HUNTSMAN
Enriching lives through innovation

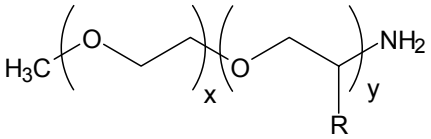
The JEFFAMINE® Polyetheramines

JEFFAMINE polytheramines are a part of an expanding family of Huntsman products. They contain primary amino groups attached to the end of a polyether backbone. The polyether backbone is normally based on either propylene oxide (PO), ethylene oxide (EO), or mixed PO/EO. Thus they are called "polyetheramines." Historically, the JEFFAMINE polyetheramine family consisted of monoamines, diamines, and triamines based on this core structure. Recently, the addition of secondary, hindered, high-conversion, and polytetramethylene glycol (PTMEG) based polyetheramines has increased the utility of this unique product range. The JEFFAMINE polyetheramines undergo typical amine reactions, often imparting increased flexibility, toughness, low viscosity, and low color. The wide range of molecular weight, amine functionality, repeating unit type, and distribution can provide flexibility in the design of new compounds or mixtures.

JEFFAMINE® MONOAMINES (M series)

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 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:



R= H for (EO), or CH_3 for (PO)

JEFFAMINE®	PO/EO mol ratio	MW*
M-600 (XTJ-505)	9/1	600
M-1000 (XTJ-506)	3/19	1,000
M-2005	29/6	2,000
M-2070	10/31	2,000

* MW = approximate molecular weight

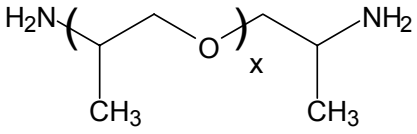
JEFFAMINE M-600 and JEFFAMINE M-2005 polyetheramines are predominately polypropylene glycol (PPG) based, whereas JEFFAMINE M-1000 and JEFFAMINE M-2070 polyetheramines are predominately polyethylene glycol (PEG) based and are therefore more hydrophilic.

JEFFAMINE® DIAMINES (D, ED, and EDR series)

JEFFAMINE diamines include the D, ED, and EDR series products. The D signifies a diamine, 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

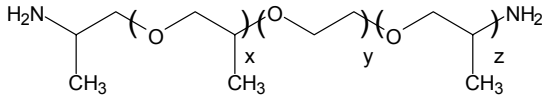
JEFFAMINE D series products are amine terminated PPGs with the following representative structure:



JEFFAMINE®	x	MW*
D-230	~2.5	230
D-400	~6.1	430
D-2000	~33	2,000
D-4000 (XTJ-510)	~68	4,000

JEFFAMINE® ED Series

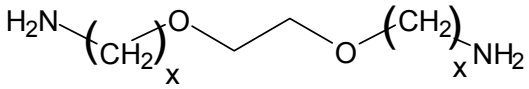
JEFFAMINE ED series products are polyether diamines based on a predominantly PEG backbone. PEG imparts complete water solubility to each of the products in this series. The JEFFAMINE ED products have the following representative structure:



JEFFAMINE®	y	x + z	MW*
HK-511	2.0	~1.2	220
ED-600 (XTJ-500)	~9.0	~3.6	600
ED-900 (XTJ-501)	~12.5	~6.0	900
ED-2003 (XTJ-502)	~39	~6.0	2,000

JEFFAMINE® EDR Series

JEFFAMINE EDR-148 (XTJ-504) and JEFFAMINE EDR-176 (XTJ-590) amines are much more reactive than the other JEFFAMINE diamines and triamines. They are represented by the following structure:

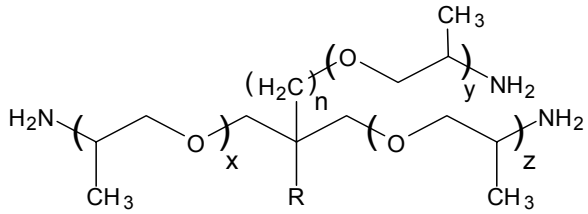


JEFFAMINE®	x	MW
EDR-148 (XTJ-504)	2.0	148
EDR-176 (XTJ-590)	3.0	176

These products can be used in a number of applications since they are unhindered diamines miscible in a wide variety of solvents. Reactions typical of aliphatic diamines (polyamide formation through reaction with dibasic acids, epoxy resin curing, polyurea formation through reaction with isocyanates) may be expected with these products.

JEFFAMINE® TRIAMINES (T series)

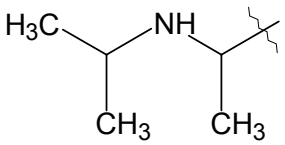
JEFFAMINE T series products are triamines prepared by reaction of PO with a triol initiator, followed by amination of the terminal hydroxyl groups. They are exemplified by the following structure:



JEFFAMINE®	R	n	Moles PO (x+y+z)	MW*
T-403	C_2H_5	1	5-6	440
T-3000 (XTJ-509)	H	0	50	3000
T-5000	H	0	85	5000

JEFFAMINE® Secondary Amines (SD Series, ST Series)

The SD Series and ST Series products consist of secondary amine versions of the JEFFAMINE core products. The SD signifies a secondary diamine and ST signifies a secondary triamine. The amine end-groups are reacted with a ketone (e.g. acetone) and reduced to create hindered secondary amine end groups represented by the following terminal structure:



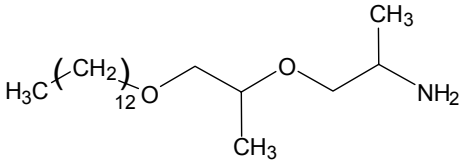
One reactive hydrogen on each end group provides for more selective reactivity and makes these secondary di- and triamines useful for intermediate synthesis and intrinsically slower reactivity compared with the primary JEFFAMINE amines.

JEFFAMINE®	Base Product	MW*
SD-231 (XTJ-584)	D-230	315
SD-401 (XTJ-585)	D-400	515
SD-2001 (XTJ-576)	D-2000	2050
ST-404 (XTJ-586)	T-403	565

EXPERIMENTAL AMINES

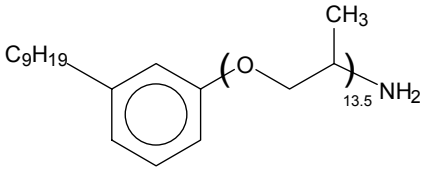
This next series of amines includes monofunctional amines similar to the M series. They are oleophilic and not water soluble.

XTJ-435 Chemical Intermediate



XTJ-435 is a monoamine derived from a PO adduct of a C_{12-14} alcohol. This product is ***"restricted"*** and may only be used as a chemical intermediate.

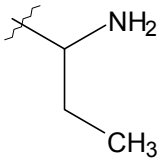
XTJ-436



XTJ-436 is a 1000 molecular weight, nonylphenol initiated, polypropylene glycol derived monoamine.

Slower Amines

Slower amines analogous to JEFFAMINE D-230 and JEFFAMINE 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 method results in primary amines with the terminal end group structure represented below:



Higher Conversion Amines

Methods have been developed to increase functionality and 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.

JEFFAMINE® Polyetheramine Properties

JEFFAMINE® Product	Typical Properties			Sales Specifications			
	Avg. AHEW g/eq	Density, 25°C, g/ml (±0.01)	Melting Point °C	Color Pt-Co APHA (Max)	Primary Amine (% Min)	Total Amine Meq/g	Max % Water
Monoamines							
M-600 (XTJ-505)	291	0.979	-40	75	95	1.58-1.79	0.35
M-1000 (XTJ-506)	489	1.066 ■	29	75	90	0.94 Min	0.25
M-2005	1045	1.000	-36	75	95	0.44 Min	0.25
M-2070	1040	1.072	17	75	95	0.45 Min	0.25
Diamines							
D-230	60	0.948	-	25	97	8.10-8.70	0.20
HK-511 ♣	62	0.991	-	75	-	8.00-9.00	0.25
D-400	115	0.972	-	50	97	4.10-4.70	0.25
XTJ-582 (HC*)	110	0.972	-	50	98	4.20-4.80	0.25
D-2000	514	0.991	-	25	97	0.98-1.05	0.25
XTJ-578 (HC*)	500	0.991	-	40	98	0.94-1.04	0.25
D-4000 (XTJ-510)	1000	0.994	-	75	95	0.44-0.52	0.25
Diamines (EO-Based)							
ED-600 (XTJ-500)	132	1.035	-10	75	95	3.00-3.43	0.35
ED-900 (XTJ-501)	250	1.065 ■	22	100	95	1.80-2.25	0.35
ED-2003 (XTJ-502)	575	1.068 ╥	43	75	95	0.90-1.05	0.35
Diamines (PTMEG-Based)							
XTJ-542	260	0.976	9▲	50	98	1.87-2.06	0.50
XTJ-548	380	0.965 ■	33	400	-	1.40-1.70	0.50
XTJ-559	355	0.977	16▲	50	98	1.35-1.46	0.50
Diamines (High Reactivity)							
EDR-148 (XTJ-504)	37	0.998	-	50	98 (% TEGDA)	12.70 Min	0.35
EDR-176 (XTJ-590)	44	0.980	-	50	99	11.00 Min	0.30
Triamines							
T-403	81	0.978	-	50	90	6.10-6.60	0.25
T-3000 (XTJ-509)	530	0.996	-	75	97	0.90-0.98	0.25
T-5000	952	0.997	-	75	97	0.50-0.54	0.25
Secondary Amines							
SD-231 (XTJ-584)	158	0.885	-	100 ●	<5 ●	5.30-6.30 ●	0.20 ●
SD-401 (XTJ-585)	258	0.921	-	100 ●	<5 ●	3.20-4.10 ●	0.20 ●
SD-2001 (XTJ-576)	1025	0.978	-	100	<5	0.90-1.03	0.20
ST-404 ♣ (XTJ-586)	189	0.923	-	100 ●	<5 ●	4.40-5.40 ●	0.20 ●
Experimental Amines							
XTJ-435 ♣	157	0.907	-	100	96	2.80-3.20	0.50
XTJ-436	525	0.979	-	100	97	0.91-1.08	0.10
XTJ-566 ♣	77	0.958	-	75	90	6.60-6.90	0.20
XTJ-568	55	0.943	-	75	93	8.60 Min	0.25

* HC = High Conversion (products have specification for high conversion of alcohol to amine)

● Proposed Sales Specification

▲ After standing for several months will partially crystallize at room temperature

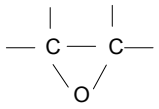
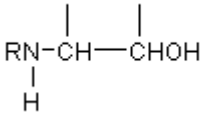
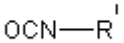
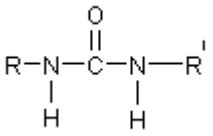
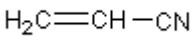
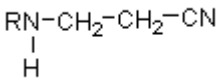
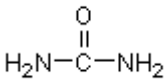
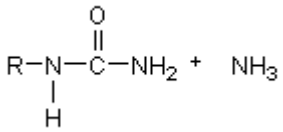
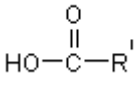
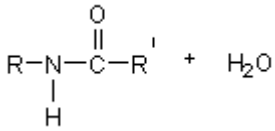
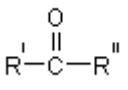
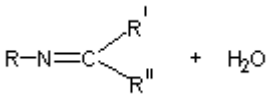
♣ Not EINECS/ ELINCS registered

■ Measured at 38°C

╥ Measured at 50°C

CHEMICAL REACTIONS

JEFFAMINE® polyetheramines undergo reactions typical of primary amines. General reactions which have proven to be useful include those listed below in the form: JEFFAMINE Amine + Reactant → Product.

	Reactant	→	Product
Epoxy reactions occur by the non-catalyzed addition of epoxides to JEFFAMINE amines. This alkoxylates each NH functionality to produce aminoalcohols.	 Epoxides ("epoxy resins")	→	 Aminoalcohols
Polyurea linkages are formed from the rapid, uncatalyzed reaction of JEFFAMINE amines with polyisocyanates. When applied to a RIM or spray process, this reaction has found great commercial utility in a variety of applications including castings, coatings, and sealants.	 Isocyanates	→	 Ureas
The **Michael addition** of an activated double bond compound to a JEFFAMINE amine is a reversible reaction[1].	 Acrylonitrile	⇄	 Cyanoethylated amines
Substituted ureas are formed by heating JEFFAMINE amines with urea at temperatures of 125-175°C, while removing ammonia. This will result in mono- and di-substituted ureas.	 Urea	→	 Substituted ureas
Amides can be formed from JEFFAMINE amines by an acid-catalyzed reaction with carboxylic acids, lactams, anhydrides, or by ester-amide interchange reactions.	 Carboxylic acids (or esters, anhydrides, etc.)	→	 Amides
Imines are formed by reacting JEFFAMINE amines with aldehydes or ketones, at elevated temperatures, while removing water.	 Aldehydes or ketones	→	 Imines
Salts of JEFFAMINE amines may be readily formed with a variety of organic and inorganic acids.	 Acids	→	 Salts

[1]Acylonitrile addition leads to a cyanoethylated product that can be catalytically hydrogenated to a non-reversible and stable aminopropylated polyetheramine.

STORAGE AND HANDLING

Materials of Construction

At temperatures of 75-100°F (24-38°C)

Tanks	Carbon steel
Lines, valves	Carbon steel
Pumps	Carbon steel
Heat exchange Surfaces	Stainless steel
Hoses	Stainless steel, polyethylene, polypropylene, TEFLON®[1]
Gaskets, packaging	Polypropylene or TEFLON®[1] (elastomers such as neoprene, Buna N, and VITON®[1] should be avoided).
Atmosphere	Nitrogen or dry air

At temperatures above 100°F (38°C)

Tanks	Stainless steel
Lines, Valves	Stainless steel
Pumps	Stainless steel or Carpenter 20 equivalent
Atmosphere	Nitrogen

[1] Registered trademark of Dupont

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.

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