Hot Topic Objectives

- Who is Infilco Degremont (IDI)
- Source of FGD Waste Water
- Factors affecting the flow & the characteristics of FGD Waste Stream
- FGD WW typical Characteristics
- The Challenges
- Treatment Design
  - Physical / Chemical
  - IX
  - Biological
- Future of FGD WWTP
Infilco Degermont is one of the leading water and wastewater treatment plant in the world and part of the $45 billion Suez Group.

- Over 100 years of US experience
- Over 500 US industrial lants
- 45 FGD WWT Plants
- 2,500 municipal wastewater plants
- 3,000 drinking water plants
- “Infilcare” services capability
International Filter Co. started in Chicago, IL

1894

International Filter Co. becomes Infilco Inc. (Relocated to Tucson)

1942

GATX purchases Infilco Inc.

1960

Westinghouse purchases Infilco Inc. (Relocate to Richmond)

1970

Degremont Technologies formed to consolidate North American Operations

2007

Degremont acquires Infilco to form Infilco Degremont Inc

2011

Present leader in water and wastewater technologies

1974
Source of FGD Waste Stream

FGD Block Diagram

FLUE GAS

ESP

BOOSTER FAN

Absorber Tower

LIMESTONE

WATER

AIR

FLUE GAS TO STACK

BLEED STREAM
(Blow down, Chloride Purge stream)
Factors Affecting the FGD Waste Stream

- Rate Capacity of the Absorber and the number of units
- Design Chloride Characteristics of the Absorber Cycle Loop
- Efficiency of Fly Ash Removal by the ESP (Electrostatic Precipitation)
- Operational practices of the scrubber
- Efficiency and type of the first & the secondary hydroclones
- Type of FGD Process (Limestone, lime, caustic soda....)
- Chemical Composition of Coal, Limestone, and Make-up Water
# FGD Waste Water Characteristics

## Design Impact Considerations

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Units</th>
<th>Typical Influent Dissolved Parameters (Range)</th>
<th>Typical Effluent Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Suspended Solids (TSS)</td>
<td>mg/L</td>
<td>500 – 20,000</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Total Dissolved Solids (TDS)</td>
<td>mg/L</td>
<td>15,000 – 45,000</td>
<td>N/A</td>
</tr>
<tr>
<td>pH</td>
<td>Standard Units</td>
<td>4 – 6</td>
<td>6-9</td>
</tr>
<tr>
<td>COD</td>
<td>mg/L</td>
<td>200 – 500</td>
<td>N/A</td>
</tr>
<tr>
<td>Chloride (Cl)</td>
<td>mg/L</td>
<td>10,000 – 30,000</td>
<td>N/A</td>
</tr>
<tr>
<td>Ammonia (N-NH₄)</td>
<td>mg/L</td>
<td>20 – 60</td>
<td>3.0</td>
</tr>
<tr>
<td>Nitrate (N-NO₃)</td>
<td>mg/L</td>
<td>30 – 200</td>
<td>N/A</td>
</tr>
<tr>
<td>Sulfate (SO₄)</td>
<td>mg/L</td>
<td>3,000 – 5,000</td>
<td>N/A</td>
</tr>
<tr>
<td>Fluoride (F)</td>
<td>mg/L</td>
<td>10 – 50</td>
<td>10.0</td>
</tr>
<tr>
<td>Aluminum (Al)</td>
<td>mg/L</td>
<td>10 – 20</td>
<td>0.1</td>
</tr>
<tr>
<td>Arsenic (As)</td>
<td>mg/L</td>
<td>0.08 – 1</td>
<td>0.1</td>
</tr>
<tr>
<td>Boron (B)</td>
<td>mg/L</td>
<td>20 – 300</td>
<td>10</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>mg/L</td>
<td>0.05 – 0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>mg/L</td>
<td>300 – 10,000</td>
<td>N/A</td>
</tr>
</tbody>
</table>

* Filters are required
- Factor affecting equipment sizing
- Biological/IX treatment required
## FGD Waste Water Characteristics

### Design Impact Considerations

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<tr>
<th>Parameters</th>
<th>Units</th>
<th>Typical Influent Dissolved Parameters (Range)</th>
<th>Typical Effluent Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromium (Cr)</td>
<td>mg/L</td>
<td>1-3</td>
<td>0.1</td>
</tr>
<tr>
<td>Cobalt (Co)</td>
<td>mg/L</td>
<td>0.1-0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>Standard Units</td>
<td>4 – 6</td>
<td>6-9</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>mg/L</td>
<td>2-5</td>
<td>0.5</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>mg/L</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>mg/L</td>
<td>200 – 4000</td>
<td>NA</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>mg/L</td>
<td>30 – 200</td>
<td>50</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>mg/L</td>
<td>1-3</td>
<td>0.001*</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>mg/L</td>
<td>1-2</td>
<td>0.2</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td>mg/L</td>
<td>0.08 – 0.8</td>
<td>0.1</td>
</tr>
<tr>
<td>Vanadium (V)</td>
<td>mg/L</td>
<td>1 – 3</td>
<td>3.0</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>mg/L</td>
<td>5-10</td>
<td>0.1</td>
</tr>
<tr>
<td>SiO₂</td>
<td>mg/L</td>
<td>50 – 300</td>
<td>N/A</td>
</tr>
</tbody>
</table>

* Filters are required

- Factor affecting equipment sizing
- Biological/IX/Evaporation treatment required
## FGD Waste Water Characteristics

### Design Impact Considerations for Dewatering

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Design Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow (GPM)</td>
<td>75 – 400</td>
</tr>
<tr>
<td>Temperature °F</td>
<td>110 – 130</td>
</tr>
<tr>
<td>pH</td>
<td>5.5 – 6.5</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>&lt;20,000</td>
</tr>
<tr>
<td>Chlorides (mg/L)</td>
<td>&lt;30,000</td>
</tr>
</tbody>
</table>

### TSS Make-up

<table>
<thead>
<tr>
<th>TSS Make-up</th>
<th>Design Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>CaSO$_4$</td>
<td>40 – 60</td>
</tr>
<tr>
<td>CaCO$_3$</td>
<td>5 – 15</td>
</tr>
<tr>
<td>Flyash</td>
<td>5 – 15</td>
</tr>
<tr>
<td>Inerts</td>
<td>20 – 30</td>
</tr>
<tr>
<td>Mg(OH)$_2$, MgCO$_3$</td>
<td>0 – 10</td>
</tr>
</tbody>
</table>
The Challenges

- FGD wastewater treatment plants must be initially designed using assumed theoretical wastewater analyses.

- Coal and limestone sources will change over time, and sometimes on the same day.

- The design must incorporate high flexibility to accommodate the actual differing supply and operating conditions of the absorbers.
Typical FGD WWTP Block Diagram

FGD Wastewater
pH = 5.5

LIME

EQUALIZATION/Desaturation
pH adjustment 8.0-8.5

COAGULANT

ORGANOSULFIDE SOLUTION

REACTION TANK

FLOCCULANT

REACTOR

CLARIFIER/THICKENERS
(DENSADEG)

SLUDGE WASTE

HCl

SAND FILTERS

DEWATERING SYSTEM

EFFLUENT Ph 6-9 TSS<5mg/L

Discharge
FGD Process Units

- Equalization
- Desaturation
- pH adjustment
- Coagulation
- Heavy Metal reaction tank
- Flocculation
- Clarification/Thickening
- Polishing
  - IX (Ion Exchange)
  - Biological
- Dewatering
Physical/Chemical Treatment
Clarification/Thickening in One Tank
The “Heart” of IDI’s Design
Design Principles of the DensaDeg

- Rapid mix of coagulant and metal scavenger
- Polymer addition via a draft ring which increases efficiency of the flocculation
- Internal solids recirculation within reactor
- External sludge recycle back to reactor/or Desaturation tank
- Dense solids/clarified water separation up flow through tube settlers
Typical WWTP 3D with Sand Filtration
Boron can be removed from FGD Wastewater via two main processes

1. Chemical Precipitation

2. Ion Exchange Concentration with final removal via:
   a. Crystallizer
   b. Chemical Precipitation
Selective IX Resin removes Boron to <5 ppm in FGD Wastewater
iX™ System is based on a Selective IX Resin that is effective in the removal of borate from FGD Wastewater.

The process relies on the selective removal of Brate from the FGD wastewater, which results in a concentrated waste stream that can be more easily treated.

The IX process has the following advantages:
1. Concentrated waste stream
2. Small waste volume
3. Lower operating cost
4. Able to handle swings in Borate concentration in the wastewater very easily.
5. Operation cost directly correlates to Borate concentration
iX™ Boron Removal Process
Standard Steps in IX Operation Lead - Lag Concept

1. Service Inlet
2. Primary Unit
   - Acid
   - NaOH
   - Rinse Water
3. Backwash (Optional)
4. Regeneration Waste
5. Lead Unit
6. Lag Unit
   - Acid
   - NaOH
   - Rinse Water
7. Service Outlet
8. Backwash (Optional)
Boron Elution

- Sulfuric Acid (H2SO4) is used to elute the Borate off IX Resin
- The concentrated Boron recovery step takes normally 1.33 Bed Volumes of 5% H2SO4 solution.
- Boron elution precedes and overlaps with H+ elution
- The concentrate acid regenerate stream normally contains between 4,000 to 8,000 ppm of Boron
The removal of oxy-anions of Selenium (Selenate and Selenite) are based on the biological reduction of selenium, via Sulfate Reducing Bacteria (SRB) and Denitrification Bacteria, to non-toxic elemental Selenium.
iBIO®

- Suspended growth activated sludge system
- Continuous Stirred Tank Reactor
- Allows for minimum impact of wastewater transients (e.g., influent TSS).
- Decouples the two stages of bacterial activity and allows for independent optimization of the “denitrification” and “selenium reduction” steps.
Denitrification

- Conversion of nitrates (NO\textsubscript{3}) to nitrogen gas (N\textsubscript{2})

- Nitrates (NO\textsubscript{3}) + Organics + Heterotrophic Bacteria = Nitrogen Gas + Oxygen + Alkalinity

Selenium Reduction Process

- Selenates/Selenites + Organics + Sulfur Reducing Bacteria = Reduced Elemental Selenium
iBIO® Process Schematic

- **MACRO NUTRIENTS**
- **CARBON SOURCE**
- **MICRO NUTRIENTS**
- **AIR**

**Units:**
- **ANOXIC**
- **ANAEROBIC**
- **ANAEROBIC CLARIFIER**
- **AEROBIC**
- **AEROBIC CLARIFIER**
- **SAND FILTERS**
- **EFFLUENT**

**Flow Diagram:**
1. INFLUENT
2. MACRO NUTRIENTS
3. CARBON SOURCE
4. MICRO NUTRIENTS
5. AIR
6. ANOXIC
7. ANAEROBIC
8. ANAEROBIC CLARIFIER
9. SAND FILTERS
10. AEROBIC
11. AEROBIC CLARIFIER
12. SAND FILTERS
13. EFFLUENT
Conemaugh Generating Station
Coal fired plants provide – 50% of USA electricity and they remain a mainstay for electricity throughout the world

150 FGD projects had been scheduled in the USA within 2008 – 2010

Some are retrofits others are new

Approximately 80% of new scrubbers will use wet – limestone technology

Reliability and abundance of limestone
THANK YOU!

Questions and Comments are Welcome