

Date: Thu, 25 Feb 1999 15:10:26 -0600  
From: Meredith Brown <racer@lanl.gov>  
Subject: Red Alert: Hydroxylamine Warning

**TITLE: Storage and Use of Hydroxylamine Free Base (NH<sub>2</sub>OH)**

IDENTIFIER: 1999-LA-LANL-ESH7-0003 DATE: February 25, 1999

**LESSONS LEARNED:** 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 being 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. 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.

**Accident Details:** 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 that the hydroxylamine free base solution actually caused the accident.

Solid hydroxylamine sulfate was neutralized with potassium hydroxide, filtered to remove K<sub>2</sub>SO<sub>4</sub> 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, NH<sub>2</sub>OH, 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:

NH<sub>2</sub>OH  $\Delta H_f$  -27.2 kcal/mol

H<sub>2</sub>O  $\Delta H_f$  -68.3 kcal/mol

m.w. 33.03 g/mol

density 1.21 g/cm<sup>3</sup>

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.

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DOE FUNCTIONAL CATEGORY: Conduct of Operations  
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REFERENCES: Concept Sciences, Inc. URL <http://www.csi-ha.com/> and Morning Call, Allentown, PA, Newspaper, with latest stories at URL <http://www.mcall.com/>

**FOLLOW-UP ACTIONS:** Information in this report is accurate to the best of our knowledge. As a means of measuring the effectiveness of this report, please contact the originator of significant action(s) taken as a result of this report or of any technical inaccuracies you find. Your feedback is appreciated.