

Polyurethane Foam

A. Background

Polyurethane foam products have been used in the coal mining industry as an effective way to aid in: sealing ventilation controls such as stoppings and overcasts; reducing the effects of high air velocities on the mine roof and ribs; helping stabilize the mine roof in high stress areas; and in building ventilation control structures.

Most polyurethane foam products contain a form of diisocyanates, a group of low-molecular-weight aromatic and aliphatic compounds. The most common diisocyanates are: methylene bisphenyl isocyanate (MDI); toluene diisocyanate (TDI); or hexamethylene diisocyanate (HDI). The most hazardous are those products containing compounds of either MDI or TDI. A National Institute for Occupational Safety and Health (NIOSH) ALERT titled "Preventing Asthma and Death from Diisocyanate Exposure" was published in March 1996. This ALERT states, "Workers exposed to diisocyanates may develop serious or fatal respiratory disease."

If proper safety precautions are followed, polyurethane foam products can be used safely without exposing miners to any of the health hazards associated with these chemicals. However, misuse of these products may result in serious health problems, such as asthma, respiratory diseases, or death.

Isocyanates are powerful irritants to the mucous membranes of the eyes, gastrointestinal tract, and respiratory system. The major route of exposure is by inhalation of the vapor or burning of the product which may be encountered during fire fighting operations. Persons exposed in this manner may suffer from respiratory irritations that may progress to chemical bronchitis with severe bronchospasms. Exposure also occurs through skin contact during the handling of the components while in liquid form. Direct skin contact can result in marked inflammation of the exposed skin.

Persons exposed to isocyanates can become sensitized, making them subject to severe asthma attacks if they are re-exposed, even at very low concentration. Persons suffering from acute hypersensitivity typically develop symptoms 4 to 6 hours after exposure. Symptoms are often flu-like and include fever, muscle aches, and headaches. Symptoms may also include a dry cough, chest tightness, and difficult breathing. Persons suffering with chronic hypersensitivity often experience progressively more difficult breathing, fatigue, and weight loss.

B. Instructions

Before an underground coal mine uses polyurethane foam, the mine operator should be advised that the ventilation plan and roof control plan for the mine must be suitable to the conditions and the mining systems in use at the mine. Thus, if polyurethane foam is being used as a roof control material, suitable provisions addressing polyurethane foam should be included in the roof control plan. Likewise, if polyurethane foam is being used as a ventilation control material, suitable provisions addressing polyurethane foam should be included in the ventilation plan. The provisions should address; notification of use, storage, pumping, application, ventilation, fire protection, spills, disposal, and training.

The following precautions and guidelines are compiled to provide assistance to mine operators in developing suitable provisions addressing the minimum requirements for the safe storage, handling and use of polyurethane foam. The MSHA districts will use these guidelines in reviewing a mine operators' proposed roof control and ventilation plan for mines using polyurethane foam products. These guidelines incorporate information from NIOSH and polyurethane manufacturers, including material from the manufacturers' Material Safety Data Sheets (MSDS) and other technical literature. Underground coal mine operators may adopt the guidelines in the proposed roof control or ventilation plan or may propose other suitable equally effective measures addressing the safe storage, use and handling of polyurethane foam products.

C. Safety Precautions and Guidelines**1. Notification of Use**

All miners who may be affected should be notified of the storage, use or transport of polyurethane foam materials in the mine prior to the components or application equipment being moved into the mine.

2. Storage

- a. Polyurethane foam chemical components are classified by the National Fire Protection Association as Class III B combustible liquids. Accordingly they should be stored in tightly closed containers, as supplied by the manufacturer, and handled in accordance with the manufacturer's specifications.
- b. Underground storage areas for polyurethane foam components should be constructed of fireproof materials and have fire fighting equipment available commensurate with the maximum amount of material to be stored. As a minimum, this should include 2 portable fire extinguishers and 240 pounds of

rock dust. This firefighting equipment is in addition to the firefighting equipment required by 30 CFR Section 75.1100-2.

- c. The maximum quantity underground should be limited to normally no more than a one week supply, and the maximum quantity at an application site should be limited to an amount sufficient for use in a 24 hour period. Unused polyurethane foam material should be promptly returned to either a suitable designated underground or surface storage area, normally within 24 hours of the end of the application.

3. **Pumping of Polyurethane Foam**

When polyurethane foam is being transferred or applied by pressure pumping, the mine operator should include provisions in the appropriate roof control or ventilation plan addressing the following minimum requirements.

- a. Pumping equipment should be provided with a pressure relief safety valve on the pump that bleeds the over pressure back through the pumping system lines as opposed to venting to the atmosphere.
- b. All fittings should be locked in place and have a pressure rating of at least 4 times the maximum rated pressure of the pumping system.
- c. All hoses should have a burst rating of at least 4 times the maximum rated pressure of the pumping system.
- d. A person should be provided to monitor the polyurethane spraying application who is responsible for immediately notifying miners working in the downwind zone to immediately remove themselves to a point out by the application site at any sign of a leak in the pumping system.

The downwind zone is defined as a distance that is 3 times the air velocity at the application site. Example: velocity at the application site = 150 feet per minute, 3 times 150 = 450 feet.

- e. All personnel at the application site should be instructed that at the first sign of any leak, the system should be shut off, and immediately repaired.

4. **Application of Polyurethane Foam**

- a. The method of application should be specified in the approved plan parameters associated with each different method noted. Different methods

of application include, but are not limited to, injection into the roof strata, spraying on various surfaces, and pouring.

- b. All persons working directly on a polyurethane foam spraying application (as opposed to a roof injection or pouring application) should be required to wear an approved Self-Contained Breathing Apparatus (SCBA) or Supplied Air Breathing Apparatus (SABA) during the application and for a period of at least 15 minutes after the cessation of the spraying action.
- c. Miners not directly involved in the spraying application process should not be permitted to work in the downwind zone (as determined in item 3.d. above) of a spraying application site. However, if it is necessary that miners perform work in the specified downwind zone, then those miners should be required to wear appropriate respiratory protection which is any approved SCBA or SABA. The purpose of this requirement is to prevent the accidental exposure of miners who are not directly involved in the application process. This is necessary due to the large quantities of isocyanate material put into the atmosphere by the spraying application.

Note: Self-Contained Self-Rescuers (SCSR's) are approved for emergency escape only, and shall not be used in lieu of a SCBA or SABA.

- d. All persons engaged in, assisting in, or supervising the application of the polyurethane foam material should be required to wear personal protective clothing consisting of chemical goggles or face shields, protective gloves, and body coverings. Protective gloves should be of a material providing protection from the polyurethane components. Body coverings may include long-sleeve shirts and full length pants. Contaminated protective clothing should be laundered before reuse or replaced. Protective clothing should be replaced if damaged or torn.
- e. All persons working on an application should have direct communications with others working on the same application. Communications may be accomplished by cap lamps if in a close area. Telephone communication may be necessary if the distance is great or the physical layout makes visual communication impractical.

5. **Ventilation**

- a. Underground storage areas where the chemicals may be opened or exposed to the atmosphere should be ventilated in such a manner that the air current is directed away from any active working sections, preferable coursed into a return air course.

- b. All work with components (transfer and injection applications sites) should be conducted in areas with adequate ventilation. If adequate ventilation cannot be maintained, all persons within 50 feet of the application site must wear an approved SCBA or SABA during the application and for at least 15 minutes after the application ceases.

Mine operators should be aware that 30 CFR Section 75.322 limits the concentration of noxious and poisonous gases (except for carbon dioxide, which is covered in 30 CFR Section 75.321) to the threshold limit values as specified and applied by the American Conference of Governmental Industrial Hygienists in "Threshold Limit Values for Substances in Workroom Air" (1972).

6. **Fire Protection**

- a. Open flames and high heat sources should be kept at least 50 feet or the distance recommended by the manufacturer, whichever is greater, from the area where polyurethane foam products are being applied.
- b. Polyurethane foam being sprayed onto the mine roof, ribs, and on ventilation controls should meet the following requirements.
 - i. Polyurethane foam applied either to seal or coat ventilation controls, such as stoppings, overcasts, seals, and outer surfaces of ventilation ducts or tubing, **shall**, as required by 30 CFR Section 75.333(f), have a flame spread index of 25 or less as determined by the "Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source", known as the ASTM E162-87 Method of Test. In addition, any overlap onto the mine roof or rib(s) should not be more than 12 inches.
 - ii. Polyurethane foam applied on the rib(s) **and** across the roof should be resistant to combustion as indicated by passing the ASTM E136-92a Method Of Test, "Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C".

Note: The ASTM documents referenced above may be purchased from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

- iii. Polyurethane foam should not be applied to the inner surfaces of ventilation duct or tubing.

- iv. If the combustion resistance and flame spread are not known, the test results, for ASTM E136-96a and for ASTM E162-87 Methods of Test, should be obtained from an independent testing laboratory.
- v. Polyurethane foam products that meet the ASTM E162-87 Method of Test with a flame spread index of 25 or less, but do not pass the ASTM E136-96a Method of Test may be used. However, the following guidelines should be used to reduce the possibility of fire propagation. If these products are being used, the additional measures should be identified in the appropriate approved roof control or ventilation plan.
 - 1. The application of polyurethane foam should be limited only to the roof or only to the ribs. Such applications should never be applied to both the mine roof and ribs at the same application site.
 - 2. Each roof application site should extend less than 30 feet in length, and each additional application of foam should be separated by bare sections of roof or rib at least 40 feet in length. Such applications should not overlap onto the rib(s) by more than 12 inches.
- vi. During the application of material, each layer should average no more than 2 inches in thickness over any area of 1 square foot or larger. Succeeding layers should not be more than 2 inches in thickness and should only be applied after the underlying material has cured.
- vii. The material should be examined following application of each layer for evidence of self-heating in accordance with the manufacturer's instructions. If there are no manufacturer's instructions, the material should be examined within 1 to 3 hours after application.
- viii. If overheating is detected, immediate action should be taken to assure the safety of affected miners. If it is deemed necessary, the mine operator should take appropriate action to cool the affected area by following the manufacturer's instructions outlined in the MSDS. If the MSDS does not address this matter, the operator should contact the appropriate manufacturer to assure the proper action can be taken if such an event were to occur.

7. **Spills**

If at all possible, spills of the isocyanate components of polyurethane foam should be cleaned up immediately. Technical publications and the MSDS recommend that the spilled material should be covered with rock dust, coal fines, sawdust, vermiculate, or other absorbent material. The absorbed material should then be shoveled into an open container and a neutralizing solution (water with 2-5 percent ammonia) added to equal or greater volume than the spilled material. The container should be left standing open for 24 to 48 hours and then disposed of in accordance with applicable laws. If the spill is in an underground mine and will be inaccessible to miners within 24 hours after the time of the spill, the material does not have to be removed, provided, the spilled material is covered with the proper absorbent and the neutralizing solution as stated above.

8. **Disposal**

Empty polyurethane foam containers should be disposed of in accordance with the manufacturer's recommendations and local requirements. As a minimum, empty containers should be filled with water and allowed to stand open for 24 to 48 hours prior to their disposal.

9. **Training**

All persons working directly in the application of polyurethane foam, transporting or handling polyurethane foam containers or application equipment, or performing other work in an area where polyurethane foam is being used, should be trained in the approved plan requirements, hazards, safety precautions, and manufacturer's data which should, at a minimum, include all data included in the MSDS for all of the components being used. This training should be provided in accordance with the requirements of Title 30 CFR Section 48.7(a) (4) .