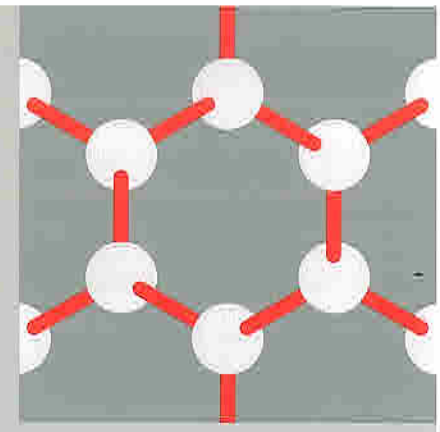
Safe Handling Guidelines

HA International LLC

Phenolic Novolac Foundry Resins:

Dust Hazards and Recommended Control Practices



Introduction

HA International, LLC (HAI) is a leading producer of binder systems for the North American metal casting market. As with many industrial chemicals, binder systems are designed to be safe when used in accordance with appropriate handling guidelines but can present real hazards when used or handled inappropriately.

This Safe Handling Guide provides users with supplementary information on hazards associated with these products when they are in a finely divided state, e.g., the dust form. These products will normally contain some dust regardless of whether the product is purchased in the flake, pastille, or powdered form, and the amount of dust can increase during normal handling and use. As a result, these guidelines should be applied to all phenolic novolac products regardless of the form in which the product is purchased.

When these products are in the finely divided state they may exhibit different and potentially more severe hazards, and may exhibit greater potential for migration and exposure, than when in other states. Although this guide focuses on these specific issues, users should recognize and effectively manage all of the hazards associated with these products. Please refer to the product labels and Material Safety Data Sheets for a more complete discussion of the various hazards associated with these products.

Summary of Safe Handling Guidelines

The following guidelines are to be adhered to when working with HA International, LLC (HAI) powdered, flaked or pastille phenolic resin systems. Local conditions may require different or additional safeguards. These guidelines are designed to supplement the information set forth in our MSDSs and labels for these products, both of which should be read and understood fully before using the products.

Safe handling of phenolic novolac resins requires the use of good industrial hygiene practices. In particular, these resin systems should be treated or handled as combustible dusts and should be considered irritants to the skin and respiratory system. To minimize the hazards presented by combustible dusts, these guidelines specifically reference the National Fire Protection Association (NFPA) Pamphlet No. 654, "Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids". Users of these products should obtain a copy of this standard, and should ensure their practices follow the standard's recommendations.

Introduction to Phenolic Novolac Foundry Resins

HAI produces a full line of binder systems and a variety of related products for the North American metal casting industry. Its phenolic novolac product lines include the PlastiFlake and Durite resin systems. The PlastiFlake product line is used as a binder in the Shell process for production of molds and cores, while the Durite system is used as the active ingredient in the production of molding adhesives. These products can be supplied in the flake, powder and pastille forms.

Overview of Industrial Hygiene Considerations

Users of phenolic novolac resins that may be in the finely divided state should be aware of the potential for dermal exposure resulting from direct contact with the resin particles. Upon prolonged contact with the skin, a redness or itchy irritation can develop at the point of direct skin contact, resulting in contact dermatitis. Contact dermatitis has two recognized forms - irritant and allergic. Most dermal contact with phenolic resins will result in the irritant form of contact dermatitis. However in some cases, the cross-linking agent hexamethylenetetramine (Hexa) has been associated with allergic contact dermatitis.

Physical contact with eyes may be irritating and should be avoided. Safety glasses may be sufficient protection in most foundry applications where risks of exposure are limited, but goggles or a full-face respirator should be considered if significant exposure to dust is more likely.

The suspension of phenolic novolac dust particles in air may result in the potential for occupational exposures via inhalation. Such exposures may potentially cause irritation of the upper respiratory tract, in addition to other lung function impacts such as pneumoconiosis that are associated with significant exposure to other inert and nuisance dusts. OSHA has established Permissible Exposure Limits (PEL's) applicable to inert and nuisance dust of 15 mg/m³ for total dust, and 5 mg/m³ for the respirable (< 10 *um*) fraction.

HAI recommends that dust levels should be controlled via engineering or process controls rather than through the use of respiratory protection wherever feasible. In the event that such controls are not feasible, the use of an air-purifying respirator may be effective in reducing exposures to acceptable levels. We recommend use of a respirator with a N-95 rating regardless of whether respirators are for maintaining exposures below PEL's or for comfort use. A full-face powered air-purifying respirator can be used in lieu of a respirator and goggles combination, and is typically more comfortable for employees working in hot environments.

Other airborne contaminants in the work area may require different respiratory protection. In the case of core and mold making operations using the Shell process, the elevated temperatures associated with this operation will result in the liberation of formaldehyde, ammonia and phenol vapors. OSHA has established exposure limits for these compounds. An exposure assessment, including exposure monitoring, should be conducted to determine whether air contaminant control is acceptable or if additional engineering controls and respiratory protection are needed.

Follow Good Industrial Hygiene Practices When Working with Phenolic Novolac Resins

- All employees assigned to handle phenolic novolac resin should review the Material Safety Data Sheet (MSDS) for the specific products used and should receive hazard communication training.
- Assess workplace conditions to determine the level and types of protective equipment that might be needed for work place conditions. Conduct workplace exposure monitoring as the basis for selecting respiratory protection equipment.
- Engineering controls should be used in preference to PPE. Use local exhaust ventilation to reduce air contaminant/dust levels.
- Avoid direct skin contact with phenolic novolac resin dusts; wear long sleeves or disposable coveralls and use impervious gloves. Personnel that handle phenolic resins should observe good personal hygiene methods to minimize the chance of contact-related disorders; launder work clothing regularly and wash exposed skin frequently. Skin irritation is the primary hazard likely to be associated with handling phenolic novolac resin, especially in hot humid environments. Consult your safety equipment vendor for assistance in selecting gloves and other protective equipment.
- Extra precautions should be taken during summer months. Workers perspire more and the pores of the skin are more open.
- Protect eyes by wearing safety glasses, goggles or face shield as indicated by conditions.
- Do not allow blowing down dusty areas as a cleanup operation. Minimize dry sweeping to avoid generation of dust clouds; use sweeping compound when sweeping is required. Vacuum dust-accumulating surfaces on a regular basis.
- Keep phenolic resins in a sealed container. Store in a cool, dry place below 77° F (25° C)

Typical Phenolic Novolac Resin Composition

Phenolic novolac resins are primarily mixtures of phenol-formaldehyde copolymer and the cross-linking agent, hexamethylenetetramine (hexa). Smaller quantities of water, release agents, flow control materials, plasticizers, and other additives may also be present. The mixtures may contain traces of unreacted formaldehyde, and up to several percent unreacted phenol. The chemical hazards associated with the resin constituents are described in the product MSDS.

Hazardous Properties—Combustible Dusts and Solids

A flash fire may occur when the following conditions are present:

1. A combustible dust is present;
2. The combustible dust is suspended in air or other suitable atmospheres at a concentration above the minimum explosible concentration (MEC); and
3. An ignition source is present

When the above conditions are present and there is adequate confinement of the combustion gasses, a deflagration or explosion may occur. An initial deflagration or explosion may shake accumulated quantities of dust off of surfaces, causing a secondary deflagration or explosion. There has been at least one catastrophic explosion in the foundry industry where a secondary explosion involving combustible dust was suggested as a possible cause of the event.

As a practical matter, sources of ignition and air are normally present in many foundry areas. Because of this, it is important to focus dust explosion control efforts on preventing hazardous dust levels from developing.

Powdered resins, in particular, exhibit the characteristics of combustible dusts. The metal casting industry has largely moved away from handling resins in the powdered state. HAI is implementing a program of reviewing the hazards associated with use of powdered resins with those customers that continue the use of powdered resins to them in assessing their risks and developing effective risk management approaches. This informational pamphlet is a part of that effort. Of course, customers using these products do so at their own risk, and must bear responsibility for ensuring the safety of their own operations.

Users should understand, however, that combustible dust hazards are not limited to materials purchased in the powdered form. Phenolic novolac resins in the flake and pastille forms can generate potentially hazardous quantities of combustible dust during normal handling operations as a result of product attrition. Combustible dusts may also be generated if these products are ground or otherwise reduced to dust-sized particles, whether intentionally or unintentionally. Potentially hazardous concentrations of combustible dust may accumulate in localized areas through intentional and unintentional particle sorting processes. Some locations where this phenomenon is known to occur include dust collectors, bucket elevators, chutes, hoppers, and beams, ductwork, and other surfaces where airborne particles may settle.

As a result, facilities using phenolic novolac resins should assess where such accumulations may occur, including both within and external to process equipment, and develop preventive practices that include frequent inspections and regular cleaning.

Users of these products must take these product characteristics into account when they design their material handling, maintenance, inspection, monitoring and training practices in order to successfully mitigate the risks of explosion and fire inherent to the handling of combustible dusts.

Material Characterization:

Typical values of explosion characteristics of phenolic resin dusts are summarized below:

Phenolic (Novolac) Resin Properties*	
Characteristic	Typical Value
Minimum Ignition Energy (MIE) mJ	2–10
Minimum ignition temperature (MIT) cloud	450–650°C
MIT layer degrees centigrade	350–540°C
Kst (bar m/s) Kst Value	129–267 1-2
Pmax (Bar) Pmax (psi)	6.3–9.93 92-144
Minimum explosible concentration (MEC) kg/m^3	0.015–0.030

*A resin's performance and characteristics may change, depending on the process and conditions in use at your facility, or due to any changes that are made to the resin during use, including further grinding or mixing with other products. Accordingly, in order to obtain more specific data for your particular resin as it is used at your facility, we recommend that you conduct your own characterization testing or engage an expert to do so.

Hybrid Mixtures:

The introduction of flammable mists/vapors into the work area may lead to a hybrid mixture of vapors/mists and dust. Hybrid mixtures will increase the rate of explosion pressure rise and the MIE will be lower than the pure dust in air mixture. The Lower Explosive Limit (LEL) of hybrid mixtures will be lower than the individual LELs for the vapors or dusts.

Protective Measures

Users of phenolic novolac resins should take precautions to manage the hazards presented by combustible dusts. Some key preventive measures are as follows:

- Train your employees to recognize the hazards associated with combustible dusts and the facility-specific measures for managing these hazards.
- Where flake products are used, minimize product attrition by designing equipment and procedures to handle the product in a gentle manner.
- Provide adequate local exhaust ventilation at transfer points to capture and remove any dust generated during handling operations.
- Carefully assess equipment and operations where phenolic novolac resins are used to identify any localized buildup of dust-sized particles. This review should include areas both inside and external to process equipment. Where the potential for buildup is identified, eliminate the buildup wherever possible through process and equipment changes.
- Where it is not possible to prevent the accumulation of resin dust, implement regular cleaning practices and frequent verification inspections.
- Provide process equipment that may contain hazardous concentrations of combustible dusts either as a normal or abnormal condition, specifically including but not limited to sand mixers, bucket elevators, bins or hoppers and dust collectors, with adequate explosion vents designed to direct the force of any blast away from areas that may be occupied by people, structures or equipment. Always use qualified outside experts in the design of explosion venting systems.
- Establish good housekeeping practices to minimize the accumulation of dusts in operating areas, especially on hot surfaces such as ovens, electrical fittings and other process and mechanical equipment.
- Remove accumulated dust by vacuuming or gentle sweeping to avoid creating dust clouds. Particular attention should be given to removing dust accumulations from beams, joists, and ledges, and from the tops of ducts, hoods, and cabinets to eliminate the possibility of a "secondary" explosion. Blowing down with compressed air is **not** a good practice.
- Control sources of static electricity at conveyors, ducts, piping, and mechanical and manual resin handling operations by installing and maintain proper electrical bonding and grounding systems.
- Conduct periodic audits of combustible dust handling areas for housekeeping, conformance to electrical classification standards, and administrative policies such as hot work permits, use of properly classified pagers and cell phones, and smoking prohibitions.

In particular, you should refer to the *National Fire Protection Association (NFPA) Pamphlet No. 654, "Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids"* that is referenced in Section 5 of HAI's MSDSs. NFPA 654 provides important information that emphasizes the need for good housekeeping and cleaning procedures, minimizing ignition sources, controlling sources of static electricity, and employee training. If you do not already have NFPA Standard 654 in your safety library, NFPA standards and guides are available for a modest charge and can be ordered online at www.nfpa.org.

Excerpts from NFPA 654 *"Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids"*

Combustible Dust

Combustible Dust is defined as "[a]ny finely divided solid material that is 420 microns or smaller in diameter (material passing a U.S. No. 40 Standard Sieve) and presents a fire or explosion hazard when dispersed and ignited in air." (§ 1.5.6)

"Any time a combustible dust is processed or handled, a potential for deflagration exists. A dust explosion has the following four requirements:

1. A combustible dust
2. A dust dispersion in air or other oxidant at or exceeding the minimum explosible concentration (MEC)
3. An ignition source such as an electrostatic discharge, an electric current arc, a glowing ember, a hot surface, welding slag, frictional heat, or a flame
4. Confinement." (§ A.1.5.6)

Dust Control

"Continuous suction shall be provided for processes where combustible dust is liberated in normal operation so as to minimize the escape of dust. The dust shall be conveyed to dust collectors." (§ 4.1)

"Equipment shall be maintained and operated in a manner that minimizes the escape of dust. Regular cleaning frequencies shall be established for floors and horizontal surfaces, such as ducts, pipes, hoods, ledges, and beams, to minimize dust accumulations within operating areas of the facility." (§ 4.2.1)

"Surfaces shall be cleaned in a manner that minimizes the generation of dust clouds. Vigorous sweeping or blowing down with steam or compressed air produces dust clouds and shall be permitted only if the following requirements are met:

1. Area and equipment shall be vacuumed prior to blow down.
2. Electrical power and other sources of ignition shall be shut down or removed from the area.
3. Only low gauge pressure [15 psi (103kPa)] steam or compressed air shall be used.
4. There shall be no hot surfaces in an area that is capable of igniting a dust cloud or layer." (§ 4.2.2)

"Dust layers 1/32 in. (0.8 mm) thick can be sufficient to warrant immediate cleaning of the area [1/32 in (0.8 mm) is about the diameter of a paper clip wire or the thickness of the lead in a mechanical pencil]." (§ A.2.2.3.1(a))

"A relatively small initial dust deflagration can disturb and suspend in air dust that has been allowed to accumulate on the flat surfaces of a building or equipment. This dust cloud provides fuel for the secondary deflagration, which can cause damage. Reducing significant additional dust accumulation is therefore a major factor in reducing the hazard in areas where a dust hazard can exist." (§ A.2.2.3.1; this section provides detailed guidelines for establishing appropriate cleaning frequency of walls, overhead beams, floors, and dust collection equipment.)

Inspections and Maintenance

"An inspection, testing, and maintenance program shall be developed and implemented to ensure that the fire and explosion protection systems and related process controls and equipment perform as designed..., to include the following:

1. Fire and explosion protection and prevention equipment in accordance with the applicable NFPA standards
2. Dust control equipment
3. Housekeeping
4. Potential ignition sources
5. Electrical, process, and mechanical equipment, including process interlocks
6. Process changes
7. Lubrication of bearings." (§§ 8.1.1, 8.1.2)

"Records shall be kept of maintenance and repairs performed." (§ 8.1.3)

Training

"Initial and refresher training shall be provided to employees who are involved in operating, maintaining, and supervising facilities that handle combustible particulate solids." (§ 7.1.2)

"Initial and refresher training shall ensure that all employees are knowledgeable about the following:

1. Hazards of their workplace
2. General orientation, including plant safety rules
3. Process description
4. Equipment operation, safe start-up and shutdown, and response to upset conditions
5. The necessity for proper functioning of related fire and explosion protection systems
6. Equipment maintenance requirements and practices
7. Emergency response plans." (§ 7.1.3)

Additional Resources and References:

OSHA
www.osha.gov

EPA
www.epa.gov

NFPA
www.NFPA.org

Fundamentals of Industrial Hygiene Barbara A. Plog, Ed., National Safety Council (3rd Ed. 1988).

NFPA 654 *Standard for the Prevention of Fire and Dust Explosions form the Manufacturing, Processing and Handling of Combustible Particulate Solids* 2000 Edition.

BIA-Report 13/97 Combustion and Explosion Characteristics of Dusts

Dust Explosion Prevention and Protection John Barton, Ed., Institution of Chemical Engineers (IChemE) 2002.

Further Information

Should you have any questions or require additional information regarding HAI's phenolic novolac resins, please contact your HAI sales representative.

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