Pretreatment Technologies Crash Course

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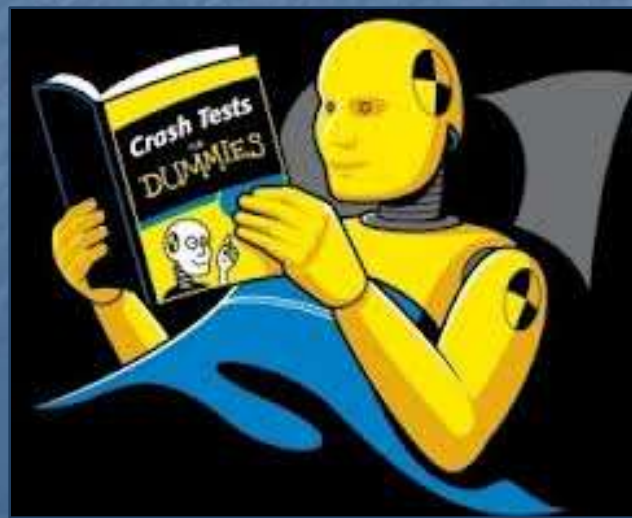


By the End of This Course

Be Able to:

- Identify common treatment technologies.
- Understand applications for treatment systems.
- Conduct informed inspections of each technology.

Waste Stream: High Variability

- Treatment: Equalization
- Applicability: hydraulic loadings, biochemical oxygen demand (BOD), pH
- Typically part of a treatment train
  - Before treatment
  - After treatment

Equalization

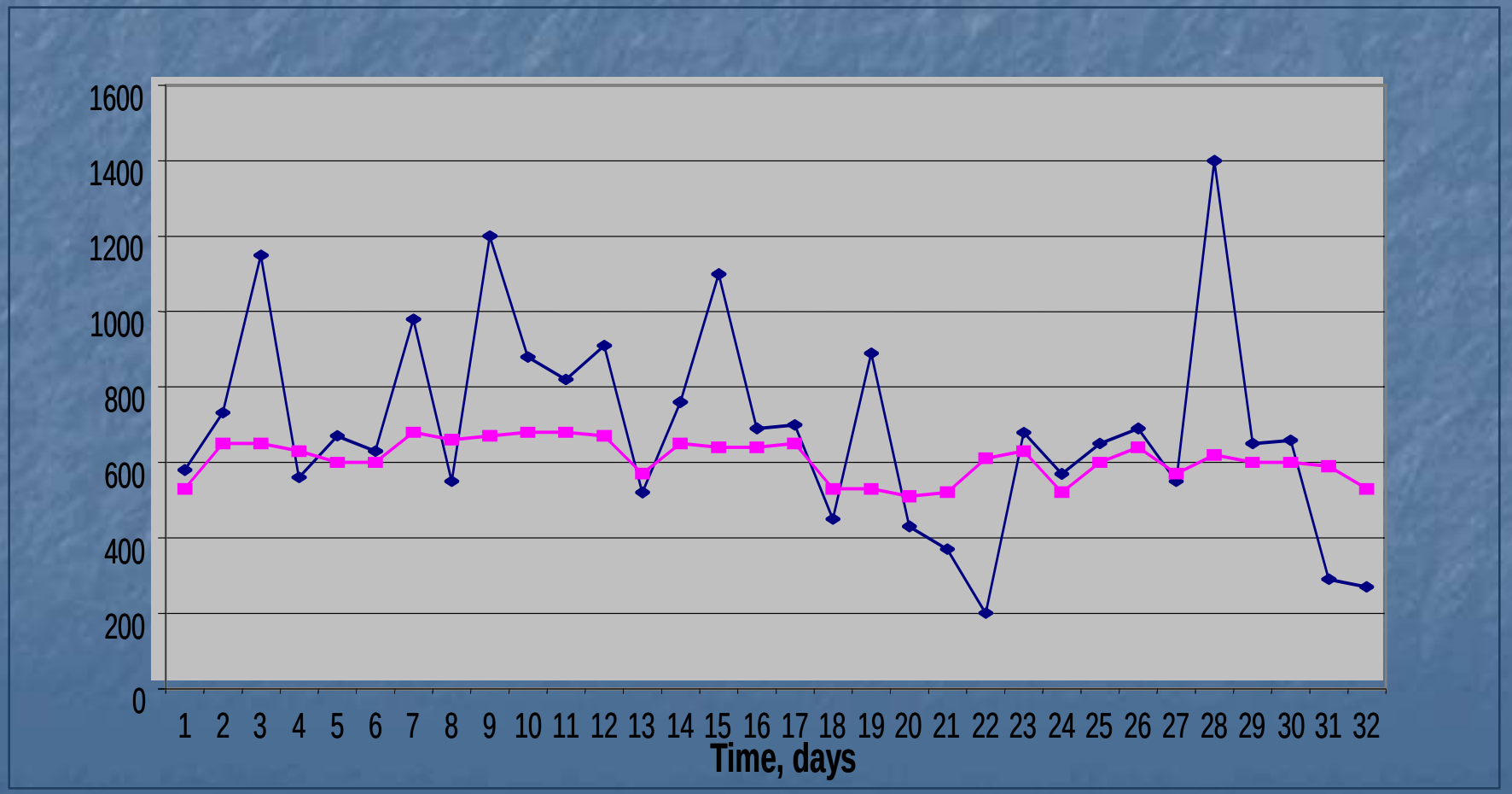
Before Pretreatment
Allows uniform waste stream for treatment

Before Discharge
Reduces peaks in discharge flows and/or loads

Equalization After Pretreatment

Effect of Equalization on Effluent COD

Before Equalization ----- After Equalization -------



Equalization – Inspection Tips

- Mixing – Reduces solids settling
- Aeration – for waste streams with BOD
  - Anaerobic degradation = Septic wastewater
    - Low pH
    - Odors

Waste Stream: Solids

- Treatment: Depends on particle size
- Typically part of a treatment train

Bar Screen

Screens-

Removes larger solids, prior to treatment

Mechanical Screen

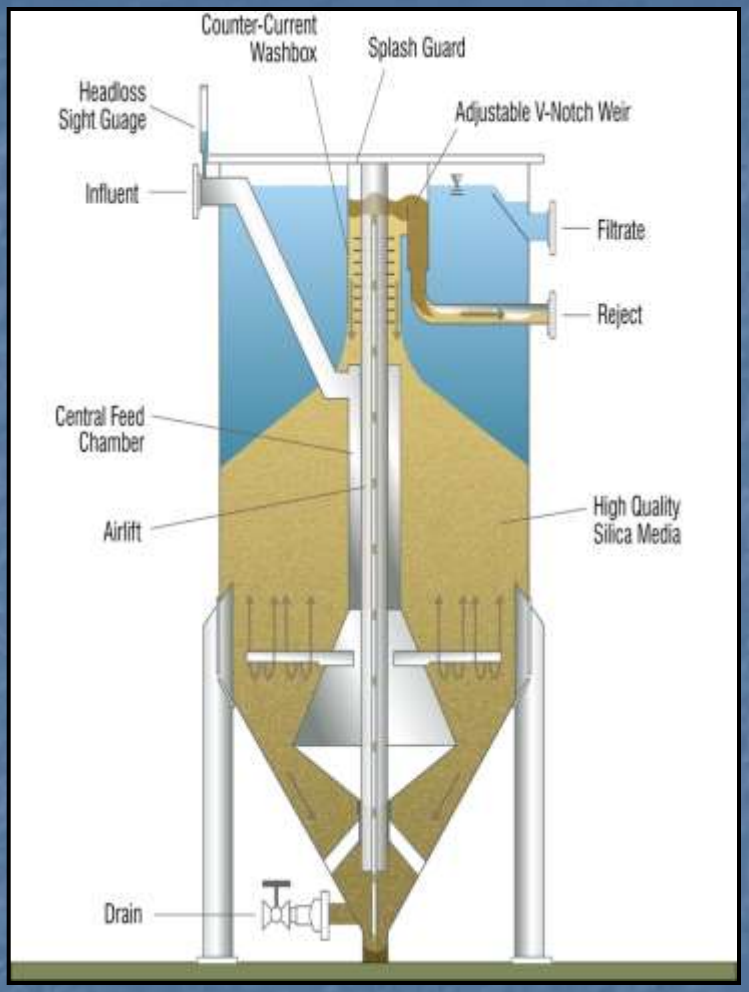
Vibratory (Shaker) Screen

Ye Olde Grinder Pump

Solids Removal

Sand Filter

Filters - Removes finer solids - After pretreatment



Bag Filter

Sand Filter Guts

Solids Removal

Density –

Particulates >H_2O

Centrifuge

Cone Bottom Tank

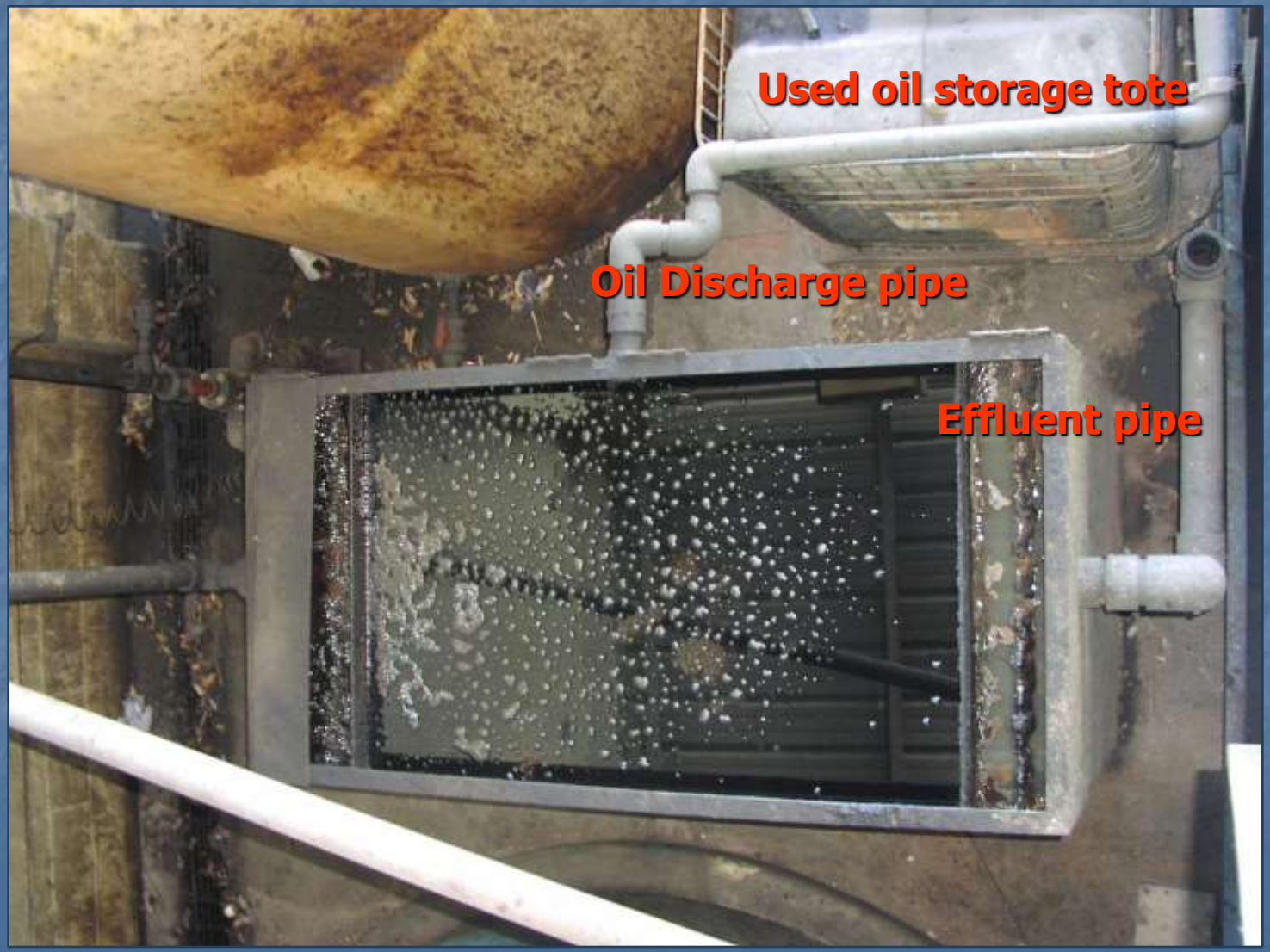
Solids Removal – Inspection Tips

- Maintenance
  - Screens – cleaning frequency
  - Solids storage
  - Hauling Co. – Disposal sites – Manifest
- Sand Filter – Backwashing
  - Backwash frequency (pressure dependent)
  - Where does backwash go?
  - Where does spent media go?
- Are chemicals used to enhance separation?

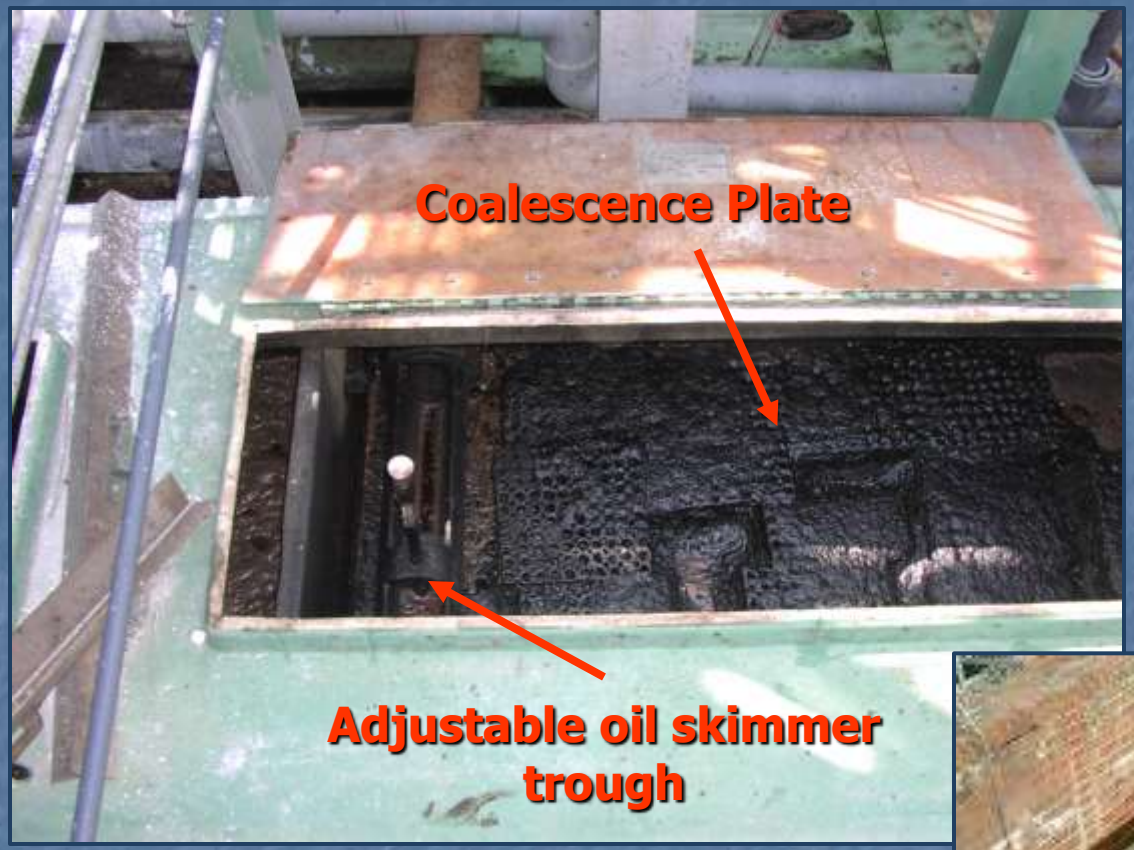
Waste Stream: Oily Water

- Treatment - depends on:
  - Free oil
  - Emulsified oil
- Applicability:
  - Vehicle repair/cleaning
  - Oil recycling
  - Industrial laundries
  - Metal coatings – "neat" oil

Free Oil - Oil Water separator

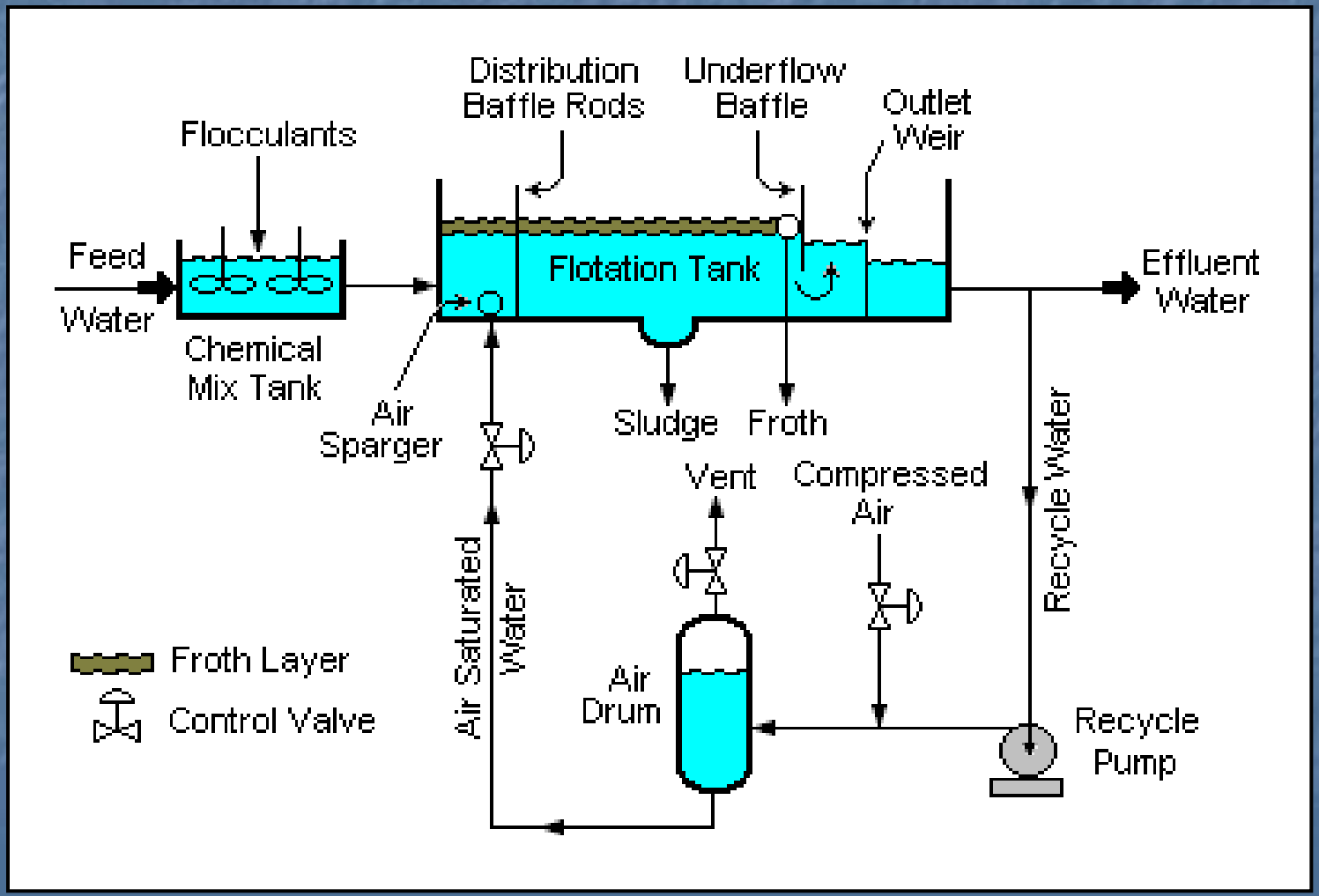


Free Oil Water Separation Aids



Rope Skimmer

DAF Unit


Distribution Baffle Rods
Underflow Baffle
Outlet Weir
Flocculants
Feed Water
Chemical Mix Tank
Flotation Tank
Effluent Water
Air Sparger
Sludge
Froth
Vent
Compressed Air
Recycle Water
Air Saturated Water
Air Drum
Recycle Pump
Froth Layer
Control Valve

DAF Unit


Polymer Addition


pH Adjustment - ~ 2- 3 SU


Flocculant Addition
What the Floc?


Solids skimmed from surface

Oily Treatment – Inspection Tips

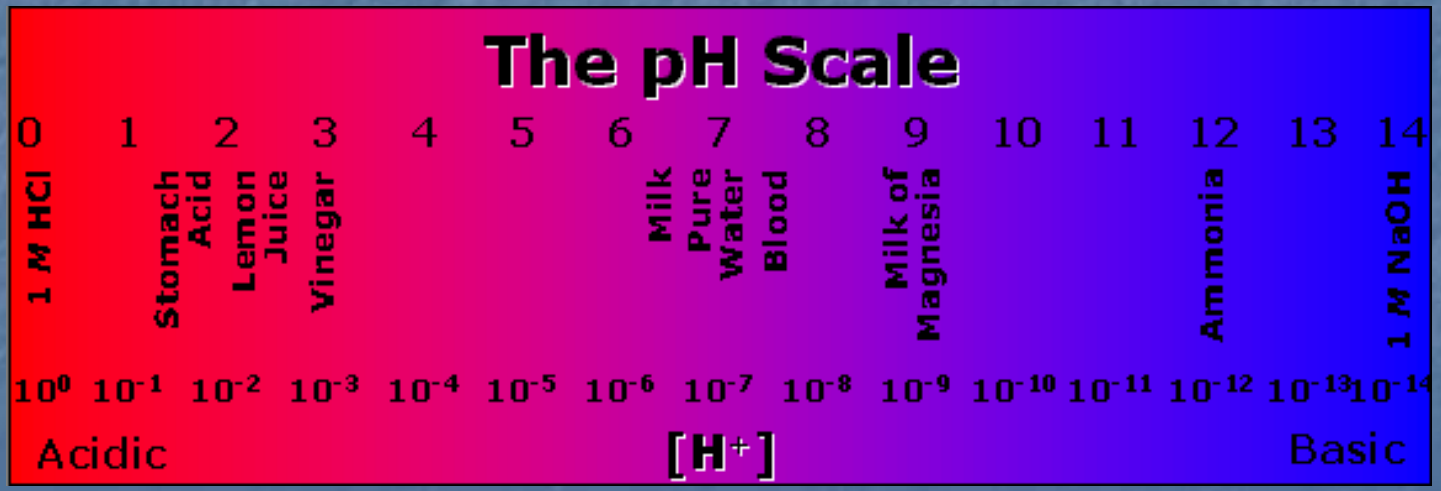
- O/W Separator
  - Flow rates – should be in equipment specs
  - Free oil: storage, destination, manifest
  - Oily sludge – removal frequency, destination, manifest
  - Visual inspection of effluent well/pipes

Oily Treatment – Inspection Tips

- DAF Unit
  - Visual:
    - Reaction tanks - Floc formation
    - Tank – froth on surface?
  - Sludge – storage, destination, manifest
  - pH – may need to be raised after acid addition

Waste Stream: Acid/Alkaline

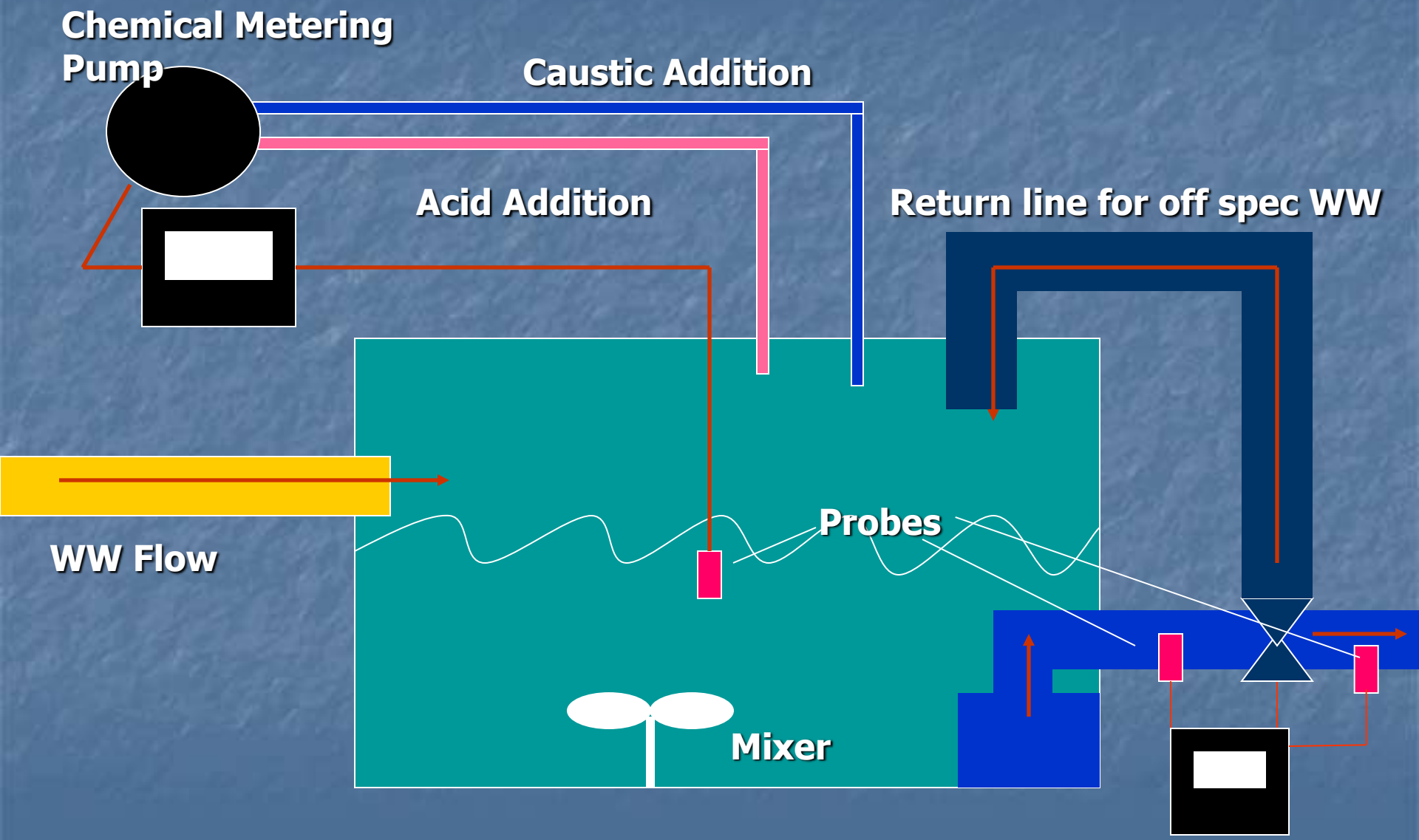
- Treatment – pH Neutralization
- Stand alone or part of treatment train



pH Neutralization

- Application:
  - Wide spread industrial applications
  - Industrial laundries – typically alkaline
  - Food & beverage industries
    - Beverages – carbonated, juices, fermented beverages - acidic
    - Fruit processing - acidic
    - Clean In Place (CIP) – caustic and acid washes

pH Neutralization



Neutralization – Inspection Tips

- Treatment chemical storage
- Continuous pH monitoring records
- IU's pH range for discharge
- Probe calibration/maintenance frequency
- Food processors – food particles can interfere w/ probes
- Mechanisms for preventing off spec discharge
- CIP - EQ tank for acid/caustic washes?

Waste Stream: Metals

- Technologies depend on:
  - Type of metals
  - State of metal:
    - Solid
    - Dissolved
    - Complexed or Chelated (tied up by some chemical)
  - Volume of waste stream
- Applicability:
  - Metal finishers
  - Electronic components
  - Printers

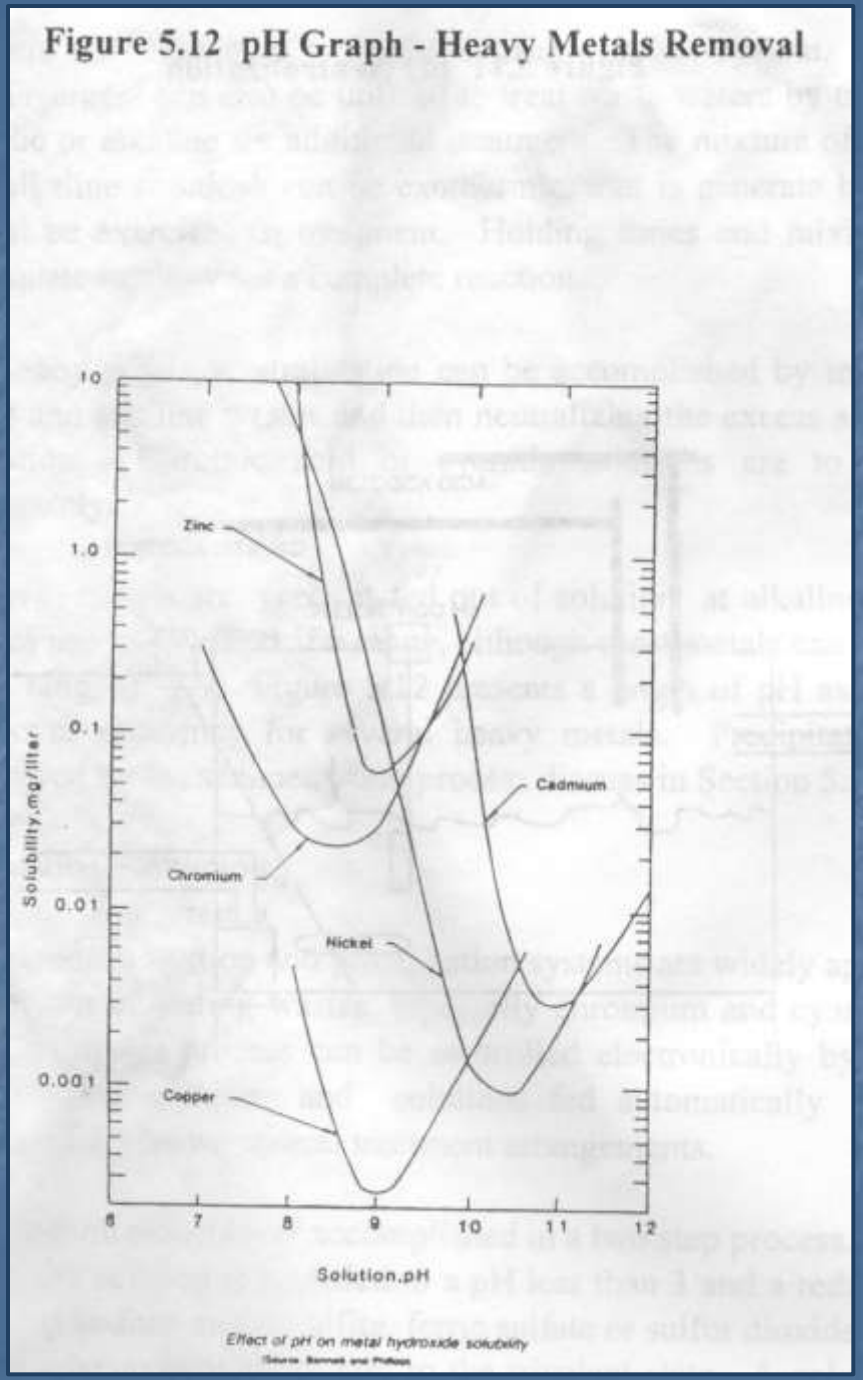
Metal Precipitation

- Common technology for dissolved metals
- Raise pH to decrease solubility of metal
- Flocculants/coagulants increase settlability

Cone bottom for solids removal

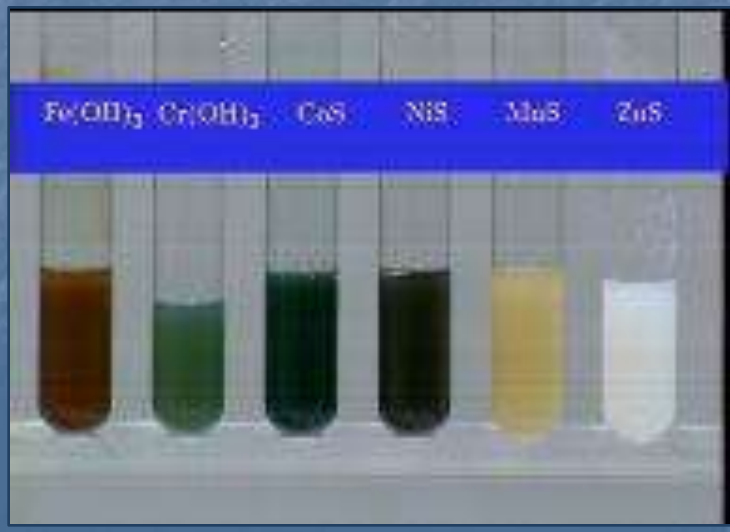
Solubility Curve for Metal Precipitation

- Metals precipitate @ different pHs
- Hexavalent chromium (Cr^{+6}) requires two step process
  1. $Cr^{+6} \rightarrow Cr^{+3}$
  2. $Cr^{+3} \rightarrow Cr(OH)_3$



Metal Precipitation Inspection Tips

- Process probe calibration frequency?
  - pH
  - Oxidation Reduction Potential (ORP)
- Final pH adjustment?
- Significant sludge generation
  - Hazardous waste?
  - Disposal - Manifest



Metals - Evaporation

- Applicability: Low volume metals waste generator
  - No discharge
- Energy intensive

Inspection Tips:

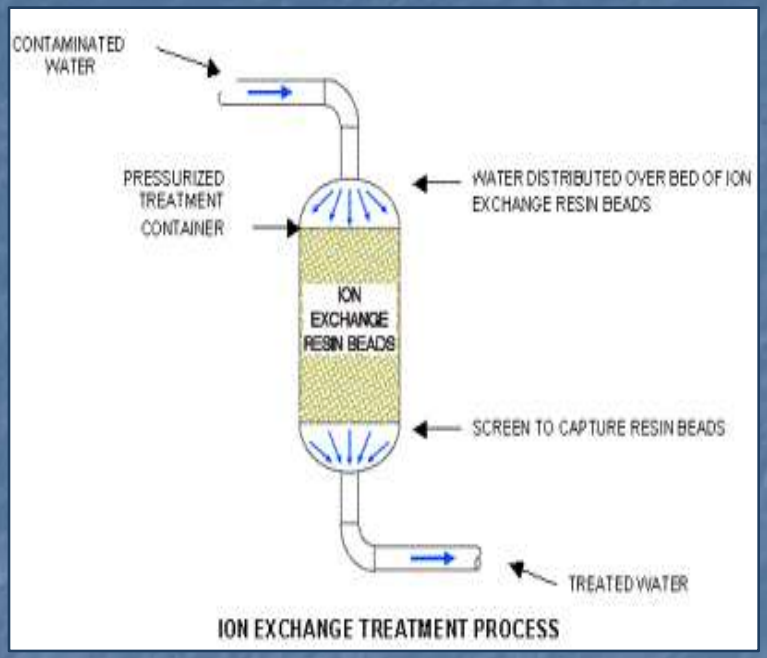
- Sludge – hazardous?
- Sludge Manifest?
- Potential discharge points?

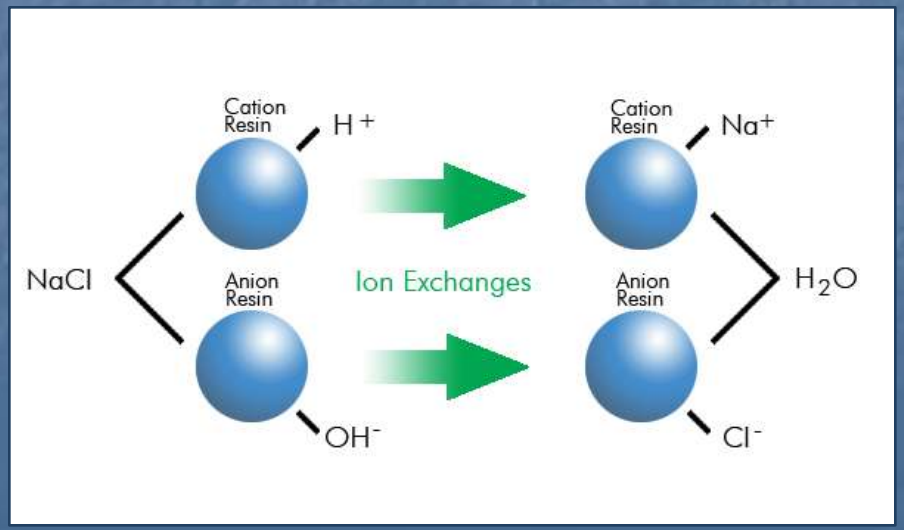
Metals - Ion Exchange

Applicability

- Low concentration waste streams
- Usually polishing step

Metals- Ion Exchange





Inspection Tips

- Resin Regeneration – requires acid & caustic washes
- Offsite – Frequency? Where?
- Onsite
  - HCl & NaOH storage
  - pH neutralization
  - Recovery of regenerant

Cyanide Treatment

- Associated with metal plating
- Treatment: Alkylchlorination
  - 2 steps
  - pH and ORP controlled

Cyanide Treatment Process
First Stage

Raise pH > 10 and chlorinate

$$NaCN + NaOH + NaClO <---> NaOCN + H_2O$$

Sodium Cyanide

Caustic

Hypochlorite

Sodium Cyanate

Really Bad Stuff!!!!

Not so Much

ORP measurements indicate when reaction is complete

Cyanide Treatment Process
Second Stage

- pH is lower ~ 8 to 9
- Hit with more caustic and hypochlorite

$$NaCNO + NaOH + NaClO \leftrightarrow NaCl + CO_2 + N_2 + H_2O$$

ORP measurements indicate when reaction is complete

Cyanide Treatment

Inspection Tips:

- ORP set points?
- pH & ORP probe calibration logs
- For 433 compliance – separate sample point

Variety of Pollutants

- Membrane Technology – removes pollutants based on molecular size

Decreasing Molecular Size

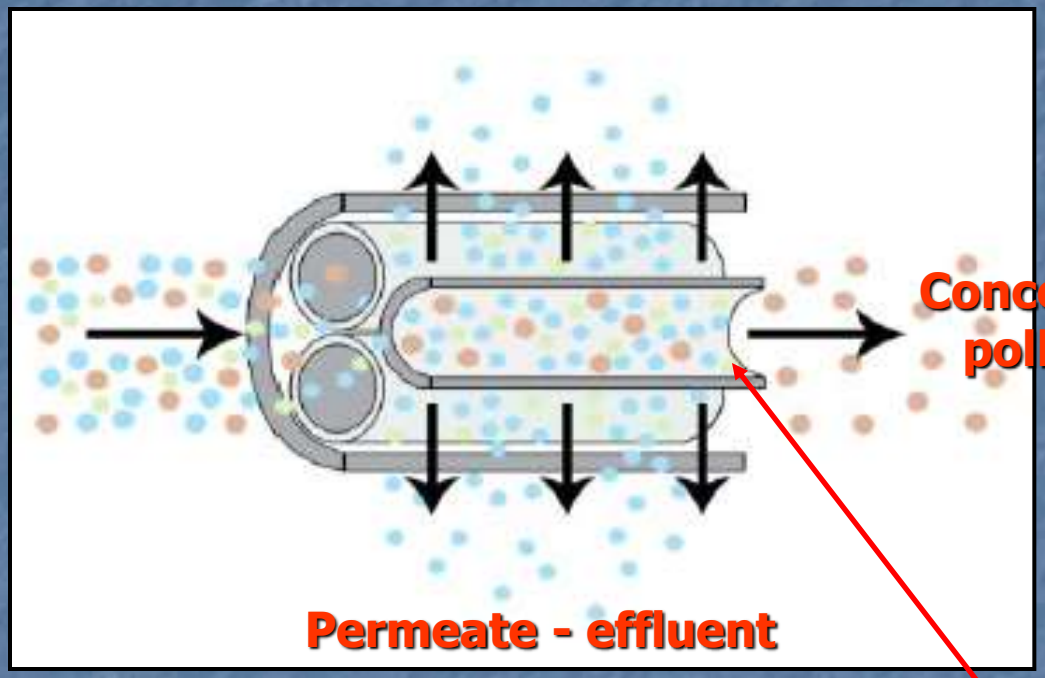
Microfiltration

Ultrafiltration

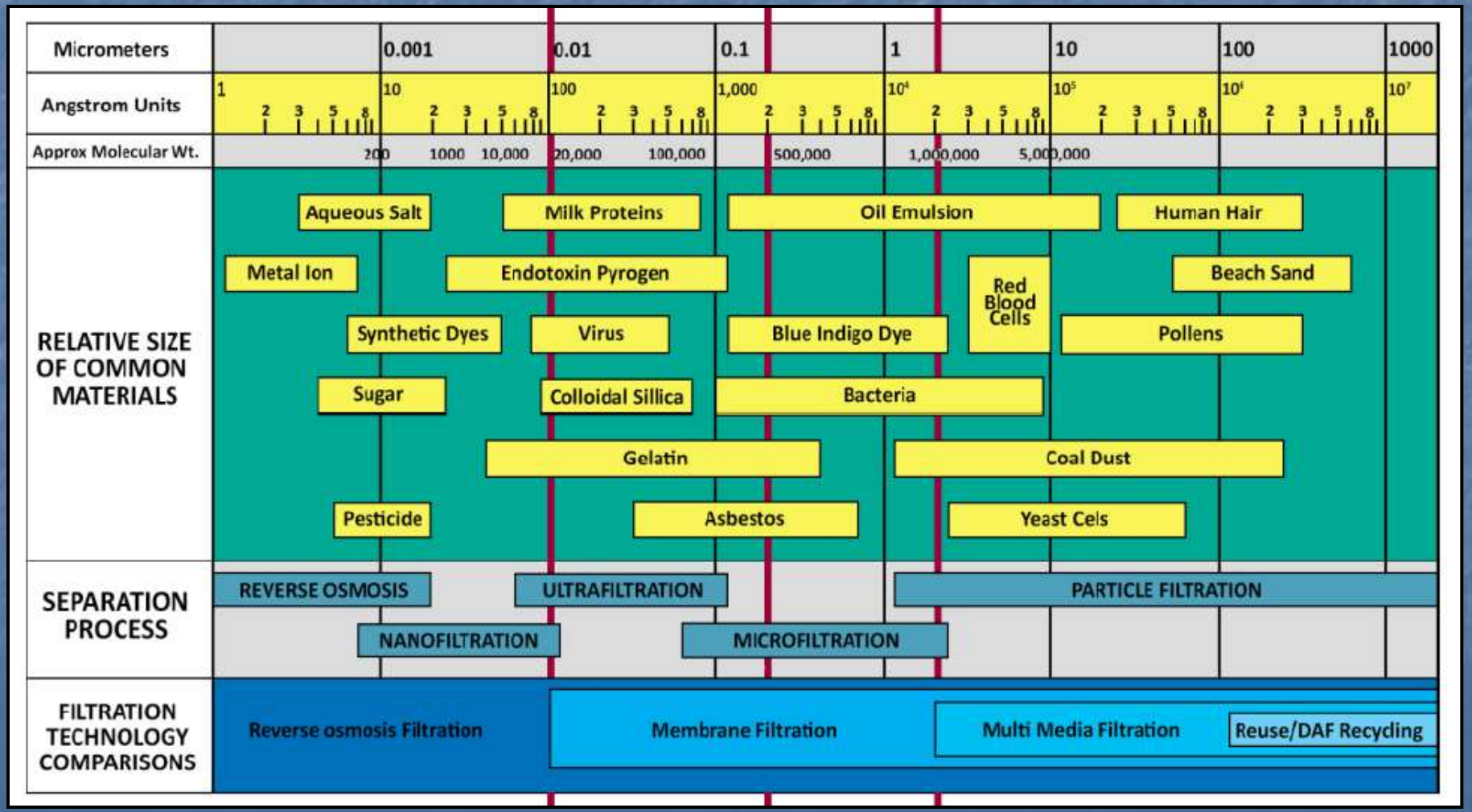
Nanofiltration

Reverse Osmosis

Variety of Pollutants- Membrane Technology



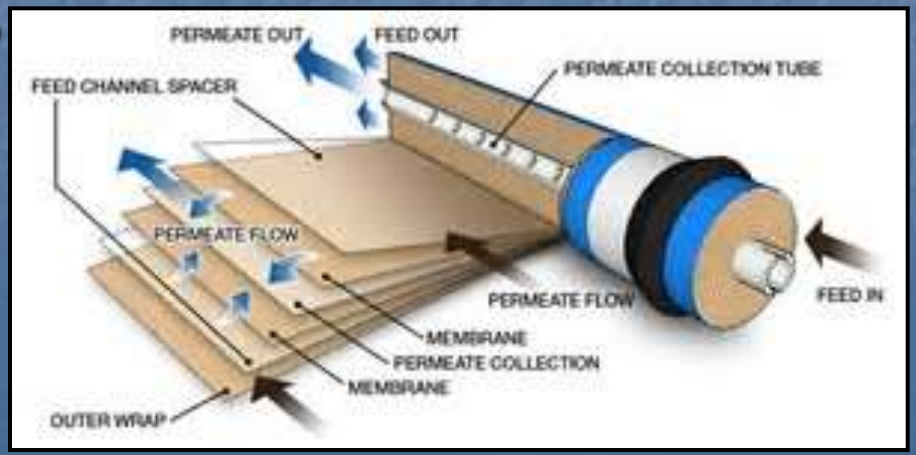
Variety of Pollutants- Membrane Technology



Variety of Pollutants- Membrane Technology

Inspection Tips:

- Is membraned correctly sized for pollutant removal?
- Membrane Regeneration?
  - Frequency?
  - Chemicals required?
  - Where does regenerant go?



Waste Stream: Organics

- Treatment – wide range of compounds
  - Volatile organics
  - Semi-volatile
  - BOD (starches, sugars, organic acids, glycols, alcohols)
- Applicability:
  - Groundwater remediation
  - Organic compound manufacturers
  - Pulp and paper
  - Industrial food processors

Organics - Air Stripping

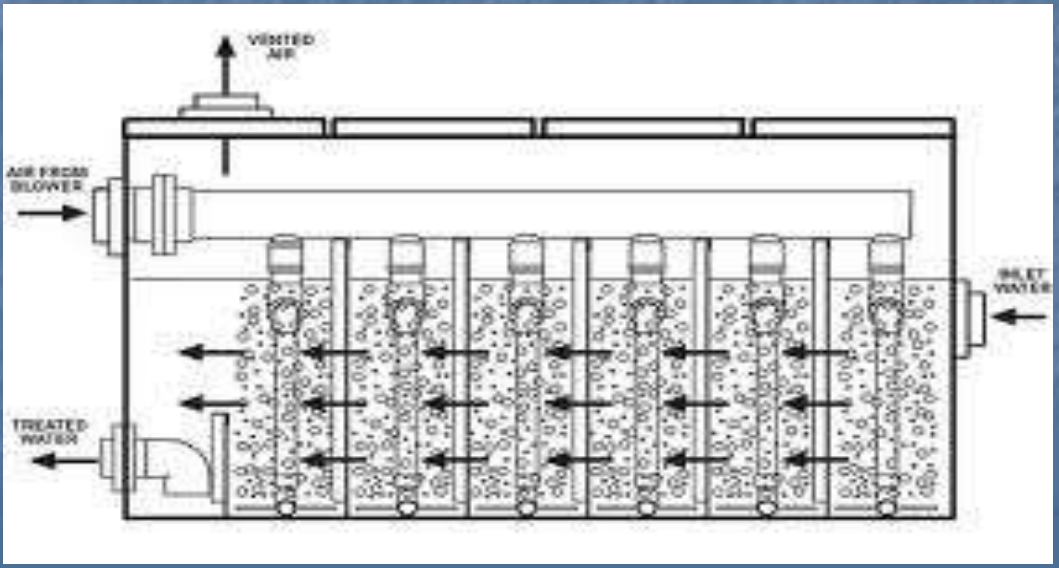
- Volatile organics
- Groundwater remediation

Packing Material

Mobile Unit – ground water remediation application

Organics - Air Stripping

- Inspection tips:
  - Proper air flow
  - Packing material fouling
  - Treatment of gas
    - Thermal oxidation
    - Activated carbon



Air Stripper Guts

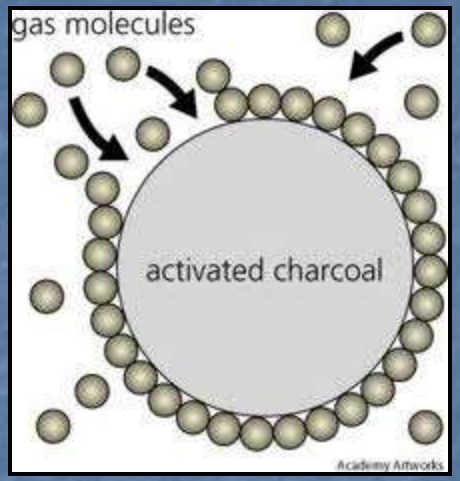
Organics – Activated Carbon

- Wide range semi & volatile organics
- Often polishing step
- Fixed beds in series
- Enhance activated sludge

Granular Activated Carbon (GAC)

Powder Activated Carbon (PAC)

Organics – Activated Carbon



- Inspection tips:
  - Break through concerns
  - Carbon replacement/re-activation frequency?
  - Spent carbon fate?

Organics – Biological Treatment

- Treatment – Biodegradable pollutants (BOD)
- Applicability:
  - Organic chemical manufacturing
  - Pulp and paper
  - Large food/beverage processors
  - Large breweries

Organics – Biological Treatment

Considerations

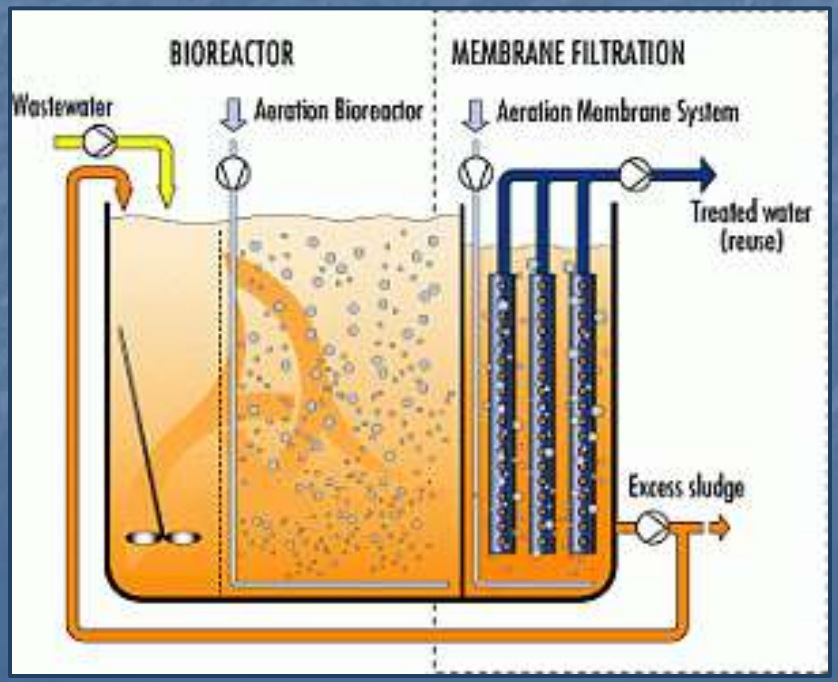
- High capital & operating costs
- Labor intensive
- May need nutrient addition
- Heavy solids generation
- Several technologies available

Moving Bed Biofilm Reactor (MBBR)

Carrier

Aerated Pond

Sequencing Batch Reactors – SBR



Membrane bioreactors - MBR

Organics – Biological Treatment

Inspection Tips

- Operational logs
- WAS/RAS rates
- Process Control Equipment

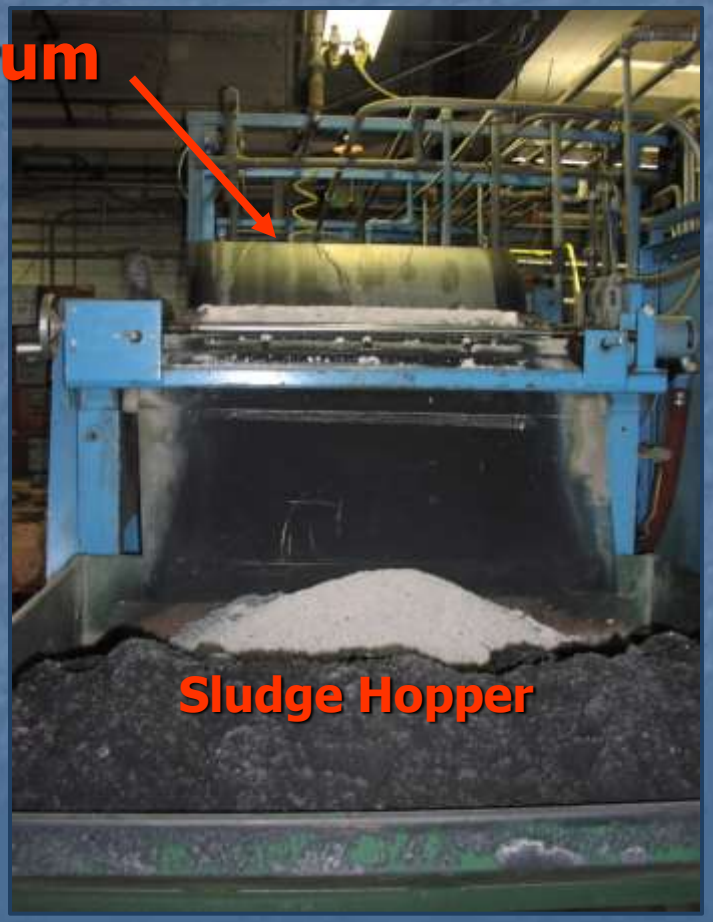
MBBR & Aerated Ponds require little process control

Solids Handling

- Many treatment processes create sludge
  - DAF
  - Metal precipitation
  - Biological treatment
- May be a hazardous – TCLP test
- Dewatering reduces disposal costs

Solids Handling

Vacuum Drum



Solids Handling

Filter Press

Belt Press

Solids Handling

Inspection Tips

- Where does filtrate go (the wet stuff)?
- Usual solids questions
  - Hazardous? Destination? Frequency? Manifest?

Pretreatment Technologies Conclusions

- Many types of treatment technologies.
- Each based on waste stream characteristics.
- You don’t have to know the right answers, just know the right questions.

Questions?

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