately, some high-sulfur Illinois coals also contain significant chlorine which converts into hydrogen chloride (HCl) in the coal-gas. This project investigates the effect of HCl, in concentrations typical of a gasifier fed by high-chlorine Illinois coals, on zinc-titanate sorbents that are currently being developed for H₂S and COS removal from hot coal gas. This study is designed to identify any deleterious changes in the sorbent caused by the HCl, both in absorptive operation and in the regeneration cycle, and will pave the way to modify the sorbent formulation or the process operating procedure to remove HCl also

Ogawa, T. and R. K. Togasaki (1988/11). "Carbonyl Sulfide: An Inhibitor of Inorganic Carbon Transport in Cyanobacteria." Plant Physiol **88**(3): 800-804.

Cells of a high CO₂-requiring mutant (E(1)) and wild type of *Synechococcus* PCC7942 were incubated with COS in the light, then suspended in COS-free medium and their CO₂ exchange was measured using an open gas-analysis system under the conditions where photosynthetic CO₂ fixation is inhibited. When the suspension of cells untreated with COS was illuminated, the rate of CO₂ uptake was high and addition of carbonic anhydrase during illumination released a large amount of CO₂ from the medium into the gas phase. The COS treatment in the light markedly reduced the rate of CO₂ uptake by the cells and the amount of CO₂ released by carbonic anhydrase. Incubation of cells with COS in the dark had no effect on the CO₂-exchange profile. The COS concentration required for 50% inhibition of CO₂ uptake was about 25 micromolar when the concentration of inorganic carbon (C(i)) in the medium was 60 micromolar; higher C(i) concentrations reduced the inhibitory effect of COS.

Measurement of C(i) uptake in E(1) cells by a silicone oil centrifugation method also indicated marked reduction of the activities of (14)CO(2) and H(14)CO(3) (-) uptake in the cells treated with COS in the light. The results demonstrated that COS is a potent inhibitor of C(i) transport.

Oh, M. S., A. K. Burnham, et al. (1988). "Evolution of sulfur gases during coal pyrolysis." Govt Reports Announcements & Index (Gra&I), Issue 23, 1988: -.

TD3: In this study, the real-time evolution of sulfur gases was monitored during slow-heating pyrolysis of coal via a triple quadrupole mass spectrometer (TOMS). The evolution of hydrocarbon gases, water, and carbon oxides was also monitored. The investigation compared the evolution profiles of sulfur gases and related them to the rank of the coal, the organic and inorganic sources of sulfur in each coal sample, and the evolution of other pyrolysis-generated gases. They also studied the extent of secondary reactions by varying the pyrolysis conditions. 18 refs., 4 figs., 3 tabs. (ERA citation 13:032082) Portions of this document are illegible in microfiche products. American Ceramics Society meeting, Toronto, Canada, 5 Jun 1988.

Op, D. E. N., P. Derikx, et al. (1991). "Odorous sulfur compounds emitted during conventional outdoor and during indoor composting." Maier, M.J.(Ed.).Mushroom Science, Vol.Xiii.Science and Cultivation of Edible Fungi, Vols.1 and 2 13th International Congress, Dublin, Ireland, September 1-6, 1991. Xx+442p.(Vol. 1); Ix+403p.(Vol. 2) A. A. Balkema: Rotterdam, Netherlands; Brookfield, Vermont, Usa. Illus. Maps. Isbn 90-5410-022-2(Vol. 1); Isbn 90-5410-023-0(Vol. 2); Isbn 90-5410-021-4(Set).; 0(0): 147-154.

RRM MUSHROOM COMPOSTS AIR POLLUTION HYDROGEN SULFIDE CARBONYL SULFIDE METHANETHIOL DIMETHYL SULFIDE CARBON DISULFIDE DIMETHYL DISULFIDE DIMETHYL TRISULFIDE OUTDOOR COMPOSTING

Op, D. E. N., A. Pol, et al. (1995). "Production of odorous sulphur compounds during indoor compost preparation and overview of possible air treatments." Elliott, T.J.(Ed.).Mushroom Science, Vol.14.1-2. Science and Cultivation of Edible Fungi, Vols.1 and 2 14th International Congress, Oxford, England, Uk, September 17-22, 1995. Xxiv+472p.(Vol. 1); Xi+501p.(Vol. 2) A. A. Balkema: Rotterdam, Netherlands; Brookfield, Vermont, Usa. Isbn 90-5410-570-4(Set); Isbn 90-5410-571-2(Vol. 1); Isbn 90-5410-572-0(Vol. 2).; 14(1-2): 181-187.

RRM BOOK CHAPTER MEETING POSTER MUSHROOM CULTIVATION COMPOSTING VOLATILE SULFUR COMPOUNDS BIOLOGICAL AIR TREATMENT CHEMICAL AIR TREATMENT ODOR CONTROL THE NETHERLANDS

Paciorek, K. L., R. H. Kratzer, et al. (1975). "Thermal oxidative decomposition studies of neoprene compositions." American Industrial Hygiene Association Journal, Vol.36, No.1, Pages 10-16, 13 References, 1975: -.

The thermal oxidative behavior of four neoprene compositions was investigated. Thermal oxidative degradation was carried out under static and dynamic conditions. For the quiescent study, samples of uncured gum, cured rubber, cable insulation, and hose conduit were placed in sealed tubes and heated at 370 degrees-C for 30 minutes. After cooling, the liquid nitrogen volatiles were collected, measured, and determined by mass spectroscopy. The solid residue was removed and weighed and the involatile oils and tars were examined by infrared spectroscopy. For the dynamic studies, a stagnant burner arrangement was used and the volatile products were quantitated on a milligram per kilogram basis. The residence time of the samples in the burner was 15 minutes and both the air and the heating block were at 400 degrees-C. Thermographic analyses were performed with a DuPont Instruments 990/951. In the quiescent system, up to 84 percent of the chlorine content was evolved as hydrogen-chloride (7647010) and the sulfur as carbon-disulfide (75150) (CS₂). No glow was observed in this system and the extent of oxidation was low. Under the more drastic conditions (higher temperatures and flowing air) of the stagnation burner, oxidation was increased and carbon-dioxide (124389), carbonyl-sulfide (463581), sulfur-dioxide (7446095) (SO₂), formic-acid (64186), and formaldehyde 50000 among others were produced. In the thermographic investigation, the first weight loss was correlated with the evolution of hydrogen-chloride. The authors conclude that the main toxic product resulting from thermal oxidative degradation of neoprene type composition is hydrogen-sulfide which is formed at 370 degrees-C in 84 and 78 percent yields from uncured and known cured neoprenes, respectively. Minor, but still important products are SO₂, CS₂, hydrogen-sulfide, carbon-monoxide (630080), benzene (71432), chloroprene (126998), acetic-acid (64197), formic-acid, formaldehyde and various mercaptans which were detected but not quantitated.

Pandey, R. A. and S. Malhotra (1999). "Desulfurization of gaseous fuels with recovery of elemental sulfur: an overview." Critical Reviews in Environmental Science and Technology **29**(3): 229-268.

RRM DESULFURIZATION OF GASEOUS FUELS WITH RECOVERY OF ELEMENTAL SULFUR:
AN OVERVIEW
LITERATURE REVIEW
THIOBACILLUS CHLOROBIIUM
THIOSULFATOPHILUM XANTHOMONAS BIOREMEDIATION AGENT
GASEOUS FUEL
ELEMENTAL SULFUR RECOVERY
SOLID ADSORPTION
LIQUID ADSORPTION
STRETFORD
PROCESS
UNISULF PROCESS
SULFOLIN PROCESS
LOCAT PROCESS
SULFEROX PROCESS
LOW SEVERITY PROCESS
HIPERION PROCESS
CONVENTIONAL CLAUS PROCESS
SHELL
CLAUS OFFGAS TREATMENT
SUPERCLAUS PROCESS
MICROBIAL DESULFURIZATION
CHEMOBIOLOGICAL DESULFURIZATION
POLLUTION ENVIRONMENTAL ENGINEERING
COMPOSITION
DESULFURIZATION
SULFUR CONTAMINATED
DESULFURIZATION
METHOD
LIQUID REDOX
SULFUR RECOVERY METHOD
GASEOUS REDOX
SULFUR
RECOVERY METHOD

Peebles, A. and R. R. Dalvi (1978). "Toxicologic studies of n-trichloro methylthio- 4-cyclo hexene-1,2-decarboximide (captan): its metabolism by rat liver drug-metabolizing enzyme system." Toxicology **9** (4): 341-351 1978 (12 References): -.

PESTAB. Captan metabolism was studied as it is catalyzed by hepatic monooxygenase enzyme system in the rat. Rats were fasted overnight before po administration of captan in corn oil. Neither a dose of

100 mg/kg nor 650 mg/kg depressed the benzphetamine N- demethylase activity of the microsomes. On the other hand, the aniline hydroxylase activity was considerably lowered at the higher dosage. In other experiments diethyl maleate and SKF 525-A were administered ip 1 hr before 650 mg/kg captan. Combined administration of diethyl maleate and captan decreased the amount of cytochrome P-450 and caused an appreciably greater loss of microsomal aniline hydroxylase activity than that of benzphetamine N- demethylase. Similarly, rats receiving both SKF 525-A and captan showed a marked loss of microsomal aniline hydroxylase. However, this loss of the enzyme activity seemed to derive from the captan action alone, and not from SKF 525-A. Experiments were also designed to determine the effect of captan on the microsomal enzyme induction by phenobarbital. In animals pretreated with phenobarbital, ip injected captan caused severe peritoneal edema. However, animals given a 33 times higher dose of captan did not show hydro peritoneum under the same conditions. Although the inhibition of drug- metabolizing enzyme activity by captan was noted in microsomal incubations with or without NADPH, a detectable amount of carbonyl sulfide was found only in the incubations containing captan plus NADPH. Carbonyl sulfide appears to arise from a captan-derived metabolite, thiophosgene, which decomposes to carbonyl sulfide in aqueous solution, and, in the presence of NADPH, inhibits the activity of drug bio transformation enzymes.

Pellizzari, E. D., T. D. Hartwell, et al. (1982). "Purgeable organic compounds in mother's milk." Bulletin of Environmental Contamination and Toxicology **28**: 322-328.

Penkett, S. A. (1977). "Measurements of carbonyl sulphide and carbon disulphide in the atmosphere. Au - sandalls fj." Atmos Environ; 11 (2).1977 197-199: -.

HEEP COPYRIGHT: BIOL ABS. Trace concentrations of atmospheric air samples were concentrated by the cryogenic trapping technique. Using a flame photometric S detector, the concentrations of both COS and CS₂ in the atmosphere were determined. The contributions of these 2 compounds to the natural annual atmospheric S turnover is shown to be less than 3% of the total.

Piluk, J., P. G. Hartel, et al. (1995). "Additions of l-djenkolic acid increase carbon disulfide cs-2 and carbonyl sulfide cos production from the roots of mimosa pudica l." Annual Meeting of the Ecological Society of America on the Transdisciplinary Nature of Ecology, Snowbird, Utah, Usa, July 30-August 3, 1995.Bulletin of the Ecological Society of America **76**(2 Suppl. Part 2): 214-.

RRM MEETING ABSTRACT MIMOSA-PUDICA FUNGUS ANIMAL CARBON DISULFIDE CARBONYL SULFIDE PROTEIN TOXICITY

Poerschmann, J., F. D. Kopinke, et al. (1996). "Hyphenated techniques for characterizing coal wastewaters and associated sediments." Journal of Chromatography a **750**(1-2): 287-301.

Capillary gas chromatography (cGC)-mass spectrometry (MS) and cGC-atomic emission detection (AED) were used for the analysis of extracts from highly contaminated wastewaters and associated sediments, The main extractable constituents in both the lignite wastewater and the sediments include

phenols, PAHs, indenols and heterocyclic compounds. Pyrolysis (Py)-GC-MS and Py-GC-AED were used for characterizing the building blocks of the dissolved polymeric organic matter. Polymers of natural and anthropogenic origins could be clearly distinguished. The Py-MS studies performed with humic organic matter at both atmospheric pressure and high vacuum (in-source mode) indicate a high portion of pyrolysis residue (about 40%, w/w) upon heating to 700°C, irrespective of the pressure level. The products released include many low molecular weight compounds which are of limited value for characterizing the polymeric network.

Pope, D., D. S. Walker, et al. (1978). "Evaluation of platinum-honeycomb catalysts for the destructive oxidation of low concentrations of odorous compounds in air." Atmos Environ; 12 (9).1978 1921-1928:

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HEEP COPYRIGHT: BIOL ABS. The destructive oxidation of malodorous compounds occurring in process emissions was investigated using commercial catalysts containing Pt supported on alumina, carried by a ceramic honeycomb (Pt-honeycomb catalysts). Initially parameters relevant to catalyst evaluation were examined: temperature, space-velocity (SV), honeycomb cell size and odorant inlet concentration in the range 10-100 vpm (volumes per million). The catalytic oxidation of single odorant compounds (100 vpm in air), acrolein, n-butanal, n-propylamine, toluene, n-butyric acid, 1,1,1-trichloroethane and dimethyl sulfide, was measured in terms of removal and total oxidation to CO₂ as a function of temperature. The performance of Pt-honeycomb catalysts for destructive oxidation was compared with published data for Co₃O₄ granular catalysts measured under identical reaction conditions. When single S compounds (100 vpm dimethyl sulfide, methyl mercaptan, carbonyl sulfide or H₂S in air) were oxidized over Pt-honeycomb catalysts (SVted complex behavior and separate observations of SO₂ oxidation were also made. In mixtures of odorants, n-butanal oxidation was inhibited by the presence of 100 vpm methyl mercaptan, H₂S or COS, (the temperature for 80% butanal oxidation was increased by 50-100°C) whereas SO₂ had little effect. The inhibiting effect of H₂S in the range 0-140 vpm was determined.

Pos, W. H., P. J. Milne, et al. (1995). "Photoproduction of carbon monoxide and carbonyl sulfide in seawater preliminary studies towards understanding the mechanism of formation." 210th American Chemical Society National Meeting, Chicago, Illinois, Usa, August 20-24, 1995. Abstracts of Papers American Chemical Society 210(1-2): Envr 169-

RRM MEETING ABSTRACT DISSOLVED ORGANIC MATTER REDUCED SULFUR ATMOSPHERIC CONCENTRATION

Protoschill-Krebs, G., C. Wilhelm, et al. (1996). "Consumption of carbonyl sulphide (cos) by higher plant carbonic anhydrase (ca)." Atmospheric Environment 30(18): 3151-3156.

Carbonic anhydrase (CA), isolated from pea leaves, was found to consume carbonyl sulphide (COS), a climatic relevant trace gas in the atmosphere. The isolated enzyme, free of other carboxylases, showed a very high affinity towards this substrate. The experiments confirm that CA is the key enzyme for the

consumption of COS in higher plants. Furthermore, the identification of this enzyme furthers our understanding of additional sinks for COS, which are needed to understand the balance of known global sources.

Radford-Knoery, J. and G. A. Cutter (1993). "Determination of carbonyl sulfide and hydrogen sulfide species in natural waters using specialized collection procedures and gas chromatography with flame photometric detection." Anal Chem **65**(8): 976-982.

Hydrogen sulfide in natural waters can be found be dissolved uncomplexed species (i.e., "free sulfide", $\text{H}_2\text{S} + \text{HS}^- + \text{S}^{2-}$), as dissolved metal sulfide complexes ("complexed sulfide"), and as particulate metal sulfides. To examine the distribution of hydrogen sulfide species and carbonyl sulfide in natural waters, a technique for their sampling and simultaneous determination was developed. Contamination and loss are minimized by using trace metal-clean and hermetic sampling techniques and apparatus. The analytical method is based on stripping an acidified 1-300-mL sample with helium, liquid nitrogen-cooled trapping of the evolved gases, followed by gas chromatographic separation and flame photometric detection. To eliminate storage artifacts, determinations are made in the field immediately after sample collection. Detection limits are 0.2 pmol for total dissolved sulfide and 1.3 pmol/L for COS. Precision is better than 5% (relative standard deviation) for both sulfur compounds.

Raiswell, R. and S. H. Bottrell (1991). "The disposal of flue gas desulfurization waste: sulfur gas emissions and their control." Environ Geochem Health **13**(2): 119-126.

Flue gas desulphurisation (FGD) equipment to be fitted to UK coal-fired power stations will produce more than 0.8 Mtonnes of calcium sulphate, as gypsum. Most gypsum should be of commercial quality, but any low grade material disposed as waste has the potential to generate a range of sulphur gases, including H_2S , COS, CS_2 , DMS and DMDS. Literature data from the USA indicates that well-oxidised waste with a high proportion of calcium sulphate (the main UK product of FGD) has relatively low emissions of sulphur gases, which are comparable to background levels from inland soils. However, sulphur gas fluxes are greatly enhanced where reducing conditions become established within the waste, hence disposal strategies should be formulated to prevent the sub-surface consumption of oxygen.

Ramanathan, V. (1998). "Trace-gas greenhouse effect and global warming: underlying principles and outstanding issues: Volvo environmental prize lecture 1997." Ambio **27**(3): 187-197.

This paper describes the developments that transformed the global warming problem from that arising solely from CO_2 increase to the trace-gas greenhouse effect problem in which several non- CO_2 gases, CFCs, CH_4 , N_2O , O_3 and others contribute as much as CO_2 . Observed trace-gas increases, including CO_2 increase, since the mid-19th century have enhanced the atmospheric greenhouse effect, G_a , (130 W m^{-2}) by about 2%. Without other competing factors, this heating should have committed the planet to a warming of about 1 to 1.5 K. The added radiative energy is maximum in the low latitudes and about a factor of two smaller in the polar regions. The largest effect of the warming is increased back radiation at the surface by as much as 6 to 8 W m^{-2} per degree warming. Not all of this increased energy is

balanced by surface emission; evaporation (and hence precipitation) increases to restore surface energy balance, by as much as 2 to 4% per degree warming. The increase in eva

Rasmussen, R. A., M. Khalil, et al. (1982). "The oceanic source of carbonyl sulfide." Atmos Environ **16** (6): 1591-1594.

HEEP COPYRIGHT: BIOL ABS. Contrary to recent conjectures, the oceans were shown to be a global source of carbonyl sulfide to the atmosphere amounting to

Rbaihi, E., A. Belafhal, et al. (1998/9). "Fourier Transform Spectroscopy of Carbonyl Sulfide from 4800 to 8000 cm⁻¹ and New Global Analysis of 16O12C32S." J Mol Spectrosc **191**(1): 32-44.

We have measured the FT spectrum of natural OCS from 4800 to 8000 cm⁻¹ with a near Doppler resolution and a line-position accuracy between 2 and 8 x 10⁽⁻⁴⁾ cm⁻¹. For the normal isotopic species 16O12C32S, 37 vibrational transitions have been analyzed for both frequencies and intensities. We also report six bands of 16O12C34S, five bands of 16O13C32S, two bands of 16O12C33S, and two bands of 18O12C32S. Important effective Herman-Wallis terms are explained by the anharmonic resonances between closely spaced states. As those results complete the study of the Fourier transform spectra of natural carbonyl sulfide from 1800 to 8000 cm⁻¹, a new global rovibrational analysis of 16O12C32S has been performed. We have determined a set of 148 molecular parameters, and a statistical agreement is obtained with all the available experimental data. Copyright 1998 Academic Press.

Reid, G. L., W. T. Wall, et al. (1993). "Cyclodextrin stationary phases for the gas-solid chromatographic separation of inorganic gases." Journal of Chromatography, Vol.633, Nos.1/2, Pages 143-149, 36
References, 1993: -.

The use of cyclodextrin stationary phases in the analysis of inorganic gases by gas solid chromatography (GSC) was investigated. Stationary phases consisting of three native and two acetylated cyclodextrins bound to silica gel were mounted in a gas chromatography system containing a thermal conductivity detector and a liquid nitrogen cryogenic coolant system. Their ability to separate mixtures of hydrogen (1333740), nitrogen (7727379), nitrous-oxide (10024972), nitrogen-dioxide (10102440), sulfur-hexafluoride (2551624), carbon-dioxide (124389), carbonyl-sulfide (463581), ethylene-oxide (75218), hydrogen-sulfide (7783064), and sulfur-dioxide (7446095) was assessed by determining their capacity and separation factors. The data were compared with data obtained using the silica gel support alone as a column and a silica gel column coated with an epoxy terminated linkage chain. The gases were more strongly adsorbed on beta-cyclodextrin (bCD) than on alpha-cyclodextrin stationary phases. A high surface density bCD column had the largest capacity factors. The silica gel support had larger capacity factors for the more polar gases than for gases containing multiple bonds. The cyclodextrin columns tended to retain nonpolar symmetrical gases or gases containing only single bonds to a greater extent than the silica gel support column. Intercolumn and intergas differences in selectivity (separation factors) were observed. The authors conclude that cyclodextrins bonded to a silica gel support appear to be useful in separating many inorganic gases by GSC. Retention of these gases appears to involve at

least two mechanisms.

Ren, Y. (1999/5). "Is carbonyl sulfide a precursor for carbon disulfide in vegetation and soil? Interconversion of carbonyl sulfide and carbon disulfide in fresh grain tissues in vitro." J Agric Food Chem **47**(5): 2141-4.

The interconversion of carbonyl sulfide (COS) and carbon disulfide (CS₂) was studied in the roots and shoots of barley and chickpeas. Ratios of conversion gases, K, 40 h after the addition of COS or CS₂ are recorded. The proportion of COS converted to each of CS₂, CO, and H₂S and the proportion of CS₂ converted to COS were greater in roots than in shoots. More COS was converted to CS₂ than CS₂ to COS in roots and shoots of barley and chickpeas. The amount of COS converted to H₂S and CO was 8 times the amount converted to CS₂ in barley and 3-4 times the amount in chickpeas. Carbonyl sulfide may be a precursor for CS₂ in vegetation and soil, just as the reverse is true in the atmosphere. These two different results might form a cycle of COS and CS₂.

Ren, Y. (1999). "Is carbonyl sulfide a precursor for carbon disulfide in vegetation and soil? Interconversion of carbonyl sulfide and carbon disulfide in fresh grain tissues in vitro." Journal of Agricultural and Food Chemistry **47**(5): 2141-2144.

The interconversion of carbonyl sulfide (COS) and carbon disulfide (CS₂) was studied in the roots and shoots of barley and chickpeas. Ratios of conversion gases, K, 40 h after the addition of COS or CS₂ are recorded. The proportion of COS converted to each of CS₂, CO, and H₂S and the proportion of CS₂ converted to COS were greater in roots than in shoots. More COS was converted to CS₂ than CS₂ to COS in roots and shoots of barley and chickpeas. The amount of COS converted to H₂S and CO was 8 times the amount converted to CS₂ in barley and 3-4 times the amount in chickpeas. Carbonyl sulfide may be a precursor for CS₂ in vegetation and soil, just as the reverse is true in the atmosphere. These two different results might form a cycle of COS and CS₂.

Ren, Y. and S. E. Allen (2001/9). "Ultrasound treatment acceleration of solvent extraction for fumigant residues from wheat." J AOAC Int **84**(5): 1551-4.

Concerns about consumer and worker safety and the fate of fumigants have fuelled strong efforts to determine their residues in foodstuffs. Fumigants are usually extracted from commodities with solvent at room temperature (25 degrees C). In this paper, solvent extraction of methyl bromide, phosphine, carbonyl sulfide, and carbon disulfide using ultrasonic acceleration or heating was evaluated. Wheat samples plus solvent, in gas-tight bottles, were placed in an ultrasonic chamber or an oven (50 degrees C), and fumigants were released into the headspace over the solvent. Completeness of extraction was demonstrated within 2 h for ultrasonic extraction, 7-20 h for 50 degrees C heating, and 8-35 h for room temperature extraction. The rapidity of extraction was mainly due to ultrasonic vibration rather than increased temperature.

Ren, Y. and D. Mahon (2007/1/10). "Evaluation of microwave irradiation for analysis of carbonyl sulfide, carbon disulfide, cyanogen, ethyl formate, methyl bromide, sulfuryl fluoride, propylene oxide, and phosphine in hay." J Agric Food Chem **55**(1): 32-7.

Fumigant residues in hay were "extracted" by microwave irradiation. Hay, in gastight glass flasks, was placed in a domestic microwave oven, and fumigants were released into the headspace by microwave irradiation. Power settings for maximum release of fumigants were determined for carbonyl sulfide (COS), carbon disulfide (CS₂), cyanogen (C₂N₂), ethyl formate (EF), methyl bromide (CH₃Br), sulfuryl fluoride (SF), propylene oxide (PPO), and phosphine (PH₃). Recoveries of fortified samples were >91% for COS, CS₂, CH₃Br, SF, PPO, and PH₃ and >76% for C₂N₂ and EF. Completeness of extraction was assessed from the amount of fumigant retained by the microwaved hay. This amount was determined from further microwave irradiation and was always small (<5% of the amount obtained from the initial procedure). Limits of quantification were <0.1 mg/kg for COS, CS₂, C₂N₂, EF, and PH₃ and <0.5 mg/kg for CH₃Br, SF, and PPO. These low limits were essentially due to the absence of interference from solvents and no necessity to inject large-volume gas samples. The microwave method is rapid and solvent-free. However, care is required in selecting the appropriate power setting. The safety implications of heating sealed flasks in microwave ovens should be noted.

Ren, Y., G. O'Brien, et al. (1997). "Improved methodology for studying diffusion, sorption and desorption in timber fumigation." Journal of Stored Products Research **33**(3): 199-208.

Methods to study movement of fumigant through timber were improved, and procedures were developed that obviated the need for sampling lines. Movement for two fumigants (methyl bromide and carbonyl sulphide) through, and sorption on, heartwood of softwood and hardwood were studied. Each fumigant was sorbed less on softwood than on hardwood and penetrated softwood better than hardwood. Neither fumigant penetrated across the grain. Carbonyl sulphide penetrated timber better than did methyl bromide, and was less sorbed on timber. A rapid method of solvent extraction was developed to enable rapid estimation of the amount of intact fumigant sorbed in wood. This procedure enabled excellent recovery of methyl bromide as either intact fumigant or as bromide ion.

Ren, Y. L. and J. M. Desmarchelier (1998). "Release of fumigant residues from grain by microwave irradiation." Journal of Aoac International **81**(3): 673-678.

Multiresidue analysis of fumigants is important because of their widespread use on staple foodstuffs, such as grain. Fumigants are usually extracted from grain either by solvent extraction or by purge- and-trap techniques. In this paper, fumigant residues in wheat were "extracted" by a microwave procedure. Wheat, in gas-tight Erlenmeyer flasks, was placed in a domestic microwave oven, and fumigants were released into the headspace by microwave irradiation. Power settings for maximum release of fumigants were determined for CH₃Br, PH₃, CS₂, and COS. Recoveries of fortified samples were > 90%. Completeness of extraction was assessed from the amount of fumigant retained by the microwave-irradiated wheat. This amount, determined from both solvent extraction and from further microwave irradiation, was always small (< 5% of the amount obtained from the initial procedure). Limits of quantitation were < 1 ng/g for CH₃Br, PH₃, and CS₂. These low limits were essentially due

Ren, Y. L., I. G. O'Brien, et al. (1996). "Effect of hydrogen cyanide and carbonyl sulphide on the germination and plumule vigour of wheat." Pesticide Science **47**(1): 1-5.

Several factors which may influence the germination of wheat fumigated with hydrogen cyanide or carbonyl sulphide were investigated. Dosages of hydrogen cyanide ranged from 10 mg litre⁻¹ for 24-h exposure up to 150 mg litre⁻¹ for 96-h exposure. Dosages of carbonyl sulphide ranged from 25 mg litre⁻¹ for 24-h exposure up to 500 mg litre⁻¹ for 72-h exposure. The experiments were conducted on wheat of 11.4, 13.8 and 15.7% moisture content. The higher levels of these fumigants exceed those needed for control of insects in wheat. Germination was not diminished and may have been slightly enhanced with hydrogen cyanide, but was diminished by high levels of carbonyl sulphide in the drier wheat. The plumule length was reduced following all dosages of hydrogen cyanide, but only after high dosages of carbonyl sulphide, especially on the driest wheat. It is concluded that hydrogen cyanide and carbonyl sulphide could be used to control insects in wheat without affecting seed viability

Rennenberg, H. and A. Polle (1994). "Metabolic consequences of atmospheric sulphur influx into plants." Alscher, R.G. and A.R. Wellburn (Ed.). Plant Responses to the Gaseous Environment: Molecular, Metabolic and Physiological Aspects **Third International Symposium on Air Pollutants and Plant Metabolism, Blacksburg, Virginia, USA, June 13-16, 1992. xvii+395p. Chapman and Hall Ltd.: London, England, UK; New York, New York, USA. ISBN 0-412-58170-1; 0(0): 165-180.**

RRM BOOK CHAPTER MEETING PAPER SULFUR DIOXIDE HYDROGEN SULFIDE
CARBONYLSULFIDE METHYLMERCAPTAN DIMETHYLSULFIDE DIMETHYLDISULFIDE
CARBON DISULFIDE ACIDIFICATION GROWTH NUTRITION POLLUTION
ENVIRONMENTAL STRESS

Riby, H. "Technology into action: the future for fumigation." International Pest Control, (November-December 2002) Vol.44, No.6, pp.320-322.print.ISSN: 0020-8256 (ISSN print). -.

Riudavets, J. R. A., K. A. Damcevski, et al. "Comparative responses of a range of psocid (psocoptera: liposcelididae) species to five alternative fumigants." Phytoparasitica, (August, 2001) Vol.29, No. Supplement, pp.80S.print.Meeting Info.: International Conference on Controlled Atmosphere and Fumigation in Stored Products.Fresno, California, USA.October 29-November 03, 2000.CODEN: PHPRA2.ISSN: 0334-2123.: -.

Roller, C. B. R. A., K. Namjou, et al. "Point-of-care breath diagnostics - field evaluation of the breathmeter (tm)." Clinical Chemistry, (JUN 2006) Vol.52, No.6, Suppl.S, pp.A190.Meeting Info.: 58th Annual Meeting of the American-Association-of-Clinical- Chemistry.Chicago, IL, USA.July 23 -27, 2006.Amer Assoc Clin Chem.CODEN: CLCHAU.ISSN: 0009-9147.: -.

Ronkainen, P., J. Denslow, et al. (1973). "The gas chromatographic analysis of some volatile sulfur compounds." J Chromatogr Sci; 11 (7).1973 384-390: -.

HEEP COPYRIGHT: BIOL ABS. Volatile sulfur compounds were analyzed on a gas chromatograph fitted with a flame photometric detector (FPD). Triton X-305 (with and without the addition of

phosphoric acid) was used as liquid phase, Chromosorb G as stationary phase, FEP (Teflon Du Pont) as column material and, in some applications, diethyl sulfide as internal standard. The addition of phosphoric acid to the liquid phase improved the separation of compounds otherwise imperfectly resolved on this system. Ethanethiol was separated from dimethyl sulfide, and with the further improvement of longer (12m) column and lower (30 degree C) temperature, carbon dioxide, carbonyl sulfide, and hydrogen sulfide were separated. At low concentrations, the FPD response varies nearly as the square of the sample concentration, but this dependence changes to a roughly linear relationship at higher concentrations. These relationships hold good for both liquid and head-space samples. (The samples, analyzed included air pollution samples, pesticides, tobacco smoke and alcohol.)

Ruishu, W., L. Xiaohui, et al. (1999). Report of toxicity test of carbonyl sulfide. J. Zuxun. Chengdu, China, Sichuan Pub. House of Science & Technology: 572-583.

Sattler, M. L. and R. S. Rosenberk (2006/2). "Removal of carbonyl sulfide using activated carbon adsorption." J Air Waste Manag Assoc **56**(2): 219-24.

Wastewater treatment plant odors are caused by compounds such as hydrogen sulfide (H₂S), methyl mercaptans, and carbonyl sulfide (COS). One of the most efficient odor control processes is activated carbon adsorption; however, very few studies have been conducted on COS adsorption. COS is not only an odor causing compound but is also listed in the Clean Air Act as a hazardous air pollutant. Objectives of this study were to determine the following: (1) the adsorption capacity of 3 different carbons for COS removal; (2) the impact of relative humidity (RH) on COS adsorption; (3) the extent of competitive adsorption of COS in the presence of H₂S; and (4) whether ammonia injection would increase COS adsorption capacity. Vapor phase react (VPR; reactivated), BPL (bituminous coal-based), and Centaur (physically modified to enhance H₂S adsorption) carbons manufactured by Calgon Carbon Corp. were tested in three laboratory-scale columns, 6 in. in depth and 1 in. in diameter. Inlet COS concentrations varied from 35 to 49 ppmv (86-120 mg/m³). RHs of 17%, 30%, 50%, and 90% were tested. For competitive adsorption studies, H₂S was tested at 60 ppmv, with COS at 30 ppmv. COS, RH, H₂S, and ammonia concentrations were measured using an International Sensor Technology Model IQ-350 solid state sensor, Cole-Parmer humidity stick, Interscan Corp. 1000 series portable analyzer, and Drager Accuro ammonia sensor, respectively. It was found that the adsorption capacity of Centaur carbon for COS was higher than the other two carbons, regardless of RH. As humidity increased, the percentage of decrease in adsorption capacity of Centaur carbon, however, was greater than the other two carbons. The carbon adsorption capacity for COS decreased in proportion to the percentage of H₂S in the gas stream. More adsorption sites appear to be available to H₂S, a smaller molecule. Ammonia, which has been found to increase H₂S adsorption capacity, did not increase the capacity for COS.

Scheffel, F. A. and F. D. Skinner (1988). "Engineering evaluation of environmental data from the krw coal gasification process development unit: topical report." Govt Reports Announcements & Index (Gra&I), Issue 10, 1989: -.

TD3: Based on the sampling and analysis program conducted by Radian at the KRW PDU in July 1985:

Hydrogen sulfide was the predominant sulfur species present in the hot product gas. Approximately 95% of the gaseous sulfur measured was present as H₂S, while the remaining 5% consisted of carbonyl sulfide (COS). Dolomite injection had a major impact on the distribution of sulfur between the gas and solid streams. Without dolomite injection, about 20% of the sulfur entering with the coal was found in the various solid streams leaving the gasifier (i.e., ash, tertiary cyclone solids, and hot gas particulates) and 80% was present as H₂S and COS in the hot gas prior to quench. When dolomite was injected into the gasifier bed, the distribution was essentially reversed; about 70% was found in the solids and 30% in the hot gas. The primary reduced nitrogen species found in the hot product gas were ammonia and hydrogen cyanide. For most of the trace elements measured, 95 to over 99% of the inlet mass was distrib

Schenk, S., J. Kesselmeier, et al. (2004/6/21). "How does the exchange of one oxygen atom with sulfur affect the catalytic cycle of carbonic anhydrase?" Chemistry **10**(12): 3091-105.

We have extended our investigations of the carbonic anhydrase (CA) cycle with the model system [(H(3)N)(3)ZnOH](+) and CO(2) by studying further heterocumulenes and catalysts. We investigated the hydration of COS, an atmospheric trace gas. This reaction plays an important role in the global COS cycle since biological consumption, that is, uptake by higher plants, algae, lichens, and soil, represents the dominant terrestrial sink for this gas. In this context, CA has been identified by a member of our group as the key enzyme for the consumption of COS by conversion into CO(2) and H(2)S. We investigated the hydration mechanism of COS by using density functional theory to elucidate the details of the catalytic cycle. Calculations were first performed for the uncatalyzed gas phase reaction. The rate-determining step for direct reaction of COS with H(2)O has an energy barrier of $\Delta G = 53.2$ kcal mol⁻¹. We then employed the CA model system [(H(3)N)(3)ZnOH](+) (1) and studied the effect on the catalytic hydration mechanism of replacing an oxygen atom with sulfur. When COS enters the carbonic anhydrase cycle, the sulfur atom is incorporated into the catalyst to yield [(H(3)N)(3)ZnSH](+) (27) and CO(2). The activation energy of the nucleophilic attack on COS, which is the rate-determining step, is somewhat higher (20.1 kcal mol⁻¹ in the gas phase) than that previously reported for CO(2). The sulfur-containing model 27 is also capable of catalyzing the reaction of CO(2) to produce thiocarbonic acid. A larger barrier has to be overcome for the reaction of 27 with CO(2) compared to that for the reaction of 1 with CO(2). At a well-defined stage of this cycle, a different reaction path can emerge: a water molecule helps to regenerate the original catalyst 1 from 27, a process accompanied by the formation of thiocarbonic acid. We finally demonstrate that nature selected a surprisingly elegant and efficient group of reactants, the [L(3)ZnOH](+)/CO(2)/H(2)O system, that helps to overcome any deactivation of the ubiquitous enzyme CA in nature.

Schilke, P., T. D. Groesbeck, et al. (1997/1). "A line survey of Orion KL from 325 to 360 GHz." Astrophys J Suppl Ser **108**(1): 301-37.

We present a high-sensitivity spectral line survey of the high-mass star-forming region Orion KL in the 325-360 GHz frequency band. The survey was conducted at the Caltech Submillimeter Observatory on Mauna Kea, Hawaii. The sensitivity achieved is typically 0.1-0.5 K and is limited mostly by the sideband separation method utilized. We find 717 resolvable features consisting of 1004 lines, among which 60 are unidentified. The identified lines are due to 34 species and various isotopomers. Most of

the unidentified lines are weak, and many of them most likely due to isotopomers or vibrationally or torsionally excited states of known species with unknown line frequencies, but a few reach the 2-5 K level. No new species have been identified, but we were able to strengthen evidence for the identification of ethanol in Orion and found the first nitrogen sulfide line in this source. The molecule dominating the integrated line emission is S₀2, which emits twice the intensity of CO, followed by SO, which is only slightly stronger than CO. In contrast, the largest number of lines is emitted from heavy organic rotors like HCOOCH₃, CH₃CH₂CN, and CH₃OCH₃, but their contribution to the total flux is unimportant. CH₃OH is also very prominent, both in the number of lines and in integrated flux. An interesting detail of this survey is the first detection of vibrationally excited HCN in the v₂ = 2 state, 2000 K above ground. Clearly this is a glimpse into the very inner part of the Orion hot core.

Schulte, H. F., M. T. Brandt, et al. (1984). "Aboveground oil shale processing: health hazard characterization." Annals of the American Conference of Governmental Industrial Hygienists, Vol.11, Acgih Transactions 1984, Pages 185-194, 27 References, 1984: -.

The information currently available regarding the potential health hazards in aboveground oil shale processing was presented. Chemical hazards included exposure to oil shale, retorted shale, free crystalline silica (7631869), hydrogen-sulfide (7783064), sulfur-dioxide (7446095), carbon-monoxide (630080), carbonyl-sulfide (463581), carbon-dioxide (124389), ammonia (7664417), carbon-disulfide (75150), arsenic (7440382), hydrogen-cyanide (74908), carbonyls, nitrogen oxides, formaldehyde (50000), trace elements, and organic oil shale products and intermediates. Exposure to hydrocarbons, which comprised the major portion of the product, included saturated aliphatic hydrocarbons, olefins and acetylenes, naphthenes, and single and multiple ring aromatics. Heterocyclic compounds, which were found in the pyrolysis products of oil shale, could contain nitrogen, oxygen, and sulfur atoms. Phenols, aliphatic and alicyclic amines, aromatic amines, and various intermediates were also listed. Physical hazards included noise, vibration, heat stress, ionizing radiation, limited egress, and working conditions in general.

Schwack, W., B. Brueger, et al. (1995). "Simultaneous differential pulse-polarographic determination of cs-2 and cos gases and its application in the analysis of dithiocarbamate fungicide residues in foods." Fresenius' Journal of Analytical Chemistry **351**(2-3): 297-300.

RRM RESEARCH ARTICLE APPLE CARBON DISULFIDE CARBON OXYSULFIDE THIRAM ANALYTICAL METHOD

Schwack, W. and S. Nyanzi (1994). "Analysis of dithiocarbamate fungicides. Second-derivative uv-spectroscopic determination of cs₂, cos, and thiram (tmtd)." Zeitschrift Fuer Lebensmittel-Untersuchung Und -Forschung **198**(1): 3-7.

The application of second-derivative UV-spectroscopy offers a highly sensitive and selective method for the determination of CS₂ and COS, as acid hydrolysis products of dithiocarbamate und thiuram disulphide fungicides, using a methanolic amine absorption reagent (ethylenediamine, piperidine). With

standard concentrations of 0.08-1.1 mug CS₂/ml and 0.3 to 2.0 mug COS/ml, respectively, calibration curves with good correlation coefficients ($r > 0.999$) were obtained. In comparison to the official method of the Deutsche Forschungsgemeinschaft (DFG method S15) the proposed alternative is at least 100 times more sensitive to CS₂. Using the second derivative method it is possible not only to clearly differentiate between CS₂ and COS but also to quantify both gases without resorting to tedious background corrections as compared to the direct photometric methods. Additionally, second derivative spectroscopy allows the direct determination of thiram in the concentration range 11

Seefeldt, L. C., M. E. Rasche, et al. (1995/4/25). "Carbonyl sulfide and carbon dioxide as new substrates, and carbon disulfide as a new inhibitor, of nitrogenase." Biochemistry **34**(16): 5382-9.

Nitrogenase is the metalloenzyme responsible for the biological reduction of N₂ to NH₃. Nitrogenase has been shown to reduce a variety of substrates in addition to N₂ and protons. General properties of alternative substrates for nitrogenase are the presence of N-N, N-O, N-C, and C-C triple or double bonds. In the present work, we demonstrate that *Azotobacter vinelandii* nitrogenase can reduce both C-S and C-O bonds. Nitrogenase was found to reduce carbonyl sulfide (COS), to CO and H₂S at a maximum rate of 37.2 +/- 2.0 nmol min⁻¹ (mg of protein)⁻¹ with a K_m of 3.1 +/- 0.6 mM. The formation of CO from nitrogenase reduction of COS was monitored spectrophotometrically in real time by following the formation of carboxyhemoglobin. In this assay, the change in the visible absorption spectrum of reduced hemoglobin upon binding CO provided a sensitive way to quantify CO formation and to remove CO, which is a potent inhibitor of nitrogenase, from solution. COS reduction by nitrogenase required the molybdenum-iron protein (MoFeP), the iron protein (FeP), and MgATP. The reduction reaction was inhibited by MgADP, acetylene, and N₂, while H₂ was not an inhibitor of COS reduction. The pH optimum for COS reduction was 6.5. Nitrogenase was also found to reduce carbon dioxide (CO₂) to CO and H₂O. CO₂ was reduced at a maximum rate of 0.8 +/- 0.07 nmole min⁻¹ (mg of protein)⁻¹ with a calculated K_m for CO₂ of 23.3 +/- 3.7 mM.(ABSTRACT TRUNCATED AT 250 WORDS)

Sehnert, S. S., L. Jiang, et al. (2002/3). "Breath biomarkers for detection of human liver diseases: preliminary study." Biomarkers **7**(2): 174-87.

Chronic liver disease is initially occult, has multiple aetiologies, involves complex diagnostic questions, and requires follow-up because progression is likely. Blood tests and biopsies are generally used, but have disadvantages. We have developed a new test for liver disease based on abnormal concentrations of metabolic products detected in exhaled breath. This test can be used, in conjunction with other clinically accepted diagnostic protocols, to detect and classify chronic liver diseases. Samples of breath collected from spontaneously breathing human subjects (86 patients presenting with 13 liver diseases and 109 subjects with normal liver function) were concentrated cryogenically and analysed by wide-bore capillary gas chromatography using various detectors. The concentrations of various molecules in exhaled breath were examined for potential use as biomarkers of liver function. Subjects with chronic liver diseases could be differentiated from those with normal liver function by comparing levels of breath carbonyl sulphide, carbon disulphide and isoprene; these differences were confirmed and correlated by comparing the levels with standard clinical blood markers of liver damage. The presence of chronic liver failure can thus be detected with sensitivity and specificity by quantifying sulphur-

containing compounds arising from the abnormal metabolism associated with liver disease. The breath test we have developed appears to distinguish between hepatocellular and biliary tract aetiologies, and allows staging for severity. This approach may provide the clinician with a simple, non-invasive technique for use in the screening of large populations and follow-up for patients with chronic liver disease.

Serafin, M. M. and S. A. Peebles (2006/11/2). "Rotational spectrum and structure of the carbonyl sulfide-trifluoromethane weakly bound dimer." J Phys Chem A **110**(43): 11938-43.

Pure rotational spectra of five isotopomers of the 1:1 weakly bound complex formed between carbonyl sulfide and trifluoromethane (TFM) have been measured using Fourier transform microwave spectroscopy. The experimental rotational constants and dipole moment components are consistent with a structure of C(s) symmetry in which the dipole moment vectors of OCS and HCF(3) are aligned antiparallel and at an angle of about 40 degrees and with a center of mass separation of 3.965(26) Å. The derived H...O distance is 2.90(5) Å, which is up to 0.6 Å longer than is seen in other similar TFM complexes exhibiting C-H...O interactions. Ab initio calculations at the MP2/6-311++G(2d,2p) level give a structure with rotational constants that are in reasonable agreement with those of the normal isotopic species.

Sills, R. C., G. J. Harry, et al. (2005/9/1). "Interdisciplinary neurotoxicity inhalation studies: Carbon disulfide and carbonyl sulfide research in F344 rats." Toxicol Appl Pharmacol **207**(2 Suppl): 245-50.

Inhalation studies were conducted on the hazardous air pollutants, carbon disulfide, which targets the central nervous system (spinal cord) and peripheral nervous system (distal portions of long myelinated axons), and carbonyl sulfide, which targets the central nervous system (brain). The objectives were to investigate the neurotoxicity of these compounds by a comprehensive evaluation of function, structure, and mechanisms of disease. Through interdisciplinary research, the major finding in the carbon disulfide inhalation studies was that carbon disulfide produced intra- and intermolecular protein cross-linking in vivo. The observation of dose-dependent covalent cross-linking in neurofilament proteins prior to the onset of lesions is consistent with this process contributing to the development of the neurofilamentous axonal swellings characteristic of carbon disulfide neurotoxicity. Of significance is that valine-lysine thiourea cross-linking on rat globin and lysine-lysine thiourea cross-linking on erythrocyte spectrin reflect cross-linking events occurring within the axon and could potentially serve as biomarkers of carbon disulfide exposure and effect. In the carbonyl sulfide studies, using magnetic resonance microscopy (MRM), we determined that carbonyl sulfide targets the auditory pathway in the brain. MRM allowed the examination of 200 brain slices and made it possible to identify the most vulnerable sites of neurotoxicity, which would have been missed in our traditional neuropathology evaluations. Electrophysiological studies were focused on the auditory system and demonstrated decreases in auditory brain stem evoked responses. Similarly, mechanistic studies focused on evaluating cytochrome oxidase activity in the posterior colliculus and parietal cortex. A decrease in cytochrome oxidase activity was considered to be a contributing factor to the pathogenesis of carbonyl sulfide neurotoxicity.

Sills, R. C., D. L. Morgan, et al. (2004/9). "Contribution of magnetic resonance microscopy in the 12-week neurotoxicity evaluation of carbonyl sulfide in Fischer 344 rats." Toxicol Pathol **32**(5): 501-10.

In this carbonyl sulfide (COS) study, magnetic resonance microscopy (MRM) and detailed light microscopic evaluation effectively functioned in parallel to assure that the distribution and degree of pathology in the brain was accurately represented. MRM is a powerful imaging modality that allows for excellent identification of neuroanatomical structures coupled with the ability to acquire 200 or more cross-sectional images of the brain, and the ability to display them in multiple planes. F344 rats were exposed to 200-600 ppm COS for up to 12 weeks. Prior to MRM, rats were anesthetized and cardiac perfused with McDowell Trump's fixative containing a gadolinium MR contrast medium. Fixed specimens were scanned at the Duke Center for In Vivo Microscopy on a 9.4 Tesla magnetic resonance system adapted explicitly for microscopic imaging. An advantage of MRM in this study was the ability to identify lesions in rats that appeared clinically normal prior to sacrifice and the opportunity to identify lesions in areas of the brain which would not be included in conventional studies. Other advantages include the ability to examine the brain in multiple planes (transverse, dorsal, sagittal) and obtain and save the MRM images in a digital format that allows for postexperimental data processing and manipulation. MRM images were correlated with neuroanatomical and neuropathological findings. All suspected MRM images were compared to corresponding H&E slides. An important aspect of this study was that MRM was critical in defining our strategy for sectioning the brain, and for designing mechanistic studies (cytochrome oxidase evaluations) and functional assessments (electrophysiology studies) on specifically targeted anatomical sites following COS exposure.

Sills, R. C. R. A., D. L. Morgan, et al. (2004). "Contribution of magnetic resonance microscopy in the biologic and mechanistic assessment of carbonyl sulfide neurotoxicity in f344 rats." Toxicology and Applied Pharmacology, (JUN 15 2004) Vol.197, No.3, pp.151-152.Meeting Info.: 10th International Congress of Toxicology.Tampere, FINLAND.July 11 -15, 2004.CODEN: TXAPA9.ISSN: 0041-008X: -.

Singh, H. (1992). "Food irradiation volatiles in flavors and off-flavors." Charalambous, G.(Ed.). Developments in Food Science, Vol.28.Off-Flavors in Foods and Beverages.Xiv+749p.Elsevier Science Publishers B.v.: Amsterdam, Netherlands New York, New York, Usa. Isbn 0-444-88558-7.; 0(0): 625-664.

RRM AROMA FOOD FLAVOR FOOD CHEMISTRY FOOD PROCESSING

Sklarew, D. S., D. J. Hayes, et al. (1984). "Trace sulfur-containing species in the offgas from 2 oil shale retorting processes." Environ Sci Technol **18**(8): 592-600.

HEEP COPYRIGHT: BIOL ABS. Six non-H₂S S species were identified and quantitated from 2 different retorting processes, a modified in situ process and an aboveground process. COS, CH₃SH, CS₂, thiophene, methylthiophene and SO₂ were determined by gas chromatography combined with a flame photometric detector. One in situ retort produced the highest concentrations of S species while the

aboveground retort produced the least of the 3 retorts studied. Other modified in situ retorts had been reported to produce relatively low concentrations of S species. Variability in the quantitative data was attributed to variability in S content of the raw oil shales and in retort conditions. Possible reaction mechanisms were considered. The non-H₂S S species comprised 0.4-6% of the low MW S species measured in the retort offgases. Abatement strategies must consider the presence of these trace species if the air quality standards proposed by Colorado (USA) are to be maintained.

Slanina, J., M. P. Keuken, et al. (1987). "Determination of sulfur dioxide in ambient air by a computer-controlled thermodenuder system." Anal Chem **59**(23): 2764-2766.

RRM AIR POLLUTION BIOLOGICAL INSTRUMENTATION MH - COMPUTER SYSTEMS

Smet, E., P. Lens, et al. (1998). "Treatment of waste gases contaminated with odorous sulfur compounds." Critical Reviews in Environmental Science and Technology **28**(1): 89-117.

RRM LITERATURE REVIEW VOLATILE SULFUR COMPOUNDS EMISSION SOURCES WASTE GAS TREATMENT ODOROUS COMPOUNDS WASTE MANAGEMENT WASTEWATER TREATMENT HYDROGEN SULFIDE DIMETHYL SULFIDE DIMETHYL DISULFIDE METHANETHIOL CARBON DISULFIDE CARBONYL SULFIDE ANAEROBIC DEGRADATION ANTHROPOGENIC SOURCES POLLUTION

Smet, E., W. Verstraete, et al. (1992). "Enrichment culture for the oxidation of organic sulphur compounds." Sixth Forum for Applied Biotechnology, Bruges, Belgium, September 24-25, 1992. Meded Fac Landbouwwet Univ Gent **57**(4 Part a-B): 1725-1728.

RRM BACTERIA POLLUTION CONTROL ENVIRONMENTAL PROTECTION WASTEWATER TREATMENT BIODEGRADATION SULFUR

Smith, K. D., K. T. Klasson, et al. (1991/3). "COS degradation by selected CO-utilizing bacteria. Scientific note." Appl Biochem Biotechnol **28-29**: 787-96.

Snyderwine, E. G. and A. Hunter (1987/5). "Metabolism and distribution of ¹⁴C- and ³⁵S-labeled carbon disulfide in immature rats of different ages." Drug Metab Dispos **15**(3): 289-94.

The metabolism and distribution of ¹⁴C- and ³⁵S-CS₂ was examined in 1-, 5-, 10-, 20-, 30-, and 40-day-old rats. During a 3-hr period following an ip dose of ¹⁴C-CS₂, 58-83% of the dose was expired as CS₂ and 4-9% was metabolized to expired CO₂ depending on age. Thirty- and forty-day-old rats metabolized significantly more CS₂ to CO₂ and expired significantly less CS₂ than 1- through 20-day-old rats. At the end of the measured expiration period, only biotransformation products of CS₂, which were in part covalently bound, remained in tissues from rats of all ages. Tissue levels of ³⁵S-CS₂-derived radioactivity exceeded levels of ¹⁴C-CS₂-derived radioactivity indicating that sulfur metabolites free from the carbon atom of CS₂ were formed in rats as young as 1 day of age. The ³⁵S-CS₂-derived

radioactivity per g of tissue and thus ³⁵S covalently bound to tissue protein was significantly higher in 1- through 20-day-old rats than in 30- and 40-day-old rats. Twenty-four hr after dosing, up to 13 times more ³⁵S-labeled metabolites were covalently bound in organs from 1-day-old rats than in similar organs from 40-day-old rats. The results showed that elimination of the biotransformation products of CS₂, in particular the covalently binding sulfur metabolites, was prolonged in newborn rats in comparison to 40-day-old rats.

Society, T. C. (1977). [no title -- miscellaneous section only]. London, The Chemical Society: 233-.

Sola, I., X. Ausio, et al. (1997). "Quantitation of volatile sulphur compounds in polluted waters." Journal of Chromatography a **778**(1-2): 329-335.

A study on the linear dynamic range of a combined cryogenic trap-gas chromatographic method with flame photometric detection (FPD) has shown that quantitation of volatile sulphur compounds (VSCs) in heavily polluted waters, in the order of hundreds of nanograms, is possible. A correct calibration of the FPD is needed for this purpose. Calibration over 2.5-3 orders of magnitude requires the determination of three different linear equations extending over this mass range. Equations for hydrogen sulphide, carbonyl sulphide, methanethiol, dimethyl sulphide and carbon disulphide are given. The intervals corresponding to each linear equation are determined from the inflexion points in the calibration plots. The changes in sign of the relative error resulting from re-calculation of the VSC mass after use of one single calibration curve for the whole mass range interval provide a secondary criterion of interest.

Sorokin, D. Y., T. P. Tourova, et al. (2007/6). "Denitrification in a binary culture and thiocyanate metabolism in *Thiohalophilus thiocyanoxidans* gen. nov. sp. nov. - a moderately halophilic chemolithoautotrophic sulfur-oxidizing Gammaproteobacterium from hypersaline lakes." Arch Microbiol **187**(6): 441-50.

Anaerobic enrichment culture with thiocyanate as electron donor and nitrate as electron acceptor at 2 M NaCl inoculated with a mixture of sediments from hypersaline lakes in Kulunda Steppe (Altai, Russia) resulted in a selection of a binary consortium of moderately halophilic, obligately chemolithoautotrophic sulfur-oxidizing bacteria (SOB) capable of complete denitrification of nitrate with thiosulfate as the electron donor. One consortium member, strain HRhD 3sp, was isolated into pure culture with nitrate and thiosulfate using a density gradient. This strain was responsible for the reduction of nitrate to nitrite in the consortium, while a second strain, HRhD 2, isolated under microoxic conditions with thiosulfate as substrate, was capable of anaerobic growth with nitrite and thiosulfate. Nitrite, either as substrate or as product, was already toxic at very low concentrations for both strains. As a result, optimal growth under anaerobic conditions could only be achieved within the consortium. On the basis of phylogenetic analysis, both organisms were identified as new lineages within the Gammaproteobacteria. As well as thiosulfate, strain HRhD 2 can also use thiocyanate as electron donor, representing a first halophilic SOB capable of growth with thiocyanate at 2-4 M NaCl. Product and enzymatic analysis identified the "carbonyl sulfide (COS) pathway" of primary thiocyanate degradation in this new species. On the basis of phenotypic and genetic analysis, strain HRhD 2 is proposed to be assigned to a new genus and species

Thiohalophilus thiocyanoxidans.

Sotnikov, E. E. (1990). "Gas chromatographic analysis preceded with concentration of atmospheric harmful substances." Gig Sanit **0**(9): 85-86.

RRM HYDROGEN SULFIDE SULFUR DIOXIDE CARBONYL SULFIDE

Staubes, R., H. W. Georgii, et al. (1989). "Flux of cos dms and carbon disulfide from various soils in germany." Tellus Ser B Chem Phys Meteorol **41**(3): 305-313.

RRM PLANT PHYSIOLOGY SOIL MICROORGANISM CARBONYL SULFIDE DIMETHYL SULFIDE ANTHROPOGENIC EMISSION

Stuedler, P. A., J. M. Melillo, et al. (1987). "Carbonyl sulfide and carbon disulfide emissions from temperate and boreal forest soils." 194th American Chemical Society National Meeting, New Orleans, Louisiana, Usa, August 30-September 4, 1987. Abstr Pap Am Chem Soc **194**(0): Envr 268-.

RRM ABSTRACT

Stuedler, P. A. and B. J. Peterson (1985). "Annual cycle of gaseous sulfur emissions from a new-england usa spartina-alterniflora marsh." Atmos Environ **19**(9): 1411-1416.

RRM HYDROGEN SULFIDE DIMETHYL SULFIDE CARBONYL SULFIDE CARBON DISULFIDE DIMETHYL DISULFIDE

Stratford, J., A. Dias, et al. (1994). "The utilization of thiocyanate as a nitrogen source by a heterotrophic bacterium: the degradative pathway involves formation of ammonia and tetrathionate." Microbiology (Reading) **140**(10): 2657-2662.

A Gram-negative soil bacterium (isolate 26B) has been shown to utilize up to 100 mM thiocyanate as a source of nitrogen when supplied with glucose as the source of carbon and energy. During growth of isolate 26B with thiocyanate as the source of nitrogen, no ammonia, nitrate, nitrite, cyanide, cyanate, sulfate, sulfite, sulfide or carbonyl sulfide was detected in the growth medium. Growth of the bacterium on ¹⁴C-labelled thiocyanate (1.6 μCi) and glucose, yielded ¹⁴C-labelled carbon dioxide (0.9 μCi). The addition of 2.9 mM thiocyanate to a bacterial suspension in phosphate buffer (50 mM, pH 7.4) resulted in the utilization of 2.1 mM thiocyanate and the production of 2.0 mM ammonia. This activity was inducible and only occurred after growth of the bacterium with thiocyanate as the source of nitrogen. Tetrathionate (0.7 mM) was detected in the medium after the utilization of thiocyanate (24 mM) by a suspension of the bacterium in phosphate buffer, and thiosulfate (1.0

Strugariu, T., S. Naim, et al. (1998/6). "Fourier Transform Spectroscopy of ¹⁸O-Enriched Carbonyl Sulfide from 1825 to 2700 cm⁻¹." J Mol Spectrosc **189**(2): 206-19.

We have measured the Fourier transform spectrum of carbonyl sulfide from 1825 to 2700 cm^{-1} , using a sample enriched in both ^{18}O (94.0%) and ^{17}O (1.54%). A careful calibration yields a line-position accuracy between 1.5 and 3.0 10^{-5} cm^{-1} . We have observed and analyzed 118 infrared bands of which 93 are measured for the first time: 55 for $^{18}\text{O}^{12}\text{C}^{32}\text{S}$, 20 for $^{18}\text{O}^{12}\text{C}^{34}\text{S}$, 11 for $^{18}\text{O}^{12}\text{C}^{33}\text{S}$, 1 for $^{18}\text{O}^{12}\text{C}^{36}\text{S}$, 12 for $^{17}\text{O}^{12}\text{C}^{32}\text{S}$, 4 for $^{17}\text{O}^{12}\text{C}^{34}\text{S}$, 2 for $^{17}\text{O}^{12}\text{C}^{33}\text{S}$, and 13 for $^{18}\text{O}^{13}\text{C}^{32}\text{S}$. Intensities are also reported and analyzed for all those bands. The intensity accuracy is better than 10%, and the precision of approximately 1% allows us to determine some Herman-Wallis coefficients. Copyright 1998 Academic Press.

Studer, S. M., J. B. Orens, et al. (2001/11). "Patterns and significance of exhaled-breath biomarkers in lung transplant recipients with acute allograft rejection." J Heart Lung Transplant **20**(11): 1158-66.

BACKGROUND: Obliterative bronchiolitis (OB) remains one of the leading causes of death in lung transplant recipients after 2 years, and acute rejection (AR) of lung allograft is a major risk factor for OB. Treatment of AR may reduce the incidence of OB, although diagnosis of AR often requires bronchoscopic lung biopsy. In this study, we evaluated the utility of exhaled-breath biomarkers for the non-invasive diagnosis of AR. **METHODS:** We obtained breath samples from 44 consecutive lung transplant recipients who attended ambulatory follow-up visits for the Johns Hopkins Lung Transplant Program. Bronchoscopy within 7 days of their breath samples showed histopathology in 21 of these patients, and we included them in our analysis. We measured hydrocarbon markers of pro-oxidant events (ethane and 1-pentane), isoprene, acetone, and sulfur-containing compounds (hydrogen sulfide and carbonyl sulfide) in exhaled breath and compared their levels to the lung histopathology, graded as stable (non-rejection) or AR. None of the study subjects were diagnosed with OB or infection at the time of the clinical bronchoscopy. **RESULTS:** We found no significant difference in exhaled levels of hydrocarbons, acetone, or hydrogen sulfide between the stable and AR groups. However, we did find significant increase in exhaled carbonyl sulfide (COS) levels in AR subjects compared with stable subjects. We also observed a trend in 7 of 8 patients who had serial sets of breath and histopathology data that supported a role for COS as a breath biomarker of AR. **CONCLUSIONS:** This study demonstrated elevations in exhaled COS levels in subjects with AR compared with stable subjects, suggesting a diagnostic role for this non-invasive biomarker. Further exploration of breath analysis in lung transplant recipients is warranted to complement fiberoptic bronchoscopy and obviate the need for this procedure in some patients.

Sun, B., X. Pan, et al. (2002/3). "[The conversion from CS_2 to COS by spark discharge]." Huan Jing Ke Xue **23**(2): 23-8.

Spark discharge method was used to take simulative investigations on the conversion reaction from CS_2 to COS by lightning. The results showed that $1.33 \times 10^3 \text{ Pa}$ CS_2 could act with O_2 or H_2O in the atmosphere (25 degrees C, 10^5 Pa) under electric discharge conditions ($V = 3000 \text{ V}$), and COS was produced as well as other species such as CO, CO_2 , SO_2 and so on. Factors such as CS_2 concentration, water vapor and discharge time played important roles in the formation of COS. Based on these results

and several theories, possible mechanisms of correlative processes during thunderstorms were proposed here, which could contribute to give evidence for the conversion from CS₂ to COS by lightning during thunderstorms.

Sze, N. D. and M. Ko (1980). "Photochemistry of carbonyl sulfide carbon di sulfide di methyl sulfide and hydrogen sulfide implications for the atmospheric sulfur cycle." Atmos Environ **14**(11): 1223-1239.

HEEP COPYRIGHT: BIOL ABS. REVIEW SULFATES SULFUR DI OXIDE HYDROXYL
RADICAL

Tameesh, A. H. H., A. O. Bender, et al. (1985). "Gas chromatographic study of the analysis and elution mechanism of hydrogen sulphide, carbonyl sulphide and light mercaptans in petroleum gases." Journal of Chromatography, Vol.321, No.1, Pages 59-67, 45 References, 1985: -.

Gas chromatographic separation of hydrogen-sulfide (7783064), carbonyl-sulfide (463581), and carbon-1 to carbon-4 labeled mercaptans in petroleum gas streams was investigated. Columns of 180 by 0.4 centimeter inner diameter were packed with 30 percent Triton-X305 on Diatomite CQ, 80 to 100 mesh, were conditioned at 200 degrees-C overnight. Standard gases of different concentrations were prepared using the calibration kit, and sample bulbs were prepared by diluting required gas with pure nitrogen. A gas chromatograph fitted with flame photometric, flame ionization, and thermal conductivity detectors was used. Carbon-disulfide (75150) and sulfur-dioxide (124389) were also separated, and all of the compounds were quantitated using a recorder and a computing integrator. Carbonyl-sulfide was eluted before hydrogen-sulfide. The column used was capable of analyzing a mixture containing carbonyl-sulfide, hydrogen-sulfide, and carbon-1 to carbon-4 mercaptans in one turn when concentrations of hydrogen-sulfide were less than or equal to 0.3 percent and at a flow rate of 20 millimeters per minute and a temperature of 200 degrees-C. Analysis time was 19 minutes. Trace amounts of carbonyl-sulfide, hydrogen-sulfide, methyl-mercaptan (74931), carbon-disulfide, and sulfur-dioxide could be separated in this order and determined in petroleum gas streams. Structural geometry, dipole moment, electron polarizability, interaction distance of the molecule, and the nature of the stationary phase modified the elution order. Concentrations of less than 0.2 part per million of sulfur gases could be determined by this method. The authors conclude that this simple gas chromatographic technique is useful in the qualitative and quantitative analysis of trace amounts of sulfur (7704349) compounds in petroleum gas streams.

Tangerman, A. (1995/10). "Analysis of carbon disulfide and carbonyl sulfide in blood subject to interference from the same components from rubber stoppers." Clin Chem **41**(10): 1541-2.

Tangerman, A. (1986). "Determination of volatile sulfur compounds in air at the parts-per-trillion level by tenax trapping and gas chromatography." J Chromatogr **366**(0): 205-216.

RRM FLAME PHOTOMETRIC DETECTOR HEPATIC COMA ATMOSPHERIC POLLUTION
CONTROL

Tarver, G. A. and P. K. Dasgupta (1995). "Design and development of a system to measure ambient levels of hydrogen sulfide and lower mercaptans from a mobile platform." Atmospheric Environment **29** (11): 1291-1298.

RRM RESEARCH ARTICLE ATMOSPHERE

Taylor, G., S. McLaughlin, et al. (1983). "The flux of sulfur-containing gases to vegetation." Atmos Environ **17**(4): 789-796.

HEEP COPYRIGHT: BIOL ABS. The flux of 5 S gases to vegetation exposed to each gas individually at an ambient concentration of 0.12 $\mu\text{mol m}^{-3}$ (5 $\mu\text{mol m}^{-3}$) was assessed using a whole-plant, gaseous exchange system. Total leaf flux of each gas was partitioned into leaf surface (adsorption) and internal (absorption) fractions. Internal flux varied 4- to 7-fold among gases, and the magnitude of flux was in the following order: $\text{SO}_2 > \text{hydrogen sulfide} > \text{carbonyl sulfide} > \text{methyl mercaptan} > \text{carban disulfide}$. The regression of internal flux on water solubility and molecular size accounted for 73 and 87% of the variation in *Glycine max* and *Phaseolus vulgaris*, respectively. Leaf conductance, which was adjusted for each gas based on their respective diffusivities in air, did not improve the regression significantly. Estimates of internal flux based on the product of leaf conductance and ambient concentration may not be an accurate technique to assess the rate of absorption for all pollutant gases into the leaf interior under daylight conditions. For highly soluble and chemically reactive gases such as SO_2 , the latter technique tends to underestimate flux by 50%, which may result from a mean SO_2 diffusive path length that is less than that for water vapor. The relationship between flux and the physicochemical properties of a gas may provide a technique for screening atmospheric emissions for their potential toxicity to vegetation.

Taylor, G. and W. J. Selvidge (1984). "Phytotoxicity in bush bean (*Phaseolus vulgaris*) of 5 sulfur-containing gases released from advanced fossil energy technologies." J Environ Qual **13**(2): 224-230.

HEEP COPYRIGHT: BIOL ABS. S-containing gases including SO_2 , H_2S , CS_2 , COS and CH_3SH are a major class of atmospheric emissions from advanced fossil energy technologies. Although phytotoxicity data for SO_2 and H_2S exist, the influence on vegetation of the remaining S gases is not known. The comparative toxicity of the 5 gases in bush bean (*P. vulgaris*) was studied. Seedlings were exposed to each gas individually for 6 h at a range of concentrations (6-82 $\mu\text{mol m}^{-3}$) in an open gaseous exchange system, during which whole-plant net photosynthesis and transpiration were monitored. At the highest exposure levels, leaf necrosis was assessed 3 days after exposure. Transpiration did not respond consistently to any of the treatments. Neither CS_2 nor CH_3SH caused any change in photosynthesis or foliar necrosis. Based on the inhibition of photosynthesis and the development of leaf necrosis at equivalent volumetric concentrations in the atmosphere, the toxicity of the remaining 3 gases was $\text{SO}_2 > \text{H}_2\text{S} > \text{COS}$. The relationship between net photosynthesis and exposure dosage (concentration and time) was biphasic, exhibiting in each gas an enhancement of photosynthesis followed by inhibition as the dosage increased. For projected emission rates from advanced fossil energy facilities, the results suggest that releases of CH_3SH and CS_2 are not likely to influence vegetation. Since plant response to H_2S , SO_2 , and COS is strongly dosage dependent, accurate estimates of field effects due to these 3 gases must

await more adequate air quality modeling near commercial-scale facilities. RN - 7783-06-4

Tompkins, M. A. (1981). "In situ oil shale retorting: water quality." Govt Reports Announcements & Index (Gra&I), Issue 19, 1981: -.

TD3: Rio Blanco Oil Shale Company completed the first burn on their modified in-situ system located in the Piceance Basin of Colorado. Gas stream analyses were performed using a small computerized mass spectrometer. These analyses were made continuously from a sample line originating at the off-gas knockout drum. In addition, the feasibility of determining trace sulfur gases in this mixture was tested. The mass spectrometer has a detection limit of about 5 ppM for a typical trace component in air or other simple gas matrix. However, because of the complex organic matrix composing the oil shale gas, it becomes very difficult to positively identify most trace components at this low ppM level. The sulfur gases which have the fewest interferences include H₂S, COS, CH₃SH and SO₂. These gases can be determined at approximately the 15 to 25 ppM level. Mass spectrometric analysis of low- or sub-ppM level trace components in complex gas mixture would require pre-treatment of the gas such as c

T-Raissi, A. (1994). "Photocatalytic oxidation of carbonyl sulfide in the presence of CO." Environmental Conference on Priorities in Pollution Prevention, Beaumont, Texas, USA, 1994. Waste Management **14**(3-4): 359-.

RRM MEETING ABSTRACT CARBON MONOXIDE TITANIUM OXIDE CHLORINATION WASTE MANAGEMENT PHOTOREACTOR

T-Raissi, A. and N. Z. Muradov (1994). "Oxidative photolysis of carbonyl sulfide over UV-excited titania in presence of carbon oxides." 207th National Meeting of the American Chemical Society, San Diego, California, USA, March 13-17, 1994. Abstracts of Papers American Chemical Society **207**(1-2): Envr 39-.

RRM MEETING ABSTRACT XENON FLASHLAMP RADIATION ANALYTICAL METHOD

Turco, R. P., R. C. Whitten, et al. (1980). "Carbonyl sulfide stratospheric aerosols and climate." Nature (Lond) **283**(5744): 283-286.

HEEP COPYRIGHT: BIOL ABS. NOTE BIOSPHERIC PROCESSES

USEPA and Monsanto] (1987). "[Monsanto- One -generation reproduction studies of male albino rats, female albino rats and previously exposed male Sprague-Dawley rats to carbonyl sulfide (COS) by inhalation] -- [probable duplicate of Fiche OTS0555041] [Old document number 8EHQ-0290-0892]." selected pages-.

Van Valin, C. C., M. Luria, et al. (1987). "Natural sulfur flux from the Gulf of Mexico: dimethyl sulfide, carbonyl sulfide, and sulfur dioxide." Govt Reports Announcements & Index (Gra&I), Issue 07, 1988: -.

TD3: Atmospheric measurements of natural sulfur compounds were performed over the northern Gulf of Mexico during the late summer months of 1984. Air samples were collected with an instrumented aircraft at elevations of 30-3500 m, during both day and night. Most air samples were representative of the clean maritime atmosphere, although some were from continental contaminated air during periods of offshore flow at the coastline. In all samples, carbonyl sulfide concentrations were within the range of 400-500 pptv. Conversely, the dimethyl sulfide concentrations showed significant variability: during clean atmospheric conditions the average of all measurements was 27 pptv, whereas under polluted conditions the average was 7 pptv. Measureable quantities of dimethyl sulfide (>5 pptv) were not observed above the boundary layer. The average sulfur dioxide concentration measured in the marine (clean) atmosphere was 215 pptv, which is consistent with the oxidation of dimethyl sulfide being its major source

Van Zanten, K. D., G. R. Chiaramonte, et al. (1986). "Control of sulfur emissions from oil shale retorting using spent shale absorption." Environmental Progress 5(2):88-94; 1986.: -.

HMTC Preliminary studies testing the viability of the absorption on spent shale process (ASSP) to control sulfur emissions from oil shale plants were conducted by the U.S. Environmental Protection Agency. Study results indicate that the best potential for ASSP application is for those processes that already have a spent shale combustor integrated into the retorting process. Process variables found to affect the ability of combusted shale to absorb sulfur dioxide include temperature, calcium-to-sulfur ratio, mineral content of the shale, extent of carbonate decomposition, use of raw shale versus spent shale as feed, solids residence time, particle size, gas residence time, gas consumption, oxygen concentration, water concentration, and solid/gas mixing. Substantial savings in capital costs for ASSP relative to Stretford and flue gas desulfurization approaches were determined. (5 ref.)

Vandergheynst, J. S., D. J. Cogan, et al. (1998). "Effect of process management on the emission of organosulfur compounds and gaseous antecedents from composting processes." Environmental Science & Technology 32(23): 3713-3718.

Pilot-scale studies were performed to assess the effects of aeration rate and initial moisture content on the emissions of odorous organosulfur compounds and nonodorous gaseous antecedents from synthetic food waste (SFW) and biosolids composting processes. In the SFW studies peak organosulfur emissions occurred at an airflow rate of 0.16 L/min-kg VS. Emission rates (mol/time) and total aerobic biological activity (cumulative mass of O₂ consumed) were lower at 0.07 L/min-kg VS, possibly because the SFW and biosolids studies CO was emitted prior to the detection of organosulfur compounds. Additionally, average correlation coefficients relating the emission rate of CO with the emission rate of organosulfur odors were 0.67 for the SFW trials and 0.75 for the biosolids trials. These results suggest that CO may be a good antecedent compound for the early warning of odors from composting processes.

Von, A. J. Kettle, et al. (1999). "Carbonyl sulphide in and over seawater: summer data from the northeast atlantic ocean." Atmospheric Environment 33(21): 3503-3514.

Carbonyl sulphide (COS) concentrations in air and dissolved in seawater were determined during a cruise in summer 1997 in the northeast Atlantic Ocean. Seawater characteristics and meteorological parameters were monitored. Dissolved COS concentrations throughout the entire cruise exhibited a strong diel cycle with maximum concentrations in late afternoon and minimum concentrations at sunrise. This is in good agreement with the theory that COS is photochemically produced from dissolved organic matter and local COS flux from the sea surface. The exchange of COS between the ocean and the atmosphere depended on dissolved COS concentrations and wind speed. The daily integrated flux was always from the sea into the air, and the average was 1.3 ± 0.8 g COS km⁻² d⁻². The collected data were used to test a mixed layer box model and a one-dimensional model, both describing the behaviour of COS in seawater. We found that the one-dimensional model simulates the data more closely, espe

von Hobe, M., T. Kenntner, et al. (2000/11/1). "Cryogenic trapping of carbonyl sulfide without using expendable cryogens." Anal Chem **72**(21): 5513-5.

We report on a cryogenic trapping procedure that functions without the use of liquid cryogens at a trapping temperature of -150 degrees C. A heat-transfer device was designed that links a commercially available closed-cycle refrigerator to a cryotrap made of a glass-coated steel tube filled with Chromosorb W adsorbent material. This forms part of an analytical system incorporating GC separation with subsequent FPD detection, used for the analysis of carbonyl sulfide. The recovery is greater than 95% for trapping times up to 30 min. The analytical performance is excellent with both accuracy and precision better than 2%. Equipped with the new cryogenic trapping device, the measurement system is capable of continuous operation over a period of several weeks.

Walrand, J., M. Lengele, et al. (2004/12). "Absolute line intensity measurements of hot bands for carbonyl sulfide at 12 microm." Spectrochim Acta A Mol Biomol Spectrosc **60**(14): 3299-303.

Using diode-laser spectroscopy, the intensities of 58 lines of the $\nu(1) + \nu(1/2) - \nu(1/2)$ band and 36 lines of the $2\nu(1) - \nu(1)$ band of OCS have been measured. The corresponding band strengths $S(0)(\nu)$ and the vibrational transition dipoles $\mu(\nu)$ have been derived through least squares fitting of these individual intensities. The band strengths values have been determined with a precision better than 2.5%.

Wang, H. P. and K. S. Lin (1997). "Gasification of waste gases." Journal of Environmental Science and Health Part a Environmental Science and Engineering & Toxic and Hazardous Substance Control **32**(7): 1989-1997.

A feasibility study of united treatment of waste gases via the gasification process was investigated in the present work. Gasification of main components in refinery off-gases and VOCs were conducted in a laboratory-scale gasifier. Condensation byproducts from these gasification experiments were not detectable. Experimental data of the laboratory-scale waste gases gasification were served as the basis for the scale-up of this technology, which was also refined with simulation calculations. The material and energy balances of the united treatment of petrochemical waste gas streams were calculated. In addition to the hydrogen generation, approximately 3.65×10^9 J/hr of thermal energy may be recovered

from the waste gas gasification process. The cold gas efficiency of the gasification is 67%.

Wang, L., F. Zhang, et al. (2001/6/15). "Carbonyl sulfide derived from catalytic oxidation of carbon disulfide over atmospheric particles." Environ Sci Technol **35**(12): 2543-7.

The formation of carbonyl sulfide (COS) by catalytic oxidization of carbon disulfide (CS₂) over atmospheric particle catalysts was explored through FT-IR, MS (mass spectrometry), and a fixed-bed stainless steel reactor. Also the crystallizing conditions and specific surfaces (areas) of the catalysts were investigated by means of X-ray diffraction (XRD) and BET. Some oxides such as CaO, Fe₂O₃, Al₂O₃, and SiO₂ were investigated under the conditions similar to the atmospheric particles as a comparison. The results showed that atmospheric particles and the oxide catalysts exhibited considerable oxidizing activity for CS₂ at ambient temperature to form COS. Elemental sulfur as well as COS was one of the main products; even CO₂ could be produced by a secondary reaction on some catalysts. Among the catalysts, CaO showed the strongest catalytic activity for oxidizing CS₂. The catalytic activities of Fe₂O₃ and Al₂O₃ decreased considerably as compared with CaO, and SiO₂ had the weakest catalytic activity. Atmospheric particles' catalytic activity is between Fe₂O₃'s and Al₂O₃'s. The atmospheric particles we collected mainly consist of Ca(Al₂Si₂O₈)·4H₂O, which is also the main component of cement. COS, the main product, is formed by the catalytic oxidizing reaction of CS₂ with adsorbed "molecular" oxygen over the catalysts' surfaces. The concentration of adsorbed oxygen over catalysts' surfaces may be the key factor contributed to the oxidizing activities. This paper first revealed that CS₂ could be catalytically oxidized over atmospheric particles to form COS. It induced that this reaction may be another important source of atmospheric COS from CS₂.

Wani, A. H., R. Branion, et al. (1997). "Biofiltration: a promising and cost-effective control technology for odors, vocs and air toxics." Journal of Environmental Science and Health Part a Environmental Science and Engineering & Toxic and Hazardous Substance Control **32**(7): 2027-2055.

Biofiltration, a relatively recent air pollution control technology, has been identified as a promising method of odor, VOC and air toxic removal from waste-gas streams because of low capital and operating costs, low energy requirements and an absence of residual products requiring further treatment or disposal. Biofiltration units are microbial systems incorporating microorganisms grown on a porous solid media like compost, peat, soil or mixture of these materials. The filter media and the microbial culture are surrounded by a thin film of water called biofilm. Waste-gases containing biodegradable VOCs and inorganic air toxics are vented through this biologically active material, where soluble contaminants partition into the liquid film and are biodegraded by the resident microorganisms in the biofilm. The technology has been successfully applied to a wide range of industrial and public sector sources for the abatement of odors, VOCs and air toxics, with an elimination

Wardencki, W. (1998). "Problems with the determination of environmental sulphur compounds by gas chromatography." Journal of Chromatography a **793**(1): 1-19.

The occurrence of environmental sulphur species, which are significant biogenic and antropogenic

pollutants of the atmosphere, and some problems with their gas chromatographic determinations are reviewed. Techniques most frequently applied for their sampling from gas and liquid matrices, as well as preconcentration or isolation methods are discussed. The problems encountered in chromatographic analysis of sulphur-containing compounds, including chromatographic columns and detection systems, are also described. The simple procedures of avoiding the losses and transformations of these compounds during storage, sampling and analysis (e.g., oxidant removal, silanization) are briefly presented.

Warneck, P. (1993). "Chemical changes of the atmosphere on geological and recent time scales." Hewitt, C.N. And W.T. Sturges (Ed.). Environmental Management Series: Global Atmospheric Chemical Change. Xi+470p. Elsevier Science Publishers Ltd.: London, England, Uk **New York, New York, Usa.** **Isbn 1-85166-889-6.**; 0(0): 1-52.

RRM AIR POLLUTION CONSERVATION GLOBAL CLIMATE CHANGE NITROGEN OXYGEN METHANE TEMPERATURE CHANGE

Weiss, P. S. (1994). "Oceanic cycle and global atmospheric budget of carbonyl sulfide." Govt Reports Announcements & Index (Gra&I), Issue 06, 1998: -.

TD3: A significant portion of stratospheric air chemistry is influenced by the existence of carbonyl sulfide (COS). This ubiquitous sulfur gas represents a major source of sulfur to the stratosphere where it is converted to sulfuric acid aerosol particles. COS is primarily formed at the surface of the earth, in both marine and terrestrial environments, and is strongly linked to natural biological processes. The goal of this study was to focus on COS in the marine environment by investigating production/destruction mechanisms and recalculating the ocean-atmosphere flux. Thesis (Ph.D.). Sponsored by Department of Energy, Washington, DC.

Weller, G. L. and R. Morton (2001/10). "Fumigation with carbonyl sulfide: a model for the interaction of concentration, time and temperature." J Stored Prod Res **37(4)**: 383-398.

The new fumigant carbonyl sulfide offers an alternative to both methyl bromide and phosphine as a grain fumigant. Separate mathematical models for levels of kill, based on quantitative toxicological studies were developed for adults and eggs of the rice weevil *Sitophilus oryzae* (L.). These models suggest that fumigation exposure times for carbonyl sulfide will be a compromise between those of methyl bromide (typically 24h) and phosphine (7-10d) to achieve a very high kill of all developmental stages. *S. oryzae* eggs were more difficult to kill with carbonyl sulfide fumigation than the adults. At 30 degrees C, a 25gm(-3) fumigation killed 99.9% of adults in less than 1d, but took 4d to kill the same percentage of eggs. Models were generated to describe the mortality of adults at 10, 15, 20, 25 and 30 degrees C. From these models it is predicted that fumigation with carbonyl sulfide for 1-2d at 30gm(-3) will kill 99.9% of adults. Furthermore the models illustrate that fumigations with concentrations below 10gm(-3) are unlikely to kill all adult *S. oryzae*. Significant variation was observed in the response of eggs to the fumigant over the temperature range of 10 to 30 degrees C. Models were generated to

describe the mortality of eggs at 10, 15, 20, 25 and 30 degrees C. As the temperature was reduced below 25 degrees C, the time taken to achieve an effective fumigation increased. Extrapolating from the models, a 25g m⁻³ fumigation to control 99.9% of *S. oryzae* eggs will take 95h (4d) at 30 degrees C, 77h (3.2d) at 25 degrees C, 120h (5d) at 20 degrees C, 174h (7.5d) at 15 degrees C and about 290h (11d) at 10 degrees C. The role of temperature in the time taken to kill eggs with carbonyl sulfide cannot be ignored. In order to achieve the desired level of kill of all developmental stages, the fumigation rates need to be set according to the most difficult life stage to kill, in this instance, the egg stage.

Weller, G. L. R. A. and R. Morton "Fumigation with carbonyl sulfide: a model for the interaction of concentration, time and temperature." Journal of Stored Products Research, (October, 2001) Vol.37, No.4, pp.383-398.print.CODEN: JSTPAR.ISSN: 0022-474X.: -.

The new fumigant carbonyl sulfide offers an alternative to both methyl bromide and phosphine as a grain fumigant. Separate mathematical models for levels of kill, based on quantitative toxicological studies were developed for adults and eggs of the rice weevil *Sitophilus oryzae* (L.). These models suggest that fumigation exposure times for carbonyl sulfide will be a compromise between those of methyl bromide (typically 24 h) and phosphine (7-10 d) to achieve a very high kill of all developmental stages. *S. oryzae* eggs were more difficult to kill with carbonyl sulfide fumigation than the adults. At 30degreeC, a 25 g m⁻³ fumigation killed 99.9% of adults in less than 1 d, but took 4 d to kill the same percentage of eggs. Models were generated to describe the mortality of adults at 10, 15, 20, 25 and 30degreeC. From these models it is predicted that fumigation with carbonyl sulfide for 1-2 d at 30 g m⁻³ will kill 99.9% of adults. Furthermore the models illustrate that fumigations with concentrations below 10 g m⁻³ are unlikely to kill all adult *S. oryzae*. Significant variation was observed in the response of eggs to the fumigant over the temperature range of 10 to 30degreeC. Models were generated to describe the mortality of eggs at 10, 15, 20, 25 and 30degreeC. As the temperature was reduced below 25degreeC, the time taken to achieve an effective fumigation increased. Extrapolating from the models, a 25 g m⁻³ fumigation to control 99.9% of *S. oryzae* eggs will take 95 h (4 d) at 30degreeC, 77 h (3.2 d) at 25degreeC, 120 h (5 d) at 20degreeC, 174 h (7.5 d) at 15degreeC and about 290 h (11 d) at 10degreeC. The role of temperature in the time taken to kill eggs with carbonyl sulfide cannot be ignored. In order to achieve the desired level of kill of all developmental stages, the fumigation rates need to be set according to the most difficult life stage to kill, in this instance, the egg stage.

Weller, G. R. A. Carbonyl sulfide fumigation of hay., Csiro Entomol, Stored Grain Res Lab, Gpo Box 1700, Canberra, Act 2601, Australia Gaye.weller@Csiro.au: -.

The disinfection of export hay to meet the phytosanitary requirements of importing countries accounts for a growing amount of methyl bromide used for quarantine and pre-shipment fumigation treatments in Australia. Alternatives currently available (phosphine and carbon dioxide) require long exposure times (7 days and 15 days respectively) and are recommended only if the ambient temperature exceeds 15 degrees C. These two factors make the alternatives unacceptable to this industry. Based on the mathematical model developed to determine the dose of carbonyl sulfide (COS) required to kill *Sitophilus oryzae* eggs (Weller and Morton, 2001), a dose of 60 g/m³ for 48 hours was deemed appropriate for hay at temperatures above 17 degrees C. Penetration into highly compressed bales,

sorption and desorption were assessed both in the laboratory and during a fumigation of a shipping container of oaten hay. The results indicate that COS is suitable for the fumigation of highly compressed hay. However, the slow diffusion of the gas out of the hay following a fumigation necessitates an airing procedure and the extended time of fumigation over methyl bromide will require a higher level of gas-tightness of shipping containers used for this purpose.

Wham, R. M. (1984). "Gas cleanup for indirect liquefaction." Govt Reports Announcements & Index (Gra&I), Issue 25, 1985: -.

TD3: Visual aids are presented describing various classes of primary gas cleanup. These are: (1) amine systems (MDEA Process); (2) alkali salt systems; (3) physical absorption systems (Selexol Process, Stretford Process); (4) mixed solvent systems; and (5) Claus Sulfur Recovery System. Flowsheets are also presented for the MDEA, Selexol and Stretford processes. (ERA citation 10:041107) 188. meeting of the American Chemical Society, Philadelphia, PA, USA, 26 Aug 1984.

Whitten, M. J., R. A. Jefferson, et al. (1996). "Needs and opportunities." Persley, G.J.(Ed.). Biotechnology in Agriculture Series, 15. Biotechnology and Integrated Pest Management Conference, Bellagio, Italy, October 4-8, 1993. Xvi+475p. Cab International: Wallingford, England, Uk. Isbn 0-85198-930-6.; 0(15): 1-36.

RRM BOOK CHAPTER MEETING PAPER PEST MANAGEMENT INTEGRATED PEST MANAGEMENT PESTICIDES BIOLOGICAL CONTROL ENVIRONMENTAL CONCERNS DISEASE RESISTANCE PEST RESISTANCE PEST CONTROL METHOD

WHO (1986). "IARC International agency for research on cancer monographs on the evaluation of the carcinogenic risk of chemicals to humans vol. 38. Tobacco smoking." WHO.IARC (International Agency for Research on Cancer) Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, Vol.38.Tobacco Smoking.421p.Iarc: Lyon, France.Illus.Isbn 92-832-1238-X(Paper); Isbn 92-832-1538-9(Cloth).; 0 (0).1986 (Recd.1987).421p.: p.122-.

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Williams, M. C. and S. J. Bossart (1988). "Alternative clean coal technologies combined with hot gas cleanup to minimize production of acid rain." Third Chemical Congress of North America Held at the 195th American Chemical Society Meeting, Toronto, Ontario, Canada, June 5-10, 1988.Abstr Pap Chem Congr North Am 3(1): Envr 130-.

RRM ABSTRACT CARBONYL SULFIDE SULFUR DIOXIDE SULFUR OXIDES NITROGEN OXIDES HYDROGEN SULFIDE ZINC FERRITE DESULFURIZATION MIXED METAL OXIDE PROCESS AMMONIA

Woodruff, T. J., D. A. Axelrad, et al. (1998). "Public health implications of 1990 air toxics

concentrations across the united states." Environmental Health Perspectives **106**(5): 245-251.

Occupational and toxicological studies have demonstrated adverse health effects from exposure to toxic air contaminants. Data on outdoor levels of toxic air contaminants have not been available for most communities in the United States, making it difficult to assess the potential for adverse human health effects from general population exposures. Emissions data from stationary and mobile sources are used in an atmospheric dispersion model to estimate outdoor concentrations of 148 toxic air contaminants for each of the 60,803 census tracts in the contiguous United States for 1990. Outdoor concentrations of air toxics were compared to previously defined benchmark concentrations for cancer and noncancer health effects. Benchmark concentrations are based on standard toxicological references and represent air toxic levels above which health risks may occur. The number of benchmark concentrations exceeded by modeled concentrations ranged from 8 to 32 per census tract, with a

Wright, E. J. R. A. "Carbonyl sulfide as new commodity fumigant." International Pest Control, (May-June 2002) Vol.44, No.3, pp.124.print.ISSN: 0020-8256 (ISSN print). -.

Wuebbles, D. J. (1993). "Global climate change due to radiatively active gases." Hewitt, C.N.And W.T. Sturges (Ed.).Environmental Management Series: Global Atmospheric Chemical Change.Xi+470p. Elsevier Science Publishers Ltd.: London, England, Uk New York, New York, Usa. Isbn 1-85166-889-6.; 0(0): 53-92.

RRM RADIATION AIR POLLUTION CONSERVATION GLOBAL CLIMATE CHANGE GREENHOUSE EFFECT

Xh, L., L. J. (Reprint), et al. "Variation of h₂s and cos emission fluxes from calamagrostis angustifolia wetlands in sanjiang plain, northeast china." ATMOSPHERIC ENVIRONMENT: <2006: <VO1>40: <IS1>N33: <IS2>OCT: <PG1>6303-6312: -.

Using the static chamber and chromatograph method, h₂s and cos emission fluxes from the mash meadow calamagrostis angustifolia and typical meadow c. Angustifolia in sanjiang plain northeast china were measured during growth season (5-9 month), the results showed that the seasonal and diurnal variations of h₂s and cos emission fluxes were obvious, the mean emission fluxes of h₂s and cos from the mash meadow c angustifolia were 0.34 And -0.29 Mu g s m(-2) h(-1), respectively, and from typical meadow c angustifolia were 0.14 And -0.20 Mu g s m(-2) h(-1), respectively, the mean emission fluxes of h₂s and cos from the mash meadow c. Angustifolia were both higher than their from typical meadow c. Angustifolia. The c angustifolia wetlands both can emit h₂s to the atmosphere and absorb cos from the atmosphere in the growth season. The h₂s and cos emission fluxes were affected by the c angustifolia growth, and the h₂s emission peak and cos absorbed peak were observed during the bloom growth time. There were negative correlations of h₂s and cos emission fluxes in c angustifolia wetlands. (C) 2006 elsevier ltd. All rights reserved.

Xia, C., M. M. Sanz, et al. (1998/4). "Diode Laser Spectroscopy of the nu1 and nu3 Bands of SD+3." J

The nu1 and nu3 bands of SD+3 were observed at 5.45 microm with a diode laser spectrometer. The ions were generated in a concentration-modulated, low-temperature, hollow-cathode discharge of deuterium and carbonyl sulfide gases. One hundred and ninety-two lines were measured and assigned to SD+3. The majority of these lines were assigned to the nu3 perpendicular band with 49 lines assigned to the nu1 parallel band. A simultaneous fit of these bands provided the first experimental parameters for the SD+3 ion. Copyright 1998 Academic Press.

Yamasaki, M., Y. Matsushita, et al. (2002/2). "Genetic and immunochemical characterization of thiocyanate-degrading bacteria in lake water." Appl Environ Microbiol **68**(2): 942-6.

Natural aquatic and soil samples were screened for the presence of thiocyanate-degrading bacteria. Using thiocyanate supplementation, we established an enrichment culture containing such bacteria from lake water. The dominant bacteria had the scnC-LS5 gene encoding thiocyanate hydrolase, which was closely related to the enzyme found previously in *Thiobacillus thioparus* THI115 isolated from activated sludge.

Yang, Z., K. Kanda, et al. (1996). "Measurement of biogenic sulfur gases emission from some chinese and japanese soils." Atmospheric Environment **30**(13): 2399-2405.

Emission of volatile sulfur gases from waterlogged paddy soils and upland soils of China and Japan was studied in the laboratory. Emission of hydrogen sulfide (H₂S), carbonyl sulfide (COS), methyl mercaptan (CH₃SH), dimethyl sulfide (DMS), carbon disulfide (CS₂) and dimethyl disulfide (DMDS) were detected. Emission of sulfur gases from paddy soil was more than that from upland, and emission from the Chinese paddy soils was more than that from Japanese. At the same soil, emission of sulfur gases, when both organic manure and chemical fertilizer were applied was higher than when only organic manure or only chemical fertilizer was applied. Under anaerobic conditions, detected biogenic sulfur gases were far more than that under aerobic conditions, H₂S was the most obvious. The results have also shown that, at higher temperature, emission and expiration rate of volatile sulfur gases were higher than that at lower temperature.

Yang, Z., L. Kong, et al. (1998). "Emission of biogenic sulfur gases from chinese rice paddies." Science of the Total Environment **224**(1-3): 1-8.

Biogenic sulfur gases emitted from Chinese rice paddies were measured with a laboratory incubation and a closed chamber method in the field. Six speciations of sulfur-containing gases were detected in both conditions: hydrogen sulfide (H₂S), carbonyl sulfide (COS), methyl mercaptan (CH₃SH), carbon disulfide (CS₂), dimethyl sulfide (CH₃SCH₃ or DMS) and dimethyl disulfide (CH₃SSCH₃ or DMDS). Among them, DMS comprised the major part of the sulfur emission. Emission of sulfur gases from different paddy soils exhibit high spatial and temporal variability. The emission of volatile sulfur gases increased with application of organic manure and positively correlated with the total sulfur content in the

soil. The diurnal and seasonal variations of total volatile sulfur gases and DMS indicate that their emissions were greatly influenced by the air temperature and the activity of the rice plant. The annual emission of total volatile sulfur gases from the Nanjing rice paddy field r

Yokouchi, Y., M. Ikeda, et al. (2002/3/14). "Strong emission of methyl chloride from tropical plants." Nature **416**(6877): 163-5.

Methyl chloride is the largest natural source of ozone-depleting chlorine compounds, and accounts for about 15 per cent of the present atmospheric chlorine content. This contribution was likely to have been relatively greater in pre-industrial times, when additional anthropogenic sources-such as chlorofluorocarbons-were absent. Although it has been shown that there are large emissions of methyl chloride from coastal lands in the tropics, there remains a substantial shortfall in the overall methyl chloride budget. Here we present observations of large emissions of methyl chloride from some common tropical plants (certain types of ferns and Dipterocarpaceae), ranging from 0.1 to 3.7 microg per gram of dry leaf per hour. On the basis of these preliminary measurements, the methyl chloride flux from Dipterocarpaceae in southeast Asia alone is estimated at 0.91 Tg yr⁻¹, which could explain a large portion of missing methyl chloride sources. With continuing tropical deforestation, natural sources of chlorine compounds may accordingly decrease in the future. Conversely, the abundance of massive ferns in the Carboniferous period may have created an atmosphere rich in methyl chloride.

Yonglin, R., J. M. Desmarchelier, et al. (1997). "Effect of grain fumigants on lipids in vivo and in vitro." Journal of Agricultural and Food Chemistry **45**(7): 2626-2629.

The effect of current and potential grain fumigants on food lipids was examined in two ways. First, wheat was fumigated in vivo and the lipid extracted and compared with that from unfumigated wheat. Second, wheatgerm and canola oil were fumigated in vitro, and the fate of both fumigant and lipid was examined. The fumigants tested were phosphine, methyl bromide, carbon disulfide, cyanogen, and carbonyl sulfide. Fumigation of wheat or oils had no effect on lipid composition as assessed by Fourier transform infrared or ultraviolet spectroscopy. In fumigation of lipids in sealed containers, some fumigant was sorbed by the lipid, but the fumigant was recovered intact after heating. The order of solubility of fumigant in lipid was carbon disulfide > methyl bromide > cyanogen > phosphine = carbonyl sulfide.

Young, J. R., E. C. Ellis, et al. (1988). "Deposition of air-borne acidifiers in the western environment usa." J Environ Qual **17**(1): 1-26.

RRM REVIEW AIR POLLUTION ACID DEPOSITION ACID PRECIPITATION NITROGEN OXIDES SULFATE EMISSIONS HYDROCARBONS WEATHER

Ys, J., C. J. (Reprint), et al. "Biodegradation of thiocyanate in biofilm reactor using fluidized-carriers." PROCESS BIOCHEMISTRY: <2006: <VO1>41: <IS1>N3: <IS2>MAR: <PG1>701-707: -.

For the biological treatment of the wastewater containing highly concentrated thiocyanate, microorganisms for thiocyanate biodegradation were isolated and the biofilm reactor charged with fluidized-carriers of tube chip type was employed. The isolated microorganisms were presumed autotrophs. In a small-scale biofilm reactor for the performance test, the observed maximum degradation rate with 80 vol% of fluidized-carriers was 8.1 Kg m⁻³ day⁻¹, which was much higher than those observed in any other reactor systems. The high performance of biofilm reactor was presumed to result from the high concentration of microorganisms attached on fluidized-carriers with high surface area. In a bench scale biofilm reactor for the commercial plant design, the biofilm reactor system showed that thiocyanate of 7000 mg l⁻¹ was successfully degraded to more than 99.9% Of removal efficiency within 36 h of total hydraulic retention time. (C) 2005 elsevier ltd. All rights reserved.

Zepp, R. G. (1994). "Effects of solar radiation on organic matter cycling: formation of carbon monoxide and carbonyl sulfide (chapter 11)." Govt Reports Announcements & Index (Gra&I), Issue 18, 1994: -.

TD3: The effects of photoinduced processes on carbon cycling and the biospheric emission of two important trace carbon gases--carbon monoxide and carbonyl sulfide--are examined. Both of these gases are likely to play an important role in the biospheric feedbacks that may reinforce or attenuate future changes in climate. Evidence is presented to support the hypothesis that a significant fraction of the global sources of both of these gases derives from the photochemical fragmentation of decayed plant materials and other biogenic organic matter in terrestrial and marine environments. Book chapter. Pub. in *Climate-Biosphere Interactions: Biogenic Emissions and Environmental Effects of Climate Change*, p203-221 1994.

Zepp, R. G., T. V. Callaghan, et al. (1998). "Effects of enhanced solar ultraviolet radiation on biogeochemical cycles." Journal of Photochemistry and Photobiology B Biology **46**(1-3): 69-82.

Effects of increase UV-B on emissions of carbon dioxide and carbon monoxide (CO) and on mineral nutrient cycling in the terrestrial biosphere have been confirmed by recent studies of a range of species and ecosystems. The effects, both in magnitude and direction, of UV-B radiation on trace-gas emissions and mineral nutrient cycling are species specific and operate on an number of processes. These processes include - changes in the chemical composition in living plant tissue, photodegradation (breakdown by light) of dead plant matter, including litter, release of carbon monoxide from vegetation previously charred by fire, changes in the communities of microbial decomposers, and effects on nitrogen-fixing microorganisms and plants. Long-term experiments are in place to examine UV-B effects on carbon capture and storage in biomass within natural terrestrial ecosystems. Studies in natural aquatic ecosystems have indicated that organic matter is the primary regulator of UV-B p

Zepp, R. G. and C. Sonntag (1995). "Environmental sciences research report 16. The role of nonliving organic matter in the earth's carbon cycle dahlem workshop berlin germany september 12-17 1993."

Zepp, R.G.And C.Sonntag (Ed.).Environmental Sciences Research Report, 16.The Role of Nonliving Organic Matter in the Earth's Carbon Cycle Dahlem Workshop, Berlin, Germany, September 12-17,

1993. Xvi+342p. John Wiley and Sons Ltd.: Chichester, England, Uk; New York, New York, Usa. Isbn 0-471-95463-2.; 16(0): Xvi+342p-.

RRM BOOK MEETING BIOGEOCHEMISTRY MATHEMATICAL MODELLING GLOBAL CLIMATE CHANGE

Zettler, J. L., J. G. Leesch, et al. (1997). "Toxicity of carbonyl sulfide to stored product insects." Journal of Economic Entomology **90**(3): 832-836.

In laboratory tests, carbonyl sulfide was toxic to 5 species of stored-product insects. At the LC50, the most susceptible insects in order of decreasing susceptibility were larval navel orangeworm, *Amyelois transitella* (Walker); adult sawtooth grain beetle, *Oryzaephilus surinamensis* (L.); adult driedfruit beetle, *Carpophilus hemipterus* (L.); adult cigarette beetle, *Lasioderma serricorne* (F.); and adult confused flour beetle, *Tribolium confusum* Jacquelin duVal. Posttreatment end-point mortality was immediate for *L. serricorne* adults (1 d) but was delayed for *O. surinamensis* adults (2 d) and *C. hemipterus* and *T. confusum* adults (3 d). Susceptibilities of life stages of *T. confusum*, the most tolerant species of those tested, varied. The egg and pupal stages were least susceptible, requiring concentration times time products of 1,008 and 750 mg/liter/h, respectively, for a LC99.9 during a 24-h exposure period. Based on pest toxicity, carbonyl sulfide has potential for use

Zhang, L. E. I. Wang, et al. (1999). "A study of sulfur gases produced from the decomposition of cystine in paddy soil." Huanjing Kexue **20**(3): 26-29.

The sulfur-containing amino acids were added into the incubated Chinese paddy soil, and the emission of sulfur gases was determined. Three sulfur gases, hydrogen sulfide (H₂S), carbonyl sulfide(COS) and dimethyl sulfide(DMS) were detected from waterlogged soil. When cystine was added, the detected concentrations of H₂S and COS increased obviously, and the other two gases, carbon disulfide (CS₂) and methyl mercaptan (CH₃SH) were also detected, while the concentration of DMS did not change significantly in incubation atmosphere. The influences of atmospheric condition, soil pH, water content and illumination during incubation on the production of sulfur gases from the decomposition of cystine were investigated.

Zygmunt, B. (1991). "Gas chromatographic sulphur-sensitive detectors in environmental analysis. Au - wardencki w." Anal Chim Acta **255**(1): 1-14.

Gas chromatographic (GC) detection systems, which are especially suited for the selective determination of sulphur compounds in various matrices, and their applications are reviewed. They include flame photometric, electron-capture, chemiluminescence, atomic emission, electrochemical and photoionization detectors. The principles of operation, characteristics and development and compatibility with capillary columns are briefly described. The possibility of coupling with supercritical fluid chromatography, liquid chromatography and some spectroscopic techniques is discussed.