Technical Bulletin

Health, Safety and Environmental Affairs – Ammonia Blush or Amine Rush

Ammonia Blush

Ammonia (NH_3) is at standard temperature and pressure (STP) a pungent smelling gas. It is most often seen in manufacturing under pressure as liquid anhydrous ammonia or as anhydrous ammonia gas. When this ammonia gas comes in contact with water it forms a compound called ammonium hydroxide (NH_3OH) if the pH is above about 10.2, and ammonium (NH_4^+) if the pH is below 8.4 (between 10.2 and 8.5 there is an equilibrium established between the ammonia and the ammonium). The ammonium is soluble in water and the ammonia is not. So when the pH of a system drops below 8.5 any ammonia that the fluid is exposed to is converted to ammonium and stored in the system. When the system pH is raised above 8.4 (through the addition of a biocide like GROTAN®, a strong base like sodium hydroxide (NaOH), an amine or any other material that raises the pH+ above 8.4), the ammonium is converted to ammonia and out gasses from the system, and we have a case of ammonia blush!

So the question is not really "what is ammonia blush?" but "how do we prevent it from occurring?" For ammonia blush to occur, the following conditions must be present:

1. the system must have a pH of less than 8.4
2. the pH must be rapidly raised (at pH's above 10.2 no ammonium ions will remain in solution)
3. there must be ammonium ions (NH_4^+) present (in metalworking fluids the source of ammonia is most often bacterial action)

So removing or mitigating any of these three conditions will prevent or reduce the severity of the problem. There are two other situations that seem to correlate with the problem but are not necessarily required:

1. bacteria populations are found to be at 10^{7th} or higher
2. the system is machining or grinding a large percentage of "gray iron"

Thus to prevent ammonia blush, control working pHs so that they remain above 8.4 and control bacterial growth. If the pH has slipped below 8.4, then raise the pH gradually and if possible on an off shift. The "bad news" is that if the problem occurs it can not be "treated", the "good news" is that while the ammonia smell is very unpleasant it will subside, especially with the use of ventilation.

Amine Rush

Amines are organic derivatives of ammonia in which one or more of the hydrogen atoms has been replaced by an alkyl or aryl group. They are important in the metalworking fluid (MWF) industry because they are an effective way of controlling pH, adding reserve alkalinity, and providing both liquid and vapor phase ferrous corrosion prevention. They are typically major building blocks of synthetic and semisynthetic fluids, but are found in soluble oils as well. On occasion it becomes necessary to add concentrated amines to a MWF working solution and a pungent odor results. This odor can be from one of two causes: the pH of the system was below 8.4 and the addition of the amine raised the pH and the ammonium in the solution was converted to ammonia which "out gassed" or the odor is the amines themselves. Amines in general, and those used in metalworking fluids in particular, tend to have fairly high vapor pressures (they evaporate easily). The addition of an amine into the turbulence of a system may cause large quantities of the amine to be volatized. These amine vapors may result in a "pungent odor". This odor is sometimes confused with the ammonia odor and is mislabeled as "ammonia blush". To reduce the probability of having this problem, add the amine a little bit at a time, and if possible add it below the surface of the working solution.

Notes:

1. While anhydrous ammonia is classified as being both toxic and dangerous for the environment, the levels found in an ammonia blush situation are well below the point where H&S issues are a concern. The human nose is sensitive to levels as low as 0.5 ppm while the PEL in the US is 50 ppm and the IDLH is 300 ppm.
2. Ammonia is a metabolic by-product of bacterial activity. They are very much an issue in the ammonia blush condition because not only do they produce ammonia, but some of their other by-products depress the pH+ of the fluid as well.
3. If ammonium (NH^4, this is ammonia NH^3 in solution) is present in a water-based fluid it will increase the conductivity of the fluid and may contribute to corrosion.

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