

# Coagulation, Flocculation and Sedimentation

Dr. John T. O'Connor, PE



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# Removal of Precipitates

- **Coagulation (Rapid Chemical Mix)**  
Destabilization of Suspended Particles
- **Flocculation (Slow Mix)**  
Particle Collision and Growth
- **Settling**      Removal of Settleable Solids



# Solids Removal Process

Coagulation  
Rapid Mix  
Flocculation  
Settling





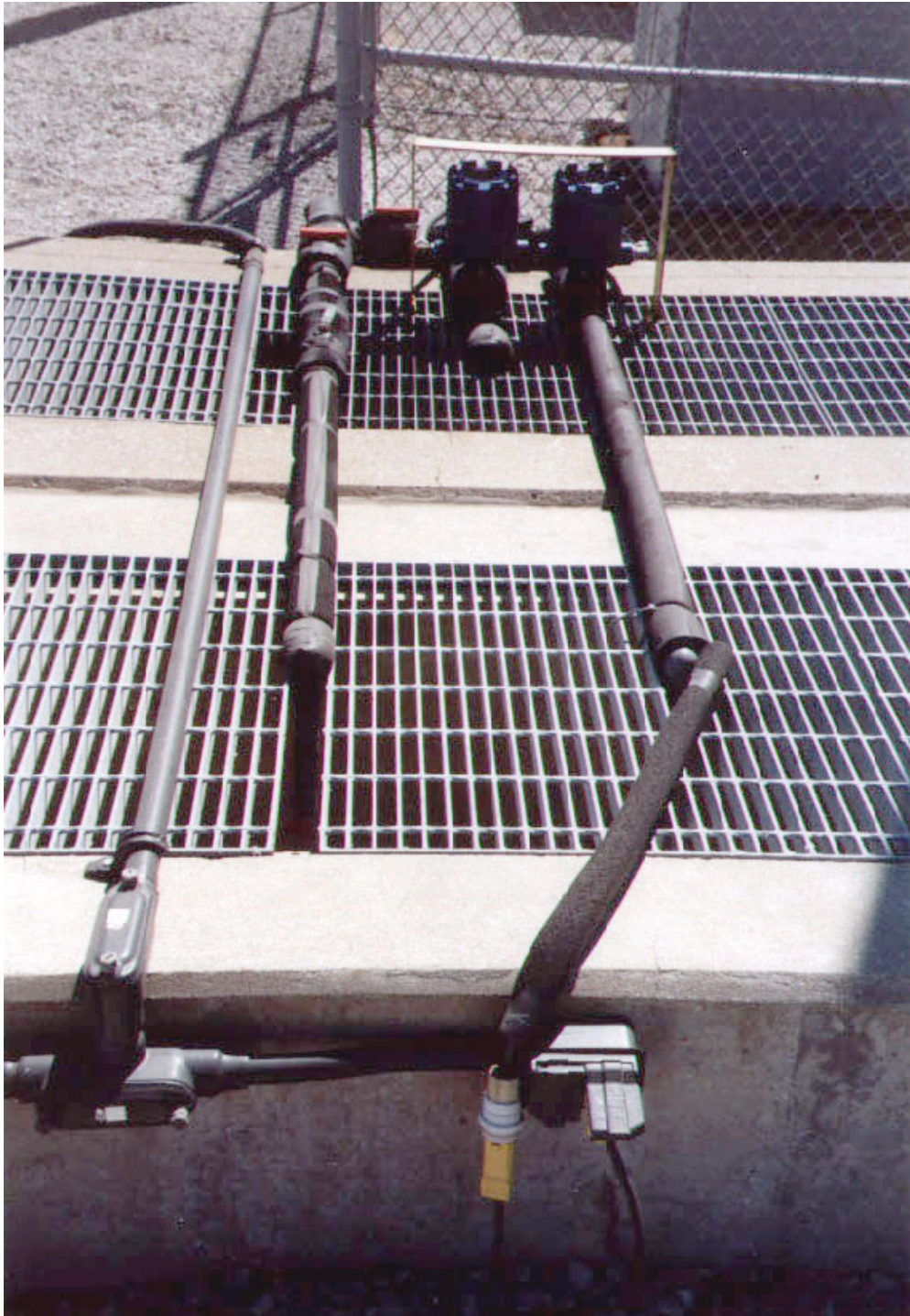


# Flumes

- Flow Diversion
- Polymer Addition
- Rapid Mixing
- Flocculation

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# Polymeric Coagulant Feed

Polymer diluted to  
0.1  
percent  
(1,000 ppm)

Polymer Dose:  
1 - 3 ppm

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# Wastewater Coagulants

- **Inorganic:** Ferric, Aluminum Sulfates
- **Natural Polyelectrolytes:** Bentonite Clay, Starch, Guar Gum, Sodium Alginate, Sodium Carboxymethylcellulose
- **Synthetic Polymers:** Polyacrylamide, Polyacrylonitrile, Polyamine, Carboxyl, Ethylene Oxide Polymers



# Synthetic Polyelectrolytes

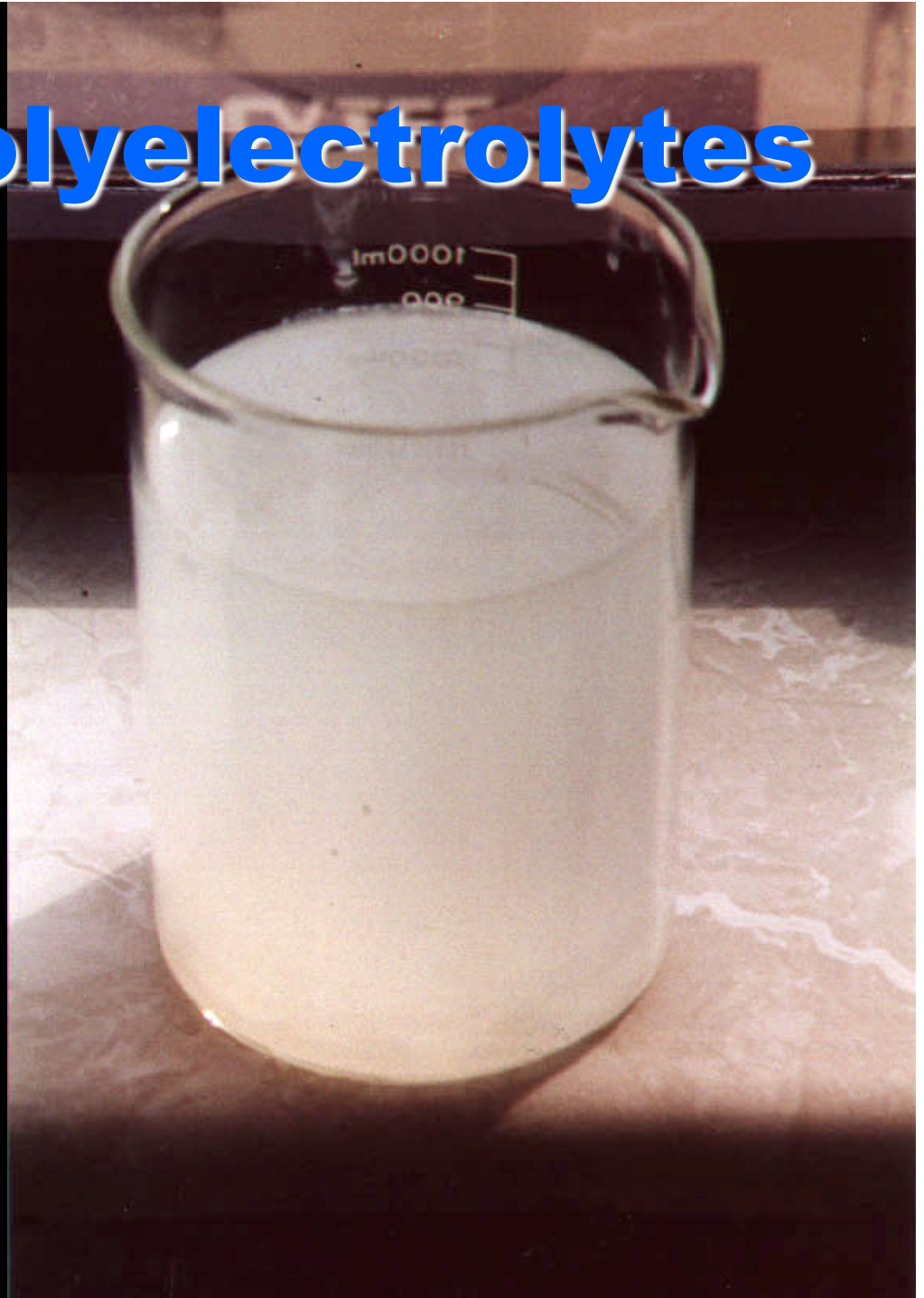
- **Anionic** (Negative)
- **Cationic** (Positive)
- **Nonionic** (Both)

**High Molecular Weight**

**~ 1,000,000 amu**

**Dosage < 1 ppm**

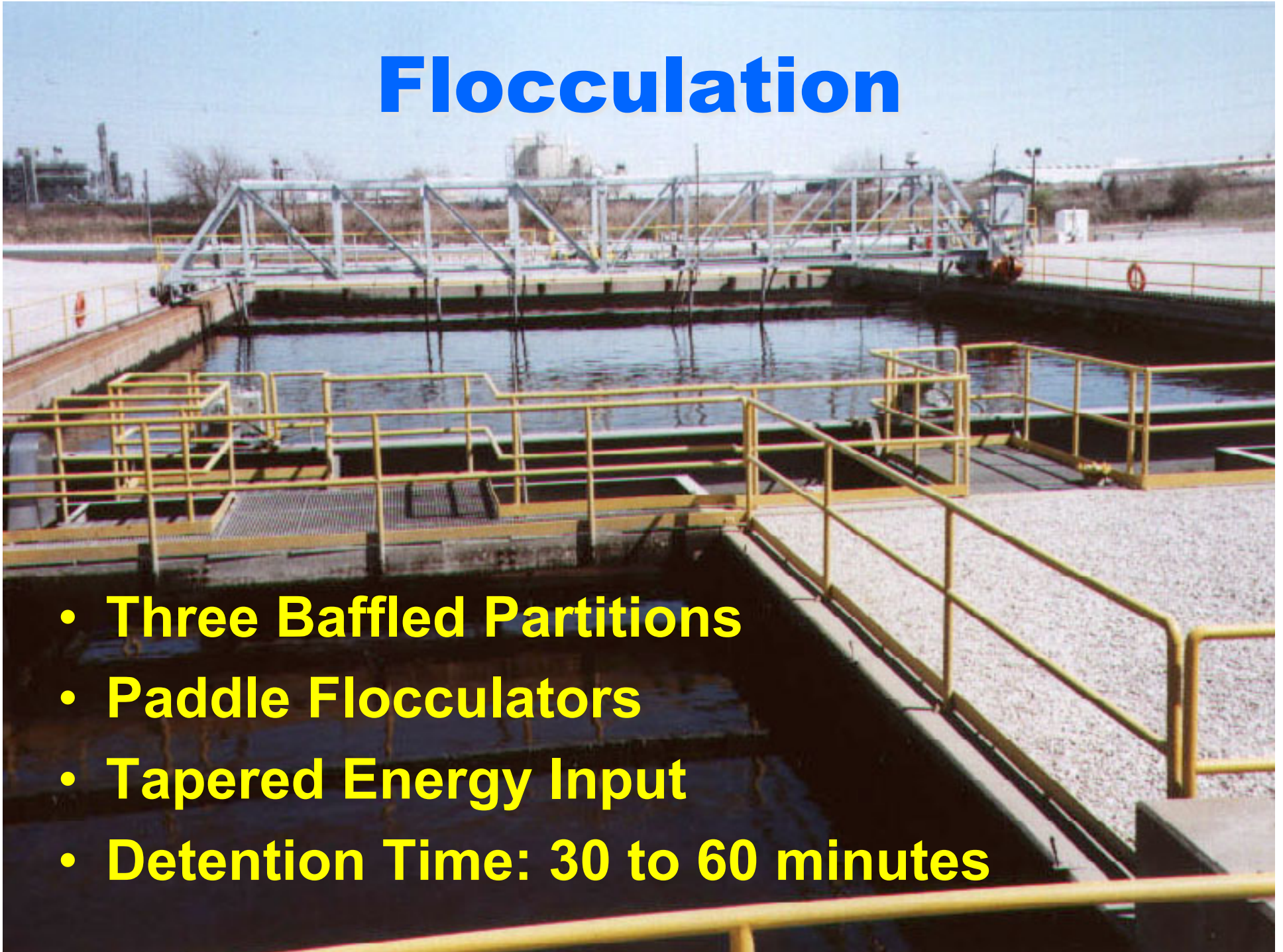
**Interparticle Bridging**





# Flocculation

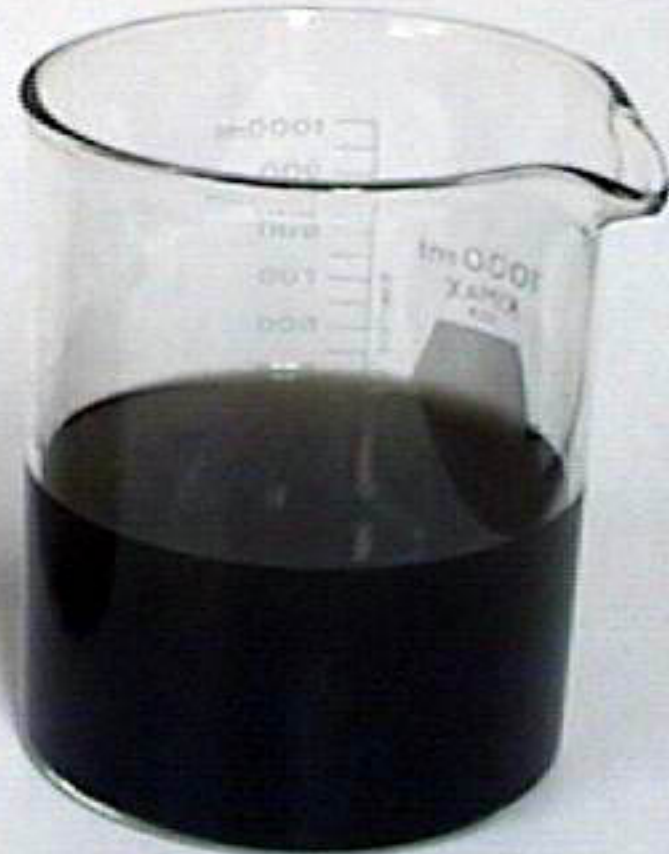
- Three Baffled Partitions
- Paddle Flocculators
- Tapered Energy Input
- Detention Time: 30 to 60 minutes



# Settling Test - 1 minute



**Flocculator  
Turned Off**



**Flocculator  
Operating**



# Settling Test - 5 minutes



**Flocculator  
Turned Off**



**Flocculator  
Operating**

# Settling Test - 15 minutes



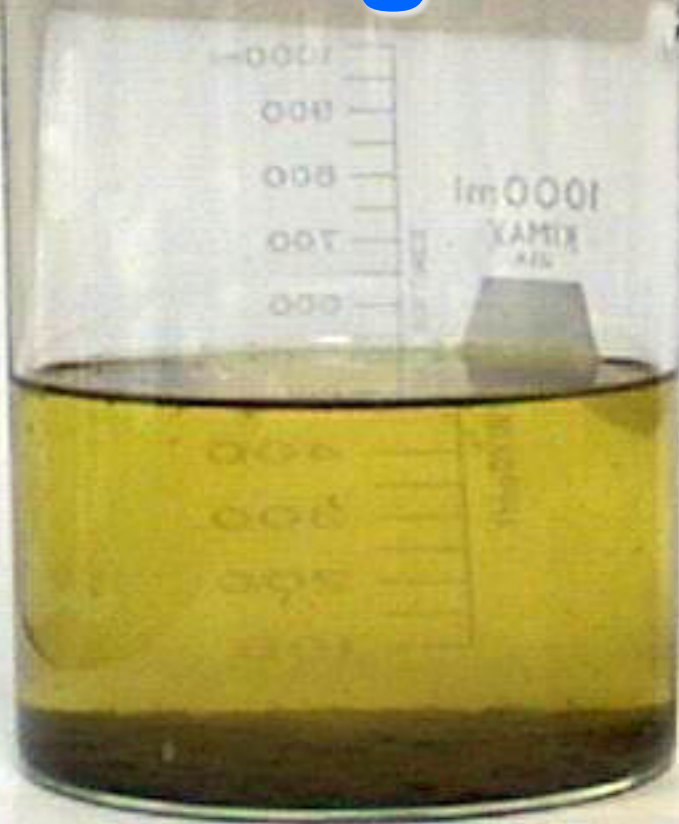
**Flocculator  
Turned Off**



**Flocculator  
Operating**



# Settling Test - 20 minutes



**Flocculator  
Turned Off**



**Flocculator  
Operating**

# Settling Test - 1 hour



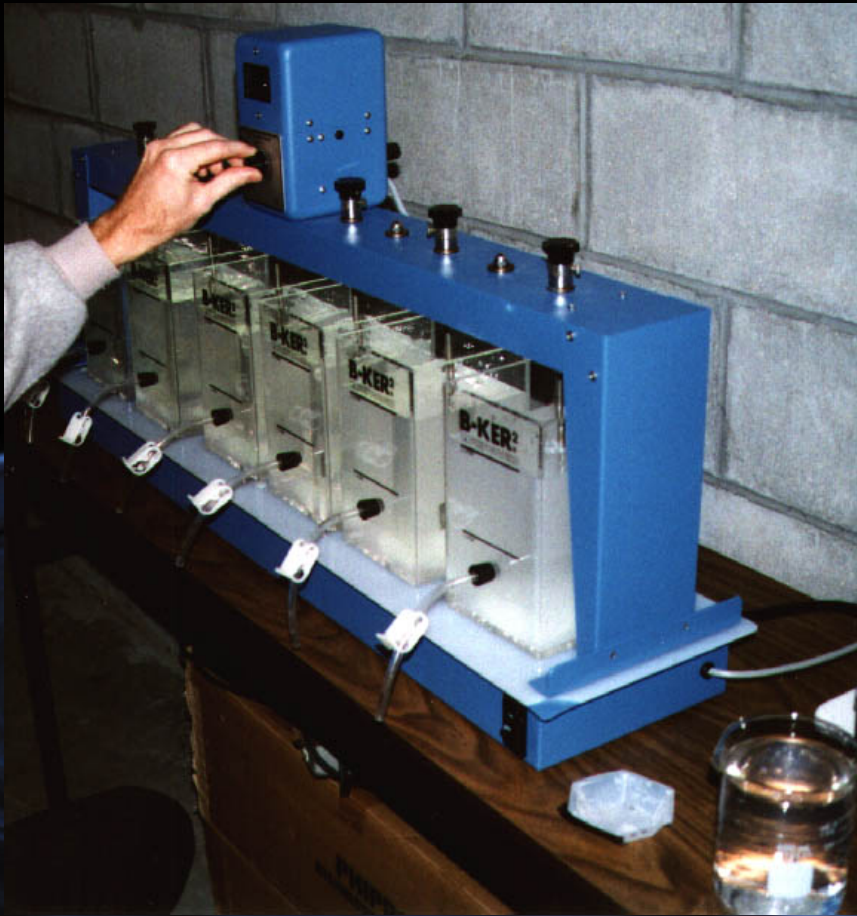
**Flocculator  
Turned Off**



**Flocculator  
Operating**



# Jar Testing Demonstration



- Dose - Response
- Energy Input
  - Rapid Mix
  - Slow Mix
- Settling Rate
- Alternate Coagulants

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# Removal of Skimmings





# **Solids Return**

**Return flow  
displaces oil layer**





# Settling Tanks

- Retention Time: > 2 hours
- Surface Loading Rate: < 1,000 gpd/sf
- Sludge Storage Hoppers
- Sludge Rake Mechanisms







# **Rising Solids**

- **Surfacing of Oil**
- **Turbulence due to Sludge Raking**
- **Gas Formation in Sludge Blanket**
- **Wind Stirring on Open Basins**
- **Temperature-Induced Density Currents**



# **Sludge Removal Mechanism**

**Chain-Driven Flights**

**Continuous Raking**

**Intermittent Solids  
Removal**

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# Effluent Weirs

- V-notch weirs to minimize effect of wind set-up and turbulence
- Serpentine to attain  $> 20,000$  gal/foot/day



# Settling Tank Detention

## Ideal Tank

3 mgd flow in 0.9 mg tank: 0.3 days

## Deviation from Ideal

- Inlet, Outlet and Sludge Storage Zones
- Variations in Flow, Uneven Distribution
- Temperature (Density), Dead Spots
- Wind Stirring, Set Up, Seiches
- Turbulence, Sludge Blanket Upsets



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