**"Perchloric Acid is one of the most challenging designs for a Mechanical HVAC designer"**

Working with a reliable Manufacturer that is experienced and knowledgeable can make all the difference in a safe and successful installation.

Perchloric acid presents a severe corrosion problem to materials such as epoxy coated mild steel, 304 and 316 stainless steel. The most effective materials to fight corrosion attack from Perchloric acid are PVC and FRP as described in this webpage. Perchloric acid also has the unique property of becoming explosive when dried and crystallized. The results of this potentially explosive safety hazard require Perchloric exhaust systems to either install a high efficiency scrubber or incorporate flushing rings every 6 feet with the discretion of the designing engineer. Each duct run is unique, and spray nozzles should be placed to wash all surface area inside the duct walls.

Plasticair has two solutions to Perchloric Acid Exhaust Systems. Our FHS-Series of fume hoods removes 96%-99% of Perchloric acid before it even exits the fume hood, and the Plasticair Venturi By-pass systems (BVS -Series) safely ventilates Perchloric acid with no moving parts in the airstream and provides high velocity discharge with clean gas dilution.

**General Information Report for Perchloric Acid**

Introduction

Perchloric acid (HClO4) is a water-white liquid (water soluble), it has no odor, the boiling point at atmospheric pressure is 203C, and under high vacuum, a 73.6% composition can be produced. The acid can be dangerously reactive and is very corrosive. At ordinary temperatures, 72% Perchloric acid reacts as a strong non-oxidizing acid. At elevated temperatures approximately 160C, it is an exceedingly strong and active oxidizing agent as well as a strong dehydrating agent.

Cold Perchloric acid, 70% or weaker, is not considered to have significant oxidizing power. Acid of 73%+ (which gives off fumes in even relatively dry air) is a fairly good oxidizer at room temperature. The monohydrate of Perchloric acid (85% acid strength and a solid) is indeed a very good oxidizer at room temperature, as it will even react with gum rubber, whereas the 73% acid does not. Contact with combustible material at elevated temperatures may cause fire or explosion. It should be known that Perchloric Acid, when in crystalline form, may be unstable, possibly leading to combustion of the accumulation.

**Safety Considerations**

Personal safety should be highly regarded, especially when dealing with chemicals. It is recommended that one wears positive pressure self-contained breathing apparatus (SCBA), when entering an area where Perchloric Acid is stored or handled. Perchloric acid use has long been associated with some violent explosions. From a safety viewpoint, one main feature of the accidents has been the severity of the accident and the fact that the persons involved are often experienced workers. The basic cause of accidents involving Perchloric acid is due to contact with organic material, or a reducing material. For any use of the acid, a review of the MSDS from each manufacturer is strongly recommended.

When considering the hazards involved in the use of Perchloric acid it should be clearly recognized that many of the reported serious laboratory accidents involved only small quantities (<1g) of reactant. These accidents occurred, even though experienced and qualified personnel were handling the reactant. The CRC Handbook of Laboratory Safety cites the Perchloric acid-Acetic Anhydride-Acetic Acid system, which, if used improperly, can lead to explosions.

The example shows that 1 g of the mixture instantaneously produces about 7 liters of gas at the explosion temperature of 2400C. There are many other illustrations and examples, but several things should be very clear to the reader. Specifically, no one should attempt to use Perchloric acid who is not fully conversant with the chemistry of the material, who has not made a careful appraisal of the operating conditions and techniques, and who exhibits any unsafe attitude about their work. Each user of the material should also recognize that any acid digestion type usage must occur in a designated Perchloric acid fume cupboard. Finally, each user should recognize that dangerous secondary reactions can occur with reactive Perchlorate compounds formed from the acid liquid or vapors in fume cupboards, storage cabinets, and laboratory benches or floor areas.

**Potential Health Effects**

Inhalation: Inhalation of concentrated vapors may cause serious damage to the lining of the nose, throat, and lungs. Breathing difficulties may occur. Neither odor nor degree of irritation are adequate to indicate vapor concentration.

Ingestion: Swallowing can cause severe injury leading to death. Symptoms include sore throat, vomiting, and diarrhea. Ingestion of as little as 1.0 ml has resulted in perforation of the esophagus.

Skin Contact: Contact with concentrated solution may cause serious damage to the skin. Effects may include redness, pain, skin burns. High vapor concentrations may cause skin sensitization.

Eye Contact: Eye contact with concentrated solutions may cause severe eye damage followed by loss of sight. Exposure to vapor may cause intense watering and irritation to eyes.

Chronic Exposure: Repeated or prolonged exposures may cause darkening of the skin, erosion of exposed front teeth, and chronic inflammation of the nose, throat, and bronchial tubes.

Aggravation of Pre-existing Conditions: Persons with pre-existing skin disorders or eye problems, or impaired respiratory function may be more susceptible to the effects of the substance.

First Aid Measures

Inhalation: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

Ingestion: DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Skin Contact: In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Call a physician.

Eye Contact: Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

**General Considerations for equipment:**

For conventional wooden wall construction, which is [not] desirable, it is highly recommended that a 6-inch concrete curb be provided for the walls to rest on. In this way, acid seepage under the wall is minimized.

Concrete of course, is not resistant to acids, and thus should be covered. Epoxy paints in general are resistant to room temperature Perchloric acid spills; however, epoxy paint will peel off concrete if pools of water stand for several days. Therefore, the floor should have a gentle slope to a drain and contain no low spots.

No equipment of any kind should ever be bolted to a floor by using bolts that screw into the floor. Perchlorates can enter and form hazardous metallic Perchlorates that can be initiate a detonation when the bolt is removed. Studs, firmly and permanently set into the floor to which the equipment can be bolted, are far safer. The nuts can then be flushed with water and sawed off with a hacksaw under a constant water spray or remove that equipment.

Laboratory benches: Laboratory benches should be constructed of resistant materials and not wood, to prevent acid absorption, especially at the bottom surface which rests on the floor and would be subject to the greatest exposure from acid spills. Bench tops of resistant and non-absorbent materials such as chemical stoneware, tile, epoxy composites, Viton, tantalum, chemically pure titanium, zirconium, niobium, Hastelloy C (slight corrosion rate), PVC, Teflon, polyethylene, polypropylene, Kel-F, vinylidene fluoride, Saran, epoxy resins, glass, glass-lined steel, alumina, and Fluorolube are recommended.

Shelves and cabinets: Shelves and cabinets of epoxy-painted steel are highly recommended over wood.

Heating source: Hot plates (electric), electrically or steam-heated sand baths, or a steam bath are recommended for heating Perchloric acid. Direct flame heating or oil baths should not be used.

Vacuum source: It is highly recommended that an exhaust system, with no moving parts, be used. The exhaust fan motor shall not be installed in the ductwork and the pulley shall be conductive as specified by NFPA 45. An induced draft system, located outside the laboratory, could be used. Equip the ventilation system with a built-in water wash-down system. Ensure that the system will adequately spray all interior surfaces of the ducting, tack, fan, plenum, baffles, and hood. The hood shall be washed down at least each day after use or more frequently if specified in a safety plan. The water shall be drained to an appropriate holding tank pending removal for treatment and disposal.

Glassware: The hazards that may ensue if an apparatus cracks or breaks due to thermal or mechanical shock are sufficient to make it desirable that quartz apparatus be considered, especially as it is necessary in many experiments to chill rapidly from the boiling point. Glass-to-glass unions, lubricated with 72% Perchloric acid, seal well and prevent joint freezing arising from the use of silicon lubricants. Rubber stoppers, tubes, or stopcocks should not be used with Perchloric acid due to incompatibility.

Stirrers: Pneumatically driven stirrers are recommended rather than the electric motor type. Repeated exposure of the motor windings to Perchloric acid vapor could result in a fire, unless the motor is an explosion-proof type, which would be unlikely.

Sundry items: The choice of tongs for handling hot flasks and beakers containing Perchloric acid mixtures should be given due thought. Since the use of radioactive materials has become commonplace, much thought has been put into the design of indirect handling equipment. The cheap, commonly used crucible tongs are most unsuitable for picking up laboratory glassware. If possible, tongs with a modified jaw design should be used to ensure that a safe grip is obtained.

Spills: Perchloric acid spilled on the floor or bench top represents a hazard. It should not be mopped up, nor should dry combustibles be used to soak up the acid. The spilled acid should first be neutralized and then soaked up with rags or paper towel. The contaminated rags and paper towel must be kept wet to prevent combustion upon drying. They should be placed in a plastic bag and sealed and then placed in a flammable waste disposal can. If the spill can be rinsed down a chemical drain, neutralization of the wetted area is recommended followed by additional rinsing.

Other recommendations include wearing a face shield and gloves while working on the spill. Cover the spill with a weak solution of sodium thiosulfate, and then transfer the slurry into a large container of water, where it should be neutralized with soda ash. After neutralization, it can be drained into the sewer, accompanied by abundant water.