Filaments and Clarifier Bulking

Activated Sludge Plant that
experienced high flow washouts due
to filamentous bacteria bottleneck.

Plant Layout

- Complete Mixed Activated Sludge
  - Two aeration basins with diffused air
  - Three clarifiers
  - Return sludge flows to Screw Lift pumps
  - RAS flow measurement
  - Splitter box to split flow to aeration.

Activated Sludge Operational Data, Jan 2005

- MLSS = 2500 mg/L
- SSV_{30} = 440 ml, with a very clear supernatant.
- SVI = 170 ml/mg
- History of blanket washouts with high flows
  - Flows 33% above capacity caused clarifier blankets to wash out resulting in effluent violations.
  - Settleable Solids values as high as 3900% above limits.
  - Also violations for TSS, BOD, Fecal, % removals

Operator Strategy

- The capacity of the clarifier to remove solids bottlenecked the plant
- In order to prevent washouts and effluent violations operators limited influent flow.
- This protected the plant, but caused raw sewage overflows.

Microscopic Exam

- Bulking clarifiers and high SVI points toward filamentous bacteria.
- Microscopic Exam at plant
  - Floc, dense large floc
  - Protozoa, free swimming & crawling ciliates, Rotifers.
  - Filaments present, extending from and bridging between the floc.

Filament Identification

- The following filaments were identified with the phase contrast microscope.
- This was a biological bottleneck.
- Filaments present
  - Thiothrix, 021N, 1851, 0092, 0041, M. Parvicella

Corrective Action

- Waste more biomass
  - Solids handling system fully loaded so there was no way to waste more.
  - Chlorination of the return sludge was chosen as the solution
  - Off/On aeration was tried as an interim measure, but made no change.

How much chlorine?

- Using the *Manual on Causes and Control of Activated Sludge Foaming, Bulking and other Solids Separation Problems*, by David Jenkins et. al., a dose of 2 lbs of chlorine per 1000 lbs of biomass was chosen. This is a maintenance dose, but also a good place to start. It is easier to go up than clean up a mess from an overdose.

How much Biomass?

- The pounds of Biomass in both aeration basins and all three clarifiers was calculated.
- Tests required
  - MLSS on each aeration basin
  - MLSS or TSS on a core sample from each clarifer. A core is the entire contents of the “Sludge Judge”.
  - MLSS or TSS on the Return Sludge.

Crunch the numbers!

- MLSS * aerator volume * 8.34 = pounds
- Clarifier Core MLSS * clarifier * 8.34 = clarifier pounds.
- Add the pounds for each aerator and clarifier to determine total pounds of Biomass.
- Pounds of Biomass * 2 lbs Chlorine / 1000 = lbs Chlorine
- Chlorinator would be set at this feed rate.

- Another consideration !
  - Number of chlorine doses per day.

Doses per Day?

- Dr. Jenkins states the for best results the biomass should receive at least three doses of chlorine per day.
- To achieve this the pounds of RAS needs to be three times the total biomass inventory.
- In this plant:
  - RAS MLSS * RAS Flow * 8.34 = Three times biomass inventory, what luck!

Chlorinating the RAS

- There were two effluent chlorinators. One in use and a second as backup.
- Piping would be installed to direct the flow from the backup chlorinator to the RAS screw lift pumps.
- By changing valves this chlorinator could be used as a backup for effluent or for the RAS.

Adding Chlorine at RAS Pumps

- Note small white pipes along the horizontal concrete beam.
- Each pipe discharges the chlorine solution into the RAS flow from one of the clarifiers.

Adding Chlorine at RAS Pumps

Before and After

Date	Chlorine	SVI	SSV 30	Biomass
3/24	Start Cl_2	271	700	103,000 lbs
3/25		250	700	
3/28		188	496	117,000 lbs
3/29		164	400	
3/30		152	350	
4/4		106	380	99,000 lbs
4/5		104	300	83,000 lbs
4/6		96	270	69,000 lbs
4/7	Stop Cl_2	102	250	
4/20		100	250	76,000 lbs

Results

- Chlorine was at a low dose of 2 lbs / 1000 lbs of biomass for two weeks.
- SVI and 30 minute settleometer improved dramatically.
- Effluent quality did not deteriorate during chlorination. BOD < 10 mg/L, TSS <20 mg/L
- Six months latter the SVI remains low.

More Results!

- Operators had stated that they had simply learned to live with high SVI's and bulking sludge.
- With the SVI in normal range and the clarifier blankets down low the next step was to increase the flow through the plant.
- During a spring rainfall event flows were increased to 160% of capacity for several days with no adverse affects to the effluent quality.
- For short periods of time they have taken flows to 200% of capacity without clarifier bulking.

Operators can make a difference!

- Identify the problem:
  - Sewage overflows
- Find a solution:
  - Put more water through the plant.
  - Reduce Inflow and Infiltration.
- Locate obstacles or bottlenecks:
  - Filamentous bulking
- Research the solution:
  - How much Chlorine, at what cost, how to measure success

Operators can make a difference!

- Sell the solution:
  - Define the Problem
  - List options for correction
  - What will it cost?
  - How will success be measured
- Be a Top Operator
  - Locate and Remove the bottlenecks.