TNEMETECH

SUBJECT

One-Hundred-Percent-Solids Epoxy Coating Safety

PURPOSE

To provide information and general guidance to users of these products and technology to assist with training and implementation of appropriate controls to prevent workplace injuries and illnesses.

GENERAL

One hundred percent solids liquid epoxy coating products present safety hazards that are similar to conventional solvent-based epoxy coatings. While some of the aspects may be unique to the technology or product, they can be used safely when proper precautions are taken and good practices are followed to ensure workers are protected.

Every user of hazardous coating products must be familiar with the potential hazards and have the knowledge needed to safely handle these products. This document is not intended to be all inclusive or replace the product safety data sheet or jobsite specific safety information. A careful review of this guidance, product specific safety information, specific job site conditions, and engineering controls among others paves the way for a solid job hazard assessment and implementation of appropriate controls to insure worker protection.

Health Hazards

One hundred percent solids liquid epoxy industrial coatings come in many formulations. Like solvent-based coatings, the technology primarily utilizes lower molecular weight resins and curing agents and reactive diluents. These types of coatings do not contain volatile organic solvents found in conventional solvent-borne technology. Because of this, the products are typically higher viscosity and corrosive elements are at higher concentrations than conventional epoxy coatings. It has been suggested that some coating applicators believe 100%-solids-epoxy coatings are safer than conventional solids solvent-based technology. While this may be accurate from a flammability perspective, the products exhibit similar health hazards as conventional lower solids epoxy products.

OSHA defines Physical and Health Hazards as follows:[1]

Physical hazard means a chemical that is classified as posing one of the following hazardous effects: explosive; flammable (gases, aerosols, liquids, or solids); oxidizer (liquid, solid or gas); self-reactive; pyrophoric (liquid or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; or in contact with water emits flammable gas. See Appendix B to 1910.1200 Physical Hazard Criteria.

[1] 29 CFR 1910.1200(c), Hazard Communication – Definition, https://www.osha.gov/laws-regs/regulations/standard-number/1910/1910.1200

> Health hazard means a chemical which is classified as posing one of the following hazardous effects: acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); or aspiration hazard. The criteria for determining whether a chemical is classified as a health hazard are detailed in Appendix A to 1910.1200 Health Hazard Criteria.

While the primary discussion in this guidance is related to mitigating health hazards some consideration should be made for physical hazards. The primary physical hazard related to 100%-solids-epoxy products is corrosivity. Corrosivity can be considered both a physical hazard and a health hazard. We will discuss corrosivity as it relates to worker exposure and protection as a health hazard. Conventional solvent-based epoxy products are typically classified as flammable and combustible liquids. One hundred percent solids epoxy products themselves are generally not classified as flammable or combustible; however, care must be taken when adding flammable thinner materials to 100%-solids-epoxy as this may present a fire risk for application. There are additional physical hazards that may need to be addressed depending on the method of application such as injection from high pressure spray, physical burns from heated equipment and physical hazards from pressurized lines and equipment.

Below is a discussion of some of the primary hazards associated with 100%-solids-epoxy products:

Acute Toxicity – Acute toxicity is concerned with toxic effects of exposure to a chemical substance over a short period of time[2]. The oral exposure route is typically seen as a classified hazard for 100%-solids-epoxy products. This exposure is relatively rare for coatings application. Certain curing agents and reactive diluents such as benzyl alcohol used in 100% solids coatings and the resultant mixture may also be classified as acutely toxic for inhalation. It should also be considered that while a product may not be classified for an inhalation hazard; users of coatings should avoid any inhalation of products atomized during spray application.

Skin Corrosion and Irritation – Skin corrosion is a primary concern for 100%-solids-epoxy coatings. Skin corrosion and irritation can be differentiated as irreversible (corrosion) and reversible (irritation). There are a number of ingredients classified as corrosive or irritating to skin including amine curing agents, reactive diluents, and additives used in these types of products. Table 1 shows the GHS classification criteria for skin corrosion/irritation.[3] As indicated in the table, products classified as a category 1 for skin corrosivity may cause visible destruction of tissue relatively quickly.

Table 1

<table>
<tr><th colspan="3">Skin Corrosion Category 1</th><th>Skin Corrosion Category 2</th><th>Skin Corrosion Category 3</th></tr>
<tr><td colspan="3">Destruction of dermal tissue: visible necrosis in at least one animal.</td><td rowspan="2">Reversible adverse effects in dermal tissue

Draize score: ≥ 2.3 < 4.0 or persistent inflammation</td><td rowspan="2">Reversible adverse effects in dermal tissue

Draize score: ≥ 1.5 <2.3.0</td></tr>
<tr><td>Subcategory 1A
Exposure < 3 min.
Observation < 1 hr</td><td>Subcategory 1B
Exposure < 1 hr.
Observation < 14 days</td><td>Subcategory 1C
Exposure < 4 hrs.
Observation < 14 days</td></tr>
</table>

[2] Borgias, Adriane P., Managing Hazardous Materials A definitive Text, 3rd Edition, 2015, Institute of Hazardous Materials Management, Rockville, MD, P63

[3] U.S. Department of Labor, A Guide to The Globally Harmonized System of Classification and Labeling of Chemicals (GHS), https://www.osha.gov/dsg/hazcom/ghsguideoct05.pdf, Table 3.9

Irritation is characterized by redness or swelling at the point of contact with effects that are commonly reversible within a few hours or several days. Exposure to chemical substances can remove oils found in the skin, lead to drying; which, can be more susceptible to damage than healthy skin. One of the concerns about irritation is the effects can be subtle and users may not be alarmed by an adverse exposure and fail to take needed precautions immediately. This can subsequently result in a more severe issue after additional exposure occurs.

Eye Corrosion and Irritation – The same concerns for skin corrosion and irritation also apply to eyes. One hundred percent solids epoxy products can cause severe eye burns and eye damage. Eye hazards can be exacerbated by spray painting and exposure to product vapors and/or aerosols in confined spaces.

Skin Sensitization – Skin sensitization is a major concern for all coatings, particularly when atomized through spray application equipment. One hundred percent solids epoxy products may contain a number of ingredients such as curing agents, epoxy resins and additives which may be classified as skin sensitizers. Skin sensitization refers to an allergic response to a chemical substance through the dermal route of exposure. Sensitization is characterized by the body reacting strongly to a very small dose of a substance. This can be caused by a single exposure or numerous exposures over time. There is a wide variance with materials and individual susceptibility to various allergens and it is possible for any individual to develop an allergy to any substance.[4] Materials are classified as sensitizers due to their adverse effect on a large percentage of the population, not due to one individual. Sensitization is a very serious health concern for workers as they can become unfit to work in the chemical industry due to various chemical allergies. Avoidance of exposure to sensitizers is important to prevent it from occurring.

Chronic Toxicity – Chronic health hazards are a result of repeated exposure of a chemical substance over long periods of time. These chronic effects are characterized as mutagenic, carcinogenic, reproductive toxicity, and specific target organ toxicity. There are many substances that will meet the classification for chronic toxicity used in organic coatings and 100%-solids-epoxy coatings are no exception. A carcinogenic classification for a product may be triggered by as little as 0.1% of the total composition. A careful review of the Safety Data Sheet for the components triggering a carcinogenic classification should be made as part of the job hazard assessment to insure worker exposure does not exceed safe exposure levels for chronic toxicants.

Handling Procedures

When handling 100%-solids-epoxy coatings, harmful worker exposures can take place when substances enter the body through inhalation, skin contact, and ingestion; although, ingestion tends to be the least likely route in industrial settings. Unless properly protected, effects from the inhalation of toxic substances, serious skin irritation and corrosion, and skin sensitization may result from exposure.

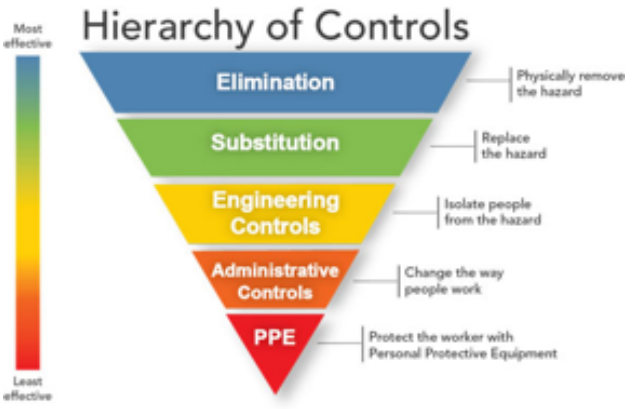
One hundred percent solids liquid epoxies also pose a risk of skin and eye corrosion, irritation and damage. Preventing exposures can be achieved through minimization and elimination of contact. Sensitization is a major concern. Any individuals who have become sensitized to epoxies should exercise extreme caution when applying 100%-solids-epoxy coatings. Employers are required to conduct pre-employment examinations for their employees involving a complete medical history, clinical examination, and baseline pulmonary function test that focuses on the ability of the worker to wear respiratory protection.[5]

[4] Borgias, Adriane P., Managing Hazardous Materials A definitive Text, 3rd Edition, 2015, Institute of Hazardous Materials Management, Rockville, MD, P66

[5] 29 CFR 1910.134(e)(2)(i), Respiratory Protection-https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.134

A history of allergies and other medical conditions may also be appropriate for pre-employment physical exams; although, it is not required. Individuals determined to have an increased risk of skin allergies or dermatitis should be diligent in preventing exposure when working with potential sensitizers such as epoxies.

A common sense approach should be utilized when identifying methods to control employee exposure when handling and applying 100%-solids-epoxy coatings. Employers should utilize a hierarchy of controls when determining the best approach to mitigating exposure risk.[6] Engineering controls, when possible, and work practices should be introduced to minimize the need for PPE. While not all inclusive, the following should be considered as part of the required Job Hazard Assessment:[7]



Supplier documentation, in the form of labels, safety data sheets, and application guides, should be read and understood prior to the use of coatings. It is also important that users be familiar with all safety warnings and harmful effects and symptoms of overexposure. Labels and SDS information must be easily accessible to those working with hazardous materials. All safety precautions and procedures recommended by the manufacturer should be followed. Safety rules and requirements of the owner and the applicable federal, state/province and local regulatory agencies should be followed by personnel engaged in the storage, handling, or application of the coatings.

Workers mixing and applying 100%-solids-epoxy coatings should utilize chemical resistant gloves and suits, protective chemical splash-type goggles, and respiratory protection (when airborne contaminate levels are above published limits or are unknown). Barrier creams should be considered for any skin areas not completely covered by protective clothing, or as an additional safety measure applied in conjunction with protective gloves/clothing. OSHA requires that the employer provide Personal Protective Equipment (PPE).

The selection of protective gloves depends on many factors that must be evaluated based on the product, application conditions and personnel elements. Multiple workplace chemicals being handled can affect selection. Physical factors such as cut and puncture rating, dexterity, and temperature fluctuations should be considered. Allergic reactions to glove materials are an additional factor to be evaluated. Information, specifications and permeation test data provided by glove manufacturers should also be leveraged when choosing a suitable glove that balances protection ratings (permeation resistance) against ease of use.

[6] The National Institute for Occupational Safety and Health, Heirarchy of Controls, https://www.cdc.gov/niosh/topics/hierarchy/default.html
[7] 29 CFR 1910.132(d)(1), General Requirements - https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.132
29 CFR 1915.152(A) / 29 CFR 1915.152(B), General Requirements- https://www.osha.gov/laws-regs/regulations/standardnumber/1915/1915.152
29 CFR 1926.28(A), General Safety and Health Provisions- https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.28

Most glove manufacturers have guidance documents related to their products available directly on their websites. These resources are invaluable in determining the most protective glove choice based on specific applications and typically will be broken down by glove material, thickness, and protection ratings against multiple chemicals. Nitrile gloves are known to be an effective means of protection against a variety of chemicals. Thickness alone may not be appropriate as the sole selection criteria for gloves, as compositions may vary among glove manufacturers. Various chemicals may degrade the glove materials and at different rates. Gloves should be replaced when signs of degradation are observed or permeation time limit is reached.

Similar to glove selection criteria, protective garments should be chosen based on the expected potential hazards the garments will encounter.[8] Protective garments undergo the same standardized testing as gloves, but only on a patch of the suit material. While the limited liquid permeation data resistance is important, other construction elements are necessary. A full body garment with elasticized cuffs at the ankles and wrists, will provide users more protection than open cuffed pieces. A built-in elastic hood that fits securely around a full face respirator (equipped with organic vapor cartridges) is recommended to prevent dermal exposure to the face when applying in confined spaces or where spray mist or vapors may occur. Taped or sealed zippers and seams may be preferred over sewn versions that allow skin exposure to harmful vapors, aerosols, and liquids. At a minimum, the garment should be rated to withstand overspray and light liquid contact, vapor, and aerosol permeation. Light overspray would be considered a representative exposure to an applicator working in a well ventilated spray booth or an open-air coatings operation. A DuPont brand Tyvek 400 protective garment, or its equivalent, would be a suitable example of a protective garment rated for this type of exposure.[9] It is important to note that garments rated for dust and particulate exposure will not protect the user against liquid chemical exposures. In fact, garments of this type may result in chemicals immediately soaking through the garment without immediate evidence to the user and cause a more severe adverse exposure. If coatings operations take place in confined spaces or areas of limited ventilation, a more robust suit rated for heavier liquid splash may be required. Confined space and restricted ventilation operations must also consider garment factors relating to heat stress and flammability. Care should be taken to prevent the garments from coming into excessive contact with coating materials. Excessive contact or use beyond the permeation time limit can compromise the ability of the suit to protect the worker. Compromised garments should be discarded and replaced or in some cases decontaminated for later reuse if recommended by the manufacturer.

All coatings should be applied and handled in such a manner that personnel, both the applicators and any other workers in close proximity to coatings operations, are not exposed to airborne concentrations in excess of published OSHA standards values or ACGIH threshold limit values. Additionally, applicators should be mindful of how overspray will affect their surroundings. Various analytical test methods and techniques exist to determine airborne component exposures.[10]

[8] Anna, Daniel H., "Types of Chemical Protective Clothing", ed. Stull, Jeffery O., Chemical Protective Clothing, 2nd Edition, 2015, AIHA, Falls Church, VA, P111

[9] DuPont Personal Protection, Product Line by Hazard, DuPont, 2016.- https://www.safespec.dupont.com/content/dam/dupont/tools-tactics/dpt/safespec-chem-na/documents/hazard_matrix.pdf

[10] SKC Guide to OSHA/NIOSH/ASTM Air Sampling Methods." SKC, Inc., 2019, https://www.skcinc.com/catalog/osha-niosh.php

Confined space operations expose workers to unique hazards that may not necessarily be present during open air jobs.[11] Assurances should be made that workers in confined spaces are provided fresh air ventilation as a means to purge harmful air contaminants from the confined work area. Clean air replacement with sufficient volume and pattern can be achieved by the use of industrial fans or blowers positioned at openings to both push and exhaust make-up air through the cavity. This provides for the removal of harmful aerosols and vapors that may be present from the application of hazardous coatings. Another concern of confined spaces is the formation of flammable atmospheres. This may not be as big of a concern with the use of lower solvent content/high solids coatings; however, given that highly volatile and flammable thinners are often used to clean, and in close proximity with, industrial coatings application equipment, the likelihood should be considered. The use of a LEL (lower explosive limit) meter may be used as well as a review of the products flammability to determine the flammable/explosive risk associated with confined work spaces. Flammable vapor limits should be established and work prohibited, if safe concentration levels are exceeded. Based on oxygen and contaminate levels, the need for respiratory protection should be evaluated.

Medical / First Aid

Skin corrosion and irritation are the most prevalent conditions that require first aid. Immediately washing the affected area with soap and large amounts of water at the first symptoms of skin exposure is very important. An affected area may appear clean, yet invisible residue may remain on the skin surface and continue to cause irritation. This is why it is important to irrigate the affected area for the entire 15 minutes to insure removal of as much of any chemical residues as possible. Immediate medical attention should be sought for conditions of skin corrosion (visible necrosis). Temporary skin irritation may not require treatment beyond first aid; however, medical advice should be sought for any persistent rash or other adverse health effects.

As is the case with most industrial chemicals, eye exposure should be avoided. Many 100%-solids-epoxy coatings are rated as causing skin and eye burns. This can occur with both liquid exposure and exposure to vapors and/or spray mist. In the event of exposure to the eyes, the eyes should be flushed with plenty of water for at least 15 minutes with follow-up treatment by a physician.

Due to the high solids and low volatility of components of 100%-solids-epoxy coatings, inhalation is not a typical route of exposure except for the case of spray coating operations where spray mist and vapors can be inhaled. If a user experiences symptoms of over exposure due to inhalation such as shortness of breath, dizziness, headache, nausea the individual should immediately be taken to a fresh air. In severe cases oxygen may be administered along with follow-up by a physician.

In the case of ingestion, individuals should contact a physician or poison control center immediately. Typically users are not advised to induce vomiting upon ingestion due to the potential for industrial chemicals causing further damage to the throat and/or lungs. Consult section 4 of the safety data sheet for specific advice. In all cases medical advice should be sought.

The information presented above is not all inclusive and should not to be construed as medical advice. Users should consult with a physician whenever treatment beyond first aid is required and whenever symptoms are ongoing or

[11] 29 CFR 1910.146(d)(2) Permit Required Confined Spaces,- https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=9797&p_table=STANDARDS
29 CFR 1926.1204 Permit-Required Confined Space Program,- https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.1204

persistent.

Spill Clean Up

Spills of industrial coating products may be harmful for the environment. Care should be exercised to prevent releases to the environment. In the event of a spill involving flammable or combustible liquids insure that sources of ignition are eliminated. This may include forklifts, saws, fans, welding operations, or any other spark or current producing equipment and/or tools. Isolate the area by evacuating all unnecessary personnel, and ventilate the area if possible. The material should be prevented from entering into soil, sewers, waterways or groundwater. It is just as important to use the appropriate personal protective equipment to avoid contact with spilled material as with any other contact. Use an inert material such as absorbent pigs or floor dry to control and contain the release. Use squeegees, shovels, mops or other appropriate tools to recover and place cleanup material into a container compatible with the waste for disposal according to Federal, State and local regulations. Refer to Section 6 of the product Safety Data Sheet for any additional personal precautions and spill clean-up methods.

The EPA has identified the four characteristics of hazardous waste as Ignitability, Corrosivity, Reactivity and Toxicity.[12] There may be cases where a spill of 100%-solids-epoxy coatings may not be characteristic of a RCRA hazardous waste. The waste may still contain organics and should be disposed through a licensed hazardous waste facility in lieu of a public landfill. Waste characterizations and compliance with applicable laws are the responsibility of the waste generator; however, manufacturers will often assist with this process if end users have questions or concerns.

The EPA has established criteria for what constitutes an empty container.[13] For a container to be excluded from RCRA, all wastes have been removed that can be removed using the practices commonly employed to remove materials from that type of container, e.g., pouring, pumping and aspirating, and no more than 2.5 centimeters (one inch) of residue remain on the bottom of the container or inner liner, or no more than 3 percent by weight of the total capacity of the container remains in the container or inner liner if the container is less than or equal to 119 gallons in size. Empty containers may be sent to container recyclers in lieu of landfill disposal.

Summary

While 100%-solids-epoxy products present physical and health hazards related to the use and installation the risk of adverse health can be avoided though implementation of appropriate controls. Employee awareness of hazards and symptoms of exposure is important for reducing risk of adverse health effects related to exposure to industrial chemicals. Skin corrosion and irritation, while a primary concern for 100%-solids-epoxy products, can be prevented with use of personal protective equipment. Manufacturers of products and PPE should be consulted for additional guidance and recommendations. This guide, while not all inclusive, provides a starting point for conducting a thorough job hazard assessment and implementation of appropriate engineering controls and selection of appropriate PPE for local job site conditions.

KF

[12] 40 CFR 261.20-24 Subpart C-Characteristics of Hazardous Waste https://www.ecfr.gov/cgi-bin/text-idx?SID=f5ef841dd72d2031562e64d034bb78e1&mc=true&node=se40.28.261_120&rgn=div8

[13] 40 CFR 261.7(b)(1)(i-iii) Residues of Hazardous Waste in Empty Containers https://www.ecfr.gov/cgi-bin/text-idx?SID=f5ef841dd72d2031562e64d034bb78e1&mc=true&node=se40.28.261_17&rgn=div8