ZOLDINE® MS-PLUS
ZOLDINE® MS-PLUS Oxazolidine Moisture Scavenger
3-ethyl-2-methyl-2-(3-methylbutyl)-1,3-oxazolidine
CAS Reg. No. 143860-04-2

ZOLDINE MS-PLUS Moisture Scavenger is a fast reacting, low viscosity oxazolidine-based moisture scavenger for use in polyurethane and polyurea coatings, sealants and elastomers. ZOLDINE MS-PLUS Moisture Scavenger will safely and effectively eliminate moisture from the raw materials used in most polyurethane and polyurea systems. ZOLDINE MS-PLUS Moisture Scavenger will also alleviate the detrimental effects of humidity in the cast or spray application of two-component polyurethane and polyurea systems.

The use of ZOLDINE MS-PLUS Moisture Scavenger in a two-component polyurethane or polyurea system will provide the following benefits:

- Eliminates bubbles and pinholes
- Alleviates downglossing and hazing
- Improves distinctness of image (DOI)
- Improves abrasion and chemical resistance
- Improves adhesion
- Eliminates gassing
- Leaves no unreacted fillers in polyurethane or polyurea matrices
- Excellent handling properties
Typical Properties

The following are typical properties of ZOLDINE MS-PLUS Moisture Scavenger. They are not to be considered product specifications.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freezing Point</td>
<td>&lt;-35°C/-31°F</td>
</tr>
<tr>
<td>Molecular Weight</td>
<td>185</td>
</tr>
<tr>
<td>Density @ 24°C</td>
<td>0.872 g/mL</td>
</tr>
<tr>
<td>Weight/Gal</td>
<td>7.27 lb</td>
</tr>
<tr>
<td>Boiling Point</td>
<td>209°C/408°F</td>
</tr>
<tr>
<td>Flash Point (Pensky-Martens Closed Cup)</td>
<td>79°C/174°F</td>
</tr>
<tr>
<td>Viscosity</td>
<td>&lt;100 cp</td>
</tr>
<tr>
<td>Vapor Pressure @25°C</td>
<td>2.4 mm Hg</td>
</tr>
<tr>
<td>Solubility</td>
<td>Soluble in polyols and most organic solvents (e.g. Toluene, MIBK, butyl acetate).</td>
</tr>
<tr>
<td>Activity</td>
<td>100%</td>
</tr>
<tr>
<td>Functionality</td>
<td>2</td>
</tr>
<tr>
<td>Equivalent Weight</td>
<td>93</td>
</tr>
</tbody>
</table>

Uses

Most components of polyurethane or polyurea systems contain various amounts of moisture. Pigments and fillers possess a monomolecular layer of water strongly adsorbed on the surface. In addition, pigments will pick up moisture during storage. Solvents, polyols and other components often require drying.

Failure to remove moisture from solvents in two-component polyurethane or polyurea compositions can cause gassing in the isocyanate portion along with the formation of insoluble urea precipitates. Moisture contamination in polyols and pigments will ultimately result in CO₂ bubble formation and lower gloss levels in curing films.

Humidity present in the application environment brings additional moisture into polyurethane or polyurea compositions as they are applied. This is especially common in spray applications. Often, substrates themselves may be wet, which can cause additional problems. For example, polyurethane maintenance coatings are routinely applied to moist substrates. Failure to remove moisture from the environment of the curing film results in the formation of CO₂ bubbles which become trapped in the coating. Excessive moisture in curing films also results in significantly lower gloss levels. This phenomenon is commonly referred to as “downglossing”.

ZOLDINE MS-PLUS Moisture Scavenger will react rapidly with water and eliminate it from the formulation. As it reacts with water, ZOLDINE MS-PLUS Moisture Scavenger hydrolyzes to form a volatile ketone and a secondary amino alcohol (see reaction to the right). Thus, ZOLDINE MS-PLUS has an equivalent weight of 93. Care should be taken not to upset the isocyanate/hydroxyl ratio when incorporating ZOLDINE MS-PLUS Moisture Scavenger into a polyurethane or polyurea composition.

For control of humidity during the spray application of two-component polyurethane or polyurea systems, ZOLDINE MS-PLUS Moisture Scavenger can be added at virtually any time to the polyol and/or amine side of the formulation. Usually about three to four percent by weight is enough to totally eliminate down-glossing or pinholing problems caused by excessive environmental humidity.

For water removal from polyols or amines, it is suggested that ZOLDINE MS-PLUS Moisture Scavenger be added to the wet material and stirred at an elevated temperature (60°C) for a minimum of one hour.

For water removal from pigments, ZOLDINE MS-PLUS Moisture Scavenger should be added early in the grind process. The shear-induced temperatures found in typical pigment grinds (110°F/43°C) are sufficient to promote complete reaction of ZOLDINE MS-PLUS Moisture Scavenger with water. Experimental evidence indicates that under the above conditions, moisture levels should easily be reduced to less than 500 ppm in one hour or less.

Special care must be taken when using ZOLDINE MS-PLUS Moisture Scavenger in one-component systems. It has been found to be relatively stable with IPDI-based isocyanates. However, it has been found to act as an isocyanurate or trimer catalyst in the presence of aromatic isocyanates. It is therefore not recommended for use in aromatic isocyanate-based one-component moisture cure polyurethane systems.
Toxicology

ZOLDINE MS-PLUS Moisture Scavenger would be considered only slightly toxic by most toxicologists, but it is a severe irritant to eyes and skin. Specifically, the LD50 by oral ingestion in the rat was determined to be 2.36 g/kg. It is not a skin sensitizer and was not mutagenic in the Ames bacterial mutation test.

Individuals handling ZOLDINE MS-PLUS Moisture Scavenger should wear protective equipment sufficient to prevent contact with skin and eyes (i.e. rubber gloves, apron, eye protection).

Environmental Effects

Proper use of ZOLDINE MS-PLUS will not result in releases to the environment. Also, when released to water, it will rapidly hydrolyze as depicted on page two of this publication.

ANGUS has conducted some testing on ZOLDINE MS-PLUS and found the 48-hour EC50 for daphnia magna to be 52 mg/L (ppm).

In addition, ready biodegradability was investigated using OECD Guideline No. 301D. Based upon actual oxygen depletion versus the theoretical oxygen demand, ZOLDINE MS-PLUS was 43% biodegraded after 28 days. The compound was not inhibitory to activated sludge.

Regulatory

The components of ZOLDINE MS-PLUS appear on the U.S. EPA TSCA Chemical Substance Inventory.

It also has been notified in Canada as a “transitional” substance. In Australia, ZOLDINE MS-PLUS has been notified and assessed under the Industrial Chemicals Act (see the Australian Chemical Gazette No. C5, July 1996). Full notification also has been made in Europe and it has been placed on ELNCS.

Approval also has been obtained for import into Japan under MITI regulations.

Precautionary Labeling

Labels for ZOLDINE MS-PLUS Moisture Scavenger bear the following precautionary statements:

WARNING! CAUSES SEVERE EYE DAMAGE AND SKIN BURNS. COMBUSTIBLE LIQUID AND VAPOR.

Do not get in eyes, on skin or clothing. Wash thoroughly after handling. Keep away from heat and flame. Wear goggles or face shield and rubber gloves when handling.

First Aid

In case of eye contact – immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

If swallowed – do not induce vomiting; give victim several glasses of water and see a physician.

Shipping and Packaging

ZOLDINE MS-PLUS Moisture Scavenger is classified as a Class 8 (corrosive) material by the U.S. Department of Transportation (DOT). The bill of lading description used by ANGUS is:

CORROSIVE LIQUID, BASIC, ORGANIC, N.O.S. (OXAZOLIDINE/N-ETHYLETHANOLAMINE)8,UN3267,III. IN CASE OF EMERGENCY USE DOT GUIDE 153 ATTACHED. TRADE NAME = ZOLDINE MS-PLUS

Storage Conditions

ZOLDINE MS-PLUS Moisture Scavenger is supplied under a nitrogen atmosphere. If the entire contents of the container are not used, the remaining product should be stored under nitrogen in order to eliminate any chance of contamination by moisture.

Product Stewardship

ANGUS encourages its customers to review their applications of ANGUS products from the standpoint of human health and environmental quality. To help ensure that ANGUS products are not used in ways for which they are not intended, ANGUS personnel will assist customers in dealing with environmental and product safety considerations. For assistance, Safety Data Sheets, or other information, please contact your ANGUS representative at the numbers provided in this document. When considering the use of any ANGUS product in a particular application, review the latest Safety Data Sheet to ensure that the intended use is within the scope of approved uses and can be accomplished safely. Before handling any of the products, obtain available product safety information including the Safety Data Sheet(s) and take the necessary steps to ensure safety of use.