Trent University

Standard Operating Procedures

   

Dangerously Reactive Materials

*This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with this chemical or procedure. This SOP is generic in nature and only addresses safety issues specific this chemical or procedure. In some instances, several general use SOPs may be applicable for a specific chemical. Upon completion, forward this SOP to the ESHO, Human Resources for approval.*

**Introduction**:

What are Dangerously Reactive Materials:

Dangerously Reactive Materials are chemicals (liquids or solids) which may

* undergo vigorous polymerization, condensation or decomposition
* become self-reactive under conditions of shock or increase in pressure or temperature
* react vigorously with water to release a lethal gas

**Vigorous Polymerization:**

Polymerization is a chemical reaction in which many small molecules (monomers) join together to form a large molecule (polymer). Often the reaction produces heat and pressure. Industry carries out these processes under closely monitored conditions. Other chemicals (catalysts and initiators) and controlled amounts of heat, light and pressure are often involved.

Vigorous polymerization is potentially hazardous because the reaction may get out of control. Once started, the reaction is accelerated by the heat that it produces. The uncontrolled buildup of heat and pressure can cause a fire or an explosion, or can rupture closed containers. Depending on the material, temperature increases, sunlight, ultraviolet (UV) radiation, X-rays or contact with incompatible chemicals can trigger such reactions.

Many pure substances (i.e. uninhibited) can undergo vigorous polymerization quite easily by themselves when they are heated slightly or exposed to light. These include:

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| Acrylic acid | Acrylnitrile | Cyclopentadiene |
| Diketene | Ethyl acrylate | Hydrocyanic acid |
| Methacrylic acid | Methyl acrylate | Vinyl acetate |

**Vigorous Condensation:**

Condensation is a chemical reaction in which two or more molecules join together to form a new substance. Water or some other simple substance may be given off as a by-product. Some polymers, such as nylon, can be formed by condensation reactions.

Vigorous condensation can produce more energy than the surroundings can safely carry away. This could cause a fire or explosion, or rupture closed containers.

Few common pure chemicals undergo vigorous condensation by themselves. Some members of the aldehyde chemical family, including butyraldehyde and acetaldehyde, condense vigorously, but bases or sometimes strong acids must also be present. Some commercial products sold to be mixed for specialized applications may undergo vigorous condensation if they are not stored, handled and used as directed by the chemical supplier.

**Vigorous Decomposition:**

Decomposition is a chemical change in which a molecule breaks down into simpler molecules. Vigorous decomposition is potentially hazardous because large amounts of energy can be released very quickly. This could result in a fire or explosion, or rupture a closed container causing the release of dangerous decomposition products. Some pure materials are so chemically unstable that they vigorously decompose at room temperature by themselves. For example, some organics are relatively safe only when refrigerated or diluted.

**Self Reactive under conditions of shock or increase in temperature or pressure:**

Materials in this group are chemically very unstable. Depending on the material, they can react vigorously and, in some cases, explosively under conditions of mechanical shock such as a hammer blow or even slightly elevated temperature or pressure. Materials in this category include:

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| Ammonium perchlorate | Azo and diazocompounds | Acetylides |
| Azides | Fulminates | Hydrogen peroxide solutions (91% by wt) |
| Many organic peroxides | Nitro and nitroso compounds | Nitrate esters |
| Perchloric acid slutions (>72.5% by wt (see Perchloric Acid Use SOP) | Picrate salts | Trizaines and some expoxy compounds |

**Vigorously reactive with water to release deadly gas:**

Some materials can react vigorously with water to rapidly produce gases which are deadly at low airborne concentrations. For example, sodium or potassium phosphide release phosphine gas when they contact water. Alkali metal cyanide salts, such as sodium or potassium cyanide, slowly release deadly hydrogen cyanide gas on contact with water. The cyanide salts of alkaline earth metals such as calcium or barium cyanide react at a faster rate with water to produce hydrogen cyanide gas. This can result in a life-threatening problem in confined spaces or poorly ventilated areas.

Large amounts of corrosive hydrogen chloride gas are rapidly released when water reacts with aluminum chloride, phosphorous trichloride, tin chloride and chlorosilane compounds. When water contacts thionyl chloride or sulphuryl chloride, they decompose rapidly giving off sulphur dioxide gas and hydrogen chloride gas.

Treat all unknown materials as very hazardous until they are positively identified.

**Toxicology**: Dangerously reactive liquids and solids can be extremely hazardous. Accidental or uncontrolled chemical reactions are important causes of severe personal injury and property damage. Rapid release of very toxic or corrosive gases occurs when water contacts some dangerously reactive materials. In addition, many dangerously reactive materials are themselves toxic or very toxic. Depending on the material, route of exposure (inhalation, eye or skin contact, or swallowing) and dose, they could harm the body. The Safety Data Sheet (SDS) should describe what these hazards are for the particular product you are working with.

**Controls**

Some dangerously reactive chemicals may have inhibitors added to them. An inhibitor is a chemical that is added to a material to slow down or prevent an unwanted reaction such as polymerization. Inhibitors are added to many materials that can polymerize easily when they are pure.

Inhibitor levels in materials may gradually decrease during storage even at recommended temperatures. At storage temperatures higher than recommended, inhibitor levels can decrease at a much faster rate. At temperatures lower than recommended, the inhibitors may separate out. This action can result in some part of the material having little or no inhibitor.

Some inhibitors need oxygen to work effectively. Chemical suppliers may recommend checking oxygen and inhibitor levels regularly in stored materials and adding more if levels are too low.

Vapours from inhibited materials do not contain inhibitors. If these vapours condense and form polymers, they can block vents or flame arrestors in process equipment or containers.

**Personal Protective Equipment:**

**Eye protection:** refer to the SDS for the chemical you are using.

**Skin protection:** refer to the SDS for the chemical you are using.

**Respiratory protection:** refer to the SDS for the chemical you are using.

**Handling Procedures:** refer to the SDS for the chemical you are using.

**Emergency Response:** refer to the SDS for the chemical you are using.

**Disposal of Waste:** refer to the SDS for the chemical you are using and to the Chemical Waste procedures.

**Please list the compounds used by this research group which are covered by this procedure. The list should also include the building/room where they are used.**

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**Lab Specific Protocol/Procedure:**

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I agree that I have read this SOP and will follow the procedures described above. Any deviation from this SOP or the SDS for the specific chemical(s) in use will only occur to make a safer situation.

Principal Investigator’s Signature/Date

**Upon completion forward to the Environmental Health and Safety Officer, Human Resources**

**EHSO approval: Signature/Date**

**Revision date:** Dec 2019

Reference: Canadian Center for Occupational Health and Safety