cefic sector group

UVEB Acrylate Resins

Safe Handling Guide UV/EB Materials

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allnex The Coating Resins Company · BASF We create chemistry · DSM · IGM Resins · RAHN · SARTOMER ARKEMA GROUP

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CEFIC and the UV/EB sector group

Cefic, the European Chemical Industry Council (http://www.cefic.org), is the forum and the voice of the chemical industry in Europe. With 650 members and affiliates representing the entire range of chemicals production, Cefic covers Health, Safety and environment, Energy and Climate Action, Industrial Policy, Legislation & Institutional Affairs, Product Stewardship, Research & Innovation, Public Affairs, Sustainability.

The UV/EB acrylate manufacturers and importers, representing more than 90% of the European market, work together in the sector group UV/EB Acrylate resins in order to jointly follow questions of common interest regarding regulatory and health, safety and environmental (HSE) issues.

Members of the UV/EB sector group: Allnex (BE), ARKEMA (FR), BASF (DE); DSM (NL), IGM Resins (NL), RAHN AG (CH).

The member companies of the UV/EB sector group act in compliance with the Responsible Care Guidelines in which the chemical industry worldwide commits to continuously improve services in the areas of safety, health and environmental protection and also to demonstrate this progress.

The most important objective of our quality policy is to offer products and services that meet Responsible Care guidelines:

Responsible Care

For further details see the following websites:
http://www.responsiblecare.org/

1. Introduction

UV/EB-curing is a drying technology for coatings, inks and adhesives. It uses light of a certain wavelength (UV) or high speed electrons (Electron Beam) to give almost instantaneous dry films. It allows formulators to develop products for a wide variety of applications and substrates without solvents.

UV/EB resins, bearing one or several acrylate or methacrylate groups, are derived from various chemical backbones such as polyol, polyester, epoxy, polyurethane and polyether. Their unsaturated acrylate functionalities have the unique property of instantaneously polymerising under ultra-violet radiation when mixed with an adequate photoinitiator or when treated with a beam of high energy electrons.

The so called UV/EB curable resins are mainly used as solventless binders in inks, varnishes, adhesives and decorative and protective coatings and paints. They can be applied on almost any substrate - paper, wood, plastics, glass and metal. Typical applications are inks and over-print varnishes, hard coatings, protective coatings used on CD's and DVD's and optical fibers, and finally, in solder and etch resistant coatings for printed circuit boards but also applications in the medical device, composite, building and construction industries.

Ultraviolet (UV) and electron beam (EB) curing has broadly been recognized as a commercially successful low to zero VOC coating and adhesives technology for over 25 years now. However, many misconceptions still exist concerning the safety of the materials and equipment used in UV/EB curing. Indeed, the UV/EB materials are not to be handled the same way as the solvent-based products they replace. Such misconceptions have overshadowed the fact that UV/EB materials are, in general, less hazardous and easier to control than most solvent based systems. In some cases, a misunderstanding of safety issues has blocked adoption of this powerful technology.

This guideline is especially designed to inform and help people who use UV/EB resin systems. Acrylate resin systems provide many unique technical advantages, which are not equaled by any other materials but also often possess hazardous properties, mainly when coming into contact with skin. However, they are perfectly safe when basic precautions are taken. After mixing of the components and application, a chemical reaction takes place producing an inert final material. The finished coating or ink does not pose any health risk and offers superior performance.

This guideline describes the main situations where there is a risk of contact with acrylate systems, and offers information for the safe handling of these products.

The information is designed to support safety and education managers, business and production managers, in the selection and provision of suitable organizational, technical and personal safety tools and procedures.

The brochure also provides helpful information for workers using the products. However, the guideline cannot replace the specific safety instructions given for each product, which must always be respected in full.

2. Materials toxicity and classification

Toxicity

Toxicity is the inherent ability of a chemical to produce a deleterious response in a biological system. All chemicals have some toxicity associated with them. Information on toxicity of substances and mixtures used in industry can be found on the respective safety data sheet (SDS).

Toxicity of UV/EB Curing Materials

Acrylates used in the UV/EB industry can be classified in different groups according to their chemical structure.

Low molecular weight acrylate monomers represent the most physiologically active materials in this class, due to the low molecular weight and high level of acrylate functionality.

The substantially higher molecular weight and lower net acrylate functionality of acrylate oligomers result in a lower level of physiological activity than the low molecular weight acrylate monomers.

Acrylate Acute Toxicity

In general, UV/EB curing acrylates have low chronic toxicity, but they can cause acute skin and eye irritation or burns. Since they do not cause immediate irritation, exposure can go unnoticed. Some individuals may also become sensitized to these chemicals as a result of contact.

Skin Irritation

Brief contact or prolonged exposure of acrylate-containing materials may cause irritation, itching, redness, dry patchy scaling and/or discharge. Skin irritation is generally confined to the area of direct contact and reaction to exposure may be delayed. Prolonged exposure may cause burns.

Skin Sensitization

Sensitization dermatitis is the result of an allergic reaction to a given substance. Direct skin contact is necessary to cause sensitization. Individuals may become sensitized to a substance after a trouble-free period of exposure.

There are many factors which affect a person's susceptibility, including existing skin diseases, personal habits, and individual sensitivity. Once a person is sensitized, even a minute exposure may trigger a severe dermatitis reaction which may spread over the body. Sensitization is permanent, so a sensitized individual should be removed from potential contact with the sensitizer.

Most UV/EB-curable materials are potential sensitizers. To avoid skin irritation or sensitization, do not allow uncured material to contact skin. Consult the respective Safety Data Sheet (SDS) for specific information about the sensitization potential of UV-curable materials.

Eye Irritation

UV/EB-curable materials may cause moderate to severe eye irritation upon direct contact.

Inhalation

Most acrylate oligomers and monomers have a low vapor pressure, and inhalation of vapors is unlikely to occur at room temperatures. Some of these products may form stable aerosols which can be inhaled and may also cause skin and eye irritation.

Acrylate vapors may irritate the nose, throat and lungs. All areas where acrylates or epoxies are handled should be thoroughly ventilated. In spray applications, the coating ingredients are vaporized directly into the air and thus may be inhaled. Breathing spray mist may irritate the respiratory tract. Measures should be taken to prevent inhalation of the spray mist since exposure can result in respiratory irritation with potential for sensitization.

Toxicity of the Cured Coating

After curing, UV/EB curable products exist as a cross-linked material which should present no hazard to health under normal use conditions. However, if the cure is not complete, low levels of volatile components may still remain. If these volatilize in an area with poor ventilation, irritating airborne contaminant levels may develop. Moreover, skin contact with incompletely cured material may result in skin irritation or sensitization.

Burning of the cured material may result in toxic gas formation depending on such factors as temperature, amount of oxygen present, and the specific formulation.

Classification and labelling

For impact on Classification & labelling of UV/EB Acrylates please refer to GUIDE TO THE CLASSIFICATION & LABELLING OF UV/EB ACRYLATES (Fourth edition, August 2011) and specific SDS from your suppliers.

3. Transport

3.1 Personal protective equipment for loading, unloading and handling

Industrial hygiene exposure limits should be considered when selecting proper respiratory protection. Appropriate gloves and full protective clothing should be considered as proposed by the suppliers following the local regulations. Full eye protection should include plastic shields with forehead protection in addition to chemical splash goggles. Contact lenses substantially increase the risk of damage to eyes and should only be worn with special precautions.

3.2 General considerations

The following are general considerations that apply to all modes of transportation for UV/EB monomers and oligomers.

- Acrylic monomers and oligomers must be stored under an atmosphere containing 5 up to 21 vol. % of oxygen as Phenolic inhibitors are not effective in the absence of oxygen
- Do not use pure nitrogen or any other inert gas for sparging, blowing lines or blanketing. Pure nitrogen or other oxygen free gas could reduce the dissolved oxygen to a dangerously low level where the effectiveness of the inhibitor could be greatly reduced
- Cleanliness is essential. All containers should be free of contamination
- Avoid overheating of acrylic monomers or oligomers. Under no circumstances should steam be used to heat. It should be ensured that the resulting maximum product temperature cannot exceed 40 °C
- Maintain a head space in storage containers. This corresponds to a minimum void space of 5 % at 25°C
- Retained samples should be stored for no more than one year in a cool dark place
- Avoid freezing of monomers and oligomers below their melting point (check the melting point of each specific product in the SDS).

3.3 Bulk transportation by road

The bulk transport of acrylic monomers and oligomers, by tank truck or iso container shall be done following the rules of ADR/RID, IATA IMDG, and applicable national rules for the transport of dangerous goods. The transport vessel should be constructed of stainless steel and in some climates it should be insulated in order to maintain the product temperature below 40°C.

Proper equipment should be used to protect against spills. It is preferable that truck unloading facilities are leveled and paved. They should be located in such a way that the truck can easily and safely be maneuvered. A place should be provided with a truck pad suitable to collect spillages for salvage or appropriate disposal. Where access to the top of the container is needed, the site should be equipped with stairs and a platform.

An electrical grounding cable is required and must be attached to the transport vessel while loading or unloading the container. The piping for unloading should be on continuous circulation or arranged so the acrylic monomers or oligomers will drain toward the storage tank when transfer is stopped. Dry disconnect couplings are recommended to be provided on the unloading hose to ensure that a possible spill will be very limited in the event of a hose break. The pump glands, flanged fittings and valve stems should be provided with splash collars in cases where personnel could be exposed to major leaks or sprays.

The preferred unloading procedure is by pumping with a closed loop (vapour balance) system in which the vapors are returned to the vessel. If this system is not possible, the vapors should be sent to a scrubber or incinerator.

3.4 Drums and intermediate bulk containers

Epoxy-phenolic lined carbon steel, stainless steel or polyethylene lined drums are suitable for acrylic monomers and oligomers storage and transportation.

Stainless steel or UV opaque high density polyethylene for which chemical compatibility has been checked are suitable as materials for Intermediate Bulk Containers (IBCs).

Plastic containers made from organic soluble materials such as polystyrene or polyvinyl-chloride (PVC) should not be used for storage and transportation.

For flammable mixtures, IBC's should be made of stainless steel unless they are equipped in such a way that no electrostatic discharge can take place during storage and unloading of the IBC.

Drums and IBC's should be labeled properly.

4. Storage:

4.1 Bulk storage

4.1.1 General design considerations

Follow all applicable local codes and regulations.

For environmental reasons, tanks and pumps should always be positioned in a diked area.

The recommended maximum bulk storage temperature range is 40 °C. This maximum allows time to detect and react to an inadvertent polymerisation. Avoid heating systems that can generate high surface temperatures. It may be necessary to use a heat exchanger in order to provide cooling during warmer weather and/or to remove heat generated by pumps. **Under no circumstances should steam or unregulated electric tracing be used to heat acrylic monomers and oligomers.**

Localised high temperatures can quickly initiate polymerisation. Uncontrolled polymerisation can be violent and may result in serious injury and/or loss of property. Electrical heat tracing should not be used on piping systems (including pumps, valves and filters) or vessels in acrylic ester service unless it

can be ensured that the resulting recommended maximum temperature of the acrylic ester cannot exceed 40 °C during heating.

Adequate inhibition, obtained with use of Phenolic inhibitors (HQ, MEHQ, BHT) is necessary to avoid polymerisation. In addition to the Phenolic inhibitor, the presence of dissolved oxygen in the liquid is essential for stabilisation. Therefore, an atmosphere containing 5 to 21 vol.% of oxygen should be maintained above the acrylic ester. **Never use an inert atmosphere**.

Typically a 10% void volume is used in bulk storage vessels as a buffer against tank overflow. This also provides adequate oxygen containing gas to activate the Phenolic inhibitor.

Take every precaution to keep acrylic monomers and oligomers free of contamination (e.g. by using dedicated equipment and lines). Trace contamination with a photoinitiator can lead to a dangerous inadvertent polymerisation

Never store or handle acrylic monomers and oligomers in a facility without first carefully reviewing the design of all vessels and accessories for potential hazards. Storage in process vessels or in storage tanks designed for other chemicals can lead to unsafe conditions.

All storage vessels (including charge or weigh tanks) should have a high temperature alarm. The purpose of this alarm is to detect an inadvertent polymerisation. Properly located and maintained redundant temperature probes (minimum 2) connected to a high temperature alarm can provide early warning of potentially unsafe conditions and allow time for corrective actions to be taken.

All acrylic monomers and oligomers pumps should be protected from overheating. If deadheaded, many types of pumps can quickly overheat and cause a violent polymerisation, which could result in serious injury and/or loss of property.

It is good practice not to leave stagnant lines after transfers. Dissolved oxygen is slowly consumed and must be replenished by occasional circulation or clearing the lines with a gas containing 5 to 21 vol% of oxygen. Depletion of oxygen can cause polymer formation and plugging.

It is recommended that vacuum and pressure relief valves be installed unless the tank has an open vent to the atmosphere. A combination pressure-vacuum relief valve, sometimes referred to as a conservation vent valve, is frequently employed

4.1.2 Polymerisation detection and restabilisation

Acrylic monomers and oligomers have the potential to polymerise very rapidly, generating a large amount of heat. A temperature rise that cannot be related to an external heat source should be considered an indication of a runaway polymerisation.

A restabilization (shortstopping) system can be installed to allow the quick addition of phenothiazine (PTZ) in the event of a fire. Acrylic monomers containing PTZ are much less likely to polymerise violently during a fire.

4.2 Storage of Drums and Intermediate Bulk Containers

Acrylic monomers and oligomers should be kept below 40 °C. Do not store in direct sunlight.

Contamination can cause an uncontrolled polymerisation which may result in violent rupture of the container, fire, serious damage to the surroundings and significant environmental impact. The presence of oxygen is required for the inhibitor (MEHQ) to be effective. Lack of oxygen can cause an uncontrolled polymerisation.

If freezing occurs, warm the container as indicated on the product's SDS and mix thoroughly with low shear to disperse the inhibitor evenly throughout the solution. Never use a band heater or steam to heat product.

5. Transfer & Handling

All transfer lines, hoses and fittings should be made of a material which is opaque, essentially non-reactive, and not affected by UV-curable material (such as stainless steel). Some plastics, such as polyethylene or Teflon®, may also be used as long as they are not affected by the UV material and are opaque to ultraviolet light.

Carbon steel and copper alloys are not recommended.

The preferred safe method for emptying drums and IBC's is by pumping. If drums or IBC's are emptied by gravity, the valves should be self-closing. Do not use pressure to displace drums or IBC contents.

Double mechanical seal and magnetic drive centrifugal pumps are commonly used for acrylic monomers service. These pumps require instrument interlocks to prevent dangerous overheating in case deadheading occurs.

In some cases, material will need to be heated for application or transfer. If this is necessary, it is advisable to apply heat slowly and uniformly. Preferred heating methods include circulating hot air, a water bath, or circulating oil. Although it takes longer, these methods are generally uniform and can be reliably controlled. Heating belts and immersion heaters should always be avoided because they produce hot spots and tend to have poor thermostatic control. For large volume usage in drum quantities, it is generally recommended that a hot room or preheat tank be installed to provide an adequate and continuous production feed. Should transfer lines require heating to assist in transfer, water jacketing is recommended. Although moderate heating can be used, localized overheating (above 70°C) should be avoided.

If agitation is required, small round containers can be rolled on a flat surface. Large containers will require slow mixing with an agitator. Prior heating to lower viscosity will assist in the agitation of high viscosity materials.

Before using any metal tanks or pipes, it is essential to thoroughly clean and flush the system before introducing the material. All transfer lines and pumps should be blown clear with clean, dry air following completion of transfer.

6. Exposure control

6.1 Uses recommended / Uses advised against

UV/EB resins are intended for use in industrial settings and some limited professional application where the exposure of the worker is minimal. Consult the safety data sheet provided by your supplier - section 1 and exposure scenario - in order to look for the uses covered and advised against (if any). Ensure that your uses and those of your downstream users comply with the instructions provided through the safety data sheets.

Due to their sensitizing properties, most of these products are not suitable for use by the general public. For uses by professional workers, the product should be contained (e.g. ink cartridges) so that the exposure of the worker is minimal.

It is strongly advised not to use products labeled as sensitiser and particularly Sensitisers 1A, in cosmetics or dental application or any other use resulting in the exposure of a large number of consumers or untrained workers.

Use of UV/EB products in such fields should be restricted to products/formulations tested non sensitisers and compliant with corresponding regulations.

Individuals who became sensitized should pay special attention to the exposure control measures detailed in this chapter or discontinue working in the areas where exposure can occur.

6.2 General exposure control measures

6.2.1 Charging & Mixing Equipment

- Provide a good standard of general ventilation. Use powered wall- or window-mounted fans to supply fresh air - five to ten air changes per hour, with a through draught
- Use closed pumped transfer systems wherever possible
- Provide local exhaust ventilation at points where exposure occurs (charging/discharging, sampling, filling, etc.)
- Individuals who become sensitized should pay special attention or discontinue working in the areas where exposure can occur.

6.2.2 UV/EB Curing Equipment

The application of UV/EB curing requires the use of specialized curing equipment. Like other industrial equipment, it contains hazards which must be understood in order to maintain a safe workplace. A well written operating/maintenance/safety manual should be developed with the equipment manufacturer for each piece of curing equipment.

UV lamps and UV LED´s lamps emit high intensity UV (and visible and infrared) light. Therefore it is necessary to ensure that suitable screening is used to protect the operators from skin and eye effects.

Curing equipment must be always provided with shielding to minimize escape of UV energy into the workplace. Sensitized individuals (sun allergy) may exhibit effects even at low exposures, and they should not work in the vicinity of UV-curing equipment or be exposed to intense sunlight. The symptoms of overexposure to UV energy are delayed, so by the time symptoms appear, the over exposure already has occurred.

EB systems emit ionising radiation and must be adequately shielded and meet any national ionising radiation regulations or Approved Codes of Practice.

Equipment condition should be assessed prior to use to ensure no UV or electron/x-ray radiation leakage.

In addition, ozone may be generated from the lamps. Thus, adequate exhaust and ventilation systems should be a part of each UV processor. Such a system will prevent the buildup of ozone and oxygen depletion (where an inert gas such as nitrogen is used). Ventilation should be designed to remove any volatiles emitted during the curing process.

6.3 Personal Protective Equipment

For UV-curable materials, appropriate gloves, work clothes and eye protections must always be worn.

6.3.1 Skin Protection - gloves

Chemically resistant gloves should be worn at all times when working with UV-curable materials. The safety data sheet of the resin supplier should be consulted to choose appropriate gloves, for each specific product. Indeed, although nitrile gloves are suitable for the protection against many radiation curable materials, there are exceptions such as HDDA and the other low molecular weight monomers. The following general recommendations can be used as a starting point.

Polyester acrylates

Nitrile rubber (NBR) gloves (0,1 mm) give adequate protection up to 30 minutes.

Nitrile rubber (NBR), NRL (latex) free; < 0.45 mm give adequate protection for most polyester acrylates up to 4 hours.

Nitrile rubber (NBR), NRL (latex) free; > 0.56 mm give adequate protection for most polyester acrylates in combination with commonly used solvents up to 8 hours.

HDDA / DPGDA and other low molecular weight monomers

Laminated multilayer gloves give adequate protection to low molecular weight monomers for more than 1 hour.

PE gloves are recommended as under gloves for difficult situations like for instance: high exposure, unknown chemicals or unknown properties of the chemicals as they offer excellent long-term protection for more than 95% of the chemicals, except halogenated hydrocarbons. Is it to be noted that PE gloves being not ergonomic and not mechanically resistant, they have to be used under other gloves offering good grip and resistance.

Working practices

- Using pre-work creams helps make removing chemicals easier. However, pre-work creams should not be seen as a substitute for gloves.
- Ensure that workers wear their gloves
- Single-use gloves: tell workers to dispose single-use gloves every time they take them off.
- Ensure workers remove and discard damaged gloves
- Ensure workers remove and discard contaminated gloves immediately and wash their hands thoroughly with soap and cool water before putting new gloves.
- Solvents should not be used to wash the skin, because they may increase the possibility of penetration of chemicals into the skin, and dermatitis may occur.

6.3.2 Skin Protection – clothes

When handling UV-curable materials, long-sleeved, chemically resistant uniforms should be worn, including both tops and bottoms. Disposable uniforms provide only limited protection against UV curable materials. Shoe coverings such as rubber boots or disposable booties should also be worn.

Working practices

- Change contaminated overalls immediately and ensure they are laundered before reuse. Wash the contacted area thoroughly with soap and cool water
- Work uniforms should not be taken home for cleaning
- Laundering of work uniforms should be performed by a professional laundry. Inform the laundry of the presence of UV-curable materials. It may be advisable to segregate uniforms worn while working with UV-curable materials containing acrylates from other soiled uniforms to avoid cross-contamination.

6.3.3 Eye Protection

Safety glasses with side shields will provide adequate protection when working with small quantities of UV-curable material. Face shields should be used where exposure to large quantities is possible. Contact lenses substantially increase the risk of damage to the eyes and should be worn with special precautions.

6.3.4 Respiratory Protection

Respiratory protection is often not necessary if engineering controls are implemented and if low volatility materials are used. However, the need for respiratory protection must be evaluated for each use of a UV-curable material.

Full face mask with organic vapor cartridge, Type A filter (BP >65°C) may be used as long as airborne contaminant levels do not exceed ten times the occupational exposure limits.

It is not recommended to hand spray acrylate based UV-curable materials.

6.3.5 Hygiene

Good hygienic practices should be rigorously followed including washing before meals, breaks, smoking, applying cosmetics, using toilet facilities and after work. Moisturize hands after the skin is washed after work to prevent drying.

Since UV-curing materials do not dry out or cure under usual shop conditions, they remain liquid and can be cleaned up easily with less aggressive solvents, such as soap and water, or citrus and vegetable oil cleaners. Solvents can be used for cleaning equipment, but only if the appropriate protective clothing is worn and steps are taken to prevent the possibility of fire or explosion.

6.3.6 Safety Showers and Eye Wash Stations

Safety showers and eye wash stations should be installed in the work areas in all locations necessary to ensure ready employee access in case of exposure. Employees should be trained in their use. Generally, if an exposure has occurred, the affected employee should flush for at least 15 minutes. Consult your Safety Data Sheet (SDS) for specific instructions.

6.4 Measures for specific uses

6.4.1 Spray Application

In no case should products containing acrylate monomers be applied in production by hand spray. Safety and ventilation techniques appropriate for any solvent-containing coating must be followed.

Engineering controls are the preferred method for reducing worker exposure if the process is unable to be automated. This includes the use of local exhaust ventilation in the application area. Explosion-proof construction may be required if spray application is used. All ventilation equipment should be electrically bonded and grounded.

To minimize exposure to UV-curable materials, they should be spray applied by conveyorised, automated, and enclosed methods.

Proper PPE and appropriate/approved respirators must be utilized where engineering controls are not sufficient.

Measurement of airborne concentrations of solvents, acrylates and other coating system components should be performed by a qualified industrial hygienist at the startup of an operation and routinely thereafter to insure continued effective control of potential inhalation hazards. The ventilation system should be routinely checked to insure adequate exhaust.

The overspray of UV curable materials does not “dry” to a hard film but rather remains “wet” until exposed to UV light. Spray booths should be lined with a fiber matting type material that can be exposed to UV light or passed through the UV processor to cure the wet film. The lining material can then be disposed of in a suitable manner.

6.5 Housekeeping and Cleaning

6.5.1 Good housekeeping

Safe usage is also a matter of good housekeeping, providing good working conditions, cleanliness, ventilation, plant layout and correct protective clothing – including gloves- , as well as eye protection at all time and respiratory protections whenever appropriate.

Provide continuous employee training in safe working procedures and practices. Avoid skin contact by any means and maintain strict cleanliness and good housekeeping.

Spills of UV-curable materials should be cleaned up immediately, so as to prevent the potential exposure to other employees. **Remember that UV-curable materials do not dry out in the open air.** Minimizing contamination of the working area can be achieved by placing disposable paper or solvent resistant film on tables and floors, which should be removed at least once a day or immediately after a severe spill.

All spilled waste, contaminated cleaning paper and rags should be disposed of according to legal and regulatory requirement, e.g. in a separate fireproof container situated outside of the factory.

6.5.2 Cleaning

UV/EB curing materials remain liquid, unless they are exposed to high energy UV light. Contaminated areas must therefore be cleaned up as soon as possible.

Cleaning procedures:

a) Only clean wipers are to be used and then placed in a collection container when soiled. Wipers must not be re-used after cleaning up UV/EB materials

b) Use only recommended solvents for cleaning equipment soiled with UV/EB curing materials, which should then be kept into separate, clearly labeled containers

c) Clean all equipment straight after use

d) Goggles for preventing eye contamination, and the appropriate type of gloves (see section on gloves in the chapter concerning “PPEs”) for effective skin protection against UV/EB curing materials without loss of dexterity, and full body protection, should be worn during cleaning operations

e) Tools must be kept clean, more specifically to protect the next user.

Water and soap, e.g. citrus and vegetable oil based cleaners, should normally be used, especially to wash skin.

Do not use solvents to wash the skin, as they drastically increase the possibility of absorption. In addition, it is recommended to use creams to prevent skin irritation due to frequent washing.

Organic solvents are normally required to clean equipment and tools as long as adequate, engineering controls are in place. The following solvents are usually recommended:

- Isopropanol (IPA) – for most UV/EB curing materials
- Acetone – for difficult to dissolve materials and cured film

IPA is a less aggressive solvent with a higher flash point, which makes its use preferred for health and safety considerations. Where improved solvency is necessary, acetone will do a better cleanup job. A final wash with soap and water will remove the last traces of UV materials. Small parts can be cleaned most effectively in an ultrasonic cleaner.

The surface to be cleaned should first be tested with the cleaning solvent before use, as these solvents are capable of dissolving certain rubbers and plastics.

Appropriate respiratory protection should be worn. Disposable wiping towels should be used rather than reusable rags. All cleaning materials should be disposed of according to legal and regulatory requirements.

Spill Cleanup:

Leaks and spills of UV/EB curing materials should be cleaned up immediately. As a general good practice, remove all sources of ignition in the cleanup area.

Refer to the MSDS for the recommended procedures for the spilled material.

Only personnel wearing the proper protective clothing and adequately trained in cleanup and disposal procedures should be permitted in the spill area. An air-supplied or air-purifying respirator, chemical safety goggles or full-face shield, impervious gloves, protective clothing, and rubber boots are recommended when exposure to hazardous chemicals is possible. Use an over-pack for leaking containers.

Small spills can be cleaned up using disposable towels, rags or an absorbent material such as sawdust, clay, diatomaceous earth, etc., which should then be collected in a sealed, marked container and disposed of as hazardous waste. The spill area can then be cleaned with an approved cleaning agent, followed by a thorough washing with soap and water. Towels and cloths used to clean up spills should never be re-used.

Large spill areas should be isolated immediately to contain the material and prevent chemicals from entering waterways. Appropriate means to recover or collect the spilled material may vary, depending on specific quantities and conditions. After the main cleanup, residual material can be cleaned up in the same manner as for a small spill. Good ventilation should be provided until the area has been thoroughly cleaned.

Contaminated areas should be thoroughly washed with a strong alkaline detergent. Washings should be collected for appropriate disposal, and care should be taken to prevent worker exposure and inadvertent contamination of underground water. The use of solvents for cleanup of large contaminated areas is not recommended, since the solvent would introduce significant new fire, toxicity and environmental hazards.

Worker Cleanup:

a) UV/EB-curable materials should be wiped off protective clothing with clean disposable towels. Any clothing contaminated with UV/EB curing materials should be disposed of properly

b) Protective clothing should be removed in this order: boots, gloves, suit, and face protection. After removing gloves, use disposable towels to protect your hands from contact with the UV liquid coating material

c) Place contaminated clothing in a sealed container for proper disposal

d) Exposed workers should shower the exposed areas with soap and water

Note: Whenever possible, maintenance work should not be performed until the equipment has been thoroughly cleaned of UV-curable materials. Tools which may be contaminated with UV-curable material must be thoroughly cleaned prior to re-use.

6.6 How to manage waste

6.6.1 Waste disposal

Fully cured UV/EB curing materials ordinarily present no safety or health related disposal hazards. Nonetheless, some areas may still regulate cured coatings as hazardous industrial waste. Contact the governmental body in your area which regulates waste disposal to determine the specific requirements for cured UV-coating waste.

For uncured or partially cured UV/EB curing materials waste that may be classified as a hazardous waste, special disposal requirements may exist. These requirements may include special packaging, storage, transportation and documentation as well as specific disposition of the waste.

The packaging, transportation and disposal methods, which are used, must prevent any form of human contact with the waste, even if it is classified as non-hazardous or unregulated. This precludes the use of disposal methods which will result in groundwater or surface water contamination.

Cleanup solvents, cleanup absorbents, as well as contaminated filters and clothing are almost always classified as hazardous wastes, thus must be handled in strict compliance with all applicable laws and regulations regarding human health, air and water pollution. Whenever any of these contain uncured or

partially cured UV-curable materials, the disposal method must preclude any form of human contact, including any which could result in ground water or surface water contamination.

Empty containers should be disposed of in accordance with applicable regulations. Always check local regulations to determine appropriate requirements for accumulation and disposal of waste coatings, spent solvents and wastewater from cleaning operations, used masking paper and tape, replaced filters from dry spray booths, and wastewater from water-wash spray booths.

Generally, non-solvent containing UV/EB-curable materials waste may be disposed of as non-hazardous waste. Recommendation: contact a reputable waste hauler for a complete analysis and classification of all wastes streams.

Additional considerations:

- Discard contaminated shoes by isolating in a sealed container and disposing of as solid waste in accordance with local legislation
- Empty plastic pails should be drained thoroughly and disposed of as solid waste
- Empty drums should be sent to a qualified drum re-conditioner.

7. First Aid

7.1 General

Every employee working in a potentially dangerous environment (with chemicals, machinery, etc.) should know the basic first aid steps to follow in case of emergency. In case an emergency occurs, the scene should be secured before providing assistance to the people injured in order to avoid the danger is spread to neighboring areas.

The location of all emergency eyewash stations and showers should be known so that in the event of an exposure they are immediately accessible.

The relevant MSDS or TDS should always be consulted for specific health and safety information on the material/s in question.

When providing first aid to a person who has been exposed to acrylates, the first step is to remove the person from the area to prevent further exposure. If the person can walk they should walk out of the immediate area. Liquid acrylates are slippery so care is necessary to prevent a fall that would increase exposure and cause injuries.

The type of exposure the person has experienced should be determined - eye or skin contact, inhalation or ingestion.

If possible, do not leave an injured person alone. Any available person should be instructed to call for help while assistance is being provided to the affected individual. Any person assisting the exposed person must take care to avoid any contact with the acrylate. Clothing or skin contaminated with acrylates may secondarily contaminate rescue and medical personnel by direct contact.

In the event of an accidental exposure to acrylates while working alone, the worker should leave the area. After finding a co-worker and instructing him/her to call for help, the exposed worker should follow procedures to remove or dilute the contamination

7.2 Contact with Eyes

In case of eye exposure to acrylates at any concentration, the person should immediately go to the nearest eyewash station and flush his/her eyes with water for at least 20 minutes while holding eyelids open and away from the eyes. A physician should be contacted immediately for further medical attention. If a physician is not immediately available, the process of flushing the eyes with water should be continued for a second 20 minute period. Do not put any ointments or medications on a person's eyes unless specifically instructed by a physician.

7.3 Contact with Skin

If acrylates come in contact with a person's skin or clothing, the individual should immediately go to the nearest safety shower and rinse off the acrylates. Once under the shower, all contaminated clothing and shoes should be removed. The affected body part(s) should be washed continuously with large quantities of water for at least 15 minutes or longer if odor persists. A physician or emergency medical services should be contacted for further assistance. No ointments or medications should be applied to the skin without specific instruction from a physician.

All contaminated clothing must be appropriately decontaminated prior to re-use.

DO NOT TAKE ITEMS CONTAMINATED WITH ACRYLATES HOME FOR LAUNDERING!

If the facility is not equipped to decontaminate clothing and other items, they should be properly disposed of and replaced. Contaminated leather items cannot be adequately decontaminated and MUST be discarded.

7.4 Inhalation

If acrylate vapors or aerosols are inhaled, the affected person should immediately be removed from the contaminated area to a well vented area. Emergency medical assistance should be requested. Acrylate exposure usually causes mucous membrane irritation, sore throat, and coughing. Rapid development of respiratory distress with chest pain, difficulty breathing, swelling of the throat and accumulation of fluid in the lungs (shortness of breath, cyanosis, expectoration, cough) may occur. Medical professionals or those properly trained may consider administration of oxygen.

7.5 Ingestion

After ingestion of any quantity of acrylates a medical professional should be contacted immediately. The person should be treated by having rinse the mouth and drink large quantities of water.

8. Workers Training

Clearly defined work procedures and effective worker training are essential for safe application of any industrial technology. The safe use and handling of application equipment, paints, coatings and workplace chemicals requires that all employees who work with these UV/EB curing materials must be trained in safe handling procedures. Training should address at a minimum:

- Identification of health and safety hazards
- Hazard communication (labels, MSDS and product information bulletins)
- Workplace engineering controls
- Personal protective equipment (including respiratory protection)
- Safe handling procedures
- Emergency procedures

Employees must be trained in the hazards and control of UV-curable materials. Such training should be provided to new employees before they begin working and to other employees at least annually.

If exposure has occurred, consult a medical professional immediately.

UV/EB curing systems vs. solvent based systems

The dermatitis effect that may occur when UV/EB formulations containing acrylates are mishandled, could actually act as a warning that handling procedures must be improved. Because consequences of poor hygiene practices are so noticeable, new users are often concerned when working with these materials. Nevertheless, it should be noted that UV/EB formulations containing acrylates are not more dangerous than other materials when proper hygiene practices are respected.

As mentioned above, early inexperience with handling acrylates and poor work habits resulted sometimes in cases of occupational dermatitis, and these incidents, as well as early toxicity testing reports, generated overstated concerns and some misconceptions about the safety of UV/EB curing technology.

UV/EB curing materials have low systemic toxicity, and acrylates as a class cannot be assumed to be carcinogenic via dermal exposure, for example. To eliminate severely irritating materials, new less irritating materials are available.

Worker training, together with good industrial hygiene practices and knowledge of safe handling procedures, are essential for safe handling of any chemical. When these principles are followed, experience has shown that UV/EB curing materials can be handled safely in widely varying industrial applications.

9. Additional Technical Information

Product label on each single packaging gives information about hazardous properties and gives precautionary statements for safe handling.

Safety data sheets are provided by the suppliers.

Technical Data Sheets are provided by the suppliers.

For further information, please consult the following websites:

- CEFIC UV/EB website: http://www.cefic.org/About-us/How-Cefic-is-organised/Speciality-Chemicals/UVEB-Acrylate-Resins/
- RadTech website: http://www.radtech-europe.com/
- EUPIA website: http://www.eupia.org/

Always consult your local authority or environmental officer for proper guidance on safe disposal. See RadTech "Guidance on cleanup & disposal of UV/EB curing waste materials".

Contact

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