



# Quaker Knowledge Network

## Amines Skill Builder

### Overview

Cutting and grinding fluids often contain chemical compounds called "amines." This "Skill Builder" will give you a basic knowledge foundation about amines and metalworking fluids.

### Definition

An amine is a classification of organic compound that contains nitrogen, carbon, and/or hydrogen. The ratio of these three elements defines the four types of amines: primary, secondary, tertiary, and quaternary. Each type is chemically different in terms of possible reactions, Chemical Abstract Service (CAS) Numbers, hazardous information, odor, alkalinity, buffering capability, and many other aspects. These variables become important to the formulating chemist.

The most common amines used in Quaker's metalworking fluids are monoethanolamine (MEA), triethanolamine (TEA), and 2-amino-2-methyl-1-propanol (AMP). Diethanolamine (DEA) was used but has been replaced almost completely. MEA and AMP are primary amines, DEA is a secondary amine, and TEA is a tertiary amine. Pound for pound, the relative cost is roughly the same for MEA, DEA, and TEA while AMP is three to four times more expensive. However, these compounds differ in strength, with MEA being the strongest and TEA the weakest. There is more on DEA later!

### Formulating Use

Amines are used to produce alkaline pHs (greater than 7.0) and provide buffering capacity. This can be achieved by using the amine alone or as a soap. A soap can be produced when an amine is blended with a fatty acid. This is not to be confused with an amide, which is basically a soap that is reacted at an elevated temperature to drive off the water. Buffering is related to the reserve alkalinity and the fluid's resistance to avoid large pH decreases.

Having a pH greater than 8.0 is helpful in reducing corrosion and minimizing microbiological growth. In general, coolants are best maintained with a pH between

8.5 and 9.5. If the pH becomes too high (in excess of 10.5) there is a risk of increased dermatitis. High pH can also create accelerated attacks on some types of non-ferrous alloys such as copper, brass, and aluminum. This can be anything from mild oxidation (greenish tint on copper and brass) to heavy staining. Keep in mind that water must be present in order for a pH to be measured. That is why some product concentrates have no pH.

Amines can be found in day to day life. MEA and TEA are found in many soaps, shampoos, shaving creams, and lotions. Amines are also used in some latex paints, pharmaceuticals, and cosmetics.

### Regulatory

In 1990, Quaker's Regulatory Department issued a memo on the subject of DEA and the National Toxicological Program (NTP) study concerning hazards associated with DEA. It was mentioned that a competitor was proactively removing DEA from its products based on its belief that DEA would be declared a carcinogen. At that time, DEA was on the SARATitle III list of hazardous compounds. In 2002, the NTP is not well supported by other groups but is still considering moving ahead with its summary to list DEA as a carcinogen. There is still controversy on this issue.

SARATitle III says that companies must keep track of their total poundage of free DEA if it is going to exceed 10,000 lbs/year. For most of our customers, that means purchases of Quaker fluids in excess of 500,000 pounds. This figure is obtainable for very large accounts. However, if a company is buying multiple products, each containing DEA, they must track each one. In response to this, some customers have simply decided that they would rather have a DEA-free product. If it's not present, it doesn't have to be monitored. At this time, the vast majority of Quaker products do not contain DEA.



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## Amines Cont. Skill Builder

### Options

In theory, it is easy to, if need be, substitute one amine for another. However, this impacts cost and performance of the final fluid. Further, there are other amines that Quaker has changed to over the years. Monoisopropanolamine (MIPA) and diisopropanolamine (DIPA) are among some of those being explored. There is also work to assess amine-free technology.

### Ammonia

Quaker conducted extensive studies in the early 1990's to better understand the relationship between amines and ammonia. The relationship is such that bacteria can degrade specific amines and convert them to ammonia. That ammonia is then released from the metal working fluid and offends the operators and the plant environment. The human nose can actually detect ammonia long before many tests and measurement devices! Bottom line is that MEA, DEA, and MIPA can break down to become ammonia while TEA and AMP cannot.

### CAS Numbers

A typical problem associated with formulating is that of Chemical Abstract Service (CAS) numbers. A CAS number identifies a chemical compound or classification of chemical compound. CAS numbers are tied very closely to the Environmental Protection Agency (EPA). The EPA actually administers the issuance of new CAS numbers.

If you have a product with MEA and you simply want to change to TEA, you have to look at what other raw materials are in the product. If the MEA is blended with fatty acid X, there may be no CAS number for a soap of MEA and fatty acid X. Under Quaker's interpretation of the rules, the MEA-fatty acid blend will be classified as a new compound, which will require a new CAS number. Before obtaining a new CAS number, you must obtain a Premanufacturing Notification (PMN) number. This is time consuming and slows down the creativity process for the formulator. We also believe that several of our competitors do not interpret the rules in the same fashion.

### Summary

As you can see, amines and their use are not as straightforward as one might believe. Again, it is not Quaker's intention to turn you into a chemist but simply to present you with some technical information without making it too technical.

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