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Appendix B

Engineering controls for spray polyurethane foam roofing with unreacted MDI

On exterior roof zone, natural engineering controls exist for exterior roof foam which don't require human administrative oversight or mechanical reliability or replacement.

Any specific airborne chemical exposure risk involves more than its hazard nature, but is directly proportional to output rates, concentration emitted and time active. Any key factors which either increase or diminish these above parameters affect risk.

An Inhalation risk involving aerosol or vapors begins with it continuing to be in this volatile aerosol physical state, in sufficient concentration, near the human inhalation openings and of particle size that can inhaled for enough of a period or through repeated conditions to cause potential adverse impact.

Roofing foam by its unique natural engineering controls mitigates inhalation risk versus interior insulation. Thus the specific product chemical, 3 lb roofing foam, provides additional protection beyond just contractors wearing PPE as evidenced by no CDC data showing outdoor application creating potential for significant adverse impact

Exterior roof foam has a unique spray process and natural engineering control from decomposition, dilution, evaporation, convection, Brownian motion, condensation, and gravity to reduce its risk.

The normal exterior spray roof foam process only emits extremely low pbb levels of free unreacted mdi even at maximum machine settings and outputs. These spray foam components readily react in the gun and then stay inside spray cone, which is directionally downward and away from the operator failing to the roof deck. The process produces a quickly polymerizing polyurethane links forming a cellular plastic roof membrane.

This unrestricted and open ambient air process is unique exterior roofing foam versus other spray foam product-chemicals like interior spray foam insulation with its confined space environment. Exterior roof foam benefits from this natural engineer controls through convection and dissipation.

1220 E. North Avenue • Fresno, CA 93725
Tel: (559) 495-4004 • Toll Free: (855) 495-GCMC • Fax: (559) 495-4009
www.generalcoatings.net

Much like a pebble thrown into a calm pond, the velocity of any particle of (low concentration) unreacted mdi at high chemical temperatures dispensed even in no wind conditions from the application gun (and only present outside the spray cone) disperses rapidly outwardly.

The low weight monomer mdi aerosol has virtually no steric hindrance in this high energy reactive state and does not exhibit natural electronic affinity to stay together, but has high probability to dilute by its dispensed inertia and decompose due to its active chemical (isocyanate) sites available for reaction with ambient moisture.

The affect of blowing agent evaporation during outdoor application aid in reducing any unreacted mdi concentration as the more volatile HFC-245fa gas is more susceptible to convection and Brownian motion increases molecule separation distance.

Additionally, in exterior roof foam, any low concentration unreacted mdi oligomer is more likely to stay in active spray cone and react fully due to its size. However, if any oligomer mdi is knocked outside this spray cone; it is less reactive, more susceptible gravity, ambient cooling (due to its larger multiple benzene ring size) and greater steric hindrance versus mdi monomer.

As gravity brings any quickly condensing, heavier oligomer mdi molecule down and away from human inhalation openings to the roof deck surface using its natural engineering controls. The newly formed spray foam roof membrane also attracts small amounts of water vapor from the air to its surface due to the exothermic heat given off by the curing process.

Any unreacted oligomer mdi will decompose readily with this ambient surface moisture due to the roof foams high cure temperature dissipating off its surface.

In summary, Outdoor field climate for roof foam offers extremely low inhalation risk versus in-plant manufacturing or confined interior foam which is primarily dependent upon mechanical reliably of the engineering control or human instruction and over sight on administrative control rather than on natural engineering controls.

Thx

Will Lorenz

Vice President - Sales

General Coatings Manufacturing Corp.

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