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TITLE
Heavy Metal Treatment
Minnesota Association of Metal Finishers
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HAWKINS

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HEAVY METAL TREATMENT

- Definitions of associated terminology involved in removing metals
- Overview of wastewater systems for heavy metal removal
- Discussion of removing heavy metals from waste streams
- Stages of operation for wastewater treatment
- Chemistry of removing metals by precipitation
- Industrial wastewater equipment

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WHY DO WE NEED TO TREAT?

- **Industries needing metal removals include mining, aircraft, plating shops, wastewater generators such as oil and chemical industries.**
- **Compliance for metal removal in needed to meet discharge rates set by the EPA and State Regulations. Discharged waters must maintain the rates or be subject to fines.**
- **Heavy metals entering the water system can be toxic to aquatic life and work its way into the food chain eventually into humans.**
- **Metals of these types stay in fat tissues and can be fatal.**

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DEFINITIONS

- **Heavy Metals - metals which include lead, silver, mercury, copper, nickel, chromium, zinc, cadmium, and tin types in concentrations significant enough to require removal for discharge**
- **Caustic - sodium hydroxide (NaOH), a strongly alkaline solution when added to water provides a pH >7**
- **Metal Hydroxides – metal containing salts formed when metals in solution are precipitated when a caustic solution is added**
- **mg/L – milligrams per liter, a representation of the quantity of metals in this case present in solution or concentration**
- **pH – the term to describe acid- base relationship in water or the concentration of H+ and relationship to OH- ions. The negative log of H+ concentraton (pH=-log[H+]). Defined as pH<7 is acidic, pH= 7 neutral, pH>7 is basic or alkaline. The lower the pH, the higher the [H+] ion, the higher the pH, the higher the [OH-] io**

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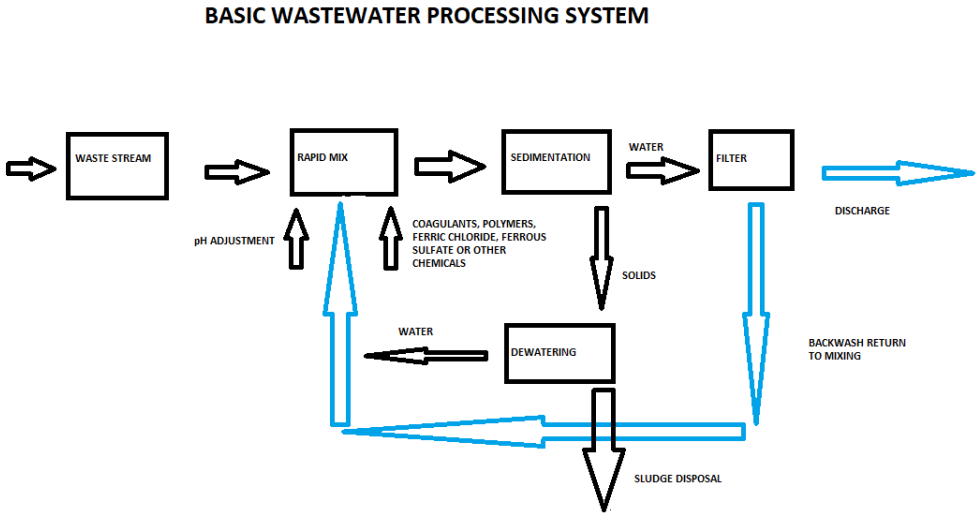
DEFINITIONS

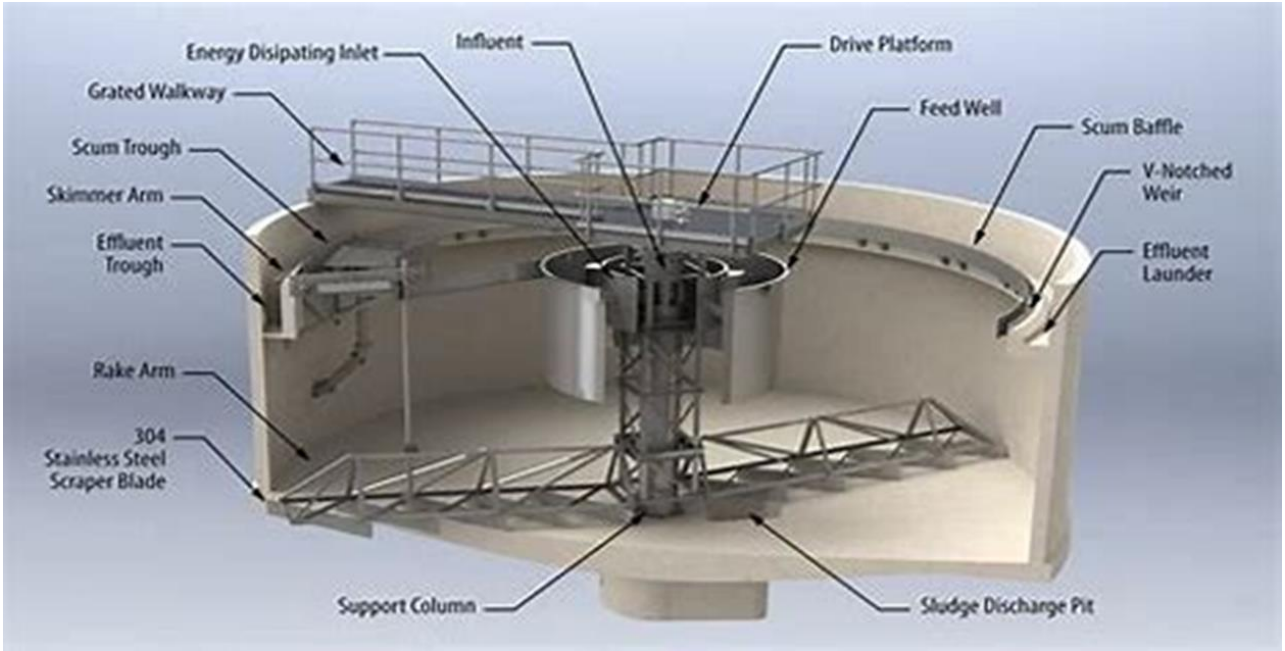
- **Precipitation – The process of producing solids from a solution by adding a chemical to form insoluble salts**
- **Solubility – The ability of a material to become dissolved or go into solution. Metal salts must be made insoluble to precipitate from solution. Making metals to precipitate allows for removal.**
- **Solubility Chart – A diagram showing pH vs metal concentration to show under what conditions of pH and amounts (usually in mg/L) that the metals will precipitate from solution.**
- **Chelating Agents – These form metal complexes with heavy metals from sources such as surfactants or cleaners. Include EDTA , Citric acid and others making precipitation difficult. Metals can be treated with DTC (dithiocarbamates) or other products to break bonds**

GENERIC WASTEWATER TREATMENT SYSTEM



TREATMENT SYSTEMS

CLARIFIER



COMMON METALS AND METHODS FOR REMOVAL

- Chromium
- Cadmium
- Lead
- Tin
- Mercury
- Silver
- Aluminum
- Copper
- Zinc
- Nickel

- **Chemical Precipitation**

  Formation of solids that can be separated from a solution by conversion to an insoluble form.

- **Hydroxide Precipitation**

  Metals in an aqueous solution are in a soluble form until introduced to a caustic solution. Once the hydroxide forms an unstable particle with the metal, a hydroxide precipitate forms. This is usually done with a pH adjustment in the >7 range and can be easily removed and discharged.

  This process is usually key to working in metal removal using equipment to adjust pH and settle for removal. Two factors are important to the success are pH and the metal concentration. Metals can be found routinely in waters from metal processing in dilute quantities (1-100 mg/L).

METAL SOLUBILITY

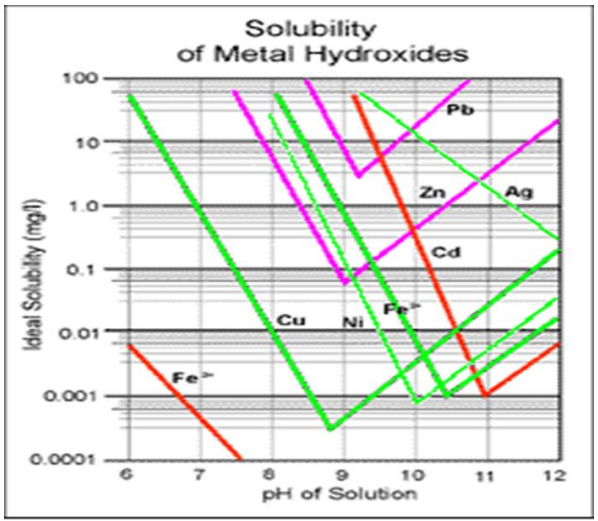
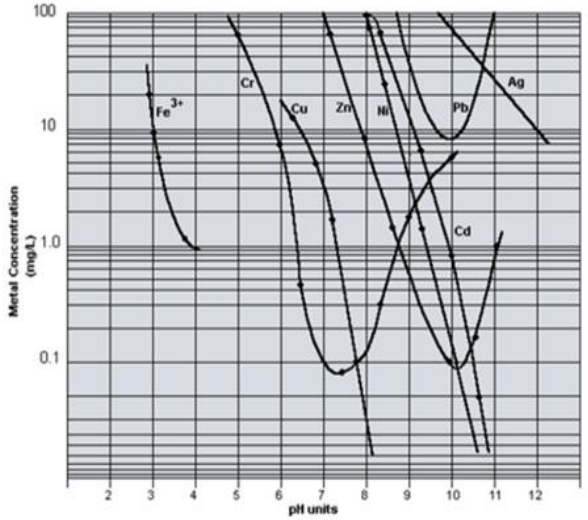


Figure 5

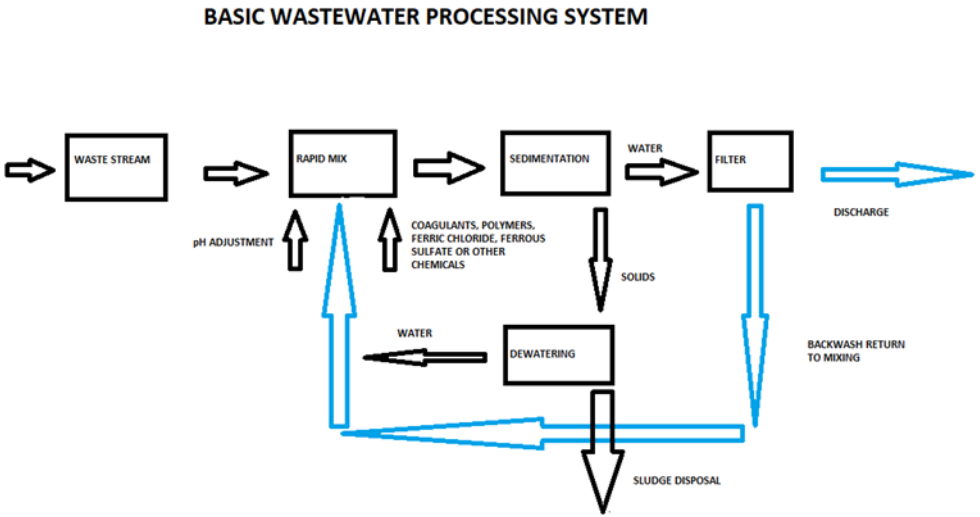


MULTIPLE METALS – CHELATED METALS

- Complex waste streams may have multiple sources of heavy metals needing removal
- In cases requiring different metals that need to be removed, it may be necessary to use multiple pH changes. Other methods may be needed to include chemical additions for chelation, settling phases, filtering, and reverse osmosis.

- Chelated Metals
- Metals kept in solution with chelating agents such as citric acid, EDTA, Gluconates, etc.
- Lower pH – break chelant grip, depending on how strong the chelant is pH 2-4.5.
- Add competing non-regulated metal (calcium, iron, aluminum) to tie up chelant.

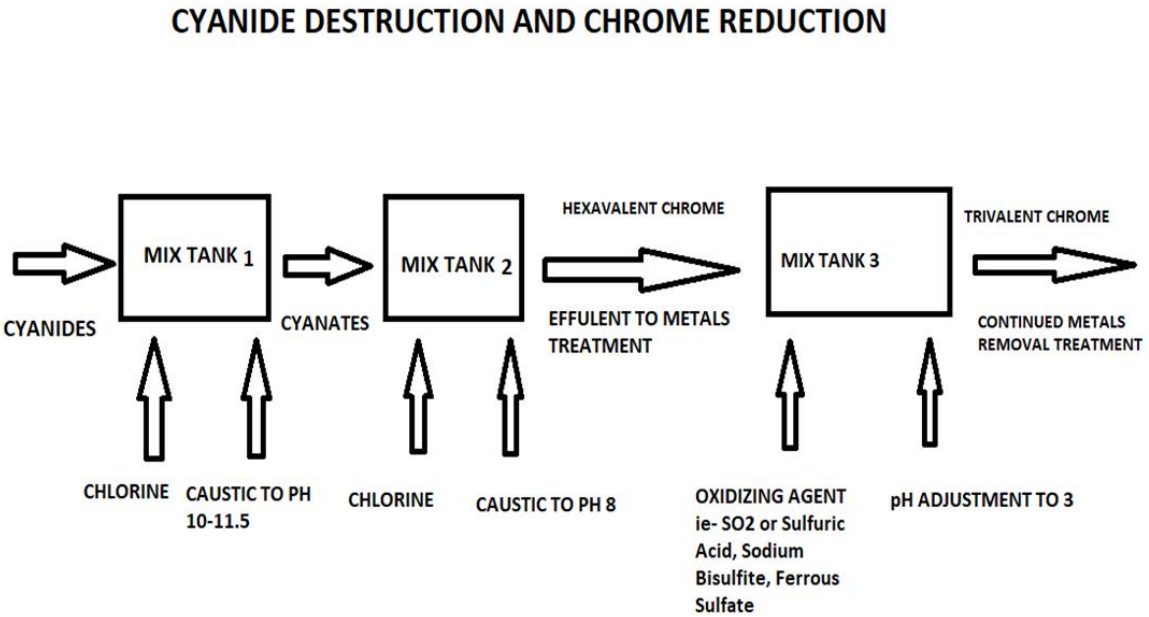
GENERAL TREATMENT OVERVIEW



CHEMISTRY GENERAL TREATMENT HEAVY METALS

- Acid - lower pH for breaking chelant bonds, generally one of the first steps sometimes be done with spent acid.
- Coagulant - satisfies charge and or chelant demand helps form an in soluble precipitate, ferric-based products, aluminum-based products.
- Heavy Metal precipitants – help provide the chemistry to precipitate metals Carbamates, Polysulfides.
- Caustic- raised the pH to a range where metals are insoluble.
- Flocculent – helps pull precipitated metals to form a floc that will sink and can be dewatered.
- Bleach – generally used in cyanide destruction
- Sulfites – generally used in hex-chrome reduction.

CYANIDE AND HEX CHROME



Thank you!