INDUSTRIAL HYGIENE WALK-THROUGH SURVEY REPORT
OF
ARMSTRONG WORLD INDUSTRIES, INC.
LANCASTER FLOOR PLANT
LANCASTER, PENNSYLVANIA

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DISCLAIMER

Mention of company or product name in this report does not constitute endorsement by the National Institute for Occupational Safety and Health (NIOSH).

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PURPOSE OF SURVEY:	To perform a walk-through industrial hygiene survey of a plant using products containing acrylates or methacrylates and determine the potential for occupational exposures to these chemicals.
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STANDARD INDUSTRIAL CLASSIFICATION (SIC) CODE:	3996 - Linoleum, Asphalted-Felt Base, and Other Hard Surface Floor Coverings 2851 - Paints, varnishes, lacquers, enamels, and allied products

ABSTRACT

A walk-through industrial hygiene survey was conducted at the Lancaster Floor Plant of Armstrong World Industries in Lancaster, Pennsylvania, on September 3, 1986. The purpose of the survey was to obtain information on the application of products with multifunctional acrylates or methacrylates and determine the potential for occupational exposures to these chemicals.

The plant, which was constructed in 1907, has been formulating coatings on-site since 1977. An enclosed process is used at the plant for both the formulation of the top coat and the manufacture of a monofunctional acrylate. The primer coat is formulated in tote tanks or drums. Acrylic inks purchased from an outside supplier are blended at the plant to various shades. The UV-curable inks and coatings are used on a tile application line. An acrylated polyester manufactured at the plant is used as an adhesive on vinyl material on a separate line.

The company has a total of 2388 employees at the Lancaster Floor Plant. A total of 61 employees, including laboratory personnel and supervisors, have potential for contact with acrylates in the various operations. Armstrong has previously monitored for the acrylates used at the plant but they do not consider these data to be reliable. There have been three cases of illnesses at the plant resulting from skin contact with acrylates. The company has a structured medical, safety, and industrial hygiene program, and maintains personnel records on all employees.

INTRODUCTION

Acrylates and methacrylates are ester derivatives of acrylic and methacrylic acid that are formed by reacting an alcohol with one of the acids. They polymerize readily, and are widely used in the chemical industry to make polymeric resins for applications including paints and coatings, printing inks, adhesives, textiles, molded plastic objects, polishes, and leather treatment.[1] Some acrylates and methacrylates have known toxic effects. For example, exposure to ethyl acrylate can result in lung edema.[2] Short-term exposure can result in marked irritation to the eyes, nose, throat, and lungs, and prolonged contact with the skin or eyes may result in severe damage.[2,3] Based on "inadequate" evidence for carcinogenicity from one human study and "sufficient" evidence for carcinogenicity from one animal study, ethyl acrylate has been categorized as a probable human carcinogen.[4] Exposure to methyl acrylate can cause acute lung damage as well as cumulative lung, liver, and kidney damage.[2] Short-term exposure can result in marked irritation to the eyes, nose, throat, and skin, and prolonged contact with the skin or eyes may result in severe damage.[2,3] Prolonged exposure can cause dermatitis.[3] 2-Ethylhexyl acrylate has been categorized as a possible human carcinogen based on "limited" evidence of carcinogenicity in animals.[4] Methyl methacrylate is a suspected teratogen.[5] In vivo studies have shown that several multifunctional acrylates (e.g., trimethylol propane triacrylate, 1,6-hexanediol diacrylate) are strong allergic sensitizers of human skin. Neopentyl glycol diacrylate and tetraethylene glycol diacrylate have been categorized as possible human carcinogens.[4]

The U.S. Environmental Protection Agency (EPA) has entered into an Interagency Agreement with the National Institute for Occupational Safety and Health (NIOSH) to evaluate the extent of exposure of workers formulating or applying products made with multifunctional acrylates or methacrylates. EPA is conducting a risk assessment for these chemicals under the Toxic Substances Control Act (TSCA) and requires information on potential occupational exposures. EPA has particular interest in obtaining information on the use of formulations containing multifunctional acrylates and methacrylates for radiation-curable applications, which is a new and growing market. NIOSH researchers are therefore investigating the potential for exposure of workers handling acrylates and methacrylates in the formulation and use of radiation-curable inks, adhesives, and coatings.

APPLICABLE STANDARDS AND RECOMMENDED LEVELS

The current legally allowable air concentrations enforced by the Occupational Safety and Health Administration (OSHA) for ethyl acrylate, methyl acrylate, and methyl methacrylate are 25, 10, and 100 ppm, respectively, for an 8-hour time-weighted average (TWA) that may not be exceeded in any 8-hour work shift of a 40-hour work week.[6] OSHA has included a "skin" notation for ethyl acrylate and methyl acrylate, which suggests that appropriate measures be taken for the prevention of cutaneous absorption so that the threshold limit is not invalidated. OSHA has not set allowable air concentrations for any multifunctional acrylates or methacrylates.

The American Conference of Governmental Industrial Hygienists (ACGIH) has established for ethyl acrylate a threshold limit value/time-weighted average (TLV/TWA) of 5 ppm and a threshold limit value/short-term exposure limit (TLV/STEL) of 25 ppm.[7] The TLV/TWA is the TWA concentration for a normal 8-hour work day and a 40-hour work week. The TLV/STEL is a 15-minute TWA exposure which should not be exceeded at any time during a work day even if the 8-hour TLV/TWA is achieved. ACGIH has also listed a "skin" notation for ethyl acrylate. ACGIH has established for methyl acrylate a TLV/TWA of 10 ppm, as well as a "skin" notation.[7] ACGIH has established for methyl methacrylate a TLV/TWA of 100 ppm and a TLV/STEL of 125 ppm, and for butyl acrylate a TLV/TWA of 10 ppm.[7] ACGIH has not recommended TLV's for any multifunctional acrylates or methacrylates.

HISTORY AND DESCRIPTION OF THE PLANT

The Lancaster floor plant is owned by Armstrong World Industries, Inc. Construction on the original 31-acre site commenced in 1907 with production occurring the following year. The first shipment of flooring was made in 1909. Coating formulation capabilities were developed in 1976 and formulation commenced in 1977. Prior to 1977, both the coatings and inks were purchased from outside formulators. The Floor Plant complex now contains more than 300 buildings covering approximately 250 acres.

In 1985, Armstrong processed more than 20 million square feet of vinyl tile with acrylic coating and inks. The production volume for Duracoat (a top coat containing multifunctional acrylates formulated at the plant) was around 1.6 million pounds in 1985. The production volume for acrylated polyester (used as a binder in a separate "Corlon" product application line) was over 50,000 pounds in 1985. In 1985, Armstrong used over 14,000 pounds of inks (containing approximately 11,000 pounds of white pigment) in their tile application line. A monofunctional acrylate (MA) is manufactured at the plant. Some of the MA used at the plant is purchased from outside sources. Multifunctional acrylates have also been previously manufactured at the plant; production of multifunctional acrylates, however, was discontinued in 1983.

Raw materials for the manufacturing of MA, formulation of inks, formulation of acrylate-based primer coat, formulation of Duracoat (top coat), and formulation of acrylated polyester are transported by common carrier. Bulk shipments of a diacrylate and a hydroxyalkyl acrylate (HAA) are transported at the rate of approximately one shipment per month. Another diacrylate and MA are transported in 55-gallon drums and delivered approximately once per month. Flexo inks are shipped in 2-1/2 gallon pails. The acrylate raw materials (except MA) and the acrylic inks are purchased solely from outside sources. Celanese (Interez), Rohm and Haas, ARCO, and Dow are the major suppliers of acrylates.

PROCESS DESCRIPTION

This section provides a description of the various processes at the Armstrong Lancaster Floor Plant that involve the manufacture, formulation, or use of acrylates. These processes include the manufacture of MA, polyester, and acrylated polyester; the formulation of a top coat (Duracoat) and a primer coat; the blending of acylate inks; the application of inks and Duracoat on tiles; and the application of an acrylate binder.

Manufacture of MA

MA, which is used in the Duracoat top coat, is manufactured in a 1000-gallon stainless steel tank equipped with a paddle mixer. This reactor is located adjacent to the coatings formulation reactor. MA is produced by the esterification of acrylic acid and the appropriate alcohol. The reaction occurs as an enclosed batch process.

The process commences with the purging of the tank with an air-nitrogen (N_2) mixture from the bottom. Next, acrylic acid, alcohol, catalysts, and inhibitors are metered into the tank. This mixture is then heated to 115°C and water is distilled off as a byproduct. The velocity of the air-N_2 mixture is increased as the reaction proceeds. The mixture is then further heated to 130°C and more water is distilled off. After sufficient water has been driven off, quality control (QC) samples are taken for analysis by gas chromatography.

A batch of MA takes approximately 16 hours for completion. After completion of a batch, the MA is pumped into either a storage tank or into 55-gallon drums.

Manufacture of Polyester

The polyester (used as one of the ingredients for the coating formulations as well as for the acrylated polyester) is manufactured via esterification in a 2000-gallon reactor at a separate facility. The reactor is purged with nitrogen and the raw materials (acids, diols, and triols) are metered in. The mixture is heated to 215°C and water is distilled off. QC checks consist of hydroxyl number and acid number wet tests. The polyester is hydroxyl-terminated, and bulk-handled via pipes to storage tanks. The polyester is again transferred via pipes to the coatings formulation process.

Formulation of Duracoat (Top Coat)

Duracoat is formulated in a 1000-gallon stainless steel tank. In the past, the tank was previously also used for the manufacture of MA. Presently, a dedicated tank is used for the formulation of Duracoat. The reactor vessel is totally enclosed.

A diacrylate (diluent) is metered into the reactor first. Next, a small amount of the initial catalyst solution is charged into the reactor through a dual nozzle valve. A small amount of stabilizer mixed with DA is then added through a funnel. Polyester and HAA are next metered into the tank. After these raw materials are added to the reactor, it is heated to 50°C.

Next, an isocyanate is slowly metered into the tank. The temperature of the exothermic reaction is controlled by adding water to the jacket and by regulating the flow of isocyanate. Quality control (QC) samples are taken and analyzed by infrared spectrophotometry in the laboratory. Once the isocyanate reaction is completed, more acrylate diluents are metered into the reactor. Lastly, a flow agent is added to the reactor. Diluents jointly constitute approximately one-fourth of the batch. The batch is mixed until the desired specifications are achieved. QC samples are collected and sent to the laboratory for checks on viscosity, transition glass temperature (T_g) analysis, and curing properties. The final top coat product is stored in tank wagons or drums prior to use. For coatings sold outside the plant, 55-gallon drums are filled to about 6 inches from the top to stabilize the finished product. Duracoat top coats are formulated routinely.

Formulation of Primer Coat

The primer coat is formulated in either 200-gallon tote tanks or 55-gallon drums. Drums containing acrylate diluent are brought into the coatings formulation area. Diluent and photoinitiators are added to the vessel and mixed.

Ink Blending

The UV-curable inks are purchased from Borden Chemical in 2-1/2 gallon pails. Inks are stored in a refrigerated chamber (10°C) with the lids off and no associated local ventilation. The ink blending room has a number of "dough blenders" for batches varying in size from 30 to 90 lb. Various colors are added to produce the required shades. Ninety percent of the formula is weighed on a scale and manually poured into the stainless steel dough blender. The last 10 percent of the batch is used for fine-tuning the blend. The mixed batch is compared to standards to ensure that the desired colors are obtained. After complete mixing, the blended inks are poured into 5-gallon plastic buckets, sealed, and stored in a refrigerated chamber at 10°C.

The ink maker collects QC samples and sends them to the raw materials laboratory for analysis. A batch takes approximately two hours for completion. The blended inks are used both at the Lancaster Floor Plant and other Armstrong facilities.

Tile Application

Inks are first applied to the tiles. The blended inks are kept on a shelf under a canopy adjacent to the tile line. Offset print is used for the application of the ink. Different printers are used for different patterns. The printers have 3 different sets of rollers which transfers up to three different inks onto the tile. The inks are added manually via cup to the reservoir on the printer. The reservoir level is checked manually. After the ink is applied, the tiles pass through UV lamps to cure the ink.

The primer coat is applied next via reverse roll coater. The bulk solution is stored on the floor above the line and is gravity-fed into a drum. The drum is preheated before the coating is pumped to a reservoir. The reservoir collects primer coat for recycle. The reservoir level is checked manually. The primer coat is not cured before the top coat is applied.

Duracoat (top coat) is applied next. The top coat feed to the line comes from bulk storage, is transferred to a reservoir, sent through a filter into the coater, and recycled to the reservoir. The UV-curing operation is located three or four feet from the coater.

QC on the tiles consists of checks for weight (once an hour), and UV intensity and glass transition temperature (once a day). The tiles are packaged after inspection.

Corlon Binder Application Line (Line No. 6)

The binder is prepared by mixing acrylated polyester with benzoyl peroxide in a drum for about one hour. The acrylated polyester binder consists of 20 to 30 percent by weight of acrylates; less than 2 weight percent of this, however, is multifunctional. This material is pumped upstairs to a product catch pan. The material is then pumped into a roller with a screen, and a bar squeezes 1/2-inch dots of acrylated adhesive onto a felt-backed vinyl material. The material passes under a shaker box containing grit which covers the dots. It is then vibrated to obtain a uniform cover. Air jets are then used to blow off excess grit into a hopper. The material is then heated in hot air ovens to dry the adhesive.

The adhesive is made only in spurts. On an average, the Corlon line operates once a month for three or four consecutive months and then remains idle for several months.

Raw Materials Laboratory

QC samples from bulk shipments are collected by attaching a mechanical fitting to the exit pipe of the truck and filling a one-gallon bucket with the material. Smaller sample jars are then filled from the bucket. The remaining material is transferred by pipe into storage tanks.

QC samples are taken from one 55-gallon drum per lot number. The drum is opened and a jar is dipped in. The jar is placed in a polypropylene bag and taken to the laboratory. The jar is washed three times with alcohol and then rinsed with water under a hood.

QC tests on acrylate raw materials consist of visual color (APHA color testing in tubes), inhibitor level test, GC analysis, and infrared analysis for further identification. These series of tests on each batch take approximately 1/2 hour.

DESCRIPTION OF THE WORKFORCE

As of September 1986, there were a total of 2388 employees at the Armstrong plant. This number comprises 1838 hourly employees and 550 salaried employees. The hourly employees consist of 1672 male and 266 female workers; the salaried personnel consist of 381 male and 169 female employees. The plant operates three shifts per day.

A total of 61 employees at the plant may be exposed to acrylates. The job descriptions and number of workers for each job category directly and potentially exposed to acrylates during both the blending/formulation of inks/coatings, and the application of inks and coatings are as follows:

Raw materials laboratory -

Laboratory technician	One to three laboratory technicians are primarily exposed. Exposure may occur for a total of six employees in this job category, of which three are male and three are female. Their duties include conducting QC checks on all raw materials. Only a small portion of their time is spent with raw materials containing acrylates. Laboratory technicians work on the day shift only.
Chemist, manager	One employee is potentially exposed in this job category. Duties consist of overseeing the activities in the laboratory. The potential for contact is very low. The chemist works on the day shift only.

Formulation of coatings -

Chemical operators	Two chemical operators are primarily exposed. Exposure may occur for a total of 12 employees in this job category of which all are male and range in age from 30 to 35 years. These operators are highly skilled and the turnover rate is very low. Exposure is estimated to be approximately 1/4 hour/day. Their duties include formulation of the top coat, collection of QC samples, and cleanup of the equipment and spills. Chemical operators work three shifts per day.

Chemical production supervisor	One employee is potentially exposed in this job category. Duties consist of overseeing the activities in the formulation of the top coat. The potential for contact is very low. The chemical production supervisor works on the day shift only.
Laboratory personnel	Four employees are potentially exposed in this job category. They may be occasionally in the formulation area. The laboratory personnel work on the day shift only.
Engineers	Two employees are potentially exposed in this job category. They may be occasionally in the formulation area. The engineers work on the day shift only.
Maintenance - pipefitters	Six employees are potentially exposed in this job category. Approximately 60 percent of their time is spent in this area and the rest is spent in the finished goods area. Two pipefitters work on each of three shifts.
<u>Ink blending</u> -	
Ink maker (blender)	One employee is directly exposed in this job category. Only one employee is trained in this task. Duties consist of blending inks to produce inks with specific colors and collecting QC samples. The ink maker works on the day shift only.
Tile technicians	Two employees are directly exposed in this job category. Their duties include performing color trials on the blended inks. Tile technicians work on the day shift only.
Ink supervisor	One employee is potentially exposed in this job category. Duties consist of overseeing the activities in the ink department. The potential for contact is low. The ink supervisor works only on the day shift.
General supervisor	One employee is potentially exposed in this job category. Duties consist of overseeing activities of the ink maker. The general supervisor works on the day shift.

Tile application -

Leaders	Three employees are directly exposed in this job category. Their duties include monitoring the operators on the tile application line, and assisting in cleaning the tile line. One leader works on each of the three shifts.
Relief operators	Three employees are directly exposed in this job category. Their duties consist of assisting the machine operator in cleaning the printer, and assisting in cleaning the tile line. One relief operator works on each of three shifts.
Machine operators	Three employees are directly exposed in this job category. Their duties include operating the No. 5 tile application line, cleaning the printer,and assisting in cleaning the tile line. One machine operator works on each of three shifts.
Feeder-packers	Three employees are potentially exposed in this job category. Their duties consist of feeding the tiles into the line and packaging the tiles. One feeder-packer works on each of three shifts.
Inspectors	Three employees are potentially exposed in this job category. Their duties consist of inspecting the tiles and conducting QC checks. One inspector works on each of three shifts.
Line supervisors	Three employees are potentially exposed in this job category. Their duties consist of overseeing the tile production line. One line supervisor works on each of three shifts.
General production supervisors and assistants	Two employees are potentially exposed in this job category. Their offices are next to the tile production line. The potential for exposure is low since they spend little time in the production area. These employees work on the day shift only.
Maintenance - pipefitters	Three employees are potentially exposed in this job category. One pipefitter works on each of three shifts.

Maintenance - electricians	Three employees are potentially exposed in this job category. One electrician works on each of three shifts.
Maintenance - millwrights	Three employees are potentially exposed in this job category. One millwright works on each of three shifts.

A total of 8 people may be involved in the Corlon production line when it is in operation. Of these people, only the leader and pumper (who pumps acrylated polyester/peroxide) have potential for contact with acrylates.

Central plant maintenance fills in for other maintenance workers during off-shifts and weekends. The central plant maintenance staff consists of 30 to 40 pipefitters, 30 to 40 electricians, 50 to 60 millwrights, 20 sheet-metal workers, 20 to 30 welders, and 100 machine shop workers. Maintenance workers are responsible for fixing the equipment and not for cleaning the equipment.

DESCRIPTION OF PAST POTENTIAL WORKER EXPOSURE

Armstrong has not conducted air monitoring for any monofunctional or multi-functional acrylates. Air sampling has been performed for the isocyanate and acrylic acid but no detectable concentrations were found.

In 1981 and 1982, there were three reported cases of illness due to the use of acrylates. No time was lost from work for any of these cases. One case occurred when a leader operator on the tile line noticed liquid on the top of a drum of liquid primer coat and when removing the lid, splashed some liquid on his arms. The leader operator received 1st and 2nd degree chemical burns from this incident. Another case occurred when a utility operator got primer coat on his hands from wearing contaminated gloves. The utility operator had dermatitis on both hands from this incident. The last case occurred when a millwright got some Duracoat top coat on his thigh when working on the tile coater. The millwright had a rash on his left thigh from this incident. Other occasional exposures have occurred over time in the raw materials laboratory and ink blending areas. Some sensitization and skin irritation has been related to handling the various isocyanates both in the QC laboratory and process area. The plant has a policy of rotating individuals out of an area when they have had sensitization or continued skin problems with either the acrylates or isocyanates.

Engineering Controls

The Hazardous Materials Response Team at the plant consists of 16 employees who are called in on any spill by means of a pager. They cover the entire plant. They respond quickly to the spill location but proceed slowly in the cleanup.

Acrylate manufacturing/coatings formulation area--

The unloading area is equipped with a spill containment system. A mechanical fitting is attached to the exit pipe of raw material trucks and the bulk raw materials are transferred by pipe to storage tanks. The mechanical fitting is cleaned by the Transportation Department.

If a small leak occurs during the manufacturing of Duracoat coatings, a bucket is placed under the leak and a pipefitter is called to repair the equipment. The spill is cleaned up by throwing absorbent material on the spill and disposing of the material as hazardous waste. If a large spill occurs, a hazard mask is put on and the Hazardous Materials Response Team is called.

The Duracoat reactor is cleaned by adding diluent (MA) and flushing the tank. The liquid is disposed of as hazardous waste. For better cleaning, toluene is added and then distilled. If the tank needs to be entered, a confined space entry permit is required.

Rupture disks on the reactor and storage tanks are vented to the roof. The storage tanks have level indicators and overfill alarms.

Elephant trunks are available when filling the product and are located near the bottom of the reactors.

The process is expected to be automated in the near future with centralized piping, control room, labeling of lines, etc.

Ink Blending--

The ink room has general dilution ventilation, and the mixing is conducted under a canopy hood. However, open ink containers are stored around the room away from the canopy hood. Mixing bowls (dough blenders) are cleaned using a mixture of methylene chloride, trichloroethylene, and methyl ethyl ketone. These are blended to produce a specific viscosity for the cleaning solution. The waste solvent is handled as hazardous waste.

Tile Application--

Local exhaust ventilation is present at the points of primer coat addition, Duracoat (top coat) addition and at the two UV units. The coater for the top coat is totally enclosed in a booth. The UV units are exhausted to the outside. Opened ink containers are stored under a canopy hood along the wall adjacent to the line. Ink presses are cleaned if a buildup of dust occurs on the pads or if excess ink is used. Some cleaning is accomplished while the equipment is in operation. The ink press is also cleaned when there is a pattern change. Additionally, the ink press is deep cleaned once a week. The cleaning solution is a blend of methylene chloride, trichloroethylene, and methyl ethyl ketone. These are blended to produce a specific viscosity for the cleaning solution. The same cleaning solution is used to clean the rest of the tile line.

Corlon Line (Line No. 6)--

Local exhaust ventilation is located at the point where the blended acrylated polyester is applied to the material. 1,1,1-trichloroethane is used to clean the screen and lines at the end of the application. Any spills on workers' hands are washed with alcohol and water.

Raw Materials Laboratory--

The laboratory is equipped with general dilution ventilation. QC samples are analyzed under hoods which are totally enclosed.

Substitutes

Substitution of tripropylene glycol diacrylate (TPGDA) for the Duracoat diacrylate, as well as the use of tetraethylene glycol diacrylate (TTEGDA) and 1,4-butanediol diacrylate (BDDA) have been considered. Armstrong has also previously investigated the use of dimethacrylates as substitutes for the primer coat diacrylate, but did not find them viable. Substitution may occur when usual suppliers are no longer available. The price of the substitute chemicals is approximately the same. These substitute chemicals will not change the performance of the product. New acrylate-based coatings are being developed in the laboratory for new tile products. These developments could possibly change the process. These changes may require the building of a new tile production line which would make the present line obsolete and/or require the addition of storage tanks.

DESCRIPTION OF THE MEDICAL, SAFETY, AND INDUSTRIAL HYGIENE PROGRAMS

Medical Program

The company conducts comprehensive preemployment physicals for all new production employees consisting of an evaluation of chest x-rays, hearing tests, vision tests, pulmonary function analysis, blood tests, and urine tests. Annual physicals are given to all fire brigade and Hazardous Material Response Team employees. Chemical operators on the tile application line are given periodic physical exams as part of the plant's sensitizer medical surveillance program. Drivers of tractor-trailers are given tests for hearing and vision once every two years. The medical staff consists of two part-time physicians, 3 full-time nurses, 2 part-time nurses, 1 radiation technician, and 50 employees trained in first-aid and CPR. Emergency medical care for workers is available at two hospitals in close proximity to the plant.

Safety Program

The Safety Program is under the direction of the Manager of Plant Hygiene, Safety and Health. There are also Supervisors for the Medical Department, and one for Plant Safety and Hygiene plus a staff of 5 (and a fire brigade). Four crew meetings relating to safety are held each year. The plant has a Central Safety Committee which is chaired by the plant manager, and subcommittees are chaired by other major plant managers.

Safety glasses are provided by the company for employees whose tasks require eye protection. Approximately 75 percent of the employees wear safety shoes. The company subsidizes 25 to 35 percent of the cost of 2 pairs of safety shoes per employee per year.

When unloading bulk shipments from trucks, the laboratory technicians wear polypropylene booties, rubber boots, rubber-coated suits (trousers and jacket), face shields, latex gloves, and safety glasses. The bulk liquid and clothing used in handling the materials are handled as hazardous waste.

When analyzing QC samples in the raw materials laboratory, the laboratory technicians wear latex gloves, boots, aprons, and safety goggles. Waste materials are identified and treated as hazardous waste.

Personal protective equipment in the formulation of the Duracoat coatings consist of white cotton coveralls which are laundered by the company. During transfer of materials, operators may wear impervious aprons, gloves, and either chemical goggles or face shields.

The ink maker wears latex gloves when blending inks. During cleaning, the ink maker also wears safety goggles and an apron.

Operators on the tile line are not required to wear any personal protective equipment (PPE). Aprons, half-mask respirators, face shields, and gloves are worn when drawing bulk solutions and cleaning the line and printer. Due to a bargaining agreement, hourly employees may choose to wear shorts, short sleeve shirts or no shirts regardless of the PPE required for the job. This has been allowed due to the lack of air conditioning in the tile area.

In the Corlon area, operators wear rubber gloves; during cleanup, they also wear paper suits and dust masks.

Showers and change areas are available. Separate lunchroom facilities are provided for eating meals. Smoking is permitted in designated areas only, such as the lunchroom and office areas.

Industrial Hygiene Program

The supervisor of Plant Safety and Health is responsible for the industrial hygiene program at the plant. Industrial hygiene surveys are conducted on an as-needed basis. The plant has conducted sampling for acrylic acid, isocyanates, noise, titanium dioxide, and antimony in the acrylate areas of the plant. Numerous other contaminants have been sampled throughout the Lancaster complex. The plant also has old monitoring data on the hydroxyalkyl acrylate and other acrylates conducted by an outside laboratory, but these are reportedly not reliable measurements. Ventilation checkups are done in hoods in some areas of the plant. No ventilation measurements, however, have been conducted on the tile coating line.

DESCRIPTION OF PERSONNEL RECORD SYSTEM

The Armstrong World Industries, Inc., Lancaster Floor Plant maintains personnel records on terminated and current employees. There are reportedly several thousand records of employees. Old records are destroyed and it is not known how long the records are retained. The personnel records contain job descriptions which can be traced to a particular department of the plant. The union also maintains membership records, but these are not as comprehensive as the company's records. Examples of types of information contained in the plant's personnel records include:

1. Name
2. Social Security number
3. Date of birth
4. Date of employment
5. Work location
6. Job description
7. Reason for termination

CONCLUSIONS

The Armstrong Lancaster Floor Plant in Lancaster, Pennsylvania, uses monofunctional and multifunctional acrylates in several areas. These include 1) the manufacture of a monofunctional arcylate (MA), 2) formulation of coatings (primer and top coats) containing monofunctional and multifunctional acrylates, 3) blending of acrylic inks purchased from an outside supplier, 4) application of UV-curable acrylic coatings and inks on vinyl tiles, and 5) application of an acrylated polyester as an adhesive on vinyl material. The manufacture of MA and the formulation of top coats occur in enclosed reactors, with local exhaust ventilation at the product filling locations. The primer coat is formulated in tote tanks or drums. The tile coating line utilizes local exhaust ventilation at the points of primer coat and top coat addition. There is also local exhaust ventilation on the acrylated polyester application line at the point where the adhesive is applied to the vinyl material.

No reliable industrial hygiene monitoring data is available at the Lancaster Floor Plant for either monofunctional or multifunctional acrylates. In 1981 and 1982, there were three reported cases of illnesses at the plant due to dermal contact with acrylates; none of these, however, resulted in lost time from work.

RECOMMENDATIONS

On the basis of information gathered and observations made during this walk-through survey, no major recommendations pertaining to the use of acrylates were considered necessary at this time. The use of disposable gloves is recommended for operations that do not require rigid handling to prevent cross-contamination of the gloves. The plant should, however, evaluate substitutes to methylene chloride for cleaning the tile coating line since high airborne concentrations of this chemical are expected in the work area while cleaning the printers and other parts of the line. Until a substitute is found, either additional exhaust ventilation should be added above the solvent container and at each point of the line where it is applied (especially at the ink press) or all employees in the area should be required to wear appropriate respiratory protection. Employees handling the acrylates and cleaning the tile line should be required to wear long pants and long sleeve shirts as part of the personal protective equipment required for the job.

REFERENCES

1. Leaf, Dennis. Preliminary Report on Potential Substitutes for Members of the Acrylate Category. U.S. Environmental Protection Agency, Economics and Technology Division, Office of Pesticides and Toxic Substances. Washington, D.C. February 1986.

2. Occupational Safety and Health Administration. Industrial Hygiene Technical Manual, Appendix A. Issued by OSHA Instruction CPL 2-2.20A, March 30, 1984; amended by CPL 2-2.20A CH-1, October 29, 1984.

3. U.S. Department of Health and Human Services. NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards. DHHS (NIOSH) Publication No. 81-123. January 1981.

4. U.S. Environmental Protection Agency. The Oncogenic Hazard of Acrylate and Methacrylate Chemicals and the Acrylate/Methacrylate Category. Health and Environmental Review Decision, Office of Pesticides and Toxic Substances. Washington, D.C. February 28, 1985.

5. International Agency for Research on Cancer. Methyl Methacrylate and Polymethyl Methacrylate. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, Volume 19. 1979.

6. Occupational Safety and Health Administration. Safety and Health Standards - Subpart Z, Toxic and Hazardous Substances. 29 CFR 1910.1000, Table Z-1.

7. American Conference of Governmental Industrial Hygienists. TLVs[R] - Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment and Biological Exposure Indices with Intended Changes for 1985-86. Cincinnati, Ohio. 1985.