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Treating Waste Water Containing Hexavalent Chromium from Aerospace and Air Craft Stripping and Painting Operations

Introduction:

The purpose of this paper is provide information on hazardous compounds found in aircraft washing, stripping and painting operations. These compounds include Hexavalent Chrome, Phenol, Methylene Chloride and Formaldehyde. This paper also provides an introduction to treating the wash waters generated in aircraft washing so that the treated water may be re-used or discharged to the city sewer.

What is Hexavalent Chromium?

Hexavalent Chrome, chemical symbol Cr(VI) also written as Cr(6) ,is a toxic form of chrome that is known to cause cancer and other serious health effects. The number 6, indicates what is called the valence state, or electron charge on the chrome atom. In this case Chromium has a positive 6 charge. For this paper, it is only important to know that chrome can be in two very different forms, Hexavalent Chrome 6 and Trivalent Chrome, Chrome 3. The major difference, and the most important difference is that Hexavalent Chrome is both cancer causing and water soluble where Trivalent Chrome is not cancer causing and it is not soluble in water.

How are people Exposed to Hexavalent Chrome in Air Craft Stripping and Painting Operations?

Aircraft are made of aluminum, and unfortunately, aluminum corrodes. To prevent corrosion an aircrafts aluminum frame, body, and outside skin of the aircraft are typically treated with a three layer protective coating. The first layer is called a conversion coating. The conversion coating is sprayed onto the aluminum parts of the aircraft and has a light green color. The conversion

coating contains the metal Hexavalent Chrome. Hexavalent Chrome is the protective agent in the coating process. However, Hexavalent Chrome is a known carcinogen. The aircraft also receives a primer coat that is applied over the conversion coat. The primer coat also contains Hexavalent Chrome. And finally the aircraft receives a final coat of paint known as the top coat. Metals such as chrome, zinc, and cadmium may also be found in the top coat or final finish to give the paint the desired color.

Exposure can be from inhalation of dry Hexavalent Chrome, paint spray mist or from internal ingestion. Inhalation exposure can occur during the painting of aircraft exteriors, interiors or parts. Exposure can also occur during the stripping of paint in preparation for a new coating.

Since Hexavalent Chrome is water soluble, both wash and rinse waters may contain chromium. This creates an exposure pathway from contact or ingestion of the wash waters. The aircraft are usually washed before a chemical paint-stripping compound is applied. After application of the stripping compound the stripping chemical along with the removed paint is washed off with water. The stripping process usually requires a minimum of two applications of the stripping compound and subsequent rinsing. It may take as many as three applications.

What are the potential Health Effects of exposure to Hexavalent Chrome.

Inhalation of Hexavalent Chrome either from spray painting or inhalation of dry paint dust can occur.

Health effects from inhalation of spray mist or dust may include:

- Lung, throat and nasal passage cancer or damage.
- Lung, eye, nose and throat damage.
- Contact dermatitis, irritation and skin ulcers.

Health effects from Ingestion from paint spray mist or ingestion of water containing Hexavalent Chrome may Include:

- Nausea
- Various cancers

Ingestion from paint spray mist or ingestion of wash water containing Hexavalent Chrome should be avoided.

What are EPA Pretreatment Regulations for Hexavalent Chromium?

The EPA Pre-Treatment Regulations require all industrial wash waters to meet a set of minimum discharge criteria. While the criteria covers a variety of compounds, we are only addressing the chemicals of concern found in washing, stripping, rinsing and painting aircraft. EPA sets Hexavalent Chrome at a maximum limit 0.05 mg/l. Concentrations found in aircraft wash waters are far higher and require treatment before disposal or re-use.

What About Other Chemicals in the Wash Water?

Typical stripping compounds are a gel like liquid and contain several chemicals that negatively impact the wash water. Stripping compounds commonly contain phenol, methylene Chloride and formaldehyde.

The EPA regulates the presence of these compounds in waste water that is to be sent to a sanitary sewer.

Note: Some states have adopted more stringent regulations. Always check your industrial sewer ordinances for compliance.

Chemical Oxygen Demand, COD in Aircraft Wash Water

In addition to the specific compounds found in the stripping gel, these chemicals add to COD (Chemical Oxygen Demand) of the waste water. COD is used by the EPA and the local regulators as a measure of the waste water strength. For example household waste water generally has a COD of around 350 mg/l, where

aircraft wash water will average around 3,000 mg/l and can spike as high as 20,000 mg/l. COD discharge limits are usually around 350 mg/L to 500 mg/l.

The local sanitary sewage authority will often charge a per gallon fee to treat waste water with a high COD. Check your water bill to see if you are being charged.

How do I treat the wash and rinse water?

The wash and rinse water should be treated to remove both the Hexavalent Chromium and the organic compounds; Phenol, Methylene Chloride and Formaldehyde and to lower the COD.

What About Biological Treatment?

Although very common, biological treatment will not work in this application, for several reasons. 1. The chromium cannot be removed in a biological process. The microbes may consume some chrome but they cannot digest it and it simply goes back in to the waste water through excrement or decay of dead microorganisms. 2. Phenol and Formaldehyde (embalming fluid) are toxic to microorganisms. Low concentrations of these compounds will kill or hinder microbial growth needed to treat the waste water biologically. 3. Methylene Chloride, while not toxic, is not easily degraded in a biological process.

What about UV Oxidation?

UV oxidation can oxidize the organic compounds but not the Hexavalent Chrome. UV oxidation can be used in conjunction with other treatment methods. UV Oxidation is also expensive.

What Reverse Osmosis or Micro Filtration?

The issue here is that these methods only treat about 1 gallon for every 5 gallons of waste water. What to do you do with the extra waste water?

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What About Ion Exchange?

Ion exchange resins are available for removing Hexavalent Chrome. Resins are expensive and can be exhausted quickly when Hexavalent Chrome concentrations are higher than 100 m/l. Ion exchange resins may be used as a polishing step after removal by precipitation. They will not remove organics or lower the COD.

Aircraft Wash Waters, Generally Require a Two Step Process?

Treating the waste water for both the organic compounds, Phenol Methylene Chloride, Formaldehyde and COD, and removing the Hexavalent Chrome generally requires a two step process.

Step one is the oxidation of the organic chemicals and lowing the COD. While this is not the only way, the simplest and the most cost effective is a process know as the Fenton Process. Oxidation is accomplished by what is know as the Fenton Reagent. The Fenton reagent is a powerful oxidant that is produced by Hydrogen Peroxide in the presence of dissolved iron. The iron acts as a catalysis to produce Hydroxyl Radicals from the hydrogen peroxide. These radicals react with and convert the organic compounds to Carbon Dioxide and Water. This process has been around for a long time, it is well understood and it works. To learn more about the Fenton process see our article Entitled "Oxidation of Organics using the Fenton Reagent". Link to the paper is: http://wilsonemi.com/chemical-oxidation-organics-using-fentons-reagent/ This process is most easily controlled when done in a batch process.

When done in a batch tank, Hexavalent Chrome can also be removed by simple precipitation. This is accomplished by converting the Cr(IV) to Cr(III) which is the insoluble form, followed by precipitation. This can all be accomplished in the same tank.

For More Information

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