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INDUSTRIAL HYGIENE WALK-THROUGH SURVEY REPORT OF INDUSTRIAL HEATING AND FINISHING CO., INC. PELHAM, ALABAMA

SURVEY CONDUCTED BY:
Charles S. McCammon, Jr., Ph.D., C.I.H.
E. Radha Krishnan, P.E.

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REPORT WRITTEN BY:
Charles S. McCammon
E. Radha Krishnan
Robert J. Goodman

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16. Abstract (Limit: 200 words)

In an effort to gather information on the potential occupational exposures to acrylates or methacrylates, a walk through survey was conducted at the Industrial Heating and Finishing Facility (SIC-3479, SIC-2851) in Pelham, Alabama. At this facility, finishing systems were processed for wood, plastic, glass and metal substrates. Acrylic coatings have been used there since 1982. Coatings were blended at this site with catalysts, solvents and photoinitiators to prepare the needed sprays. Current OSHA standards for exposure for an 8 hour work shift of a 40 hour work week were 25, 10 and 100 parts per million (ppm) for ethyl-acrylate (140885), methyl-acrylate (96333), and methyl-methacrylate (80626), respectively. At the site, the company used a spray booth and an ultraviolet curing unit connected by a conveyor system to demonstrate spray coat applications on three dimensional objects to potential clients. During these demonstrations the spraying was done by hand. However, during normal operations, an automated spraying system was incorporated. The spraying was done in a separate room which was equipped with a ventilation system. Two of the 50 employees at the facility were involved in the spray applications. The facility did not have an industrial hygiene program, but material safety data sheets were posted in areas where the materials were used. There have been no health problems reported at this location.

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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.
EMPLOYER REPRESENTATIVES CONTACTED:	Henry Arnold, President Werner Lemmermann, Laboratory Supervisor - UV sales
EMPLOYEE REPRESENTATIVES CONTACTED:	No union
STANDARD INDUSTRIAL CLASSIFICATION (SIC) CODE:	3479 - Coating, engraving, and allied services, not elsewhere classified 2851 - Paints, varnishes, lacquers, enamels, and allied products

ABSTRACT

A walk-through industrial hygiene survey was conducted at the Industrial Heating and Finishing (IHF) plant in Pelham, Alabama, on November 11, 1986. The purpose of the survey was to obtain information on the application of products with acrylates or methacrylates and to determine the potential for occupational exposures to these chemicals.

IHF manufactures finishing systems for wood, plastic, glass and metal substrates. The plant, which was constructed in 1975, has been using acrylated coatings since 1982 for demonstrating ultraviolet (UV)-radiation-cured spray applications on three-dimensional (3D) objects to potential clients. The acrylated formulations are purchased from outside suppliers. At the Pelham plant, IHF blends coatings, catalysts, solvents and photoinitiators in appropriate ratios on a laboratory bench to prepare the spray coatings. IHF has a spray booth, a 3D UV curing unit and a flat line curing unit including roll coaters and curtain coaters at the Pelham facility. The spraying is performed manually for the demonstrations, although IHF's recommended designs include automated spray systems. IHF has performed UV-cured spray applications on a variety of wood, plastic, glass, and metallic products.

The company has a total of 50 employees at the Pelham Plant of which only 2 are associated with the 3D UV-cure spray applications. The 2 employees have potential for contact with acrylates in the laboratory-scale investigations. IHF has not conducted air monitoring for the acrylates used at the plant. There have been no reported cases of illnesses at the plant attributable to contact with acrylates. The company has a safety 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 Pelham plant is owned by Industrial Heating and Finishing (IHF) Co., Inc. The plant was built in 1975 and covers 2.5 acres. The company has been in business for 29 years. IHF's business is comprised of sales, engineering, manufacturing and installation of finishing systems. IHF also designs and supplies industrial washers, air makeup units, conventional ovens, and three-dimensional (3D) and flat line ultraviolet (UV) units. Since 1976, IHF has primarily been supplying finishing systems for metal substrates (e.g., metal furniture and appliances). This accounts for approximately 80% of their business. Since 1982, IHF has been investigating 3D UV-cured spray applications using acrylated coatings on a variety of wood, plastic, glass, and metallic products. As of the survey date, IHF only had a few commercial applications of their 3D UV-cure systems. IHF attributes the low commercial potential of their applications to the questionable toxicity of the UV-curable formulations, lack of definitive regulation of the acrylated materials and the difficulty associated with rectifying defects in sprayed UV-finishes.

The area of interest in the walk-through survey was IHF's 3D UV curing operations. The Pelham facility has a spray booth and a UV curing unit connected by a conveyor system for demonstrating spray coat applications on 3D objects to potential clients. The spraying is performed manually during the laboratory-scale demonstrations; IHF's full-scale designs, however, incorporate automated spraying systems.

The raw materials used in the 3D coating application are transported to the plant in trucks. The raw materials include top coats, base coats, catalysts, photoinitiators, and hydrocarbon solvents. Formulations containing multifunctional acrylates are stored in quart cans and 5 gallon pails. The primary suppliers of the raw materials are NOVA Industries, Lilly Industrial Coatings, and Red Spot Paint and Varnish Co. Other suppliers have included BASF-Inmont, PPG Industries, and Valspar Corporation.

PROCESS DESCRIPTION

Information is not available on the specific multifunctional acrylates constituting the top coats and base coats purchased by IHF. Specific coatings

are made to the specifications of or supplied by the potential customers. IHF does not recommend specific coatings but rather refers the customers to different suppliers who in turn define the products to be used.

The spray coat is prepared by blending different types of raw materials (i.e., coatings, catalysts, solvents, photoinitiators) in appropriate ratios on a laboratory bench outside the 3D UV spray work area. The blending is performed by an operator who mixes the raw materials in a spray can and stirs the mixture with a spatula. A batch of sealer spray coat that was mixed during the survey contained 400 ml coating, 80 ml catalyst, 50 ml solvent, and 12 ml of photoinitiator. The two most common solvents used were ethyl butyl acetate and n-butyl acetate. In the manual compressed-air spray applications employed at the IHF facility, the use of solvents allows a thicker coat to be initially applied which eventually dries to a thinner coat after the solvent in the formulation evaporates. For instance, if a 1-mil coat is desired, the operator would initially apply a 3-mil spray coat. More viscous coats, i.e., with less solvent, can be applied in thinner layers using spinning disks or turbines rather than spray guns.

Figure 1 is a diagram of IHF's laboratory-scale 3D UV-cure spray system in Pelham, Alabama. Figure 2 shows a detailed sketch of the 3D UV-cure unit. The application line consists of a spray booth and the UV curing unit. A conveyor transfers the object from the booth to the UV-curing room. The number of revolutions the object undergoes in the UV zone can be varied by using wheels of varying diameter on the conveyor. An 8-inch diameter wheel is used to achieve four rotations of large objects such as chairs for increased UV exposure. With a 4-inch diameter wheel, there are 7 revolutions in the UV zone, whereas a 2 1/8-inch wheel allows 11 revolutions. As a rule of thumb, the larger the object to be coated, the fewer the revolutions (i.e., the larger the wheel used). A slower line speed will increase the UV contact time. The curing time is typically 20 to 30 seconds with an 8 to 12 ft/min conveyor speed.

In the spray booth, the operator can spray any or all of the following on the substrate: stain, sealer, or a top coat. For some substrates more than one coat is required. A stain coat, a seal coat and two top coats may be applied for the finishing of a piece of wood. A seal coat may also be substituted for one of the two top coats. For the coating of plastic headlamps, a base coat and a top coat are applied. Metallized coatings are not applied at IHF's Pelham plant. Between each spray application the substrate is cured with UV light.

The stain, sealer, and top coat are all applied in the spray booth using a compressed air spray gun. For commercial use, IHF recommends that this operation be automated with the use of airless spray guns.

The finishing of a piece of wood was demonstrated during the survey. The entire operation is accomplished by one operator. First the wood is sprayed with the stain. Typically the stain is alcohol-based rather than water-based. Each spray application is accomplished in 1 to 2 minutes. Next, the

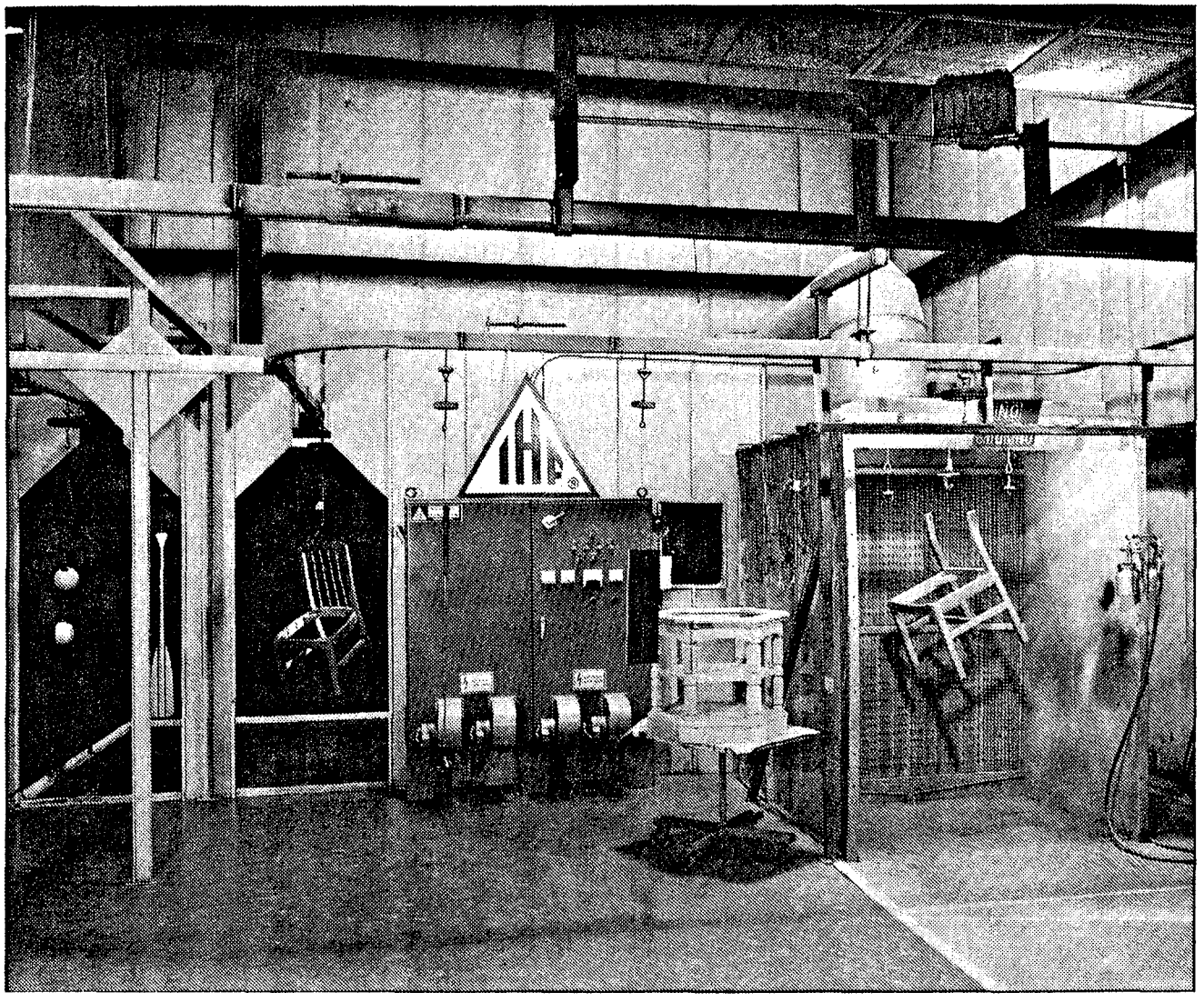

Figure 1. IHF's Laboratory-Scale 3D UV-Cure Spray System in Pelham, Alabama. (Source: IHF Literature)

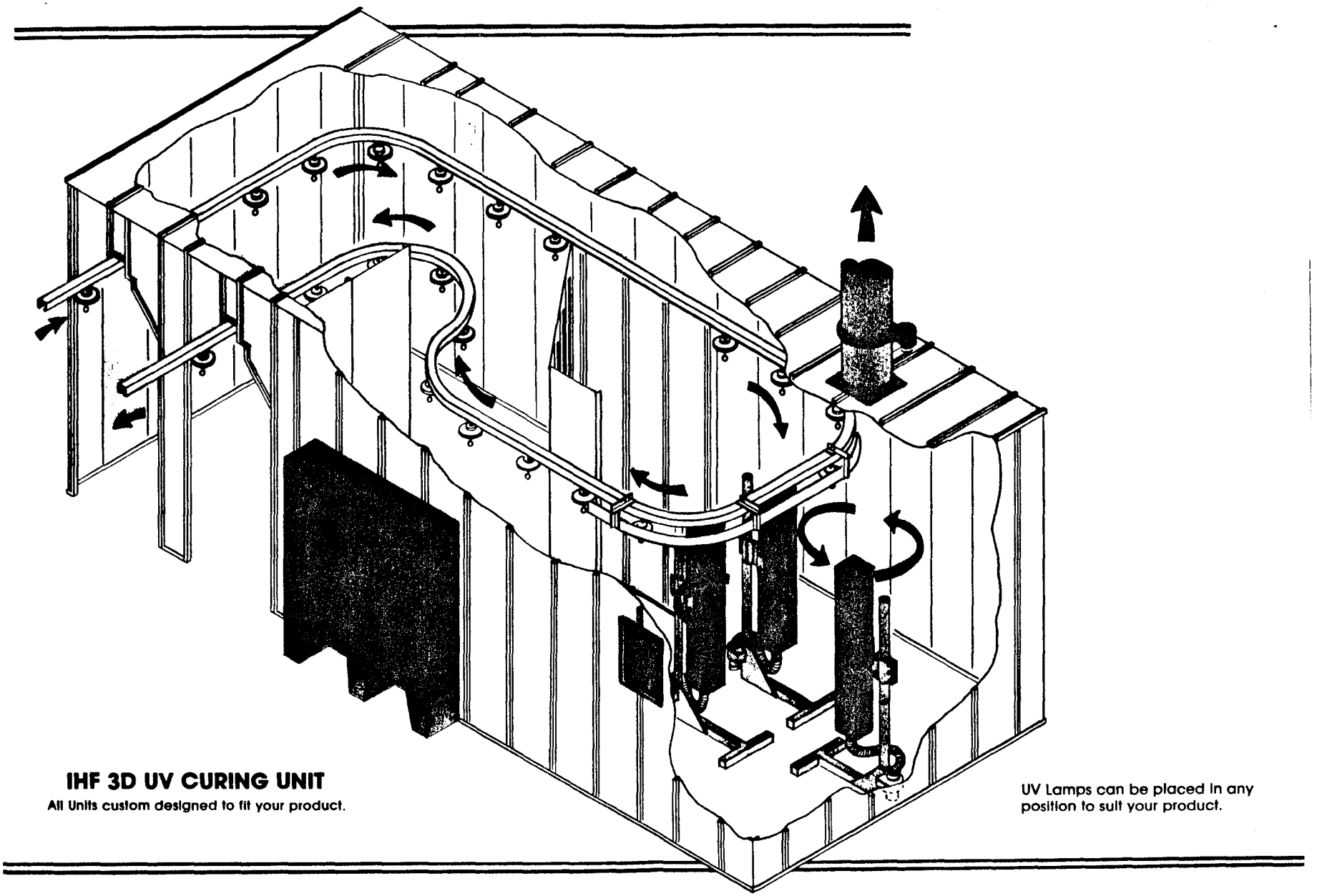

Figure 2. Detailed Sketch of IHF's 3D UV Curing Unit.
(Source: IHF Literature)

operator places the sprayed object on the conveyor and it is transferred into the UV-cure room. The UV curing unit has three UV mercury lamps positioned at different angles (1 downward, 1 upward, and 1 vertical) to cure all surfaces of the object. The setup of the lamps is based on the complexity of the substrate. Generally in the furniture industry the distance between the center of the object and the UV light source is 24 inches. UV mercury vapor lamps range in size from 6 to 80 inches; IHF typically uses 48-inch lamps. The lamps are rated at 200 watts/in^2. The object moves on the conveyor through the UV room and returns to the operator.

The operator takes the object off the conveyor and places it on a hook in the spray booth. Next, the seal coat is applied to the piece of wood. A batch of seal coat is blended by the operator in a spray can on a laboratory bench. The coated wood is again placed on the conveyor and returns to the UV curing unit. After curing, the wood is taken off the conveyor, lightly sanded, and a second seal coat is applied. It is then placed on the conveyor to be cured again.

After curing, the wood is taken off the conveyor, sanded again, and the top coat applied. The operator places the spray coated wood back on the conveyor to be UV-cured for the last time. For a wet-look finish, IHF uses coatings containing polyester, polyisocyanate, and a catalyst. When durability is desired, urethanes are used.

Finally, the operator takes the wood off the line and tests the quality of the finish. These tests include methyl ethyl ketone (MEK) rub tests, print tests, and fingernail scratch tests. The print test consists of placing a 5 lb weight on 1 square inch of the material for at least 12 hours, and checking for imprints on the coating.

DESCRIPTION OF THE WORKFORCE

As of November 1986, there were a total of 50 employees at the Pelham plant of which 46 are male and 4 are female. The average age of the employees is 37 years. Work schedules are based on production needs. At the time of the survey, IHF was operating 1 shift, 10 hours per day, 5 days per week.

There are two employees associated with the laboratory scale 3D UV-cure spray applications. Only one employee, however, works regularly on the process. The job descriptions for the two employees directly and potentially exposed to multifunctional acrylates during the coating applications are as follows:

Laboratory supervisor - One employee is directly exposed in this job category. The laboratory supervisor is exposed for 8 hrs/day. The duties of the laboratory supervisor consist of mixing of the coatings, spraying of the objects, cleanup, and other miscellaneous tasks.

Laboratory technician - One employee is potentially exposed in this job category. The laboratory technician assists the laboratory supervisor in cleanup and other miscellaneous tasks. This worker is potentially exposed 4 to 5 hrs/day.

DESCRIPTION OF PAST POTENTIAL WORKER EXPOSURES

IHF has not conducted any air monitoring for multifunctional acrylates used in the coatings. There have been no reported cases of illnesses at the plant attributable to the use of acrylates. IHF relies upon instructions from the chemical suppliers for proper and safe handling of the raw materials.

Engineering Controls

The spray operations are conducted in an exhausted spray booth. The face velocity of the hood is 175 linear ft/min, estimated by IHF to be high enough to control overspray. The compressed-air spray guns have a pressure of less than 30 psig in order to reduce both overspray and the intensity of the spray. The spray room is under positive pressure to keep the area clean. The UV unit is in an enclosed room and has a separate exhaust ventilation system.

Methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), and acetone are the solvents used to clean the spray guns. The waste liquid from the cleanup is stored in 55-gallon drums. This waste is classified and disposed of as hazardous waste. Rags used in cleanup are disposed of separately.

Substitutes

At this time IHF has no substitutes for the acrylate-based coatings used in the 3D UV-cure applications. Thermally cured solvent-based spray coatings could be substituted; such coatings, however, have environmental implications associated with volatile organic compound (VOC) releases.

DESCRIPTION OF THE MEDICAL, SAFETY, AND INDUSTRIAL HYGIENE PROGRAMS

Medical Program

IHF does not require pre-employment or annual physicals for its employees. Two employees per shift are trained in first-aid. Emergency medical care for workers is available at a hospital located 3 miles from the plant.

Safety Program

The Production Manager is in charge of safety at the plant and chairs a Safety Committee. There are five members on the Safety Committee and meetings are held once a month.

Safety glasses are required at all times in the shop area. Safety goggles are required for welding and burning operations. Work shoes are required in the shop area; these shoes are not steel-toed, however. In the laboratory, workers wear lab jackets and gloves. Gloves are also worn in the sheet metal department. Respirators are required during painting operations. The company maintains a Model 8901B Versatile Eye/Face and Body Spray with patented feather-flo head and handle-grip valve mounted on a 6-inch heavy duty rubber hose for emergency use.

Cotton-lined gloves and an apron are worn by the operator during the mixing operation. Edmont 26-665 rubber gloves are also available in the plant. When spraying the stain, seal coat and top coat, the operator wears a 3M 8710 half-face dust mask. If the top coat contains isocyanates, the operator is required to switch to a cartridge-type respirator.

Two shower facilities are available at the plant. Two separate lunchroom facilities are provided for eating meals. Smoking is permitted in designated areas only.

Industrial Hygiene Program

There is no industrial hygiene program at the plant. Material safety data sheets are posted in applicable areas for informing workers of hazardous materials in the work place.

DESCRIPTION OF PERSONNEL RECORD SYSTEM

IHF maintains personnel records on terminated and current employees. These records go back 15 years. Examples of types of information contained in the plant's personnel records include:

1. Name
2. Address
3. Phone number
4. Emergency contact
5. Job title
6. Job description
7. Employment date
8. Termination date
9. Hourly wage
10. Increase in payroll status.

CONCLUSIONS

The IHF plant in Pelham, Alabama, uses coatings containing multifunctional acrylates for demonstrating UV-cured spray applications on 3D wood, plastic and metallic products. The coatings are purchased from outside suppliers and blended at the plant. The coating is applied manually via a compressed-air spray gun in a spray booth equipped with local exhaust ventilation. The 3D UV-cure unit is in a separate room with exhaust ventilation.

No industrial hygiene monitoring data is available at the IHF plant for the multifunctional acrylates. Since startup of the laboratory-scale 3D UV-cure system in 1982, there have been no reported cases of illnesses at the plant attributable to contact with acrylates.

RECOMMENDATIONS

On the basis of information gathered and observations made during this walk-through survey, no major recommendations regarding the use of engineering controls were considered necessary at this time. The use of rubber gloves is, however, preferred over cotton-lined gloves when mixing batches containing solvents and acrylated raw materials.

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