Performance Products

JEFFAMINE® Polyetheramines

Asia Pacific Region

www.huntsman.com/performance_products
Huntsman’s JEFFAMINE® range offers the world’s most extensive selection of polyetheramines, many of which are unavailable elsewhere. These highly versatile products contain primary amino groups attached to the end of a polyether backbone normally based on propylene oxide (PO), ethylene oxide (EO), or a mixture of both oxides.

Historically, the core JEFFAMINE® polyetheramine family consisted of monoamines, diamines and triamines based on the core polyether backbone structure. More recently, the addition of secondary, hindered, high-conversion, and polytetramethylene glycol (PTMEG)-based polyetheramines has increased the breadth of utility of the product line.

The JEFFAMINE® polyetheramines typically impart increased flexibility and toughness and are easily handled low viscosity, low color products. The broad range of molecular weights, amine functionality, repeating unit type and distribution offers great scope to design new compounds or mixtures. The amines are particularly important in the production of polyurea coating technologies, epoxy applications and pigment formulations.
JEFFAMINE® Polyetheramines

JEFFAMINE® Monoamines

JEFFAMINE® monoamines are designated as the JEFFAMINE® M series. The letter M signifies a monoamine and the number represents the approximate molecular weight.

JEFFAMINE® M Series Monoamines

JEFFAMINE® M series products are prepared by reaction of a mono-alcohol initiator with EO and/or PO, followed by conversion of the resulting terminal hydroxyl groups to amines. M series products have the following representative structure:

\[ \text{Structure} \]

<table>
<thead>
<tr>
<th>JEFFAMINE® M Series Monoamines</th>
<th>MW</th>
<th>Average AHEW, g/eq</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polypropylene glycol (PPG) based:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative hydrophobic. Preparation of comb polymers with poly(acrylic acid) or similar linear polymers.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-600</td>
<td>600</td>
<td>291</td>
<td>• Molecular weight control in polyamides</td>
</tr>
<tr>
<td>M-2005</td>
<td>2,000</td>
<td>1045</td>
<td>• Molecular weight control in polyamides</td>
</tr>
<tr>
<td>Polyethylene glycol (PEG) based:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relatively hydrophilic. Formulating emulsifiers and corrosion inhibitors.</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
| M-1000 | 1,000 | 489 | • Ore flotation agent  
• Agricultural emulsifier  
• Emulsification of epoxy resins |
| M-2070 | 2,000 | 1040 | • Formulating pressure sensitive adhesives  
• Reactive dispersant |

JEFFAMINE® Diamines

JEFFAMINE® diamines include the D, ED, and EDR series products. The D signifies a diamine with a PPG backbone, ED signifies a diamine with a predominately PEG backbone, and EDR designates a highly reactive, PEG based diamine. As with the M series, the number represents the approximate molecular weight.
JEFFAMINE® D Series Diamines

JEFFAMINE® D series diamines products are amine terminated polyoxypropylene glycols. The amines are of low viscosity, color and vapor pressure and are miscible with a variety of solvents.

<table>
<thead>
<tr>
<th>JEFFAMINE® D Series Diamines</th>
<th>MW</th>
<th>Average AHEW, g/eq</th>
<th>Application</th>
</tr>
</thead>
</table>
| D-230                         | 230 | 60                 | • Provides tough, clear, impact resistant coatings, castings, and adhesives  
• Reacts with carboxylic acids to form hot melt adhesives  
• Reacts quickly with isocyanates  
• Readily forms salts for surfactant use  
• Gives coatings free of surface blush prevalent with many amine curing agents |
| D-400                         | 430 | 115                | • Used in polyurethanes, polyureas, and thermoplastic polyamide adhesives  
• Forms salts for use in cutting fluids |
| D-2000                        | 2,000 | 514                | • Key ingredient in the formulation of polyurea spray  
• Co-reactant in epoxy systems which require increased flexibility and toughness  
• Increases peel strength |
| D-4000                        | 4,000 | 1,000              | • Co-curing agent in epoxy systems which require increased flexibility and toughness  
• General polymer flexibilizer  
• Increases peel strength in adhesives |

JEFFAMINE® ED Series Diamines

JEFFAMINE® ED series diamines products are polyether diamines based on a predominantly PEG backbone. PEG imparts complete water solubility to each of the products in this series. The JEFFAMINE® ED diamines products, which are miscible with a variety of solvents, provide tough, clear, impact-resistant coatings, castings and adhesives.

Structure
JEFFAMINE® Polyetheramines

<table>
<thead>
<tr>
<th>JEFFAMINE® ED Series Diamines</th>
<th>MW</th>
<th>Average AHEW, g/eq</th>
<th>Application</th>
</tr>
</thead>
</table>
| ED-600                        | 600 | 132               | • Molecular weight control in polyamides  
                             |     |                   | • Preparation of comb polymers with poly(acrylic acid) or similar linear polymers  
                             |     |                   | • Preparation of epoxy resin adducts |
| ED-900                        | 900 | 250               | • Modification of polyamides for enhanced hydrophilicity  
                             |     |                   | • Preparation of biocompatible articles and coatings  
                             |     |                   | • Preparation of hydrogels with isocyanates  
                             |     |                   | • Hydrophilicity from polyethylene glycol  
                             |     |                   | • Reactivity from amine end group  
                             |     |                   | • Biocompatibility of polyethylene glycol |
| ED-2003                       | 2,000 | 575            | • Hydrophilic polymers  
                             |     |                   | • Antistatic agents  
                             |     |                   | • Epoxy modifiers  
                             |     |                   | • Textile treating  
                             |     |                   | • Water-based coatings  
                             |     |                   | • Water-soluble, water-dispersible, water-swellable polyamides  
                             |     |                   | • Water-soluble polyurea formulations  
                             |     |                   | • Reactivity of the primary amine end groups |

JEFFAMINE® EDR Series Diamines

JEFFAMINE® EDR-148 and JEFFAMINE® EDR-176 amines are much more reactive than the other JEFFAMINE® diamines and triamines due to the unhindered nature of the amine groups.

<table>
<thead>
<tr>
<th>JEFFAMINE® EDR Series Diamines</th>
<th>MW</th>
<th>Average AHEW, g/eq</th>
<th>Application</th>
</tr>
</thead>
</table>
| EDR-148                       | 148 | 37                | • Epoxy curing agent  
                             |     |                   | • Monomer for polyamides  
                             |     |                   | • Imparts flexibility and toughness to thermoset polymers  
                             |     |                   | • Can be formulated to cure at room temperature  
                             |     |                   | • Rapid cure at elevated temperatures  
                             |     |                   | • Excellent thermal shock resistance in cured epoxies |
| EDR-176                       | 176 | 44                | • Epoxy curing, polyamide preparation; other applications for reactive, high purity diamines  
                             |     |                   | • Relatively rapid cure rate, good cured resin mechanical properties in epoxy curing  
                             |     |                   | • Low viscosity, high purity  
                             |     |                   | • May add flexibility and hydrophilicity to polyamides  
                             |     |                   | • Potential partial replacement for TETA in polyamide preparation |
JEFFAMINE® T Series Triamines

JEFFAMINE® T series products are triamines prepared by reaction of PO with a triol initiator, followed by amination of the terminal hydroxyl groups.

<table>
<thead>
<tr>
<th>JEFFAMINE® T Series Triamines</th>
<th>R</th>
<th>MW</th>
<th>Average AHEW, g/eq</th>
<th>Application</th>
</tr>
</thead>
</table>
| T-403                         | C₂H₅ | 440 | 81                 | - Moderate reactivity in epoxy curing.  
- Anti-sag agent for polyurethanes  
- Low color, viscosity, and vapor pressure. Can be blended with higher-viscosity curing agents to reduce viscosity, or with cycloaliphatics to improve the elongation of higher-Tg cure resins.  
- Completely miscible with a wide variety of solvents, including water  
- Improves flexibility and strength |
| T-3000                        | H   | 3,000 | 530              | - Highly reactive soft block in polyurea spray applications  
- Thermoplastic polymer modifier and adhesion promoter in epoxy systems  
- Modifier and curative in polyurethane elastomers and foams  
- Flexible crosslinking  
- Moderate reactivity |
| T-5000                        | H   | 5,000 | 952              | - Crosslinker for polyurea  
- Co-reactant in epoxy systems where adhesion promotion and flexibility are important  
- Surfactant and corrosion inhibitor applications  
- Low color  
- Increased peel strength in epoxy adhesives  
- Increased toughness |
JEFFAMINE® RFD-270 Amine

JEFFAMINE® D RFD-270 amine is a 270 average formula weight, novel amine containing both rigid (cycloaliphatic) and flexible (polyetheramine) segments in the same molecule. “RFD” stands for “Rigiflex diamine”. The product offers a unique formulating option for composites, coatings, and adhesives. When used for epoxy resin curing, this amine can provide synergistic processing and cured resin performance advantages relative to simple mixtures of polyetheramines and cycloaliphatic amines.

JEFFAMINE® RFD 270 amine is used as an epoxy curing agent in composite applications such as wind turbine rotor blades, coatings, and other applications, polyamides and polyureas. One of the benefits of this material is its higher glass transition temperature capability for epoxy curing agent applications.

JEFFAMINE® THF-100, JEFFAMINE® THF-140 and JEFFAMINE® THF-170 amines

The JEFFAMINE® THF products are diamines based on a PTMEG [poly(tetramethylene ether glycol)] / PPG (polypropylene glycol) copolymer. Polyetheramines of this type are useful in a variety of polymers, including cured epoxy resins, polyurea, and polyamides. In particular, higher molecular weight polyetheramines are effective in flexibilizing and promoting adhesive peel strength in epoxy formulations. They have also been used to improve flexibility and low temperature properties of polyamides.

As with most other JEFFAMINE® polyetheramines, the amine groups in the THF-series products are adjacent to methyl groups, which moderates their reactivity somewhat.

<table>
<thead>
<tr>
<th>New Products</th>
<th>Average AHEW, g/eq</th>
<th>Benefits</th>
</tr>
</thead>
</table>
| RFD-270      | 67                 | • Faster curing and property development, allowing reduction of any accelerator usage  
|              |                    | • Low viscosity, color and vapor pressure  
|              |                    | • Lower blushing or carbamation (reaction with atmospheric carbon dioxide) compared to cycloaliphatic amines  
|              |                    | • Faster strength development than PEA curatives and excellent mechanical properties  
|              |                    | • Potential cost savings when formulated with JEFFSOL® PC carbonate-diluted resin vs. aliphatic epoxy-diluted resin  
|              |                    | • Improved chemical resistance to typical acids and bases in coating applications |
| THF-100      | 260                | • Used in polyurethanes, polyureas, and thermoplastic polyamide adhesives |
| THF-140      | 355                | • Forms salts for use in cutting fluids |
| THF-170      | 380                |          |
EXPERIMENTAL POLYETHERAMINES

High Functionality Amines

XTJ-616 is a predominantly tetrafunctional, primary amine with an average molecular weight of about 660 and amine hydrogen equivalent weight of 83. The primary amine groups are located on secondary carbon atoms near the ends of the aliphatic polyether chains.

XTJ-616 provides tough, clear, impact resistant epoxy coatings, castings, and adhesives and improves shear-thinning properties in nylon. Other benefits are low vapor pressure and reduced “amine blush” formation in epoxy systems.

Slower Amines

Slower amines analogous to JEFFAMINE® D-230 and T-403 polyetheramines are now available under the names XTJ-568 and XTJ-566, respectively. These unique materials are primary amines created by amination of butylene oxide (BO) capped alcohols. This process results in primary amines with the terminal end group structure represented here.

Higher Conversion Amines

Processes have been developed to increase conversion to primary amines for several of the core JEFFAMINE® polyetheramines. Two such products are currently available: a high conversion 440 molecular weight diamine (XTJ-582), and a high conversion 2000 molecular weight diamine (XTJ-578). The higher functionality and conversion are beneficial in polymerizations such as polyamide formation.
STORAGE AND HANDLING

Materials of Construction

JEFFAMINE® polyetheramines may be stored under air at ambient temperatures for extended periods. A nitrogen blanket is suggested for all storage, however, to reduce the effect of accidental exposure to high temperatures and to reduce the absorption of atmospheric moisture and carbon dioxide. It should be noted that pronounced discoloration is likely to occur at temperatures above 140°F (60°C), whatever the gaseous pad. Dispose of waste in strict accordance with local, state, and federal regulations.

<table>
<thead>
<tr>
<th>At temperatures of 75-100°F (24-38°C)</th>
<th>At temperatures above 100°F (38°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanks</td>
<td>Tanks</td>
</tr>
<tr>
<td>Lines, valves</td>
<td>Lines, valves</td>
</tr>
<tr>
<td>Pumps</td>
<td>Pumps</td>
</tr>
<tr>
<td>Atmosphere</td>
<td>Atmosphere</td>
</tr>
<tr>
<td>Heat exchange Surfaces</td>
<td></td>
</tr>
<tr>
<td>Tanks</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Lines, valves</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Pumps</td>
<td>Stainless steel or Carpenter 20 equivalent</td>
</tr>
<tr>
<td>Atmosphere</td>
<td>Nitrogen</td>
</tr>
</tbody>
</table>

Hoses

Stainless steel, polyethylene, polypropylene, TEFLO® Polypropylene or TEFLO® (elastomers such as neoprene, Buna N. and VITON® should be avoided).
Sustainable chemistry

We are dedicated to sustainable chemistry and the ongoing development of low impact chemical components that can help resolve some of the major global challenges facing the human population. Contributing to formulations that maximize the use of our planet’s natural resources, we employ bio-based renewable feedstocks and raw materials wherever possible. Our sites also comply with the highest operational standards, making it easier for our customers to adhere to complex regulatory guidelines in their own industries.