

# Standard Operating Procedure

## 70% Hydrogen Peroxide

*Laboratory Safety Manual and Chemical Hygiene Plan.*

<b>Department:</b>	Mechanical Engineering
<b>Date SOP was written:</b>	9/3/2015
<b>Date SOP was approved by PI/lab supervisor:</b>	9/3/2015
<b>Principal Investigator:</b>	Amrutur V. Anilkumar
<b>Internal Lab Safety Coordinator/Lab Manager:</b>	Benjamin Gasser
<b>Lab Phone:</b>	615 322 3889
<b>Office Phone:</b>	615 343 7293
<b>Emergency Contact:</b>	A V Anilkumar 615 5126486
<b>Location(s) covered by this SOP:</b>	Olin 413, Olin 515

**Type of SOP:**    ☐ Process            ☒ Hazardous Chemical            ☐ Hazardous Class

### Purpose

Hydrogen peroxide is a clear liquid and strong oxidizer. It is a corrosive chemical that is toxic by ingestion. It may be harmful if inhaled or absorbed through the skin. It can cause severe burns to the digestive tract, respiratory tract, skin, and eyes with irreversible damage. Due to its strong oxidizing properties, hydrogen peroxide has several applications. It is often used as a bleach, cleaning agent, and disinfectant. It can also be used as a rocket propellant. The VADL will use the lowest possible grade of H<sub>2</sub>O<sub>2</sub> ie 70% for its rocket thruster operation.

### Physical & Chemical Properties/Definition of Chemical Group

Class: **Oxidizer, corrosive, toxic**

Molecular Formula: H<sub>2</sub>O<sub>2</sub>

Form (physical state): Liquid

Color: Colorless

Boiling point: 125 °C

### Potential Hazards/Toxicity

Hydrogen peroxide is a strong oxidizer that has a potential to cause a fire or explosion in contact with incompatible materials. It is corrosive and light-sensitive. It is toxic if swallowed. It may be harmful if inhaled or absorbed through the skin. May cause burns to digestive and respiratory tract. It may be destructive to the tissue of the mucous membranes and upper respiratory tract. Cause skin and eye burns. Prolonged exposure may cause dermatitis

### Personal Protective Equipment (PPE)

#### Face & Eye Protection

Always use goggles and a face shield

Use nitrile gloves and avoid cotton clothes

Leather materials can be reactive

Avoid skin contact; immediately wash with excess water.

#### Eye Protection

ANSI approved, tight-fitting safety glasses/goggles. Face shields are also recommended. Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

#### Skin and Body Protection

Flame resistant lab coat, long pants, no skin exposed below waist, and closed-toe shoes.

#### Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

Work with hydrogen peroxide should be conducted in a chemical fume hood unless other controls are designated in the Protocol/Procedure section, as the presence of forced exhaust ventilation for engine testing.

### First Aid Procedures

#### If inhaled

Move person into fresh air.

#### In case of skin contact

Wash off with soap and plenty of water for at least 15 minutes while removing contaminated clothing. Consult a physician.

#### In case of eye contact

Rinse thoroughly with plenty of water for at least 30 minutes lifting upper and lower eyelids and removing contact lenses. Consult a physician. Continue rinsing eyes during transport to hospital.

#### If swallowed

Do not induce vomiting; give 2-4 cupfuls of water or milk. Rinse mouth with water. Consult a physician.

## Special Handling and Storage Requirements

### Working alone

**Never work alone with extremely hazardous materials/operations. Never work without adult supervision.** Always conduct experiments with properly vented exhausts. Use the lowest volume required.

**Precautions for safe handling:** Avoid contact with skin, eyes, and clothing. Avoid inhalation and ingestion. Ensure adequate ventilation. Keep away from sources of ignition- No smoking.

**Conditions for safe storage:** Keep container tightly closed in a dry and well-ventilated area. Opened containers must be carefully resealed and kept upright to prevent leakage. Recommended storage temperature is 2-8 °C. Store protected from light. Store away from combustible materials or other chemicals that are easily oxidized. Avoid alkalies, oxidizable material, alcohols, permanganates, zinc, powdered metals, iron, copper, nickel, brass, iron and iron salts. If not in use, hydrogen peroxide should be stored in a dark cool place. Once done using hydrogen peroxide, it should be immediately put back in the dark cool storage location. Store and transport hydrogen peroxide in secondary containment (for example polyethylene bottle carrier).

## Spill and Accident Procedure

**Never handle more than 200mL of H<sub>2</sub>O<sub>2</sub> at a time.**

**Spill** – Assess the extent of danger. Help contaminated or injured persons. Evacuate the spill area. Avoid breathing vapors. If possible, confine the spill to a small area using a spill kit or absorbent material. Keep others from entering contaminated area (e.g., use caution tape, barriers, etc.). If you have training, you may assist in the clean-up effort. Use appropriate personal protective equipment and clean-up material for chemical spilled. Double bag spill waste in clear plastic bags, label and take to the next chemical waste pick-up.

**Chemical Spill on Body or Clothes** – Remove clothing and rinse body thoroughly in emergency shower for at least 15 minutes. Seek medical attention. *Notify supervisor and EH&S immediately.*

**Chemical Splash Into Eyes** – Immediately rinse eyeball and inner surface of eyelid with water from the emergency eyewash station for 15 minutes by forcibly holding the eye open. Seek medical attention. *Notify supervisors immediately.*

## Medical Emergency Dial **911**

## Decontamination/Waste Disposal Procedure

### Label Waste

- Hydrogen Peroxide waste should be placed in a chemically compatible container with a sealed lid and clearly labeled.

### Store Waste

- Store hazardous waste in closed containers, in secondary containment and in a designated location
- Double-bag dry waste using transparent bags.
- Waste must be under the control of the person generating & disposing of it

### Dispose of Waste

- Dispose of regularly generated chemical waste within 6 months.

## Protocol/Procedure

CAS#: 7722-84-1

<b>Preparation</b>	<p>Know the location of the nearest fire extinguisher, eyewash, and safety shower before beginning work.</p> <p><b>Handle hydrogen peroxide in smallest quantities suitable for the experiment design.</b> The reagent slowly decomposed with time.</p>
<b>Lab-Specific Information</b>	<p>Never work alone. Make sure there is another worker present who is also trained in the hydrogen peroxide SOP.</p> <p>All work for this procedure is to take place in the designated fume hood. Wear proper PPE.</p> <p>Keep hydrogen peroxide containers tightly closed and stored in a dark cool place away from incompatible substances.</p> <p><i>Never shake or violently perturb hydrogen peroxide solutions.</i></p>

Procedure/Use	Scale	Engineering Controls/Equipment	PPE (eye, face, gloves, clothes)	Procedure Steps and Precautions
1. Use in oxidations	Use no more than 200 ml (commercially available 70% diluted aqueous solution) per reaction.	<p>Work with hydrogen peroxide should never be performed alone.</p> <p>All work using hydrogen peroxide must be performed in a ventilated fume hood or area.</p> <p>Eliminate ignition sources such as open flames, hot surfaces, steam baths, static electricity, and operation of mechanical and electrical equipment that is not intrinsically safe.</p> <p>Ensure proper grounding and avoid creating static electricity. Be sure to ground metal containers when transferring flammable liquids.</p> <p>A blast shield should be utilized when working with</p>	<p><b>Eye protection:</b> Wear tight-fitting safety goggles or safety glasses with side shields.</p> <p><b>Face protection:</b> Wear goggles or full-faced shield with goggles</p> <p><b>Gloves:</b> Nitrile gloves (double gloved) for dilute hydrogen peroxide solutions and heavy nitrile or neoprene gloves for handling concentrated solutions. Extended contact should never occur.</p> <p><b>Clothing:</b> Wear fire/flamm resistant lab coat (100%</p>	<p>Non-oxidizable solvents should be used for reactions with hydrogen peroxide.</p> <p>Reducing agents can violently react with hydrogen peroxide so care should be used.</p> <p>1. An adequate amount of hydrogen peroxide measured with a clean and dry syringe.</p> <p>2. Carefully add dropwise to a precooled reaction mixture.</p> <p>Hydrogen peroxide can be a potential explosive and thus temperature control over reactions with hydrogen peroxide are required.</p> <p>Exposure of the reaction to light should be minimized as hydrogen peroxide can</p>

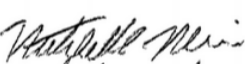
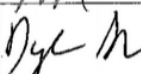
## Vanderbilt Aerospace Design Laboratory

		higher concentrations of hydrogen peroxide	cotton based); an acid resistant apron; cotton based clothing/attire; full length pants or equivalent; and close-toed, close-heeled shoes.	decompose upon exposure to light.  3. After completion, an adequate amount of sodium thiosulfate should be added to reactions so as to neutralize the hydrogen peroxide.
--	--	--	--	--

### Documentation of Training (signature of all users is required)

- Prior to conducting any work with hydrogen peroxide, designated personnel must provide training to his/her laboratory personnel specific to the hazards involved in working with this substance, work area decontamination, and emergency procedures.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.
- The Principal Investigator must ensure that his/her laboratory personnel have attended appropriate laboratory safety training or refresher training within the last one year.

I have read and understand the content of this SOP:

Name	Signature	Identification	Date
Andrew Voss		SENIOR	9/9/15
Mitchell Masia		SENIOR	9/9/15
Robinson Rutherford		SENIOR	9/9/15
Dylan Shane		SENIOR	9/9/15
Justin Broughton		SENIOR	9/9/15
Matthew Kelley		SENIOR	9/9/15
David Hirsch		SENIOR	9/10/15
Andrew Martin		SENIOR	9/9/15
Quinlan Monk		SENIOR	9/9/15

## **Hydrogen Peroxide (H<sub>2</sub>O<sub>2</sub>) Safety and Handling Guidelines**

### **H<sub>2</sub>O<sub>2</sub> setup**

Hydrogen peroxide is well-established as an environmentally-friendly, deodorizing and bleaching agent. Its uses include organic and inorganic chemical processing, textile and pulp bleaching, metal treating, cosmetic applications, catalysis of polymerization reactions, municipal odor control, industrial waste treatment (detoxification), and control of bulking in wastewaters. These uses are continually expanding, making it a necessity not only to understand the mode of hydrogen peroxide application but the safe handling of the chemical as well.

### **Properties of Hydrogen Peroxide**

A basic understanding of the properties of hydrogen peroxide is essential to the safe handling of this chemical. Hydrogen peroxide is clear, colorless, water like in appearance, and has a characteristic pungent odor. Nonflammable, it is miscible with water in all proportions and is sold as a water solution.

The amount of hydrogen peroxide in commercial solutions is expressed as a percentage of the solution's weight. Thus, a 35% solution contains 35% hydrogen peroxide and 65% water by weight. Most municipal and industrial applications call for 35% or 50% concentrations.

### **Delivery and Storage**

The methods available for delivery to bulk storage installations accommodate shipments of 70% hydrogen peroxide for dilution to the 35% or 50% storage concentrations. Solutions containing more than 8% hydrogen peroxide are classified by the U.S. Department of Transportation (DOT) as an oxidizer.

Under normal conditions hydrogen peroxide is extremely stable when properly stored. Rate loss in large containers such as tanks is less than 1% per year at normal ambient temperatures; in small containers, such as drums, rate loss is

less than 2% per year. The larger the ratio of the storage container surface areas to the volume of hydrogen peroxide, the greater the rate loss.

Decomposition of hydrogen peroxide liberates oxygen and heat. In dilute solutions the heat evolved is readily absorbed by the water present. In more concentrated solutions, the heat raises the temperature of the solution and accelerates the decomposition rate. Special stabilizers are added during the manufacture of all grades of hydrogen peroxide to inhibit the catalytic decomposition effect of metals and other impurities that may accidentally contaminate the chemical during shipment, storage, and handling.

However, since no additive will prevent decomposition if excessive contamination occurs, the best practice is to prevent contamination through proper handling. All handling procedures must, therefore, be directed towards maintaining the same degree of purity and freedom from contamination as is maintained during the manufacturing process:

Storage of hydrogen peroxide should be restricted to its original shipping container or to properly designed containers made of compatible materials which have been thoroughly passivated.

**Hydrogen peroxide that has been removed from the original shipping container should not be returned to it.**

All containers must be properly vented, and preferably stored away from sources of direct heat and combustible materials.

Adequate ventilation and ample water supply for thorough flushing of accidental spillage on personnel and property should be provided.

Hydrogen peroxide itself will not burn, but its decomposition liberates oxygen which supports combustion. Fires involving hydrogen peroxide are best controlled by using large quantities of water.

Hydrogen peroxide is not considered an explosive. However, when it is mixed with organic substances at significant concentrations, hazardous impact-sensitive compounds may result. Small amounts of other materials that contain catalysts (silver, lead, copper, chromium, mercury, and iron oxide rust) can cause

rapid decomposition and an explosive pressure rupture of the containing vessel if it is not properly vented.

In addition to accelerated decomposition through contamination, the decomposition rate of hydrogen peroxide is increased with alkalinity, contact with certain materials of construction, and increasing temperatures. The rate of decomposition increases approximately 2.2 times for each 10 degrees C rise in temperature in the range from 20 degrees C to 100 degrees C, or 1.5 times for each 10 degrees F rise from 68 degrees F to 212 degrees F.

Decreasing temperatures have little effect on hydrogen peroxide until they drop substantially below 0 degrees C. Crystals do not begin to appear in 35% and 50% solutions until -33C (-27.4F) and -52.2C (-62F), respectively.

### **Eye Protection**

Hydrogen peroxide and its decomposition products are not systematic poisons but contact with hydrogen peroxide can be irritating. Concentrated vapors cause discomfort in the mucous membranes and the eyes. Contact of the eyes with hydrogen peroxide is particularly dangerous because corneal burns can occur very rapidly. Therefore, safety glasses or, preferably, goggles should always be worn when handling concentrated hydrogen peroxide. If, however, any hydrogen peroxide does get in the eyes, flush eyes thoroughly with water and consult a physician promptly.

### **Protective Clothing**

In addition to eye protection, rubber gloves and suitable protective clothing such as aprons or coveralls made of polyester acrylic fiber, polyvinyl chloride, polyethylene, or neoprene should be worn when handling concentrated hydrogen peroxide. Protective clothing, which lacks fire resistance, must be washed thoroughly with water should it come in contact with hydrogen peroxide. If allowed to dry in the fabric, the chemical may cause fire, particularly if the clothing is soiled.



Contact with moderate concentrations of hydrogen peroxide will cause whitening of the skin and stinging sensations. The whitening is due to the formation of gas bubbles in the epidermal layer of the skin. The stinging, in most cases, subsides quickly after thorough washing, and the skin gradually returns to normal without any damage. Highly concentrated hydrogen peroxide can cause blistering if left on skin surfaces for any length of time.

Inhalation of hydrogen peroxide vapors can cause irritation and inflammation of the respiratory tract. For this reason, the American Conference of Government Industrial Hygienists has determined a Threshold Limit Value (LTV) or 1 ppm (1.4mg/m<sup>3</sup>) of hydrogen peroxide vapor in air as a maximum exposure limit for any eight-hour workday of a normal 40-hour work week. If hydrogen peroxide vapor is inhaled, fresh air should be sought at once; if the inhalation has been prolonged, a physician should be consulted immediately.

### **Accidental Swallowing**

Hydrogen peroxide, a mild disinfectant, is useful in counteracting various microorganisms. Because of their antiseptic action, dilute hydrogen peroxide solutions (3% or less) are frequently used to treat open wounds and can be used as a gargle or mouthwash. However, contact or concentrated solutions (over 3%) with the members of the mouth is to be avoided. Under no circumstances should hydrogen peroxide be taken internally. If hydrogen peroxide is swallowed, drink water immediately to dilute, and contact a physician but do not attempt to cause vomiting.

In using hydrogen peroxide, safety should be first in the minds of everyone, and as with any other chemical, initial steps should be taken to familiarize all personnel with its safe and proper handling. Acceptance of hydrogen peroxide in a wide variety of industrial applications is a reflection of its simplicity in use.

Maximum safety in handling hydrogen peroxide is assured through the use of proper materials of construction, recognition of the need for venting in storage, and overall avoidance of contamination. The oxygen and water by-products of decomposition are innocuous, but splashing, inhaling vapor, and ingesting hydrogen peroxide must be avoided. If by unusual circumstances an accident

**should take place, flushing with large quantities of plain water is the simple corrective action needed. By adhering to straight-forward common sense procedures, every aspect of your operation will be aimed toward safety and a clean environment.**

**- FMC Pollution Control Release No. 24**