AMMONIA

Overview

Ammonia is a clear, colorless gas with a sharp, characteristic odor. It is lighter than air and very soluble in water. Ammonia release from metalworking fluids is an unfortunate consequence that leads to employee dissatisfaction, loss of work time, temporary plant closures and potentially poor worker health. This phenomenon, also called an ammonia "flush" or ammonia "burp," has been a sporadic but ongoing problem for years.

Definition

Ammonia (NH_3) is a gas as described above. When it is in solution, it exists as an ion called ammonium (NH_4^+). When the pH of an aqueous system (either as a solution or an emulsion) is around 9.2 or higher, ammonia exists as a gas in the air. Below that pH, it prefers to exist as the ion in solution.

In the metalworking fluid, the growth of micro-organisms is the main driving force that causes a decrease in the pH. It is also those same micro-organisms that are creating the ammonia present as the ammonium ion by degrading the nitrogen-containing compounds. The main source of these nitrogen-containing compounds is the amines that are used to produce salts/soaps with certain fatty acids, and to help control the pH. When plant personnel add pH enhancers, such as liquid caustic, the ammonium becomes ammonia as the pH climbs. When biocides are added, the organisms die and the pH starts to climb as a result. Again, the ammonium converts to ammonia and is released. Conclusions drawn from the testing conducted at Quaker Houghton were:

- Ammonia production in metalworking fluids is almost exclusively driven by microbiological degradation of specific nitrogen containing compounds
- The microbiological population does not have to be significant to initiate the conversion

How Is Ammonia Produced in metalworking fluids?

- The formation and/or presence of ammonia were found to be more prevalent with ferrous operations but have been seen with nonferrous applications (a.k.a. aluminum) as well
- Specific amines will breakdown to produce ammonia while others will not. This list is proprietary based on the testing conducted
- A specific test was developed to evaluate the ammonia potential of specific components in a metalworking fluid
- Specific analytical procedures were developed to analyze and quantify the presence of the ammonia in the used samples
- The gas detected and collected when ammonia occurred was positively identified as ammonia
- Post addition of specific compounds has shown some benefit in minimizing the effects of ammonia

Avoiding Ammonia

Based on the knowledge above, it is possible to avoid and even perhaps eliminate the ammonia flushes that can be experienced at a manufacturing facility. The approach to making necessary improvements would have to involve:

- Education of the plant personnel to be aware of those conditions that contribute to any microbiological growth
- Formulation of a product that will function in the processes but not contain any of the compounds that will produce ammonia
- Installation of monitoring equipment that will assist plant personnel in the tracking of pH, dissolved oxygen and ammonia on a continuous basis for troublesome systems

Quaker Houghton can educate account personnel and formulate a product. It would be necessary to contact a manufacturer to see what equipment might be available to assist should ammonia surface. There are suppliers than can provide this type of monitoring equipment.

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Test Method

There are a number of test methods or capabilities for assessing and/or measuring the presence of ammonia in an industrial environment. The best person to conduct such testing is an Industrial Hygienist (www.aiha.org).

An "on the spot" method to detect ammonia gas is a detector tube system. This method uses a pump to pull a fixed quantity of air through a calibrated tube. The tubes are glass vials filled with a chemical reagent that reacts with a specific chemical or family of chemicals. The color changes in the tube, if that chemical is detected, to indicate its concentration. These tubes have a large error associated (10-25%) with the reading. The second option with the tube method is to use tubes that have to be sent to a specific laboratory that will analyze the contents of the tube.

Direct read instrumentation can use ammonia-specific sensors or photo-ionization technology to display real time levels of ammonia.

Personal monitoring is designed to measure exposure to chemicals over time. This is often used to determine compliance with Permissible Exposure Limit (PEL) or Short Term Exposure Limit (STEL) as defined by OSHA. This method is the use of vapor monitors. This is a porous badge worn by the plant personnel that collects air over time at a specific rate and volume. The badge is sent to a specific laboratory that will analyze the contents.

Safety

Ammonia can be irritating to the skin, eyes, throat and lungs and cause coughing and burns. A very large concern is associated with high levels of ammonia that displace the oxygen to cause asphyxiation. This level of ammonia is never reached in a metalworking environment. Some workers with asthma may be more sensitive to breathing ammonia than others.

The OSHA permissible exposure limit (PEL) for ammonia is 50 ppm time weighted average (TWA). This TWA is based on an 8-hour work period. The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV) is 25 ppm (TWA), 35 ppm short term exposure limit (STEL). The National Institute of Occupation Safety & Health (NIOSH) recommended exposure level (REL) is 25 PPM TWA, 35 ppm STEL.

According to the Environmental Contaminant Reference Databook, the level of human perception is 5.2 ppm. This means that the average person will notice the ammonia odor long before it becomes dangerous.

Example of an Investigation

Recently a customer contacted Quaker Houghton to report an ammonia odor in and around their coolant. The Quaker Houghton Process Engineer investigated the situation and found the following conditions:

- There was no ammonia odor near the central coolant system
- Used coolant from the central system, when held in hand, also contained no ammonia odor
- The concentration and pH of the coolant were right where they needed to be
- An investigation of the coolant system determined that the ammonia was isolated to one part of the plant
- Further investigation revealed that a large clump of aluminum chips had become lodged in the return trough. A significant amount of coolant had become stagnant behind the large clump of chips. Once the debris was removed and the coolant began to flow freely, the ammonia odor dissipated and did not return

What If You Have Ammonia?

Since the ammonia is microbiologically driven, the first action is to kill the micro-organisms. Most post-dosage biocides work better at a pH less than 9.0, so treat while the pH is below the level where ammonia will be released. After you confirm that the microorganisms have been eliminated, then you need to slowly increase the pH of the system. Be aware that increasing the pH may release the ammonia captured as ammonium in the fluid.

Conclusion

The presence of ammonia is related to microbiological control. Please read our Skill Builder - Bugs (i.e. understanding microorganisms) for more information. Controlling the microbiological growth in the fluid is critical, as is the pH of the fluid. Controlling the pH is also part of concentration control. The other aspect is making sure that the fluid does not get stagnant. Keeping these parameters in check will take you down the correct path for controlling ammonia in your metalworking fluid.

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