

JEFFADD™ MW-781 Etheramine: a Multi-functional Primary Amine for Water-miscible Metalworking Fluids

Huntsman Corporation
Huntsman Performance Products

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Scientist



Today's presentation

- Huntsman Performance Products
 - Products for Metalworking
- JEFFADD™ MW-781 Etheramine
 - Performance evaluation
 - Formulations
- Conclusions



Performance Products

Key Products

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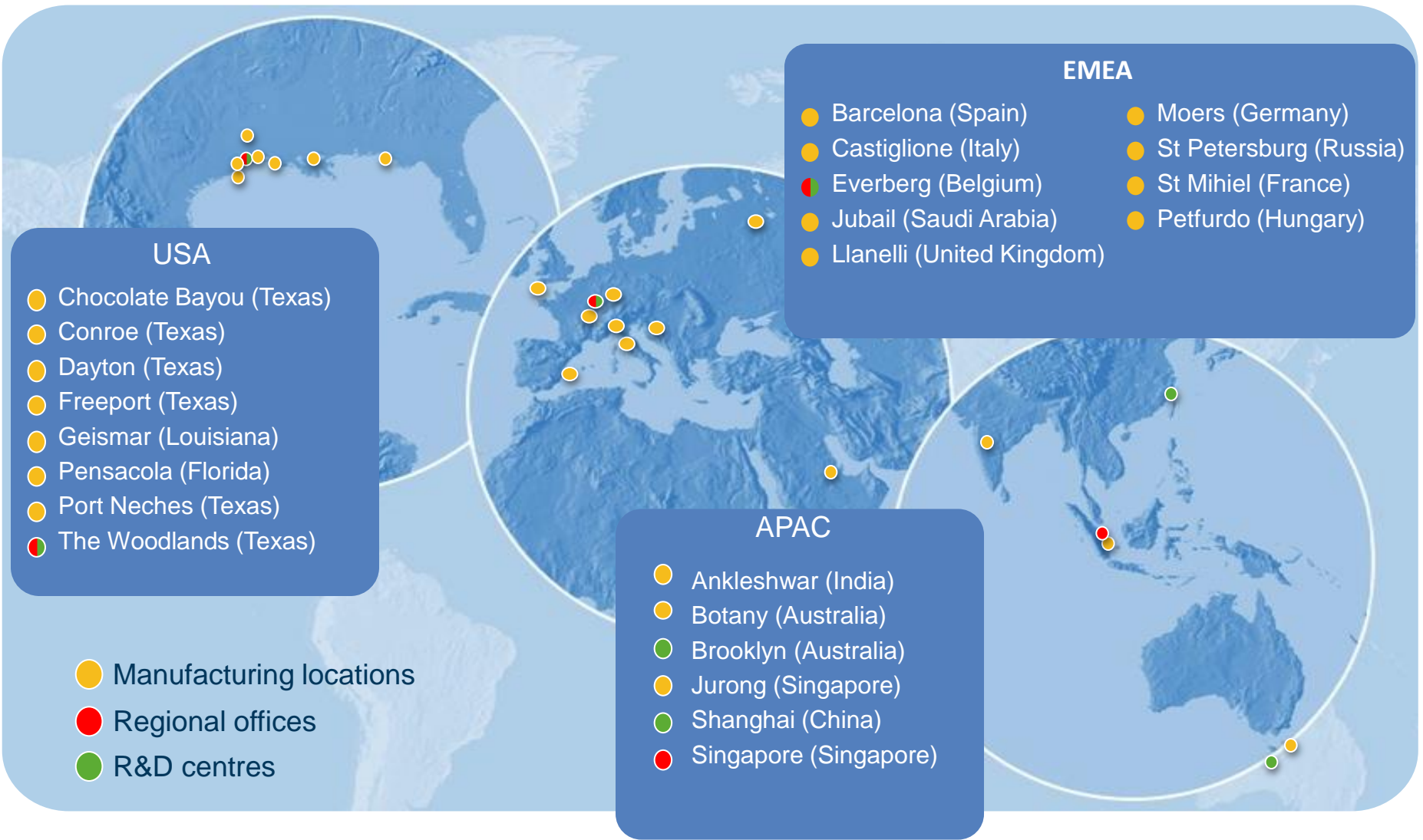
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We modify base chemicals to create the molecular building blocks that improve functionality, enhance processes and create differentiated formulas.

Specialty Amines	Surfactants
<ul style="list-style-type: none">• Alkylalkanolamines• Ethanolamines• Ethyleneamines• Morpholine / DGA™ agent• Polyetheramines• Substituted propylamines	<ul style="list-style-type: none">• Nonionic• Anionic• Cationic• Amphoteric• Polymeric surfactant
Carbonates	Intermediates
<ul style="list-style-type: none">• JEFFSOL® ethylene carbonate• JEFFSOL® propylene carbonate• JEFFSOL® glycerine carbonate• ULTRAPURE™ propylene carbonate• ULTRAPURE™ ethylene carbonate	<ul style="list-style-type: none">• Maleic anhydride• Glycols• Linear alkylbenzene• Specialty alkylates

About us

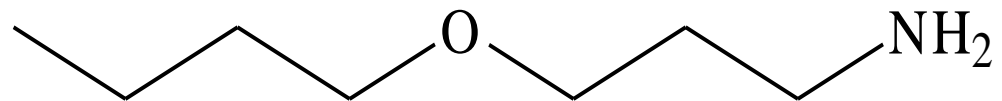
Global presence



JEFFADD™ MW-781 Etheramine

Specialty Amine

- Low molecular weight primary amine
- Mild to low staining on aluminum
- Inhibits staining on aluminum in the vapor phase
- Alkalinity source
- Inherently low foaming
- Excellent tramp oil rejection in synthetic fluids



JEFFADD™ MW-781 Butoxypropylamine

JEFFADD™ MW-781 Etheramine

Specialty Amine

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Comparison of JEFFADD™ MW-781 Etheramine with Other Amines for Metalworking

Amine	CAS#	Molecular Weight	Viscosity cSt,25°C	Freezing Point °C	pKb
JEFFADD™ MW-781 etheramine	16499-88-0	131	2	-47	4.23
Monoethanolamine (MEA)	141-43-5	61	19	11	3.50
2-amino-2-methyl-propanol (AMP)	124-68-5	89	147	30	4.28
Diethanolamine (DEA)	111-42-2	105	147	28	5.00
Methyldiethanolamine (MDEA)	105-59-9	119	101 (20°C)	-21	5.41
Triethanolamine (TEA)	141-43-5	149	527	21	6.24

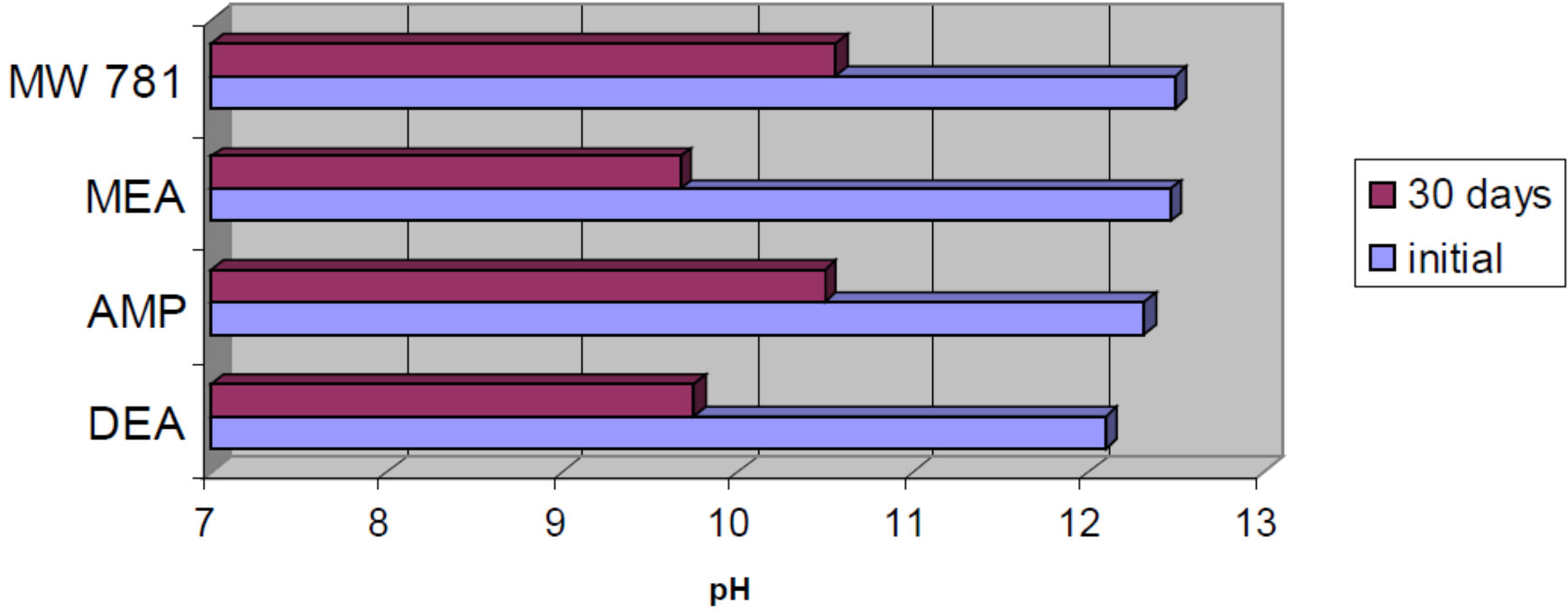
JEFFADD™ MW-781 Etheramine

Specialty Amine



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pH Stability of Amines Over Time



Test Conditions: 5% aqueous amine solution at room temperature

JEFFADD™ MW-781 Etheramine

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Aluminum Staining



Performance Evaluation: Aluminum Staining

MW-781 Salts

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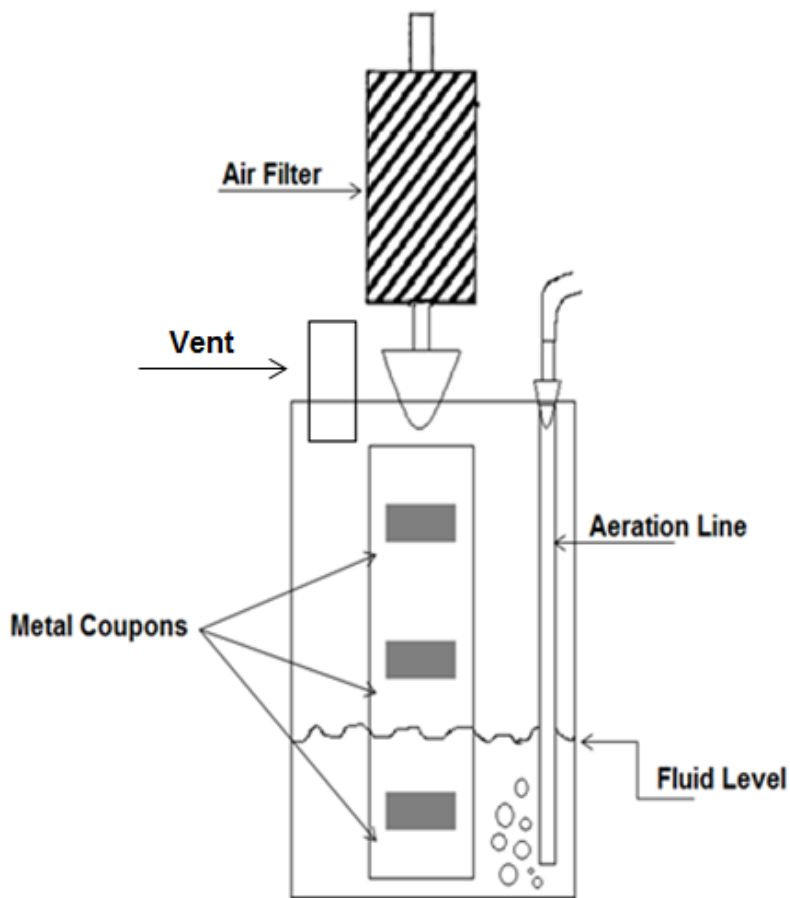
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Alloy	1.0% MW-781 Aqueous	1.5% MW-781 + Polycarboxylic acid	1.5% MW-781 + Dodecanedioic acid	1.5% MW-781 + Sebacic Acid	1.5% MW-781 + Isononanoic Acid	1.5% MW-781 + Boric Acid
Al 2024						
Al 6061						
Al 7075						

Test Conditions: Coupons half submersed in 2:1 amine: acid solution; adjusted pH of 9.30 and placed in oven for 3 hours at 50° C

Performance Evaluation: Aluminum Staining

Vapor Phase Staining on Aluminum



Test vessel used for evaluating MW-781 staining of aluminum in the vapor phase

Components	Make-up of Fluid Concentrate (Wt. %)		
DI Water	60.00	60.00	60.00
MEA	5.00		
AMP		5.00	
MW-781			5.00
TEA	15.00	15.00	15.00
Dodecanedioic Acid	2.00	2.00	2.00
Isononanoic Acid	8.00	8.00	8.00
SURFONIC® 17R4 Surfactant	10.00	10.00	10.00
Appearance	Yellow , Clear	Yellow , Clear	Yellow , Clear
Initial pH	9.00	8.28	8.11
Final pH after adjustment*	10.00	9.00	9.00

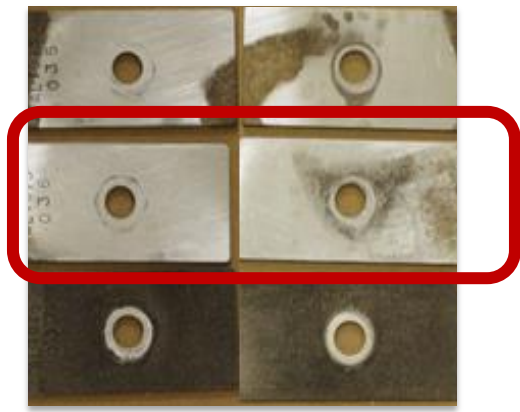
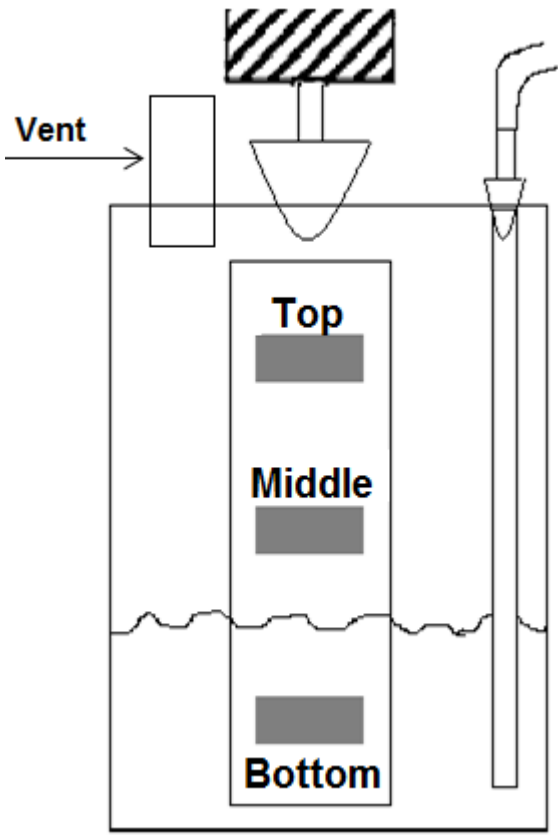
- 5% dilution in 125ppm hard water was adjusted with 50% NaOH
- Test conditions: 50°C, with aeration for 4 days, using AI7075

Performance Evaluation: Aluminum Staining

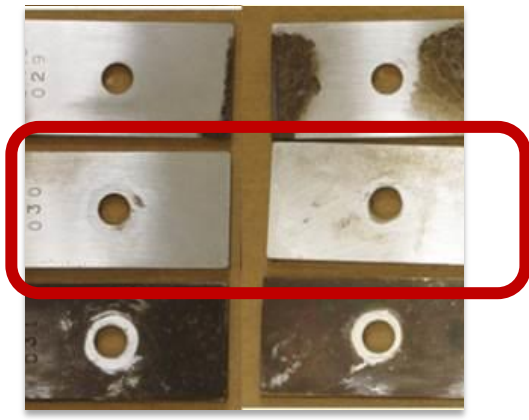
Vapor Phase Staining on Aluminum



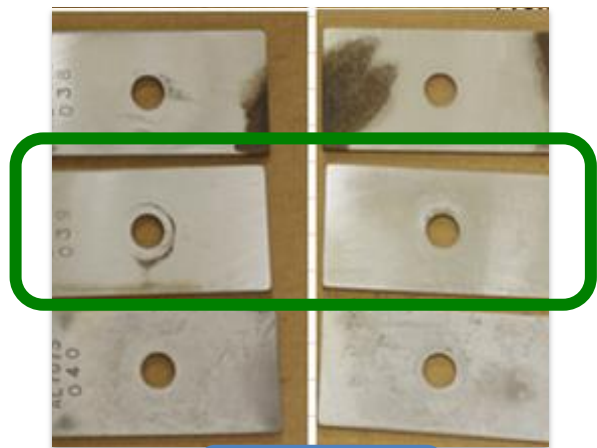
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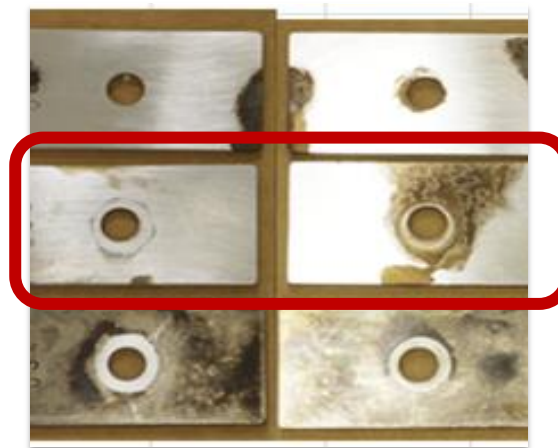
MEA at High pH



MEA



MW-781



AMP

JEFFADD™ MW-781 Etheramine

Aluminum Staining

- MW-781 salts show mild to low staining on aluminum alloys
- MW-781 with dodecanedioic acid shows slight corrosion on Al 2024, Al 6061, and Al 7075
- MW-781 borate shows no corrosion on Al 6061
- MW-781 shows protection against staining on aluminum in the vapor phase

Low Foaming



Performance Evaluation: Low Foaming Amine Salt Solution



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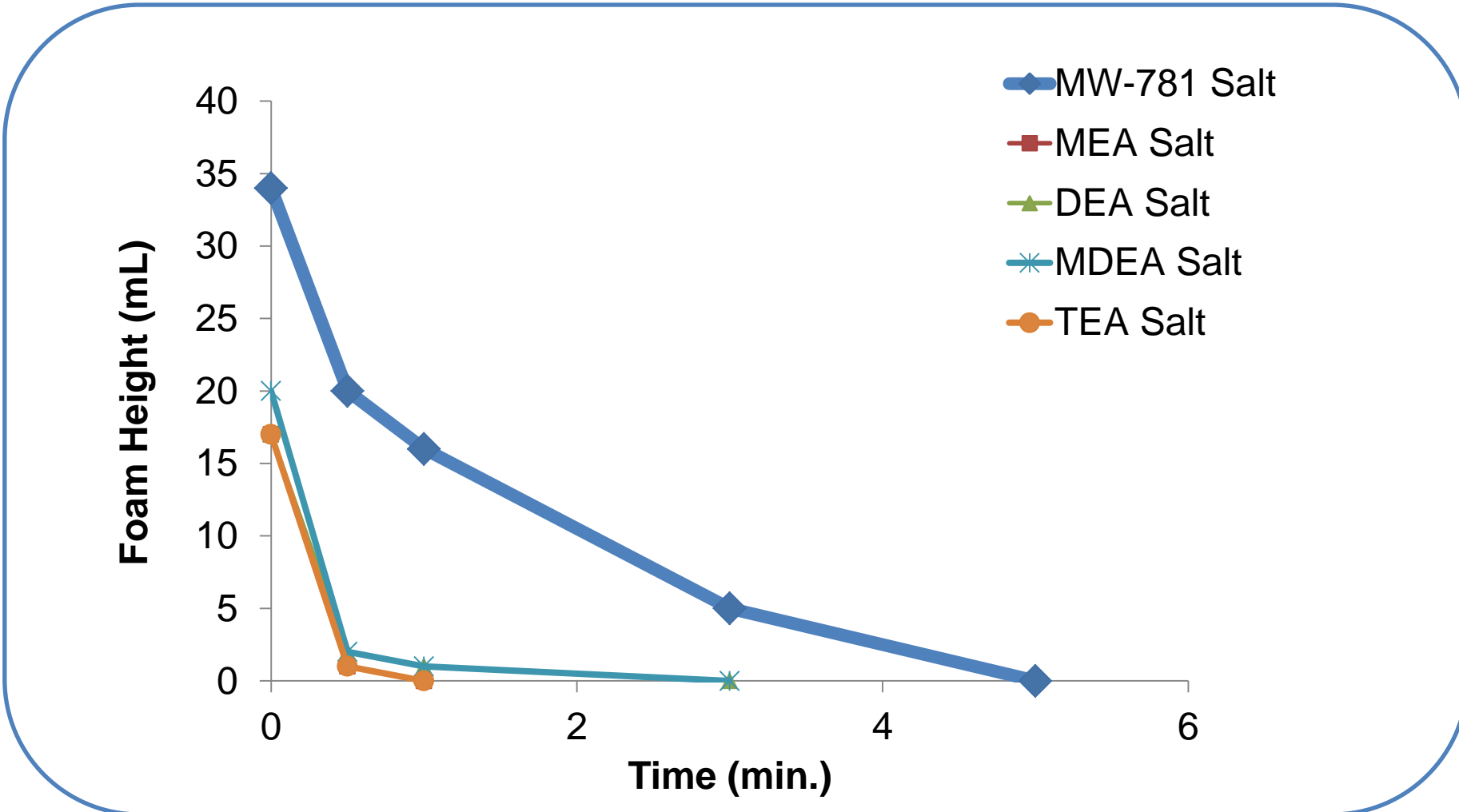
Component	Make-up of Amine Salt Solution (Wt. %)				
Isononanoic Acid	2.00	2.00	2.00	2.00	2.00
MW-781	1.80				
MEA		1.00			
DEA			2.64		
MDEA				1.70	
TEA					3.60
Deionized Water	98.00	98.00	98.00	98.00	98.00
pH of amine salt solution	9.29	9.29	9.28	8.02	7.97

Conditions

- pH value adjusted with amine
- TEA and MDEA pH set lower due to lower pKb of amines
- Foam test performed by the hand-shaken method with 60mL of amine salt solution in a 100 mL graduated cylinder at room temperature.

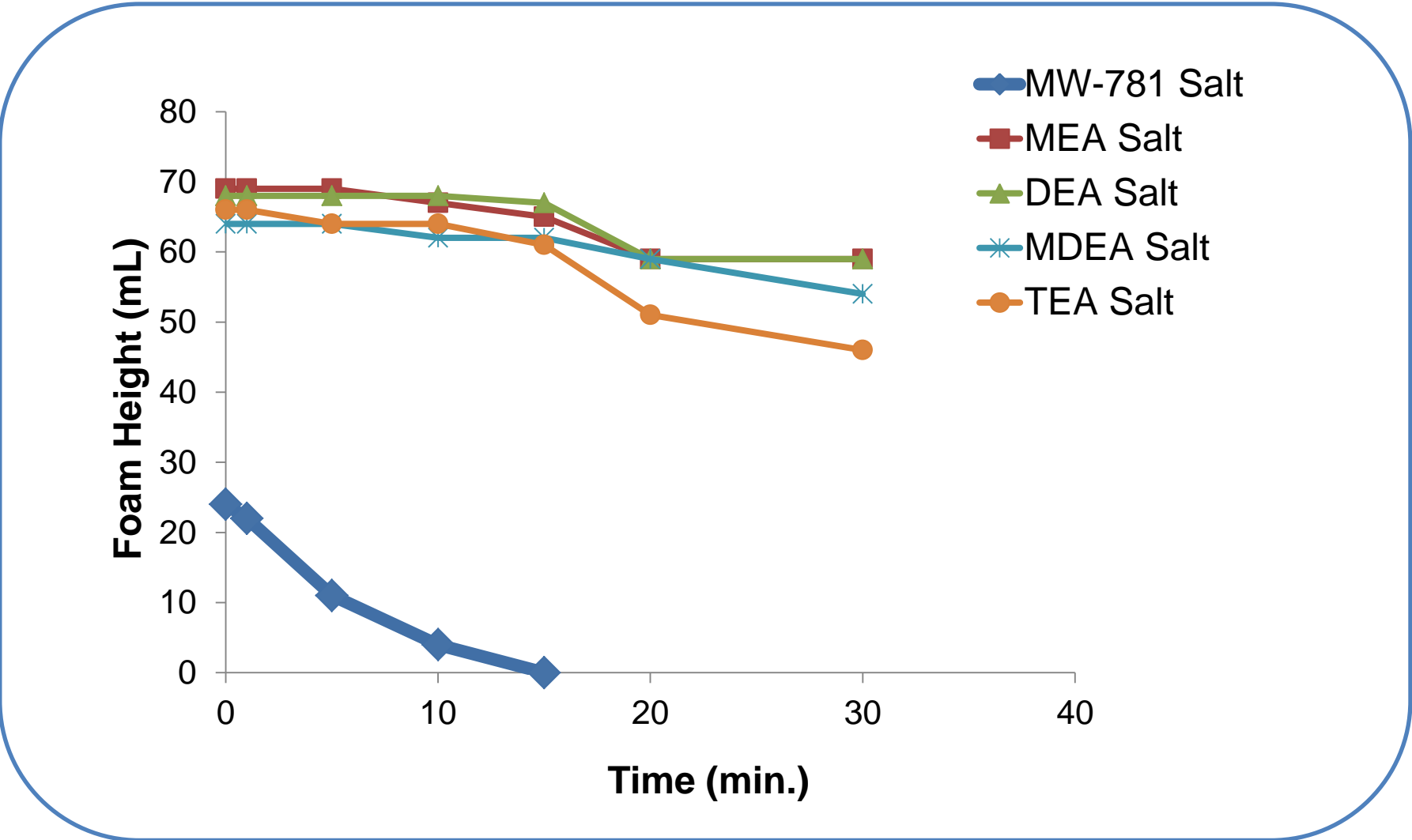
Performance Evaluation: Low Foaming

No Surfactant



Performance Evaluation: Low Foaming

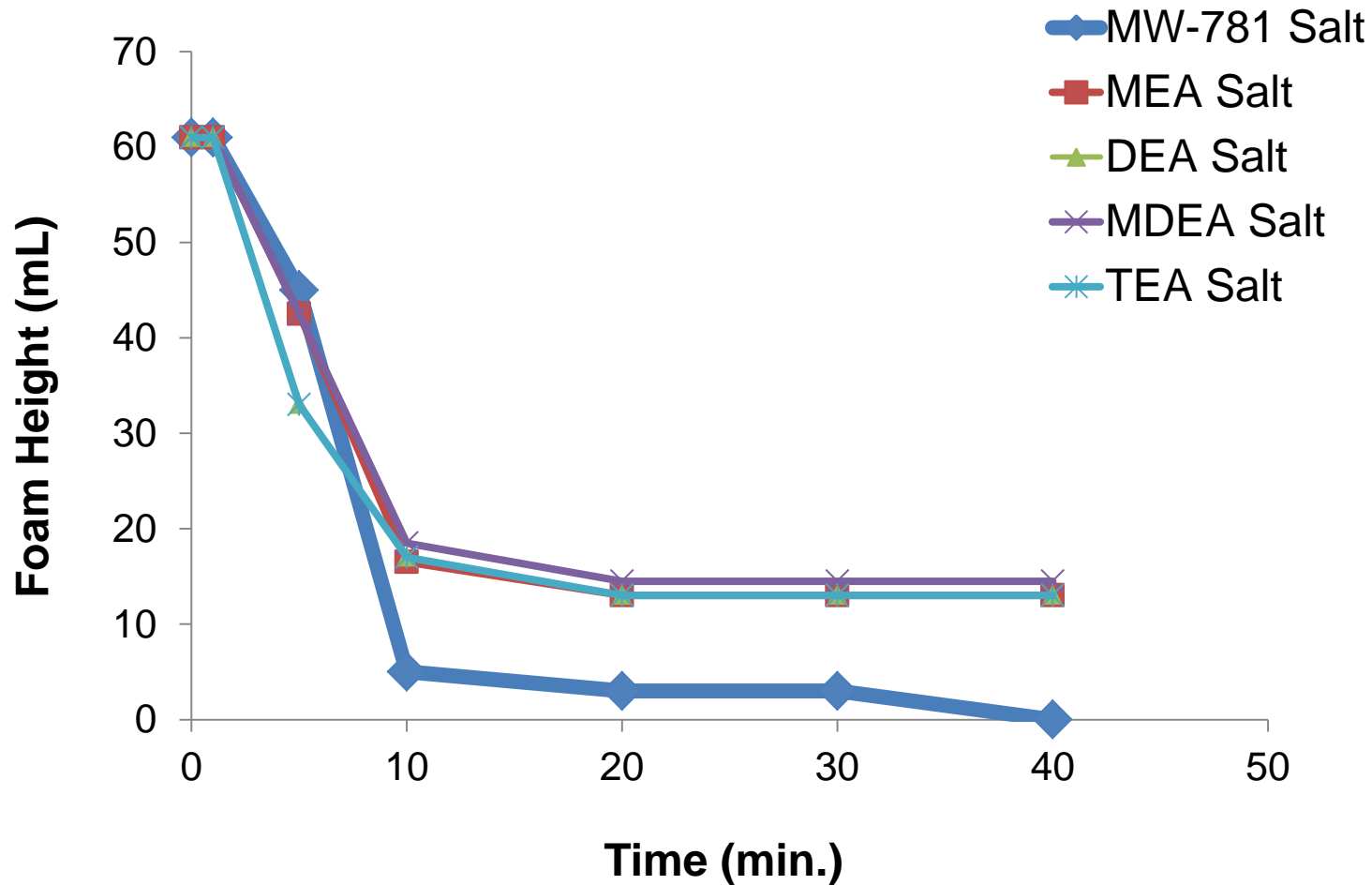
Anionic Surfactant: SDBS



Test Conditions: 1% of surfactant added to 60mL of amine salt solution

Performance Evaluation: Low Foaming

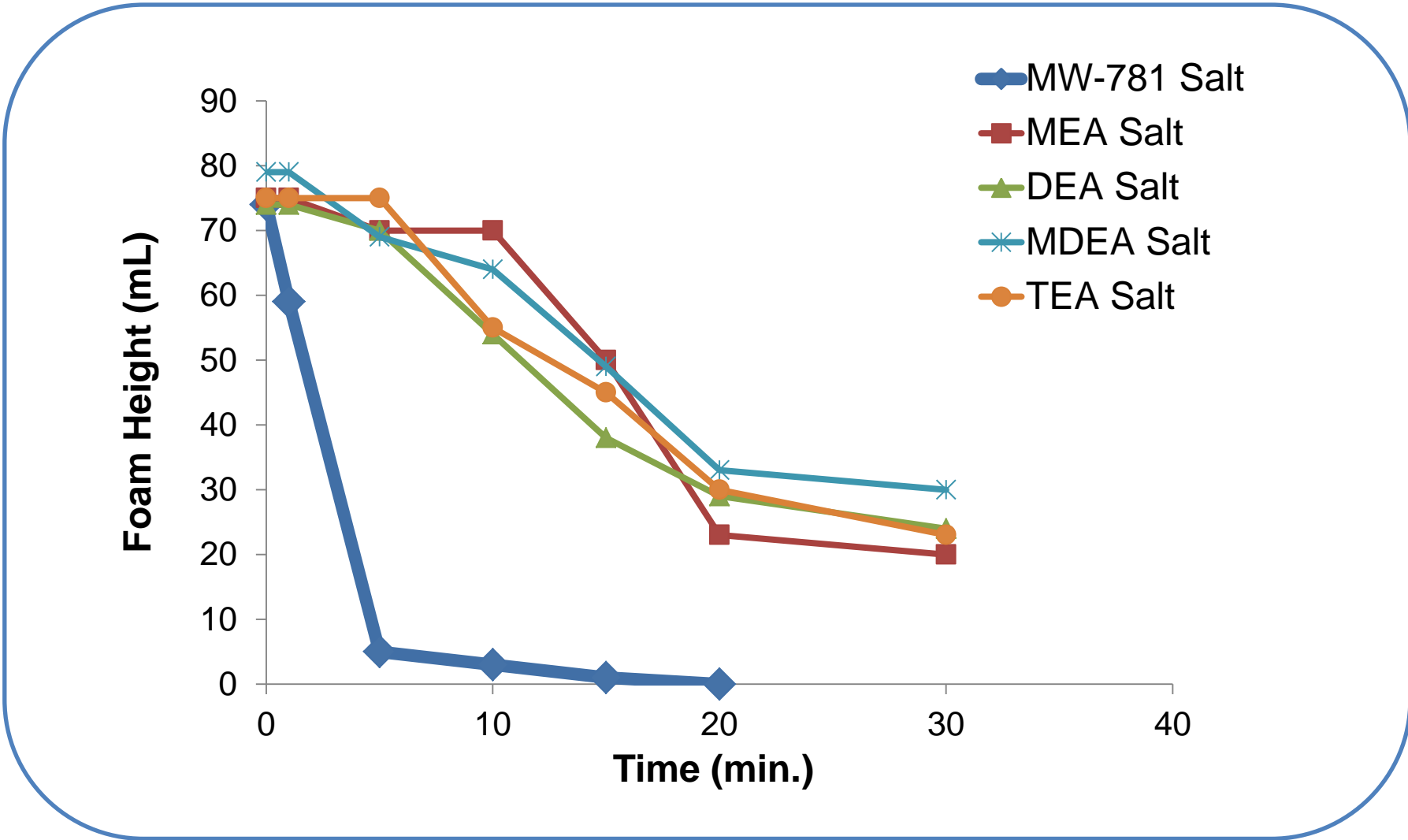
Anionic Surfactant: Ether Carboxylic Acid



Test Conditions: 1% of surfactant added to 60mL of amine salt solution

Performance Evaluation: Low Foaming

Non-ionic Surfactant : NPE



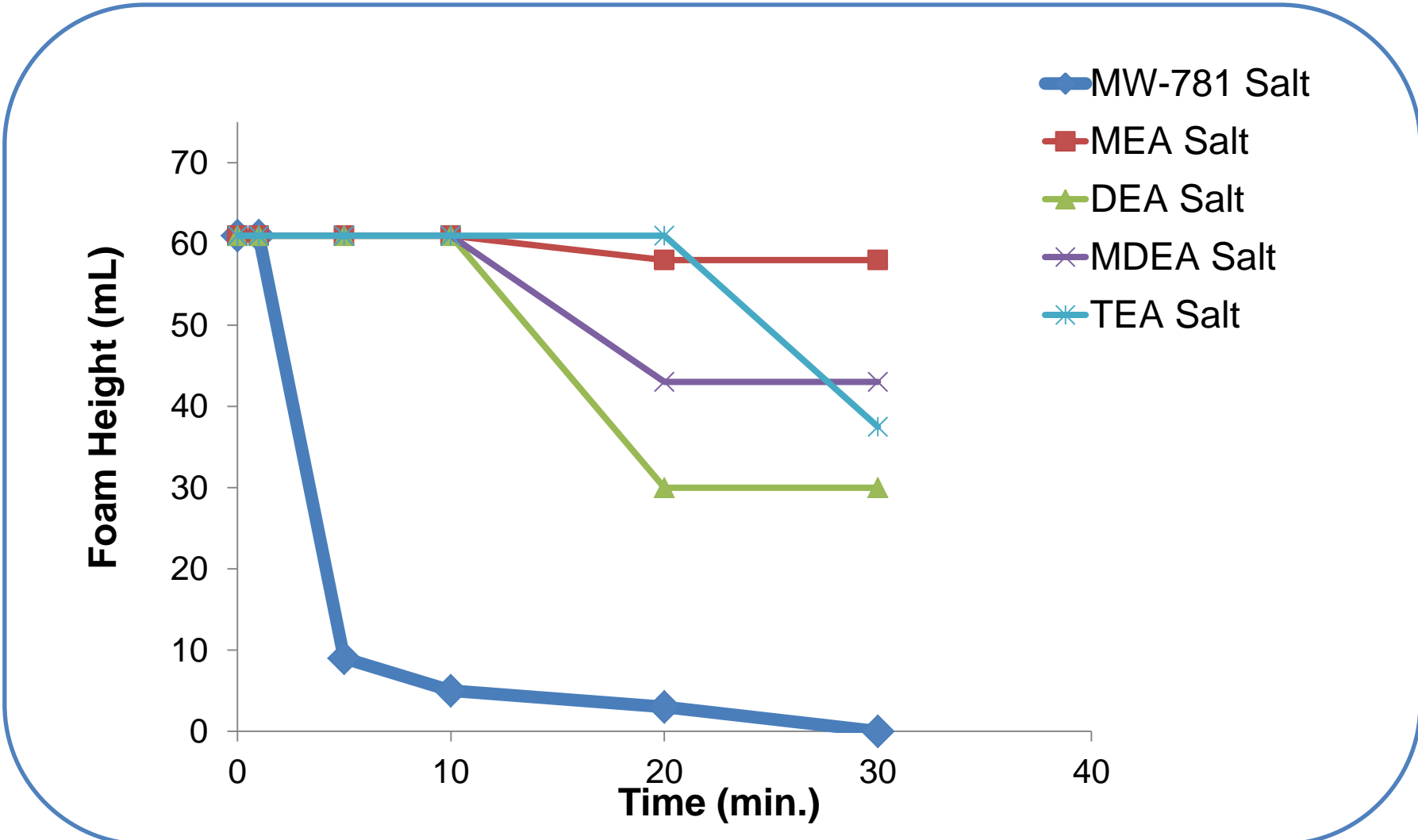
Test Conditions: 1% of surfactant added to 60mL of amine salt solution

Performance Evaluation: Low Foaming

Non-ionic Surfactant: Linear Alcohol Ethoxylate



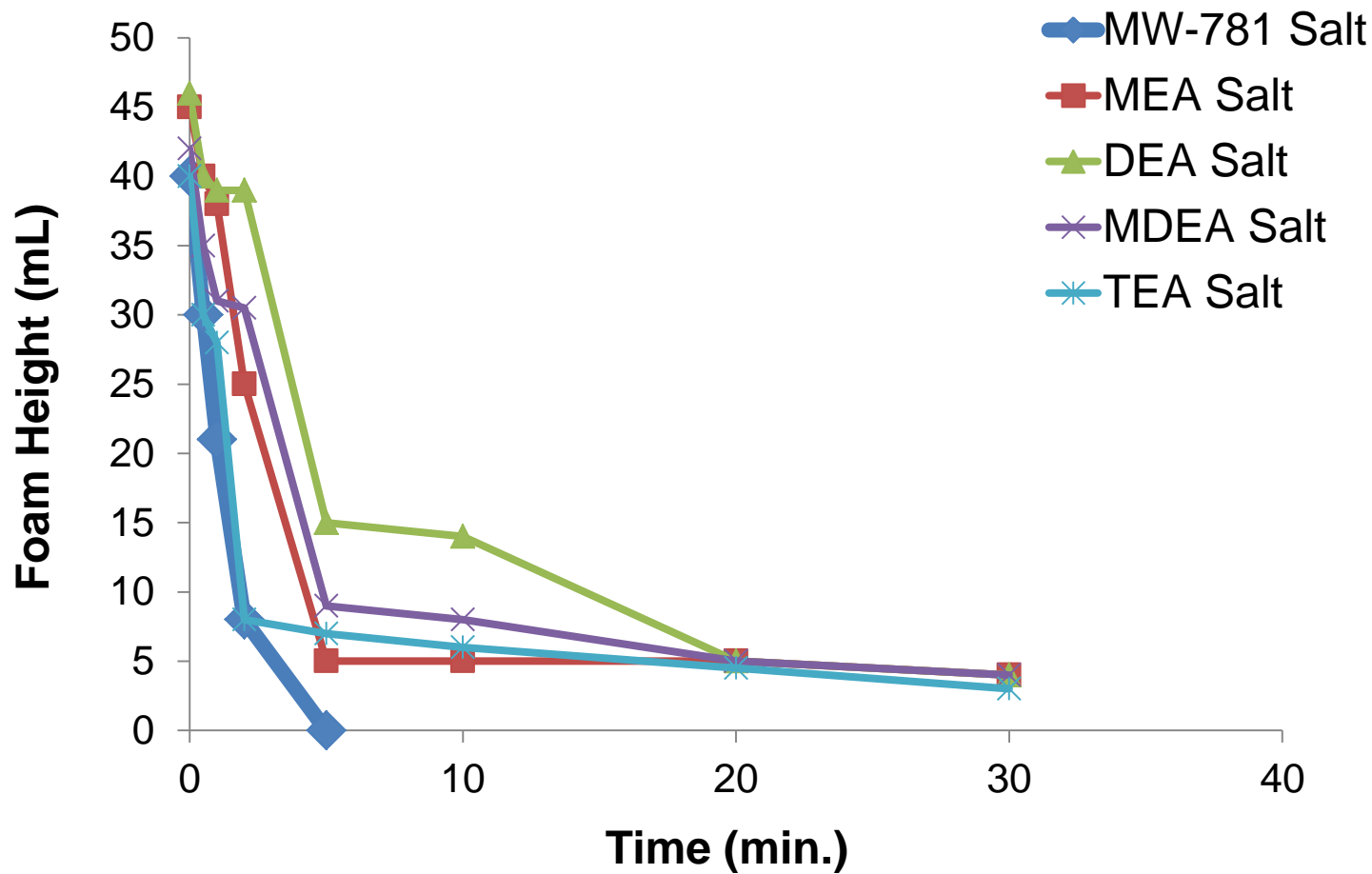
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Test Conditions: 1% of surfactant added to 60mL of amine salt solution

Performance Evaluation: Low Foaming

Non-ionic Surfactant: Reverse EO:PO Block Copolymer



Test Conditions: 1% of surfactant added to 60mL of amine salt solution

JEFFADD™ MW-781 Etheramine

Inherently Low Foaming

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- Inherently low foaming
- Low foaming observed with non-ionic and anionic surfactants compared to amine salt of other amines
- Excellent low foaming ability with reverse EO:PO block copolymers
 - No foaming in less than 5 minutes.



Performance in
Synthetic fluids



JEFFADD™ MW-781 Etheramine:

Performance Evaluation in a Synthetic Fluid

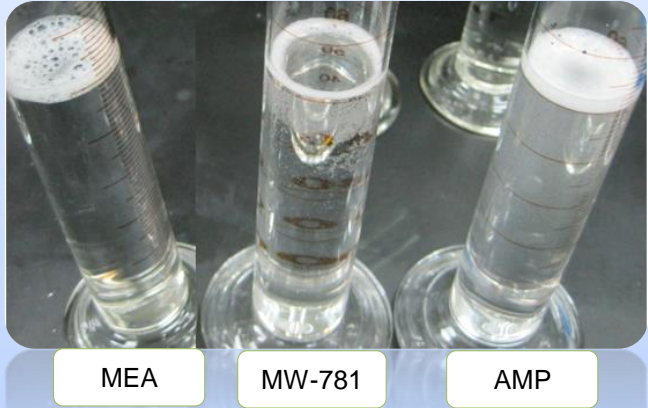
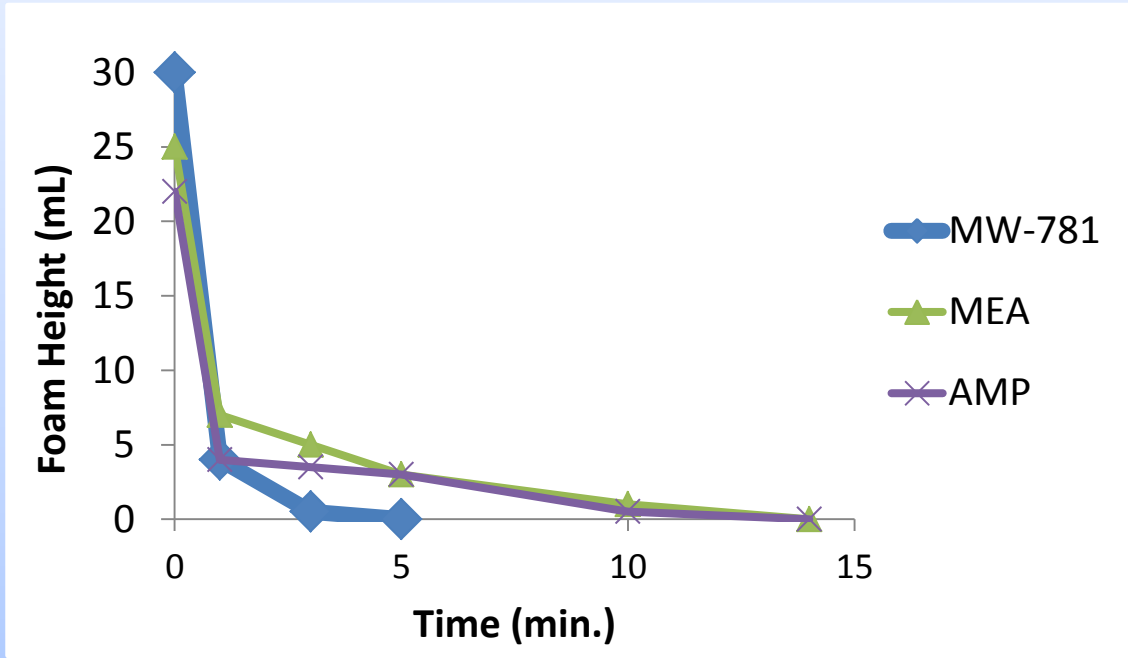
Component	Make-up of Fluid Concentrate (Wt. %)		
Deionized Water	60.20	57.70	58.90
Monoethanolamine	4.80	2.50	1.30
Triethanolamine	15.00	15.00	15.00
MW-781	-	4.80	-
AMP	-	-	4.80
Isononanoic Acid	8.00	8.00	8.00
Dodecanedioic Acid	2.00	2.00	2.00
SURFONIC® 17R4 Surfactant	10.00	10.00	10.00
Appearance	Yellow, Clear	Yellow, Clear	Yellow, Clear
pH, 5% in DI water	9.24	9.27	9.26

Performance Evaluation

- Foaming
- Tramp oil rejection
- Staining on aluminum

JEFFADD™ MW-781 Etheramine:

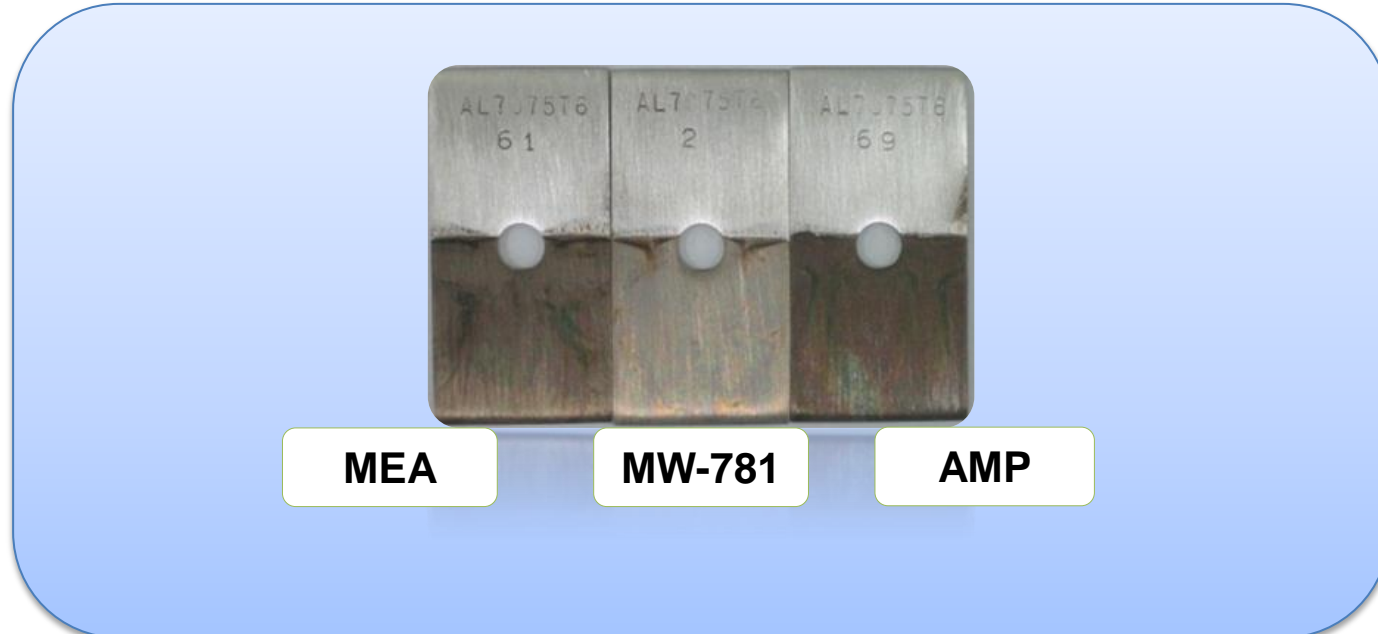
Foaming in a Synthetic Fluid



JEFFADD™ MW-781 etheramine has better foam control performance than MEA and AMP

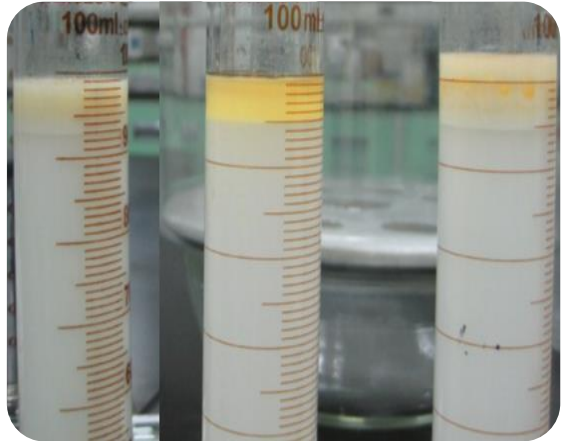
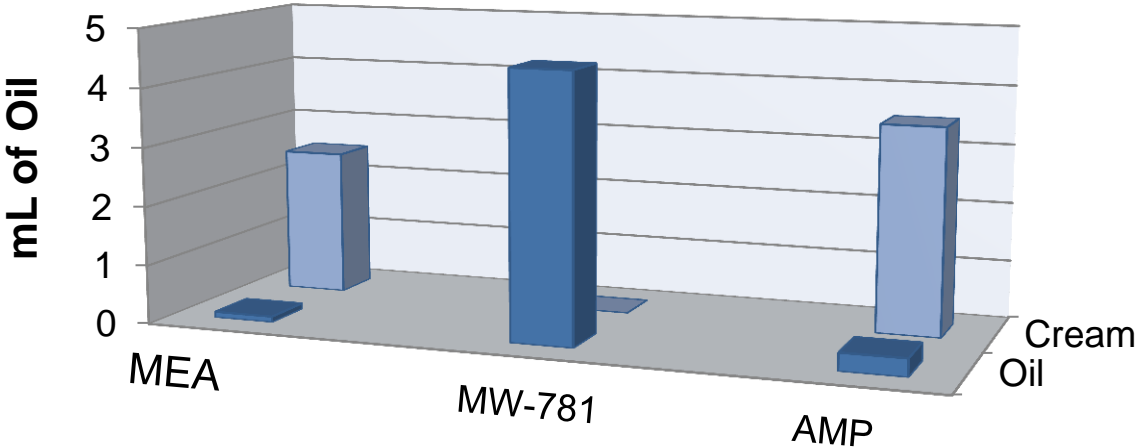
JEFFADD™ MW-781 Etheramine:

Aluminum Staining in a Synthetic Fluid



JEFFADD™ MW-781 etheramine has the least amount of staining on aluminum compared to MEA and AMP

JEFFADD™ MW-781 Etheramine: Tramp Oil Rejection in a Synthetic Fluid



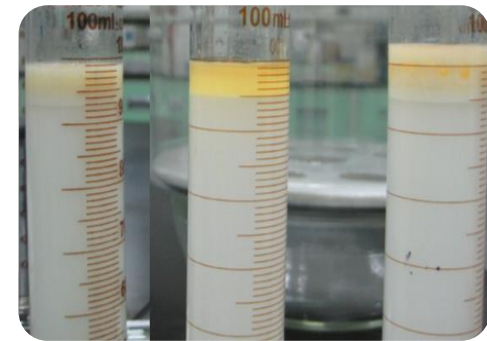
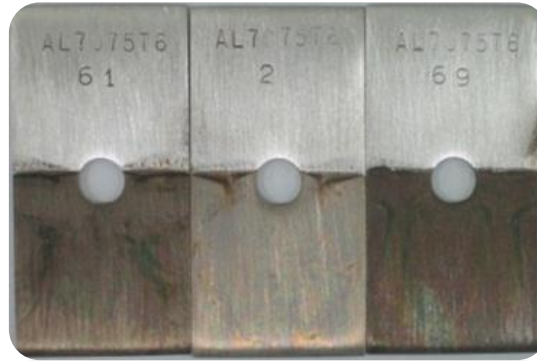
MEA MW-781 AMP

JEFFADD™ MW-781 etheramine has better tramp oil rejection performance than MEA and AMP.

JEFFADD™ MW-781 Etheramine:

Performance Evaluation in a Synthetic Fluid

- Excellent tramp oil rejection compared to other amino alcohols
- Low foaming
- Low staining on aluminum



Formulation



JEFFADD™ MW-781 Etheramine

Emulsification in Soluble Oil Before pH Adjustment



Component	Make-up of Fluid Concentrate (Wt. %)			
DI Water	10.00	10.00	10.00	10.00
Isononanoic Acid	5.00	5.00	5.00	5.00
MW-781	3.00	-	-	-
AMP	-	3.00	-	-
Dicyclohexylamine	-	-	3.00	-
MEA	-	-	-	3.00
TEA	8.00	8.00	8.00	8.00
Oleyl-cetyl Ether Carboxylic Acid	5.00	5.00	5.00	5.00
Naphthenic Oil	46.00	42.00	45.40	42.00
TOFA Amide	5.00	5.00	5.00	5.00
Methyl Oleate	4.00	4.00	4.00	4.00
Dodecanol	4.00	4.00	4.00	4.00
SURFONIC® L24-3 Surfactant	9.00	9.00	10.60	14.00
Appearance	Clear, Yellow	Clear, Yellow	Clear, Yellow	Clear, Yellow
pH 5% in 125ppm Hard Water	8.50	8.90	8.20	9.10

- Soluble Oil formulation with anionic surfactant
- Before pH adjustment with MEA
- Emulsification similar to AMP and lower than other amines

JEFFADD™ MW-781 Etheramine

Emulsification in Soluble Oil After pH Adjustment



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Component	Make-up of Fluid Concentrate			
	(Wt. %)			
DI Water	10.00	10.00	10.00	10.00
Isononanoic Acid	5.00	5.00	5.00	5.00
MW-781	3.00	-	-	-
AMP	-	3.00	-	-
Dicyclohexylamine	-	-	3.00	-
MEA	1.25	1.00	2.25	3.00
TEA	8.00	8.00	8.00	8.00
Oleyl-cetyl Ether Carboxylic Acid	5.00	5.00	5.00	5.00
Naphthenic Oil	46.00	41.00	45.40	42.00
TOFA Amide	5.00	5.00	5.00	5.00
Methyl Oleate	4.00	4.00	4.00	4.00
Dodecanol	4.00	4.00	4.00	4.00
SURFONIC® L24-3 Surfactant	9.00	14.00	13.60	14.00
Appearance	Clear, Yellow	Clear, Yellow	Clear, Yellow	Clear, Yellow
pH 5% in 125ppm Hard Water	9.20	9.10	9.30	9.10

- Soluble oil formulation after adjustment with MEA
- No change in the amount of non-ionic surfactant added.
- The amount of emulsifier required increased for other amines

JEFFADD™ MW-781 Etheramine

Emulsification in a Semi-synthetic Formulation

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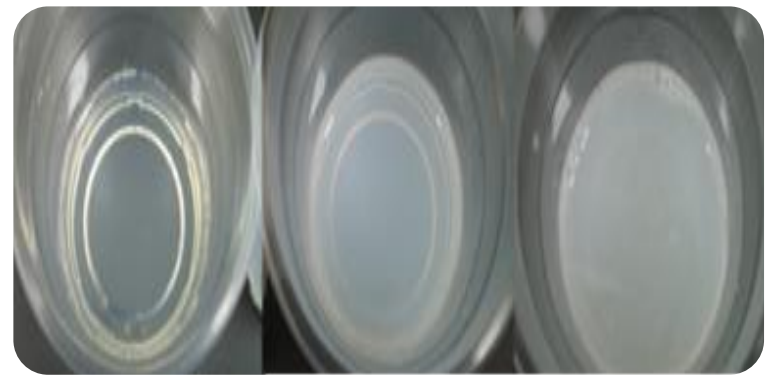
Component	Make-up of Fluid Concentrate (Wt. %)		
Naphthenic Oil	20.00	20.00	20.00
Isopropyl Palmitate	5.00	5.00	5.00
Polycarboxylic Acid	3.00	3.00	3.00
DI Water	34.00	36.00	34.00
MW-781	5.00	-	-
MEA	-	4.00	-
AMP	-	-	5.00
TEA	8.00	8.00	8.00
SURFONIC® L24-7 Surfactant	16.00	11.00	12.00
NANSA® SM60/HBH Emulsifier	3.00	5.00	5.00
Dicarboxylic acid	3.00	3.00	3.00
Diglycol Monobutyl Ether	-	2.00	2.00
Dodecanol	3.00	3.00	3.00
pH 5% in 125ppm Hard Water	9.39	9.29	9.79

- MW-781 can be incorporated using a low HLB emulsifier
- Required less low HLB emulsifier in formulation

JEFFADD™ MW-781 Etheramine

Emulsification in Soluble Oil and Semi-synthetic Fluids

- Compatible with non-ionics and most anionics
- Can be incorporating into soluble oil and semi-synthetic formulations with low HLB emulsifiers



Summary of Advantages

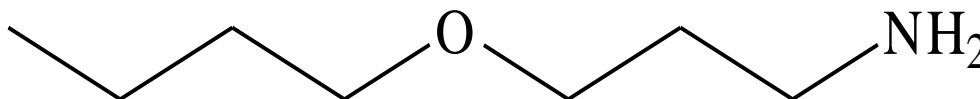


JEFFADD™ MW-781 Etheramine: Specialty Amine

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- Multi-functional additive with advantages for aluminum applications
- Coupling agent
- Easily formulated into water-miscible fluids with low HLB emulsifiers
- Can improve tramp oil rejection in synthetic fluids



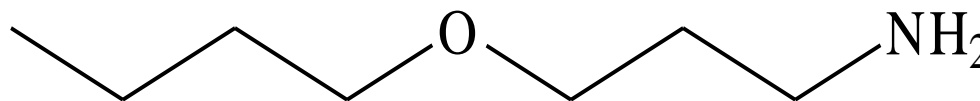
JEFFADD™ MW-781 Butoxypropylamine

JEFFADD™ MW-781 Etheramine: Specialty Amine

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- Amine salts can be low staining on aluminum
 - No corrosion on Al 6061 with MW-781 borate
 - Low staining with MW-781 dodecanedioic acid salt
- Inherently low foaming
 - Excellent low foaming with EO:PO block copolymers



JEFFADD™ MW-781 Butoxypropylamine

JEFFADD™ MW-781 Etheramine: Specialty Amine

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- Listed on:
 - TSCA
 - NDSL
 - EINECS
 - KECL
 - ENCS

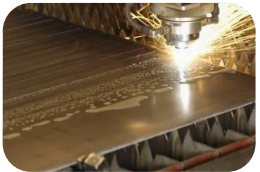


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