Global Network

Amines production sites

BASF produces 300 different amines at six production sites around the world. Along with alkyl-, alkanol- and alkoxyalkylamines, the company offers heterocyclic, aromatic and other specialty amines. This wide range of products is complimented by an expanding portfolio of chiral amines of high optical and chemical purity. The versatile products are used mainly to manufacture process chemicals, pharmaceuticals and crop protection products, as well as cosmetic products and detergents. They also serve as the basis to produce coatings, specialty plastics, composites special fibers, lubricants and metalworking fluids.

The BASF Group's Intermediates division develops, produces and markets a comprehensive portfolio of about 700 intermediates around the world. Its most important product groups include amines, diols, polyalcohols, acids and specialties. Intermediates are for example used as starting materials for coatings, plastics, pharmaceuticals, textiles, detergents and crop protectants. Innovative intermediates from BASF help to improve both the properties of final products and the efficiency of production processes. The ISO 9001 certified Intermediates division operates plants at production sites in Europe, Asia and North America.

Amines for Metalworking Fluids
Selection Guide

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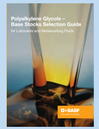

Polyalkylene Glycols – Base Stocks
Selection Guide
for Lubricants and Metalworking Fluids

Emulsifiers – Selection Guide
for Metalworking Fluids

Esters – Base Stocks Selection Guide
for Lubricants and Metalworking Fluids

Components – Selection Guide
for Metalworking Fluids

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CI 1603-11/16-500. Status: February 2019

BASF
We create chemistry

Amines for Metalworking Fluids

Selection Guide

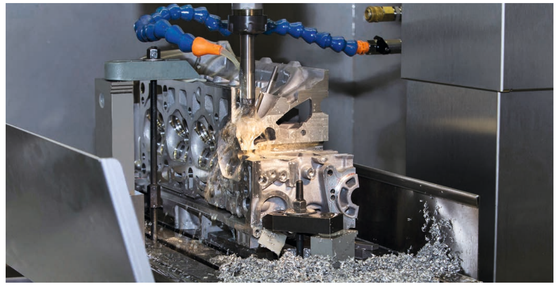
Amines for Metalworking Fluids

We have the broadest portfolio to meet your needs

BASF offers the broadest portfolio of hydrophilic and hydrophobic amines that combine established and innovative products to bring effective solutions to the global metalworking fluid industry. Due to their strong performance in pH-buffering and anti-corrosion properties, the amines enhance both the stability and efficiency of metalworking fluids.

Today it is a major challenge for formulators to find effective amines considering new regulations in a globally changing environment. The choice of multifunctional amines is a key factor for a long-lasting and high performance fluid. In order to facilitate this process, BASF has run comparative tests with a selection of alkanol-, alkylalkanol- and alkylamines. This brochure shows the relative performance of BASF amines in a synthetic fluid test matrix according to three essential criteria: **alkaline reserve, metal compatibility and resistance to micro-organisms.**

This brochure offers a **convenient and predictive guideline** to metalworking fluid formulators. The selection of amines shown in this brochure is only a part of the BASF amines portfolio and will continue to expand. If you have any questions regarding the BASF amines portfolio, please contact BASF at: info.intermediates@basf.com.



Performance of Amines in a Synthetic Fluid Test Matrix

A generic formulation of a synthetic fluid based on acids, corrosion inhibitor and metal deactivator was used to determine the relative performance of BASF amines.

All mixtures are based on the same molar equivalent of amines, providing the same amount of excess amines. This ensures that the measured performance differences between the formulations are linked only to the intrinsic properties of the amines. Neutralized amines with acids are mainly used for corrosion protection. An excess of amines is necessary for the pH buffering and aging resistance properties. A concentrate, according to the table below, was diluted to a 5% solution in water for general testing. The alkalinity and the corrosion properties were measured without the addition of biocides in order to only evaluate the performance of the amine.

ADDITIVES	MASS %	ACID/BASE (Number of mole)
IRGACOR L190+	6	0.025
2-ETHYL HEXANOIC ACID	5.2	0.036
ISONONANOIC ACID	4	0.025
IRGAMET BTZ	0.5	–
AMINE(S)	0.172* MW (amine)	0.172
DEIONIZED WATER	Added to 100%	–
TOTAL AMINES functions	–	0.172
TOTAL ACID functions		0.086
AMINE EXCESS functions		0.086

ALKALINE RESERVE

The effect of amines on the alkaline reserve enables a significant extension of the lifespan of the fluid. An optimized pH is required to limit the growth of micro-organisms and at the same time ensure a worker-friendly formulation. A pH between 9-9.5 is a commonly used range.

This brochure describes the alkaline reserve of the formulated synthetic fluid matrix previously mentioned, tested at 5% in tap water, with different hydrophilic amines. Initial pH, buffer pH and the repartition of alkalinity above pH 9 and pH 8 are excellent indicators to support the formulation of fluids with long-term stability.

- **Initial pH** is a short-term value of the pH when the fluid is freshly prepared. The pH will drop to its stable value after a few days of use.
- **Buffer Value** is a pH value where the buffer effect is maximized.
- **% Alkalinity to pH 9:** % of total alkalinity located above pH 9. Indication about how long pH in use will remain above 9 for better control of micro-organisms growth.
- **% Alkalinity to pH 8:** % of total alkalinity located above pH 8. Indication about how long pH in use will remain above 8 for better overall stability and anti-corrosion properties.
- **Total alkalinity to pH 6:** alkaline reserve of the fluid provided mainly by free amines.

In the case of **hydrophobic amines**, only trends are given due to the lack of solubility in the fluid. Hydrophobic amines with high pKa are used as an alkalinity booster in mixture with hydrophilic amines offering multiple combinations for customized solutions. For more details on combinations of amines, please contact BASF at: info.intermediates@basf.com.

AMINES SELECTION			HAZARD IDENTIFICATION		CHEMICAL AND PHYSICAL PROPERTIES OF AMINES					ALKALINITY OF FORMULATED SYNTHETIC FLUID					METAL COMPATIBILITY			MICROBIAL RESISTANCE IN COMBINATION WITH BIOCIDES
Product Name	Abbre-viation	CAS Number	GHS Label	Hazard Classifi-cation	Chemical Structure	MW[1] g/mol	pKa	Amine Number mg KOH/g	ml HCl Equivalent ml HCl 0.5N/g	Resis-tance to Tramp Oil	Initial pH	Buffer Value	% Alkalinity @pH 9	% Alkalinity @pH 8	Total Alkalinity (ml HCl 0.5N) @pH 6	Aluminium Staining 5% solution 0°dH 2h	Cast Corrosion 4% solution 40°dH 2h	Copper Corrosion 0,3% solution 0°dH 24h @ 60°C	Resistance towards bacteria, mold and yeast
HYDROPHILIC AMINES																			
Triethanolamine	TEOA	102-71-6	None	None	Tertiary	149	7.85	375.90	13.40	++	8.00	7.50	n.a.[2]	0.00	5.15	++	O	++	O
Triisopropanolamine	TIPOA	122-20-3		H 318, H 319	Tertiary	191	7.86	293.25	10.50	+	8.21	7.80	n.a.[2]	15.00	5.30	++	++	++	n.a.[3]
Methyldiethanolamine	MDEOA	105-59-9		H 319	Tertiary	119	8.52	470.67	16.80	++	8.80	8.40	n.a.[2]	57.00	5.40	+	+	++	+
Methyldiisopropanolamine	MDIPOA	4402-30-6		H 314	Tertiary	147	8.71	381.02	13.60	+	9.04	8.60	2.00	63.00	5.30	O	+	++	+
Butyldiethanolamine	BDEOA	102-79-4		H 318	Tertiary	161	8.90	347.89	12.40	+	8.95	8.60	n.a.[2]	68.00	5.04	O	++	++	++
Dimethylaminoethoxyethanol	DMAEE	1704-62-7		H 312, H 314	Tertiary	133	9.30	421.13	15.00	++	9.18	8.80	17.00	74.00	4.80	O	++	O	n.a.[3]
Dimethylethanolamine	DMEOA	108-01-0		H 314, H 312, H 331, H 302, H 226, H 335	Tertiary	89	9.30	629.33	22.50	++	9.38	9.00	36.00	78.00	5.50	–	+	+	+
Monoethanolamine	MEOA	141-43-5		H 314, H 312, H 332, H 302, H 412, H 335	Primary	61	9.50	918.20	32.80	++	9.63	9.30	47.00	78.00	4.85	–	+	+	O
2-(2-Aminoethoxy)ethanol	ADG	929-06-6		H 314	Primary	105	9.62	533.43	19.00	++	9.68	9.30	48.00	76.00	5.25	–	++	O	O
Monoisopropanolamine	MIPOA	78-96-6		H 314, H 312	Primary	75	9.62	746.80	26.70	++	9.52	9.20	46.00	77.00	4.65	–	++	+	++
N,N-Dimethylisopropanolamine	DMIPOA	108-16-7		H 226, H 312, H 331, H 302, H 314	Tertiary	103	9.80	543.79	19.40	+	9.56	9.20	46.00	81.00	5.40	O	++	+	++
Diethylethanolamine	DEEOA	100-37-8		H 314, H 311, H 331, H 302, H 226, H 335	Tertiary	117	10.10	478.72	17.10	O	9.84	9.50	58.00	74.00	5.00	O	++	+	++
HYDROPHOBIC AMINES																			
Octyldiethanolamine	ODEOA	15520-05-5		H 318, H 315, H 302, H 412	Tertiary	217	8.90	258.11	9.22	O			O			++	O	++	+
N,N-Dibutylethanolamine	DBEOA	102-81-8		H 312, H 302, H 335, H 314	Tertiary	173	10.30	323.76	11.56	O			++			O	++	O	++
Dicyclohexylamine[4]	DCHA	101-83-7		H 314, H 311, H 301, H 410	Secondary	181	10.39	309.50	11.05	–			++			O	++	O	++

Status: February 2019

++ Most favorable, + Favorable, O Less favorable, – To avoid

[1] Molecular Weight
[2] pH of the fluid below the desired value due to too low pkA of the amine
[3] not tested
[4] not in the portfolio anymore, included for benchmark purposes

METAL COMPATIBILITY

Avoiding unwanted side-effects of amines on metal surfaces is a crucial parameter for their selection. This brochure presents amine trends for cast corrosion and aluminium staining tested in the formulated synthetic fluid matrix.

BASF focused on the aluminium staining tests to meet the expectations of formulators facing a growing demand of aluminium processing, especially in aeronautics and automotive industries.

Test conditions aluminium: The aluminium staining tests have been conducted simultaneously on four different alloys: AGM3 (Al + 3% Mg); Alumec 79 (Al + 3% Mg + 5% Zn); 7075 (Al + 2.5% Mg + 5.5% Zn + 1.6% Cu); 2017A (Al + 4% Cu). The relative intensity of aluminium staining is measured with MDEOA as a reference (favorable). A trend per amine is given by combining all four different alloys.

In the case of semi-synthetic fluids, a generally more favorable compatibility is expected. For example DEEOA, BDEOA, MDIPOA or DBEOA could be classified as favorable.

Tests conditions cast and copper: The cast corrosion tests, using the method DIN 51360/2, were conducted on the formulated synthetic fluid matrix at 4% in tap water (this concentration has been chosen to emphasize the differences between amines). Copper corrosion tests were made on pure amines in deionized water (at 0.3%) to obtain higher differentiation.

MICROBIAL RESISTANCE

A sufficient alkaline reserve provided by selected amines, in combination with registered biocides, is necessary to obtain a long-lasting effective metalworking fluid. However, some amines are more prone than others to degradation by micro-organisms. Microbial resistant amines are a key component of a successful metalworking fluid formulation.

The performance test was designed to isolate the intrinsic resistance of each amine towards microbial degradation. Alkalinity loss is a more relevant indicator of amine degradation than pH or the measurement of overall micro-organism contamination. Thus, the comparison of alkalinity loss is used to assess the relative amine performance. Alkalinity loss of the fluids in the presence of micro-organisms was measured after 10 weeks (One injection of micro-organisms per week). After 10 weeks the fluids still had a good pH and low microbial contamination, but other indicators, such as cast corrosion (DIN 51360/2), showed the beginning of fluid degradation. Hydrophobic amines have been tested at low concentration (0.022 moles in the concentrate) in association with hydrophilic amines leading to optimum performance at lower pH. For more details on combinations of amines, please contact BASF at: info.intermediates@basf.com

Tests conditions: The injection is based on a large spectrum of bacteria, yeast and mold. A bactericide (N,N'-Methylene-bismorpholine, at 750 ppm) and a fungicide (BBIT, at 25 ppm) have been added to the 5% dilution synthetic fluid matrix for testing.

Injection concentration: Bacteria cocktail ~10^8 CFU/ml, Yeast + Mold cocktail ~10^6 CFU/ml.