Chemical Treatment

Maryland Center for Environmental Training
301-934-7500
info@mcet.org
www.mcet.org

Chemical Treatment

WWW 5840

7 contact hours
9 CC10 hours

In water treatment, chemicals are used to adjust pH, aid in settling particulate matter, to enhance filtration, and to remove trace constituents. In wastewater treatment, chemicals can be used to remove phosphorus; they can enhance settling in primary and/or biological treatment; they can assist in odor control, sludge thickening, sludge dewatering, and sludge stabilization. In this class, you will learn about the various chemicals used, how they can be stored and handled safely, and how to calculate dosages. Ideas on costs and how to contract for the purchase of chemicals will be provided.

Course Objectives – **Chemical Treatment**

1. Identify the role of chemicals in the processes of water and wastewater treatment
2. Compare the various options they have in selecting chemicals based on process results desired
3. Recognize the polymer selection process for liquid treatment and for solids thickening and dewatering
4. Compare the options they have for storing and feeding the various chemicals safely
5. Identify how chemicals are priced in the market place and develop options for chemical purchase

Agenda

1. Introduction (30 minutes)
2. Role of Chemicals (Include examples of chemicals used for each) (180 minutes)
    a. Liquid Treatment
        i. Precipitation
        ii. Coagulation
        iii. Disinfection
        iv. pH adjustment
        v. Control of biology
    b. Solids Treatment
        i. Sludge conditioning for thickening and dewatering
        ii. Chemical stabilization with lime
    c. Odor Control
    d. Other uses
        i. Scale control
3. Chemical selection process (60 mintues)
    a. Jar tests
    b. Full scale testing

    c. Polymer selection
4. Safety (60 mintues)
    a. MSDS - examples
    b. Fires
    c. Spills
    d. Medical emergencies
5. Storage of chemicals (60 minutes)
    a. Bulk storage
        i. Sizing of storage tanks; Days of storage
        ii. Material of construction for tankage
6. Post Test; Evaluations (30 mintues)

CHEMICAL TREATMENT
Water & Wastewater

The Water & Waste Operators Association of Maryland, Delaware and District of Columbia

CSM college of southern maryland
La Plata · Leonardtown · Prince Frederick · Waldorf

MCET
environmental, health, and safety training

Terence Bradley CSP, CIT

February 8, 2023

Course Objectives

By participating in this course, students will develop an understanding of:

- The role of chemicals in the processes of water and wastewater treatment
- The various options they have in selecting chemicals based on process results desired
- The polymer selection process for liquid treatment and for solids thickening and dewatering
- The options they have for storing and feeding the various chemicals safely
- How chemicals are priced in the market place and develop options for chemical purchase

Chemical Class Content

- The role of chemicals (What Do Chemicals Do?)
- Chemical Selection Process
- Safety
- Chemical Storage
- Chemical Delivery
- Addition of Chemicals
- Dosages
- Optimization
- Purchasing Techniques
- Video

What do chemicals do?

- Liquid Treatment (water and wastewater)
  - Coagulation and Precipitation
  - Disinfection
  - pH Adjustment
  - Control of Biology

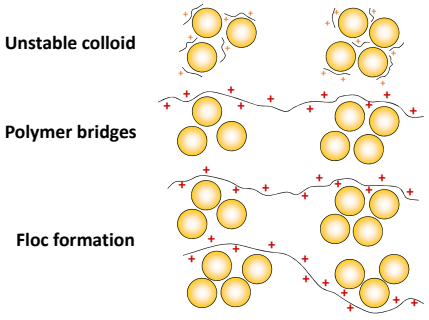
What do Chemicals Do? (cont)

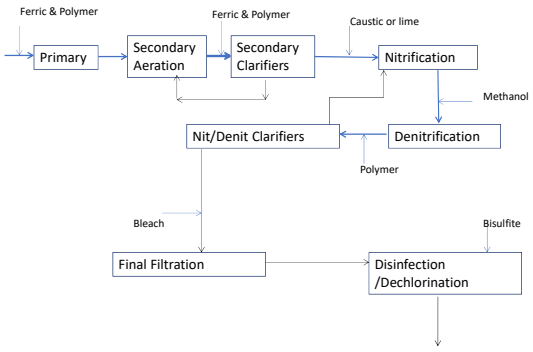
- Solids Treatment (water and wastewater)
  - –Sludge Conditioning for Thickening & Dewatering
  - –Chemical Stabilization with lime
- Odor Control
  - –Treating wastewater
  - –Treating air
- Other uses (water and wastewater)
  - –Scale or corrosion control
  - –Addition of a particular chemical (e.g. fluoride)

Coagulation & Precipitation

- Definitions
  - –Coagulation destabilizes the negatively-charged particles so that they are not repelled by each other
  - –Flocculation then brings the small particles together to be a "Floc"
  - –Precipitation alters the physical state of dissolved and suspended solids and causes them to settle
  - –Chemical addition is generally an additive process, as it increases the volume of sludge

FLOCCULATION





Liquid Treatment

- Chemicals originally for improved settling
- Now for Phosphorus removal and heavy metals removal
- Also Physical-Chemical Treatment

Improved Settling*

- Alum
- Lime
- Iron Salts e.g. Ferric Chloride, Ferrous Chloride, Waste Pickle Liquor

- Results

60% removal of total suspended solids (TSS) w/o chemical

80 – 85% removal of TSS with chemical

Advantages/Disadvantages*

- Adding chemical produces more primary sludge
  - Improves dewatering
  - Reduces loadings on secondary treatment
  - But it produces more sludge to process (up to 25% more)
  - And increases total dissolved solids in the effluent

Chemical Equations for P removal

- $FeCl_3 \rightarrow Fe(OH)_3 + FePO_4$
- $AlSO_4 \rightarrow AlPO_4 + Al(OH)_3$

Reactions*

- Alum and Ferric Chloride usually react in 1 second when added
- Good mixing is required
- Difficult to get good mixing in raw sewage.
- Discuss why

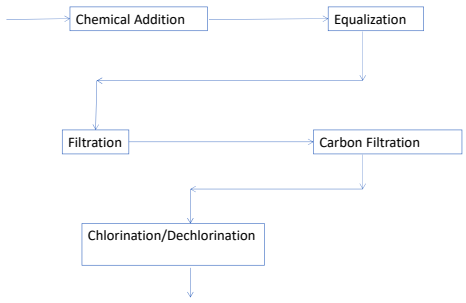
For Heavy Metal Removal

- Can aid in removing
  - Arsenic
  - Barium
  - Cadmium
  - Mercury
  - Nickel
  - Selinium
  - Zinc

Physical Chemical Treatment*

- Rarely used for municipal wastewater, because it does not meet treatment standards
- OK for industrial waste treatment
- Often used for water treatment
- Processes include
  - –Chemical Addition with settling
  - –Equalization
  - –Filtration
  - –Carbon treatment
  - –Chlorination/Dechlorination

Physical Chemical Treatment



What do chemicals do?

- Liquid Treatment
  - Coagulation and Precipitation
  - Disinfection
  - pH Adjustment
  - Control of Biology

Disinfection

- Definition – The partial destruction of disease-causing organisms
- Methods – Addition of:
  - –Chlorine
  - –Sodium Hypochlorite
  - –Calcium Hypochlorite
  - –Chlorine Dioxide
  - –Chloramines (water)
  - –Ozone (water)
  - –Peracetic Acid (PAA)
  - –Ultraviolet light (UV) – Not a Chemical

Chlorine

- Most commonly used
- Transported by truck/rail
- Highly toxic to humans and fish
- Reacts with other compounds in water to form carcinogens
- Facilities are highly regulated and require emergency systems
  - –Total containment
  - –Caustic Scrubbing

Chlorine (cont)

- Heavier than air
- Dry chlorine uses black steel piping
- Liquid Chlorine is evaporated and injected into water solution – PVC piping
- Use clean water for transport to end point of use
- Must generally include dechlorination after chlorination (for wastewater) – SO_2 or Bisulfite

Chlorine (cont)

- All chlorine compounds react with ammonia and other organic constituents
- Reaction with ammonia forms chloramines which also disinfect, but at a slower rate. Chloramines used for water.
- Detention time after chlorine addition is regulated and usually 30 minutes or more

Sodium Hypochlorite (Bleach)*

- Delivered as a liquid - 10 to 20% available chlorine
- Can store inside in lined steel tanks or FRP tanks
- Corrosive- can be fed as delivered or diluted
- Loses strength with time, esp. in warm weather – Dilution reduces this reaction
- Can be generated on-site, but uses a lot of power and is expensive to operate
- Often considered a good alternative to chlorine

Sodium Hypo Storage

Calcium Hypochlorite

- Often used in small plants
- Can be purchased in liquid or granular form or briquets
- Convenient to use

Chlorine Dioxide

- Seldom used
- Generated on site using chlorine gas and sodium chlorite solution
- Requires an evaporator/chlorinator to put chlorine gas into a water solution

Ozone

- Generated on site using oxygen and electricity
- An unstable gas
- Very effective viricide
- Mostly used in water treatment for taste and odor control
- Produces no TDS, not affected by ammonia nor pH

Peracetic Acid

- New to the US; used in Europe and Canada
- Used in food, beverage industry
- Stronger disinfectant than chlorine
- Leaves no residual; no harmful byproducts
- Shelf life of 6 to 12 months; little degradation
- Approved by EPA as wastewater disinfectant

Peracetic Acid (cont.)

- Dosage of 1 to 2 mg/l for secondary effluent
- Average cost of $1.00/lb
- Contact times same as with chlorine
- Can reduce lamp cleaning with UV
- Chemical symbol CH_3CO_3H
- Use at a 12 to 15%; handle carefully
- Mix well at point of addition

UV

- A good alternative to chlorine compounds
- Used in small to mid size WWT plants or water plants
- Installed in an open channel, or can be enclosed
- Uses a lot of power
- Requires maintenance, esp. for cleaning tubes from scale. Difficult to know how the chemistry will affect the tubes
- https://www.youtube.com/watch?v=18dK-vWBnFA

Dechlorination

- Most receiving streams have restrictions on chlorine discharges – toxic to fish
- After disinfection usually have 0.2 to 0.5 mg/l residual
- Add SO_2 or sodium bisulfite, which reacts instantaneously to achieve 0 residual
  - –Find a point of turbulence, e.g. a weir drop
- Can also flow through activated carbon (but carbon is used up)

What do chemicals do?

- Liquid Treatment
  - Coagulation and Precipitation
  - Disinfection
  - pH Adjustment
  - Control of Biology

pH Adjustment

- Wastewater usually enters plant at a pH near 6.5, but can vary depending on industrial component
- Usually regulated to discharge at 6.0 to 9.0
- Some processes cause a drop in pH
  - Chemical (ferric chloride) for P removal
  - Nitrification

pH Adjustment (cont)

- To increase pH in WWT or Water add – (this is more common)
  - Lime
  - Caustic
  - Magnesium Hydroxide
- To decrease pH add
  - Sulfuric or hydrochloric acid
  - Carbonic acid (CO_2)

Raising Alkalinity (pH)

Chemical	CaO	Ca(OH)2	Mg(OH)2	NaOH
#chem/#alk	0.575	0.758	0.595	0.81
$/# chem.	$0.079	$0.125	$0.25	0.30
$/# alk added	0.045	0.095	0.149	0.243
Cost/day (1,000#/day)	$45	$95	$149	$243

pH Adjustment (cont)*

- Lime (quicklime) is the least costly, but comes with handling problems
  - Must be slaked
  - Lime must be kept away from moisture
  - Some large facilities have been shut down due to handling difficulties
    - Absorbs moisture in storage
    - White-outs
    - Scaling in lines after slaking

pH Adjustment (cont)

- Calcium hydroxide (Hydrated lime) made from quicklime – must be made into a slurry
  - There are companies that slake the lime and deliver a 30-35% slurry
- Same with $Mg(OH)_2$ – also a slurry
- Caustic is easy to handle but a hazardous material – a liquid at 25% or 50%

Case Study

- Problem Definition
  - Caustic used to adjust pH of liquid stream during high flow events. Very expensive but effective.
  - Desktop study of alternatives evaluates lime and magnesium hydroxide (milk of magnesia).
  - Costs compared. Lime cheapest, then Mg(OH)2, then Caustic.
  - But lime must be slaked and has handling problems

Case Study (cont)

- Need to continuously make up 30,000 lb/day of alkalinity
- Solution is to bring in a trailer and test for 1 to 2 months.
  - Look for adverse effects.
  - Check handling issues
  - Assess availability
  - Determine total costs

Results

- Lime addition showed a correlation of alkalinity increase vs. amount of lime fed
- No scaling
- Easy to handle so long as feed tank is close to point of use
- Costs confirmed
- Next step is to build an interim facility

What do chemicals do?

- Liquid Treatment
  - Coagulation and Precipitation
  - Disinfection
  - pH Adjustment
  - Control of Biology

Control of Biology

- Chlorine is used to control filamentous growth in biological treatment
- Added in low dosages – usually about 0.25 mg/l for short time periods
- Must be careful not to overdose and kill good bacteria

What do Chemicals Do? (cont)

- Solids Treatment
  - Sludge Conditioning for Thickening & Dewatering
  - Chemical Stabilization with lime
- Odor Control
  - Treating wastewater
  - Treating air
- Other uses
  - Scale control

Sludge Conditioning

- Sludge has a negative charge. Repels other sludge particles
- Chemicals like lime, ferric, alum, polymers have a positive charge. Brings sludge particles together.
- Lab testing is used to select chemicals and determine minimum dosage

Conditioning*

- Improves some thickening operations
- Always necessary for dewatering
- Lime and ferric add weight to solids
- Polymer does not add weight
- Lab tests include CST, Buchner Funnel, jar tests

Inorganic Chemicals

- Lime used as quicklime – must be slaked to get hydrate
- Ferric chloride – used as is
- One pound of each adds approximately one pound to solids
- If adding both (filter press), add ferric first then lime.

Polymers

- Can be cationic (for WAS) or anionic (for Primary)
- Can be dry or liquid
- For dry must always mix thoroughly and then age for minimum 30 minutes
- Pumps are gear, rotary lobe, or progressive cavity
- Critical as to where polymer is added

Factors affecting conditioning

- Sludge properties, source, % solids, age, pH, alkalinity
- Mixing – enough for good incorporation of chemical, without breaking down the floc.
- May use a flocculation tank

Polymer Silo

Polymer Feed Hopper

Polymer Feed Line

Polymer Makeup Unit

Polymer Mixing Tank

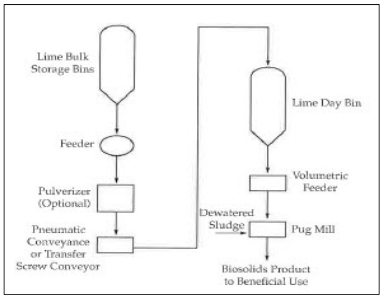
Polymer Aging Tank

Polymer Feed Piping

What do Chemicals Do? (cont)

- Solids Treatment
  - Sludge Conditioning for Thickening & Dewatering
  - Chemical Stabilization with lime
- Odor Control
  - Treating wastewater
  - Treating air
- Other uses
  - Scale control

Lime Addition



Lime Stabilization*

- Add lime to undigested sludge to pH > 12.0 for 24 hours
  - –Lime causes a temperature rise and ammonia can be released
  - –Difficult to control to pH 12.0. Often overdose
  - –Usually 15 – 20% by weight
  - –Lime cake can be sticky
- An alternative is to add lime prior to dewatering – uses more lime and scale can form

Calculation

- Assume: 1 MGD plant = 2000 dry pounds/day of sludge produced.
- How much lime to add for lime stabilization?
- 2000 X 0.2 = 400 pounds/day lime needed

Biosolids Bunker

What do Chemicals Do? (cont)

- Solids Treatment
  - Sludge Conditioning for Thickening & Dewatering
  - Chemical Stabilization with lime
- Odor Control
  - Treating wastewater
  - Treating air
- Other uses
  - Scale control

Odor Control*

- Most effective/efficient in water phase
  - Add chemicals in sewer or at plant influent
  - Sulfide forms when no DO and pH is low
  - Ferrous reacts with sulfide
  - Lime, $Mg(OH)_2$ raise pH
  - Can inject air
- Also works in collected air
  - Chemicals added in wet scrubbers

Odor Control (cont)

- Chemicals used
  - Sodium Hypochlorite
  - Ferrous chloride
  - Lime, $Mg(OH)_2$, or Caustic (to elevate pH)
  - Hydrogen Peroxide (Blue Plains experience)
  - Ozone

Odor Control (cont)

- Chemicals used
  - –Sodium Hypochlorite & Caustic
  - –Potassium Permanganate
  - –Hydrogen Peroxide

Non-chemical solutions for odor control
- Biotowers
- Biofilters

Odor Scrubber

Odor Control Captures

- Hydrogen sulfide – 98% removed
- Ammonia – 98% removed
- Mercaptans – 90%

What do Chemicals Do? (cont)

- Solids Treatment
  - –Sludge Conditioning for Thickening & Dewatering
  - –Chemical Stabilization with lime
- Odor Control
  - –Treating wastewater
  - –Treating air
- Other uses
  - –Scale control
  - –Addition of a particular chemical

Scale Control

- Usually Calcium carbonate is formed
- Can lower pH with acid and remove scale
- Or can use a scale inhibitor (often used in water distribution systems)
  - Blended phosphates
  - Zinc orthophosphate

Fluoride Addition

- For water treatment to prevent tooth decay
- Hydrofluorosiliac Acid
- Amount depends on base fluoride in water supply

Chemical Class Content

- The role of chemicals (What Do Chemicals Do?)
- Chemical Selection Process
- Safety
- Chemical Storage
- Chemical Delivery
- Piping and Pumping
- Addition of Chemicals
- Dosages
- Optimization
- Purchasing Techniques
- Video

Chemical Selection Process

- Jar tests
  - For screening polymers
  - For optimizing dosages
- Full scale testing

Jar testing

Jar Testing (cont)

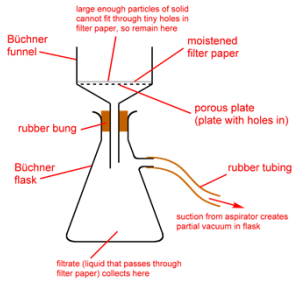
- Use a 1 to 2 liter beaker
- Add chemicals and observe performance
- Used for trying different chemicals or to determine dosages
- Measure results by lab analysis, e.g. pH, alkalinity, solids capture, phosphorus removal
- Can also use a tall graduated cylinder – to measure % solids or overflow

Jar Testing in a Cylinder

Jar Testing- Other Methods

- Buchner Funnel – for sludge conditioning
- Capillary Suction Time (CST) – for sludge

Buchner Funnel



Full Scale Testing

- On total or a portion of main flow
- Ferric chloride & polymer to influent
- Ferrous chloride – for odor control – measure sulfides
- pH adjustment

Polymer Selection Process

- Jar tests by vendors (on-site with sludge as produced)
- Full scale with a centrifuge for a day – to confirm choice of polymer and determine dosage
- With 3 different polymers from different companies, run side by side tests – conducted by plant staff. Need extra equipment.
- Results

Centrifuge

Centrifuge Control Panel

Polymer Feed Tank

Chemical Class Content

- The role of chemicals (What Do Chemicals Do?)
- Chemical Selection Process
- Safety
- Chemical Storage
- Chemical Delivery
- Addition of Chemicals
- Dosages
- Optimization
- Purchasing Techniques
- Video

What's in a SDS?

- Product, Supplier, Emergency Contacts
- Composition of chemical
- Hazard identification
- First Aid
- Fire fighting measures
- Accidental release measures
- Handling and Storage

Globally Harmonized System

- Labels are changing to conform with the Globally Harmonized System or GHS.
- Worldwide effort by the United Nations to have common ways to describe chemicals and how to use them safely.
- Very similar to what is already on today's labels.
- Became effective – June 1, 2012
- Labeling effective – June 1, 2015

90

What's in a SDS? (cont)

- Exposure control and PPE
- Physical/chemical properties
- Stability/Reactivity
- Toxicological information
- Ecological information
- Disposal information
- Transportation requirements
- Regulatory information

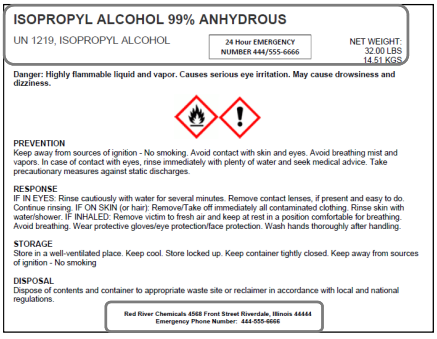
What's on the Label?

Labels must have five things:

1. Product Identifier – what is this chemical
2. Signal words – to tell us about the danger level
3. Hazard Statement – what kind of harm could the chemical cause
4. Pictograms – a symbol that tells us about the hazards
5. Precautionary Statement – what do we need to do to be safe around this chemical.

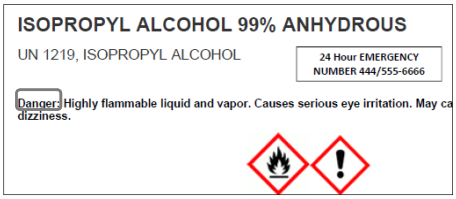
92

Product Identifier



93

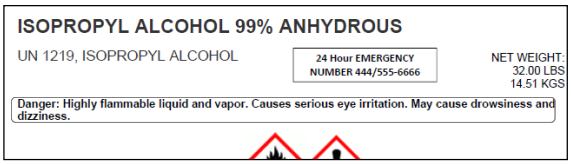
Signal Words



- **DANGER**
- **WARNING**

94

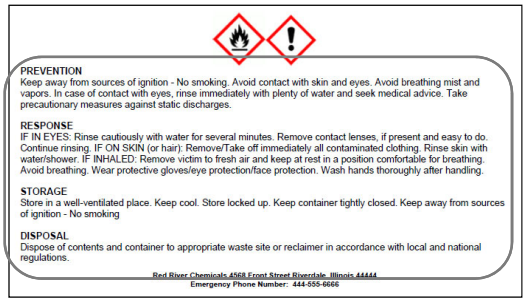
Hazard Statement



- Describes what kind of hazards this chemical has, such as:
  - Highly flammable liquid.
  - Causes serious eye irritation
  - May cause drowsiness and dizziness.

95

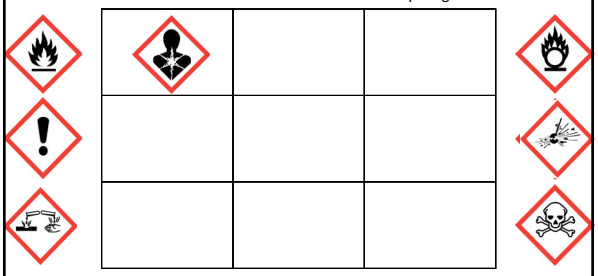
Precautionary Statements



96

Pictograms

- Symbol for the hazards of the product.
- Product can have one or more pictograms.



97

Wear Personal Protective Equipment

- Glasses, goggles, shield
- Respirator
- Gloves, boots, and clothing
- Head protection
- Hearing protection

05/07

Tools and Other Safety Equipment

- Fire extinguisher
- First aid
- Non-sparking tools
- Explosion proof lighting
- Communication equipment
- Rescue equipment

05/07

Shower and Eyewash Station

Maintenance of showers

- Test monthly for 15 minutes
- Keep eyewash clean
- Check tempered water
- Heat trace outside lines

Other Safety Information

- Should have a written procedure for possible emergencies
  - Fires
  - Spills
  - Medical emergencies

Chemical Class Content

- The role of chemicals (What Do Chemicals Do?)
- Chemical Selection Process
- Safety
- Chemical Storage
- Chemical Delivery
- Addition of Chemicals
- Dosages
- Optimization
- Purchasing Techniques
- Video

Storage of Chemicals

- Depends on quantities used, type of chemical, how delivered, how much to store, etc.
  - Solid chemicals – lumps, ground, in 50 lb. bags or bulk in 2000 lb. bags
  - Liquid chemicals – Barrels, carboys, totes, bulk storage
  - Many chemicals are corrosive and require special materials of construction for storage and piping

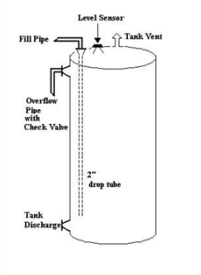
Drums

Totes

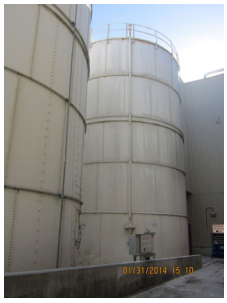
FRP Bulk Storage

Ferric Chloride Storage

Bulk Chemical Tank



LIME SILOS



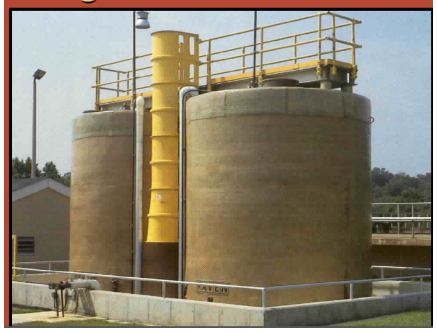
How much storage?

- Some plants want 30 days supply
- Most settle for less
- Depends on supplier distances, potential weather or traffic issues
- Supplier(s) track record, ability to store
- Supply locations of some chemicals

Materials of Construction

- Ferric chloride – FRP, Rubber lined steel, polyethylene, polypropylene
- Alum – Iron, steel
- Dry polymer and lime – steel
- Sodium hypochlorite – FRP, rubber lined steel
- Sulfuric acid – steel (93%), Glass lined (<90%)

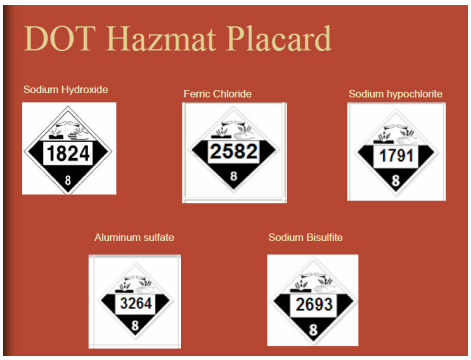
Storage Tanks



Tank Inspections

- Check for leaks
- Flush out sediment (Ferric chloride)
- Check for deterioration esp. around the base and bolts – can be mild vibration
- Best to have manways in the bottom
- A confined space
- Arlington experience

Labeling



Containment

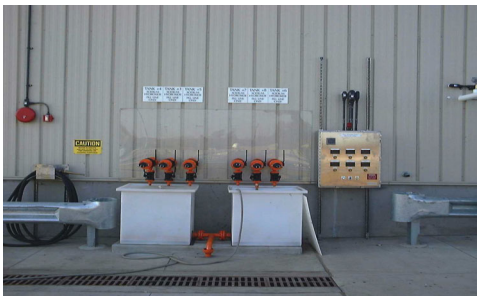
- If bulk storage of a hazardous liquid, need 110% containment of a tank
- Can be a dike
- Double-walled tank, with leak detection

Hypo Tank with Containment

Spill Control

- Designate an area with a drain to park the truck and connect hoses
- Have a place to pump out the area in event of a spill
- Insure that the entire pipeline is clear of all chemical before disconnecting

Chemical Unloading Station



Fill Pipes

- If multiple chemicals in one location, consider having each chemical with a different size connection
- Adequate signage
- Locked connections. Operator must unlock and observe delivery
- Allow for vibration of fill pipe
- Lime needs abrasion-resistant liners at elbows

Polymer Fill Line

Lime Pneumatic Convey Piping

Tank Overflow

Tank Overflow Lines

- Sized to handle maximum unloading gpm
- Same with vent line

Shelf Life of Chemicals

- Most chemicals do not deteriorate
- Exceptions
  - Sodium hypochlorite, loss of chlorine with time
  - Emulsion polymer – a few months – recirculate or mix

Chemical Class Content

- The role of chemicals (What Do Chemicals Do?)
- Chemical Selection Process
- Safety
- Chemical Storage
- Chemical Delivery
- Piping and Pumping
- Addition of Chemicals
- Dosages
- Optimization
- Purchasing Techniques
- Video

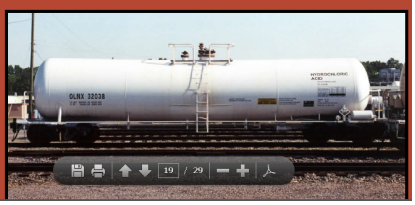
Deliveries

Bulk Deliveries

- Rail
- Truck
- Unloading with air pressure or pumping

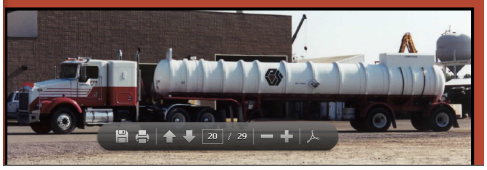
Delivery Vehicle – RailCar

17,000 gallon



Delivery Vehicle – Tank Truck

- MI – 4000, 6000, 8000 gallon
- Material compatibility
- Placard



Truck Safety Issues

- Very important not to have spills
- Contractual requirements
  - –Responsible to unload
  - –Must wear PPE
  - –Clean up spills
  - –They bring Bill of Lading with Chemical Analysis
  - –They seal all points of entry after loading at their site
  - –Certify a clean tank

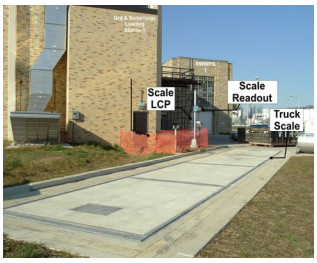
Truck Safety Issues (cont)

- They weigh truck at their facility and the plant
- They inspect and observe during unloading
- They have an emergency plan for spills
- Owner QA on product
- Owner picks storage tank

Truck Safety (cont)

- US DOT website
- FMCSA site for on-road safety record of each trucking firm
- Why monitor?
- How to monitor?

Truck Scales



Chemical Class Content

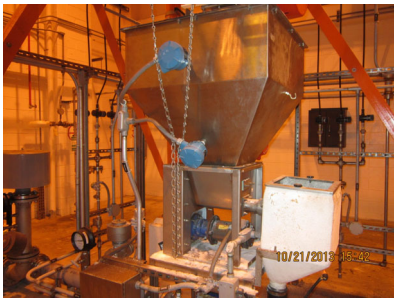
- The role of chemicals (What Do Chemicals Do?)
- Chemical Selection Process
- Safety
- Chemical Storage
- Chemical Delivery
- Addition of Chemicals
- Dosages
- Optimization
- Purchasing Techniques
- Video

Feeding Chemicals

- Dry Product
  - Gravimetric
  - Volumetric
- Liquids
  - Pumping a liquid or slurry, w/wo carrier water
- Gas
  - Must be dissolved in water

Dry Feeders*

- Usually a silo or day tank to a volumetric feeder
  - Day tank can be on a scale
  - Can use a calibrated screw to feed. Requires periodic calibration
  - Other feeders – Belt, Revolving plate, Rotary, Shaker
  - Inspect to avoid buildup from moisture



Feeding Liquids

- Positive displacement pumps
  - Gear pumps
  - Hose pumps (2000 hours life)
  - Diaphragm pump
  - Rotary lobe pump
  - Progressive cavity pump

Pump Selection*

- Gear pumps – becoming more popular
- Hose pumps – Hose has a life span
  - No air binding
- Diaphragm pumps
  - Vari-speed and vari-stroke
  - Can air bind

- View videos

Polymer Feed Pump

Pump Selection (cont)

- Rotary lobe pump – handles product without damaging, e.g. polymer
- Progressive cavity pump – Good general, all-purpose pump
- Drum pump – for small feed systems

- Pumps cannot be over or under sized
- Use graduated cylinder for calibrating pumps
- Carrier water advantages/disadvantages

Hose Pump for Hypo

Calibration Chamber

Carrier Water*

- Works to help disperse the chemical in the total flow, esp. if little mixing at point of application
- Some chemicals react with carrier water
  - Ferric chloride forms ferric hydroxide

Flushing Water

- All chemical piping should have a flushing connection
  - Never leave chemical sitting in a pipe. It attacks the piping/glue at fittings - hypo
  - Can have an auto solenoid to flush when feed stopped
  - Story about bisulfite flushing line
  - Protect from leaving it on

Piping

- Must be compatible with all possibilities for chemical concentration
- PVC often used, Stainless steel for methanol
  - Case study of sulfuric acid 93%

Methanol Feed Piping

Feed Controls – Liquid

- Can be constant flow, but not optimum
- Best if flow-paced with main flow – metered flow rate determines pump speed or stroke
- Difficult to measure flow rates of chemical, often use a correlated speed
- Target a mg/l dosage into liquid flow
- Can use feedback from an on-line analyzer, e.g. NO_3 analyzer to set methanol flow

Feed Controls - Solids

- Target a #/dry ton in solids streams
- Difficult to have an on-line analyzer that works
- Can run % solids or TSS in field
  - Need visual or grab sample of dewatered cake or centrate – to vary polymer dose

Feeding Gas*

- Examples – Chlorine, Sulfur dioxide, Oxygen, Ozone
- Need an evaporator for Cl_2 and SO_2
- Water solution

Piping Materials of Construction

- Ferric chloride - PVC
- Methanol – Welded stainless steel
- Sodium Hypochlorite – CPVC
- Caustic - PVC
- Sodium Bisulfite – PVC or 316 SS
- Polymer - PVC

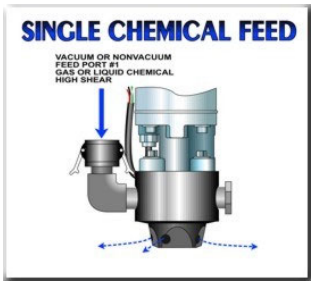
Addition Points

- Get good mixing
- Reaction times
- Add at a point of natural turbulence or install a mixer
  - Chemical Injection Units
  - Ejectors
  - Static Mixers
  - Flocculation Tanks (mostly for solids streams)

Addition Points (cont)

- Difficult to get good mixing in raw sewage
- Most mechanical mixers require clean water
- CIUs are high speed machines that work well for Hypo, ferric chloride, and caustic
- Ejectors also work with these chemicals

Chemical Injection Unit



Chemical Class Content

- The role of chemicals (What do Chemical Do?)
- Chemical Selection Process
- Safety
- Chemical Storage
- Chemical Delivery
- Addition of Chemicals
- Dosages
- Optimization
- Purchasing Techniques
- Video

Example Chemical Dosages

- Ferric Chloride (P removal) – 5 mg/l of Fe and another 2.5 at second point
- Sodium Hypochlorite for Disinfection – 4 mg/l
- Sodium Bisulfite – 2.5 mg/l
- Methanol – 3 lbs/lb of NO_3-N
- Caustic – 0.81 lbs/lb of alkalinity
- Lime for solids stabilization – 15 to 20% of dry solids

Example Chemical dosages

- Polymer – in wastewater to aid settling- 0.2 mg/l
- Polymer for Thickening – 5 lbs/dry ton solids
- Polymer for Dewatering – 10 to 15 lbs/ton solids

Calculation (1)

- Given: Average flow = .075 MGD
- Fe dosage of 7.5 mg/l
- Calculate gpm of Ferric chloride feed

- 0.75 MGD X 8.34 #/MG/mg/l X 7.5 mg/l of Fe = 46.9 # Fe/day
- 46.9 #/day X (162.35/55.85) = 136.4 # $FeCl_3$/day

Calculation (2)

- Given $FeCl_3$ as delivered is 34% solution; density of 11.67 # solution/gallon.
- 136.4 # $FeCl_3$/day /0.34 # $FeCl_3$/# solution = 401.2 # solution/day
- 401.2/ 11.67 #/gal = 34.4 gal/day of $FeCl_3$ solution
- 34.4/1440 min/day = 0.24 gal/min $FeCl_3$ solution

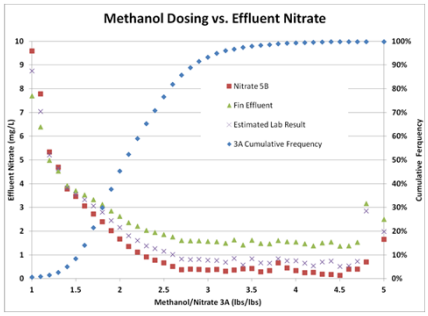
Chemical Class Content

- The role of chemicals (What Do Chemicals Do?)
- Chemical Selection Process
- Safety
- Chemical Storage
- Chemical Delivery
- Addition of Chemicals
- Dosages
- Optimization
- Purchasing Techniques
- Video

Optimizing Chemical Feed*

- Trend data – know where you are
  - Measure flow or lbs of solids processed and lbs of chemical used per what is measured – Daily/Weekly/Monthly
  - Plot data
  - Look for ways to reduce consumption
  - Chemicals can be a large portion of total budget – approximately 20 to 30%

Trend Chart Example



Optimizing Chemical Feed*

- Use flow pacing, on-line analyzers
- Give operators the data
- Set performance targets
- Calibrate pumps and dry feeders monthly/quarterly
  - Hose pumps and diaphragms wear
  - Volumetric screws get plugged

Resources

- Chlorine Institute – www.cl2.org
  - Chlorine, hypo, caustic, hydrochloric acid
- Methanol Institute – www.methanol.org
- National Lime Association – www.lime.org

Calculations from your plants

Questions?

Review & Exam