Mercury Sorbents and Carbon Black Derived From Waste Tires

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Environmental Problem

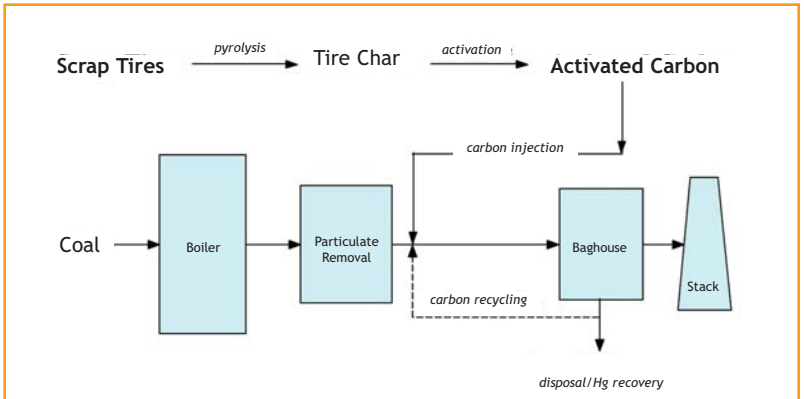
The U.S. power generation industry relies heavily on coal, burning nearly 1 billion tons per year to provide heat and electricity. Burning coal, however, emits mercury into the air, where it contributes to air pollution and falls to earth again during rainfall, contaminating water supplies. Consumption of fish exposed to mercury in these contaminated sources can lead to many adverse health effects. One of the most effective methods of controlling mercury emissions from power plants is carbon injection, whereby activated carbon is injected into the flue gas stream exiting the boiler and adsorbed onto particulate matter that then is removed. The cost of commercially available activated carbon, however, is prohibitive (approximately $0.40-$0.50 cents/lb). Thus, low-cost carbons are extremely attractive for this application.

A promising new source for these low-cost activated carbons takes advantage of waste tires, which present their own serious environmental problem. Scrap tires are immune to biological degradation and thus present formidable disposal problems. Landfilling of the 280 million tires generated each year in the United States is an unacceptable solution. In addition to the continuous flow of waste tires, there are approximately 2-3 billion tires already stored in piles throughout the country; illegal dumping also is a problem. The tires take up large amounts of valuable landfill space, provide breeding sites for mosquitoes and rodents, and present fire and health hazards. Tire pyrolysis (thermal decomposition into usable end products like steel, oil, and carbon black) is an effective method of disposing of scrap tires, but the economic leverage needs to be improved because the end products are of low quality compared to the virgin materials. This leveraging can be accomplished by producing value-added products such as carbon black, a high-value feedstock for the rubber industry, and activated carbon, which is used as a mercury sorbent in power plants.

SBIR Technology Solution

With support from EPA's SBIR Program, Advanced Fuel Research, Inc. (AFR), developed a technology to address both: (1) removal and recovery of mercury from combustion/incineration flue gas, and (2) reprocessing of waste tires into value-added products. AFR's approach is based on mercury adsorption on low-cost, sulfur-rich activated carbons derived from scrap tires. The sulfur added to tire rubber in the process of vulcanization makes the tire-derived sorbents particularly effective in mercury removal. The first step in the waste-tire processing scheme is pyrolysis, which involves thermal decomposition of tire rubber in an oxygen-free atmosphere. The solid product of pyrolysis (tire char) subsequently is converted into activated carbon. The sulfur content increases during tire processing, which is believed to facilitate mercury-capture efficiency. The cost-performance characteristics of tire-derived carbons are excellent and more favorable than those of the benchmark commercial carbon, Norit FGD.

Two possible implementations of the process are envisioned: (1) sorbent injection into the flue gas duct (near-term applications), and (2) a patented regenerative scheme (long-term applications). AFR's technology for the removal of mercury from combustion/incineration flue gas, which is combined with the simultaneous utilization of massive amounts of solid waste (scrap tires), has applications for coal-fired power plants and municipal, medical, and hazardous waste incinerators.



Schematic of AFR's process that converts solid waste (scrap tires) to mercury sorbents.

In another SBIR-supported project, AFR developed a technology based on reprocessing tire-pyrolysis oils into virgin carbon black. In addition to manufacturing carbon black, this process also creates a market for the large stream of solid waste comprised of scrap tires. In addition, this process reduces the demand for fossil fuels, the conventional feedstock for carbon black manufacturing.

Commercialization Information

AFR has secured two patents for the mercury sorbent technology and was invited to participate in a full-scale Department of Energy/National Energy Technology Laboratory (DOE/NETL) evaluation of mercury-control technologies. The invitation was extended to AFR on the basis of data showing excellent performance characteristics of tire-derived sorbents combined with their exceptional cost-effectiveness. Participation in the DOE/NETL program is an important recognition of AFR's approach to mercury control and waste tire utilization. AFR currently is pursuing business arrangements for the production of ton quantities of tire-derived mercury sorbents.

Company History and Awards

Founded in 1980, AFR celebrated its 25th anniversary in early 2005. The East Hartford, Connecticut-based company has 14 employees at present. Through SBIR and industrial support, AFR has successfully developed a number of innovative laboratory and process control instruments and software products that today are serving industrial and academic clients throughout the world. AFR received the U.S. Small Business Administration's prestigious Tibbetts Award in 2000 for exemplary achievement in commercializing technology developed with the support of the SBIR Program. AFR's success has led to two spin-off companies: MKS Instruments On-Line Products Group and the newly formed Real-Time Analyzers, Inc.

SBIR Impact

- Mercury emissions from coal combustion and incineration of municipal and hazardous wastes and the disposal of scrap tires represent two serious environmental problems.
- AFR developed a novel technology for the removal of mercury from combustion/incineration flue gas while at the same time utilizing massive amounts of solid waste (scrap tires).
- Applications of this technology include use in coal-fired power plants and municipal, medical, and hazardous waste incinerators.
- AFR also has demonstrated the feasibility of making virgin carbon black from oils produced by waste-tire pyrolysis.