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Review of Hydrogen Peroxide Material Safety Data Sheets

M. Ventura & E. Wernimont
General Kinetics, LLC
Lake Forest, CA

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Overview

- Toxicity Definition & H2O2
- H2O2 Background
- Typical MSDS
- Non-Natural H2O2
- Natural H2O2
- Personal Exposure (the 1 ppm limit)
- Toxicology Data
- Ecological Data
- Conclusions

Toxicity Definition and H2O2

- Toxic definitions are qualitative
- Injury to humans, likelihood of injury
- H2O2 has a 1 ppm exposure limit, looks toxic
- Prior work has compared with fuels
- Investigate data, especially 1 ppm limit and understand how H2O2 affects humans

H202 Background

- Commercial chemical, wide usage
- 1,000,000 tons/yr. on 100% basis
- Actual usage is at 30 to 70%, larger mass usage
- 40 major sites
- 52,800 people (1982)
- In usage for ~ 100 years
- Bulk is commercial paper, chemicals, etc…
- Used in past as mono-propellant (WWII)
- Replaced by hydrazine and nitrogen oxides
- Currently in revival for certain applications

Typical MSDS

- MSDS has many section, this paper looks at 8, 11, and 12
- Section 8 – Exposure Controls/Personal Protection
  - 1 ppm limit (1.4 mg/cubic meter)
- Section 11 – Toxicological Information
  - Inhalation, ingestion, dermal, ocular
- Section 12 – Ecological Information
  - Aquatic, plants, animals, micro-organisms

Non-Natural H2O2

- Human generated H2O2
- Difficult to reach environment due to waste streams
- Sources: H2O2 plants, pulp, nuclear plants, sterilization, pesticides, detergents, sewage

Natural Sources of H2O2

- Forms in atmosphere – photo-chemical
  - Natural and smog variety
- Forms in water (sea and ground)
  - Photo-chemical and chemical
  - Condenses from air and rains into water
    - More H_2O_2 enters surface water from natural precipitation than all human sources combined
    - Varies with depth
    - Can form in ground water via other reactions

Natural Sources of H2O2 - Continued

- Produced by plants and animals
  - Algae, beetles, humans (breath)
  - Human breath is higher in H2O2 than ambient atmosphere
  - Smoggy or foggy air can have higher H2O2 than human breath
- Vegetables
  - Tomato 3.1 to 3.5 ppm
  - Castor bean 4.7 ppm
  - Potato 7.6 ppm

Natural Sources of H2O2 - Continued

- Atmospheric concentrations
  - Rainwater 0 to 6766 micro-grams/liter
  - Cloud water 0 to 5678 micro-grams/liter
  - Rural air 0.3 to 3 ppb
  - Polluted air 40 to 180 ppb or even 0.18 ppm
  - Deposits in snow, found in glacial ice

Natural Decomposition Rates

- Half life
  - Water 8 to 60 hrs
  - Atmosphere 10 to 20 hrs
  - Soil Minutes to 15 hrs
- Occurs by organic processes and inorganic compounds
- Organic processes use natural catalyst
- H2O2 does not bio-accumulate due to these reactions
- H2O2 has difficulty entering biological systems due to these reactions

Personal Exposure (1 ppm)

- See Table I
- Value is a TWA, very common in several countries
- Higher values permissible for shorter exposure
- Maximum value is 75 ppm for 30 minutes, no respirator
- 1 ppm level is based upon irritation limiting data. Irritation limit is ~ 10 to 20 mg/cubic meter (~ 7 to 14 ppm)
- Actual industrial exposure is consistent with this value (0.1 to 6 mg/cubic meter typical)
- Irritation is to the eyes and mucous membranes

Toxicological Data

- Data is variable depending on the animal study
- Oral toxicity ranges from 75 to 2000 mg/kg
- Humans have died from ingesting > 30% H2O2
- If humans survive, they typical recover in 2-3 weeks
- 1-3% has virtually no effect on skin
- > 50 ppm irritates eyes, used for contact lens
- Effect is altered by amount of natural catalysts (catalase)
- Animals and organs with more catalase more resistant to H2O2
- Mice has less catalase than other animals (rats and humans)
- Mice are more affected by H2O2 than humans and rats

Ecological Data

- Can effect aquatic animals and plants
- Rapidly decomposes in environment, difficult to create contamination
- Terrestrial plants tolerate H2O2 better than aquatic plants
- Mammals are difficult to poison with H2O2 due to catalase and rapid decomposition upon exposure to body, preventing H2O2 from entering into the body significantly

Conclusion

- 1 ppm NIOSH limit is based upon irritation and not toxicity
- Toxicology animal study data must be viewed with caution due to the effect of catalase and other catalysts on results
- H2O2 common chemical in nature and human biological chemistry
- Humans and nature have a familiarity and means of decomposing H2O2, this feature limits the toxicity of H2O2
- Primary impact of exposure to humans is due to physical damage caused by the reaction of the H2O2 with the body (gas evolution, distention, etc..)
- H2O2 is rapidly attacked and decomposed by the environment
- Unique interaction of humans and earth ecology with permit H2O2 to be defined as a truly “green” or “non-toxic” chemical