

Storage and Use of Hydroxylamine Free Base (NH₂OH)

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Date: 2/25/99

Lesson Learned Statement

Very pure 50 wt% hydroxylamine stabilized solutions are considered safe. However, extensive stabilizer additives are vital to their safe storage. Safe handling and storage of these solutions are also affected by contamination with metal ions, excessive temperatures above 35C, inadvertent concentration, and containment. At greater concentrations than 50 wt%, hydroxylamine solutions can be potentially hazardous.

Discussion

This information is published in response to the serious accident with five fatalities at Allentown, PA, on February 19, 1999. The precise cause(s) of the accident is not known at this time [February 25, 1999]. However, enough information is available from the February 19 incident and previous incidents in the DOE involving similar chemicals to generate this general warning about safe storage and handling of 50 wt% hydroxylamine free base solutions, which are readily available on the market and in wide use. These solutions have energy contents around 600 cal/g, which is sufficiently large to result in destructive reactions if the kinetics of decomposition are unfavorable. The Department of Energy published a Technical Report on Hydroxylamine Nitrate, available at http://tis.eh.doe.gov/web/chem_safety/Docs/hydroxylamine.pdf

Analysis

The accident, which killed five people and injured 13 others, resulted in a 4 foot deep by 16- to 18-foot diameter crater and damaged adjacent buildings. Standard blast estimates suggest that such a crater would be formed by about the equivalent of 600 pounds of high explosive. NOTE: It is not clear yet [as of 2/25/99] that the hydroxylamine free base solution actually caused the accident. Solid hydroxylamine sulfate was neutralized with potassium hydroxide, filtered to remove K₂SO₄ precipitate, and then vacuum distilled at 50C to produce 50 wt% HA distillate with proprietary stabilizer package. Evidently, this was the first batch run at full scale (meaning of "full scale" unknown). Reportedly, this distillation had been performed hundreds of times on a smaller scale by the company, Concept Sciences, Inc. The energy density for the pure free base hydroxylamine, NH₂OH, decomposing as $\text{NH}_2\text{OH} \rightarrow \frac{1}{2}\text{N}_2 + \frac{1}{2}\text{H}_2 + \text{H}_2\text{O}$ is 1,240 cal/g for pure hydroxylamine. This is approximately as energetic as TNT. The actual decomposition reaction could be much different and this calculation only shows the worst thermodynamic case. Basis values: NH₂OH deltaHf -27.2 kcal/mol H₂O deltaHf -68.3 kcal/mol m.w. 33.03 g/mol density 1.21 g/cm³ The MSDS for hydroxylamine, which included warnings about contamination with some metals and about not distilling to dryness, recommends refrigeration. Additional recommended precautions include protecting hydroxylamine solutions against contact with any metal, avoiding concentrating hydroxylamine solutions without precautions, and avoiding containment without adequate pressure relief for long term storage. MSDS extract: HYDROXYLAMINE, 50 WT. % SOLUTION IN WATER Hazards LABEL PRECAUTIONARY STATEMENTS CORROSIVE CAUSES BURNS. HARMFUL BY INHALATION, IN CONTACT WITH SKIN AND IF SWALLOWED. HEATING MAY CAUSE AN EXPLOSION. POSSIBLE RISK OF IRREVERSIBLE EFFECTS. POSSIBLE MUTAGEN. TARGET ORGAN(S): BLOOD CENTRAL NERVOUS SYSTEM IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF WATER AND SEEK MEDICAL ADVICE. TAKE OFF IMMEDIATELY ALL CONTAMINATED CLOTHING. WEAR SUITABLE PROTECTIVE CLOTHING, GLOVES AND EYE/FACE PROTECTION. DO NOT BREATHE VAPOR. DO

NOT DISTILL TO DRYNESS. REFRIGERATE. Stability and Reactivity STABILITY STABLE. CONDITIONS TO AVOID DO NOT DISTILL TO DRYNESS. INCOMPATIBILITIES HEAT OXIDIZING AGENTS POTASSIUM DICHROMATE CHROMIUM TRIOXIDE ZINC CALCIUM COPPER SODIUM AMMONIA PHOSPHORUS HALIDES CARBONYLS PYRIDINE HYPOCHLORITES HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS TOXIC FUMES OF: NITROGEN OXIDES HAZARDOUS POLYMERIZATION WILL NOT OCCUR.

Recommended Actions

Accident investigation continues as of 2/25/99. **Originator**

Los Alamos National Laboratory See Concept Sciences, Inc. URL <http://www.csi-ha.com/> and Morning Call, Allentown, PA, Newspaper, with latest stories at URL <http://www.mcall.com/>

Validator: Not applicable

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DOE Function / Work Categories: Conduct of Operations - General

Hazard: Firearms & Explosives; Personal Injury / Exposure - Hazardous Material (General)