AUTOMOTIVE REFINISHING INDUSTRY
ISOCYANATE PROFILE

INTRODUCTION

Under the Environmental Technology Initiative for chemicals ("ETI for Chemicals"), the Environmental Protection Agency's New Chemicals Program seeks to reduce human health and environmental risks that arise during the manufacture, processing, use and disposal of chemicals. The ETI for Chemicals encourages all types of risk reduction by working in partnership with industry to develop innovative, sensible approaches to risk management and by minimizing or eliminating regulatory requirements, as appropriate. With respect to isocyanates, the Agency would like to see the protective levels it requires for use of new compounds achieved by similar isocyanate chemicals already in commerce.

The Agency selected isocyanates as the first chemical class for in-depth review for a number of reasons. First, during the use of isocyanates in coating operations, workers are typically exposed to isocyanates and other substances in the form of mists; as a result, they are at risk for various health effects, including sensitization to skin and respiratory tract and lung effects. Second, the Agency receives many premanufacture notices (Toxic Substances Control Act, Section 5) for isocyanate chemicals and regulates those substances that may present an unreasonable risk to workers; plus isocyanates are subject to testing requirements under TSCA and other EPA and non-EPA related regulations. Finally, many manufactures of isocyanates and some of their customers have expressed a strong interest in working with the Agency to reduce risk and develop alternative approaches to risk management. For these reasons, the Agency believe an important opportunity exists to realize meaningful risk reduction during the use of isocyanates.

The purpose of this report is to investigate isocyanates, especially concerning their use in the automotive refinishing industry. The report provides information on automotive refinishing, control technologies employed to reduce exposures, and the regulatory status of a group of isocyanate compounds. The report also points out opportunities for innovation in reducing exposures and risks and promoting pollution prevention.

Automotive refinishing refers to paint products applied to any motor vehicle subsequent to the initial manufacturing process. Due to the nature of the manufacturing process, the original equipment manufacturer (OEM) can apply coating products which are cured at any temperature, commonly up to 150-160^{o}C (302-320^{o}F) range. However, once completely assembled (i.e., fitted with fabrics, plastics, rubber components, and possibly combustible petroleum products), finishes can not be cured at these temperatures. Thus, refinishing paint products must strive to be equivalent to OEM finishes but cure at ambient, or slightly higher than ambient (e.g., 66^{o}C, 150^{o}F) temperatures (Howe-Grant, 1993).

The most commonly used automotive refinishing paint categories include: acrylic lacquers; acrylic enamels; acrylic urethanes; and polyurethanes. This report concentrates on the polyurethane-based paint products used in the automotive refinishing market which are derived from diisocyanates.

AUTOMOTIVE REFINISHING INDUSTRY BACKGROUND

Automotive refinishing includes operations in auto body repair/paint shops, production auto body paint shops, new car dealer repair/paint shops, fleet operator repair/paint shops, and custom-made car fabrication facilities. Refinishing work typically consists of structural repair, surface preparation and painting. Surface preparation includes grinding the paint off sheet metal, and applying, smoothing, shaping and sanding polyester resin body fillers. Painting involves matching paint colors, mixing paint formulations, and painting the repaired area using custom and conventional painting techniques. Workers involved in auto body repair, and refinishing can potentially be exposed to a wide range of air contaminants. During structural repair, activities such as sanding, grinding, and welding generate aerosols that are released into the worker's breathing zone. If the surface of the vehicle being repaired contains toxic metals such as lead, cadmium, or chromium, exposure to these metals is possible. Automobile painters can be exposed to organic solvents, hardeners that may contain isocyanate resins, and pigments that may contain toxic components. Within the automobile refinishing industry, the major air contaminant exposure appears to be polyisocyanates (Heitbrink, 1995).

Paints and coatings are comprised of binders, pigments, solvents, and various additives. Most automobile paint components for which PMNs have been submitted in the past are nonvolatile; a volatile PMN used for automobile paint may, in fact, be a monomer which would be consumed during the paint formulation step. During automobile refinishing and in many (but not all) automobile manufacturing operations, the paint is sprayed onto the automobile. This profile is most applicable to evaluating nonvolatile isocyanates that are part of paint solids.

Conventional coatings are typically comprised of three major components: a pigment for color; a polymer that acts as binder; and a liquid carrier-generally a solvent. In some coating formulations the solvent portion can account for two-thirds of the coating. Volatile organic compounds (VOCs) are solvents that evaporate or volatilize during the painting process and include thinners, reducers and cleaning solvents. Mixed in coatings, solvents provide proper viscosity, flow, and drying characteristics. These coats act as a shield for primers by resisting the penetration of solvents in topcoats and clear coats.

For the automotive refinishing industry, the paints can be set into different groups which include pretreatments, primers, sealers, precoats, specialty coatings, and various topcoats. Topcoats can be pigmented (color coats) or clear (clearcoats). Pigmented topcoats can provide a high gloss (“single stage”) or can be subsequently covered with a clearcoat which provides gloss and protection (“basecoat”). Isocyanates are components of the hardeners used in topcoats, most notably the clearcoats. (BASF Corporation)

Automotive precoats can be defined as any coating that is applied to bare metal in order to deactivate the metal surface for corrosion resistance to a subsequent water-based primer. This coating is applied to bare metal solely for the prevention of flash rusting caused by the water in water-based primers. Automotive pretreatments are any coating that contains a minimum of 0.5% acid by weight and is applied directly to bare metal surfaces to etch the metal surface for corrosion resistance and primer adhesion. Specialty coatings include coatings that are used to perform unusual job requirements such as helping to prevent surface defects and improve desired coating properties. Examples include coatings for plastic parts, anti-glare coatings, and gloss flatteners (Kirk-Othmer, 1992 and TNRCC, 1995).

The spray coatings applied by body shops differ from those applied by original equipment manufacturer's (OEM's). OEM facilities use coatings that require temperatures up to 400°F (204°C) in order to cure the coating. This is possible because no temperature-sensitive materials have yet been installed in the automobile. Body shops, on the other hand, must use coatings that cure at temperatures less than 150°F (66°C) to avoid damaging the vehicle's upholstery, glass, wiring or plastic components.

Low VOC coatings have two distinct advantages when compared to higher VOC coatings. These two advantages are reduced occupational exposures to solvents and environmental releases of VOCs.

Polyisocyanates can be aliphatic or aromatic (a small number of compounds exist as a combination), and both types are commercially important depending on the use. The following general differences have been documented between these two general classes (Oertel, 1985):

- Coatings based on aliphatic polyisocyanates are more light stable than their aromatic counterparts

- Coatings based on aromatic polyisocyanates lose their gloss relatively fast upon weathering, unlike their aliphatic counterparts.

- Coatings based on aromatic polyisocyanates are generally quicker drying than those based on aliphatic polyisocyanates.

Given these properties, it is expected that most paint used for automobile refinishing should be based on aliphatic rather than aromatic polyisocyanates since light stability and gloss retention are obviously very important characteristics. In fact, industrial hygiene surveys and occupational health literature reviewed by the Agency has shown this to be the case. Most of the resources EPA examined indicate that polyisocyanates sampled in automobile paint shops are based on the aliphatic compound hexamethylene diisocyanate (HDI).

A driving force behind the automotive refinishing industry converting to the use of low VOC coatings has been the introduction of state regulatory requirements reducing the amount of VOCs in

paints. These state requirements are in response to the Clean Air Act Amendments passed by Congress in 1990. In addition, the EPA is proposing new regulations on VOCs in the automotive refinishing industry through its Office of Air and Radiation. This proposed rule "the National Volatile Organic Compound (VOC) Emission Standards for Automobile Refinish Coatings was promulgated on April 30, 1996 and seeks to reduce emissions of VOCs from the use of automobile refinish coatings. The proposed standards are part of the Clean Air Act (Act) and require the EPA to control VOC emissions from certain categories of consumer and commercial products. Automobile refinish coatings are included under the definition of consumer and commercial products since the definition under section 183(e) of the Act specifically includes paints, coatings, and solvents. The regulation is required by March 1997. The compliance date of the rule is four months after the promulgation date of the rule. The criteria which contribute to the prioritization of automobile refinish coatings to be regulated include the availability of alternatives, the cost-effectiveness of controls, and the VOC emissions in ozone nonattainment areas.

The EPA believes that the proposed standards would reduce nationwide emissions of VOC from the use of automobile refinish coatings by an estimated 32,500 Mg (35,800 tons) in 1996. These reductions are compared to 1995 baseline emissions estimates. Since many regulated VOC species are also on the list of hazardous air pollutants (HAP) in section 112 of the Act, the proposed rule is expected to reduce some HAP emissions from the use of automobile refinish coatings.

The provisions of this proposed rule apply to automobile refinish coatings that are manufactured or imported for sale or distribution in the United States. The proposed standards do not apply to the following automobile refinish coatings:

1. Coatings manufactured exclusively for sale outside the United States;
2. Coatings manufactured or imported before the compliance date of the rule;
3. Coatings manufactured for use by original equipment manufacturers for assembly-line coating operations; and
4. Coatings supplied in nonrefillable aerosol containers.

The proposal sets VOC limits (grams-per-liter) by automotive refinish category and would phase out the U.S. sale of automotive refinish coatings with high VOC content. Products that exceed the limits could not be manufactured or imported for U.S. sale after the rule takes effect. Coatings subject to this proposed rule shall comply with the VOC content standards listed in the Table below. If a coating is marketed under more than one of the listed coating categories, the coating shall comply with the lowest applicable VOC content standard.

VOC Content Standards for Automobile Refinish Coatings

Coating Category	VOC Content (grams/liter)
Pretreatment Wash Primer	780
Primer/Primer Surfacer	575
Primer Sealer	550
Single/2 Stage Topcoats	600
Topcoats of 3 or more stages	625
Specialty Coatings	840

Automobile refinish coating regulations are in place or under development in a number of States. For the companies that market automobile refinish coatings nationwide, trying to fulfill the differing requirements of State rules has created administrative, technical, and marketing problems. A Federal rule is expected to provide some degree of consistency, predictability, and administrative ease for the industry. In addition, State representatives have recommended that the EPA develop and implement nationwide Federal control measures to enhance enforceability and conserve State resources.

State regulations are also an important factor to consider when looking at the industry and its use of low VOC coatings. Some states have regulated the auto body refinishing industry while others have not, so the information is not representative. States like Texas, California, and Maryland have taken initiatives to require automotive refinishers to register for air permits and adopt new technologies within industry. Texas, for example, has specific guidelines established for the auto body coating industry. The California Air Resources Board (CARB) has actively endorsed technology through development of proposed regulations forcing VOC limits on many coatings market segments. In 1989, California issued several rules which required coating manufactures to produce coatings with little or no VOCs. At that time however, industry was not effective in creating the new compounds to meet the required deadlines. Revisions to the regulations were made and consequently, today there are several paint vendors in California that offer a variety of low VOC coatings (CARB, 1991). In 1992, additional regulations were issued requiring auto body shops in most CARB districts to incorporate the low VOC coatings. CARB was expected to complete a comprehensive survey of the auto body industry in California in May of 1996. The data will be used to develop generic chemical formulations for different categories of automotive coatings. These generic formulation will be used to track and evaluate emissions from auto body shops state wide (Watkins, 1996).

Maryland State regulations concerning the use of low VOC paint became effective on April 15, 1996. These new regulations limited the types of paints that shops can use and specific VOC concentrations are spelled out for specific types of paint. Discussions with automotive refinishers and paint vendors indicate that, in Maryland, there was already a trend toward the use of low VOC paints. However, many of the older paints cannot be used in Maryland due to the regulations and the new paints are not as easy to apply and have longer drying time than some of the older lacquer paints. As a result, the amount of work (i.e., number of cars that can be painted) has been reduced drastically. The paints previously used dried in approximately 10 minutes at ambient temperatures.

Paints and coatings typically fall into four general end use categories as defined by the Bureau of the Census' Census of Manufactures - Industry Series for paints and allied products (SIC 2851 or Industry 2851). These categories include:

- *Architectural Coatings* (SIC 28511): are formulated for normal environmental conditions and general applications on new and existing commercial, residential, institutional, and industrial structures.

- *Original Equipment Manufacturer Product Finishes* (SIC 28512): for original equipment manufacturers are formulated to meet specific conditions of application and product requirements.

- *Special Purpose Coatings* (SIC 28513): are specifically formulated for refinishing and specialty applications or for environmental conditions such as extreme temperature or corrosive chemical atmospheres (NIOSH 1984). Automotive refinish coatings are covered under the special purpose coatings category.

- *Miscellaneous Allied Paint Products* (SIC 28515): such as cleaners, thinners, and preservatives.

The Special Purpose Coatings (SIC 28513) is the end use category of interest for automotive refinishing industry.