

## Amines

TT-015-0891

COMMON NAME	BOILING POINT °F	STEAM DISTRIBUTION RATIO	AMINE/CARBONATE FORMATION	AZEOTROPIC FORMATION
Cyclohexylamine	273	1.6 - 9.0	Yes	Yes
Diethylaminoethanol	325	3.1 - 4.1	No	Yes
Morpholine	262	0.3 - 0.7	Yes, Slight	No
DMA-2P	253	1.1 - 9.2	No	Yes
Ammonia	----	10	----	----
Octadecylamine	450	No data	No	No

### Cyclohexylamine

This neutralizing amine has generally been used for low pressure operations with long condensate returns. Pure cyclohexylamine will boil at 273°F. This corresponds to a minimum boiler pressure of 30 psig. The boiling point of the neutralizing amines is not the only criteria for evaluating their effectiveness. Cyclohexylamine goes through a mechanical function called the formation of an azeotropic mixture. The azeotropic point of a cyclohexylamine mixture has a boiling point of 207°F. Cyclohexylamine has one of the highest steam distribution ratios. The steam distribution ratio of an amine is defined as the ratio of the amine contained in the steam vs. the amount of amine contained in the condensate at that pressure. This means that more cyclohexylamine will stay with the steam as pressures are reduced. Cyclohexylamine will carry out to the far reaches of the condensate system.

Cyclohexylamine has a high potential for formation of an amine carbonate in condensate systems. When used in steam humidification systems it is possible for odor problems to occur.

### Diethylaminoethanol (DEAE)

DEAE is probably the most widely used neutralizing amine today. While the boiling point of DEAE is higher than other amines (325°F) it also forms an azeotropic mixture which is approximately 210°F. The steam distribution ratio falls midway between morpholine and cyclohexylamine. DEAE provides

good general coverage to low pressure as well as higher pressure systems. DEAE does not form an amine carbonate like other neutralizing amines.

### Morpholine

Morpholine has one of the lowest boiling points of all amines. The boiling point of morpholine is 262°F which corresponds to about a minimum boiler pressure of 22 psig. Morpholine does not form an azeotropic mixture so a low boiling point is necessary. The steam distribution ratio for morpholine is the lowest of all amines. Morpholine will have more amine in the water phase than in the steam. For this reason where low pressures are involved we would not find sufficient amounts of amine remaining in the steam for complete coverage. Morpholine is also a very effective neutralizer up to a pH of 7.0. Its effectiveness drops off in trying to raise the condensate pH to a 8.0 to 8.5 range. Morpholine also has a slight tendency to form an amine carbonate.

### Dimethylamino-2-Propanol (DMA-2P)

DMA-2P is a lesser known amine than the first three discussed. DMA-2P has a low boiling point of about 253°F. This amine also forms an azeotropic mixture which has a boiling point of 207°F. DMA-2P has a very high distribution ratio even higher than cyclohexylamine. DMA-2P will protect the far reaches of long distance low pressure systems. DMA-2P will not form an amine carbonate in the condensate return system.

### Ammonia

Ammonium hydroxide is used as a neutralizing amine in situations where live steam contacts a food product. This type of amine is the only product acceptable in dairy plant systems. Ammonia has a very high distribution ratio even higher than cyclohexylamine and DMA-2-P. Ammonia should not be fed into the feedwater or D.A. tank because of loss through the tanks vent. Ammonia is also very corrosive to copper and copper alloys.

### Octadecylamine

Octadecylamine is not a volatilizing amine. It will not volatilize in a boiler below 425 psig. ODA therefore must be injected into the steam header via a vapor steam injection nozzle. When injected into the steam header it exists as dispersion in the steam. Octadecylamine is not soluble in water so when it falls out of the steam solution it lays down the passivating mechanism. A monomolecular film is formed when the hydrophobic ends of the amine molecule attach to the metal surfaces. This monomolecular film repels water creating a barrier between corrosive condensate and the metals. Excessive feed or too rapid of feed will cause the system to plug iron oxides removed from the metals. Incomplete film formation will cause localized corrosion. Extreme care and monitoring are required when using ODA.

### Ethoxylated Soya Amine

Ethoxylated soya amine is another type of film forming amine. The major difference between ODA and this type amine is that ODA has one hydrophilic attachment where the soya amine has three. This increases the solubility of the molecule resulting in a lower sludging tendency. The soya amine is therefore easier to apply and maintain. Again extreme care and monitoring are required when using this amine.

### Neutralizing Capacity

ppm of amine required to raise pH to 7.5 when containing 32 ppm CO<sub>2</sub> at ambient temperature.

<b>Morpholine</b>	<b>84</b>
<b>Cyclohexylamine</b>	<b>64</b>
<b>DMA-2P</b>	<b>59</b>
<b>DEAE</b>	<b>71</b>
<b>Ammonia</b>	<b>14</b>