Water Harmony
Erasmus+

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# Operation and maintenance
## Trouble shooting of processes

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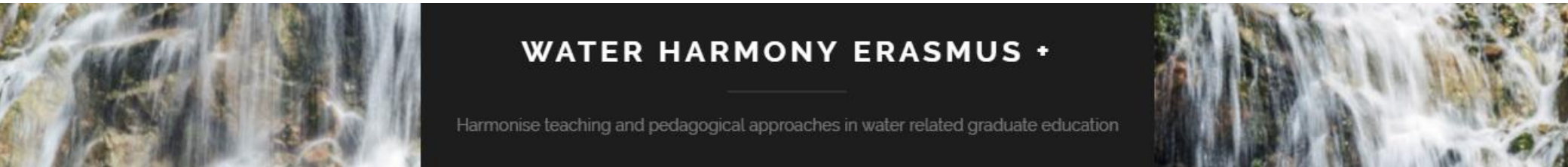

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# Troubleshooting

- identify the problem – What?
- understand the probable causes- Why?
- resolving the problem – How?

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# Troubleshooting: Mechanical bar screens

| Problems | Probable causes | Solutions |
|---|---|---|
| Obnoxious odours, flies and other insects | Accumulation of rags and debris | Increase frequency of removal and disposal to an approved facility |
| Excessive grit in bar screen chamber | Flow velocity low | Remove bottom irregularity, or resole the bottom. Increase flow velocity in a chamber of flush regularly with a hose. |
| Excessive screen clogging | Unusual amount of debris in wastewater. Check industrial wastes | Use a coarser screen or identity source of waste causing the problem so its discharge in the system ca be stopped. |
| Screening downstream screens | Overflow, damaged bars | Repair or replace screen |

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# Troubleshooting: Grit removal

| Problems | Probable causes | Solutions |
|---|---|---|
| Grit packed on collectors | Collector operating at too high speed | Reduce collector speed<br>Increase speed of grit removal from collector |
| | Bucket elevator/removal equip. too slow speeds | Removal system speed |
| Rotten eff odor in grit chamber | Hydrogen sulphide formation | Wash chamber and dose with hypochlorite |
| Accumulated grit in chamber | Submerged debris | Wash chamber daily.<br>Remove debris |
| | Flow velocity too low or broken chain or flight | Repair equipment |
| Corrosion of metal and concrete | Inadequate ventilation | Increase ventilation and perform annual repair and repainting |

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# Troubleshooting: Grit removal

| Problems | Probable causes | Solutions |
|---|---|---|
| Removed grit is grey in color, smells, and feels greasy | • Inadequate air flow rate | • Increase velocity in grit chamber.(0.3 m/s usually optimum unless operating strategy calls for lower velocity |
| Surface turbulence in aerated grit chamber is reduced | • Diffusers covered by rags or grit | • Clean diffusers and correct screens or other pretreatment steps to prevent |
| Low recovery rate of grit | • Bottom scour at excessive speeds | • Maintain velocity near 0.3 m/s |
| | • Too much aeration | • Reduce aeration<br>• Increase retention time by using or reducing flow to unit |
| Overflowing grit chamber | • Pump surge problem | • Adjust pump controls or control infiltration and inflow |
| Septic waste with grease and gas bubbles rising in grit chamber | • Sludge on bottom of chamber | • Wash chamber daily |

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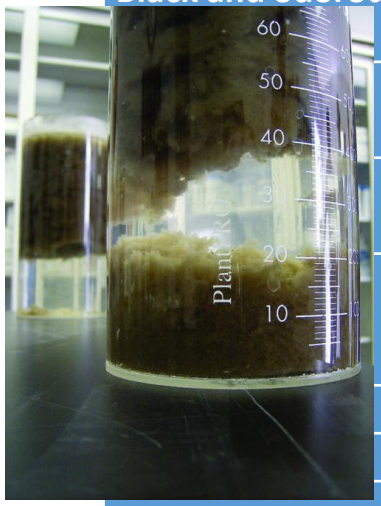
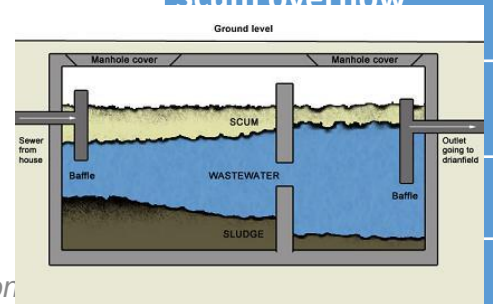
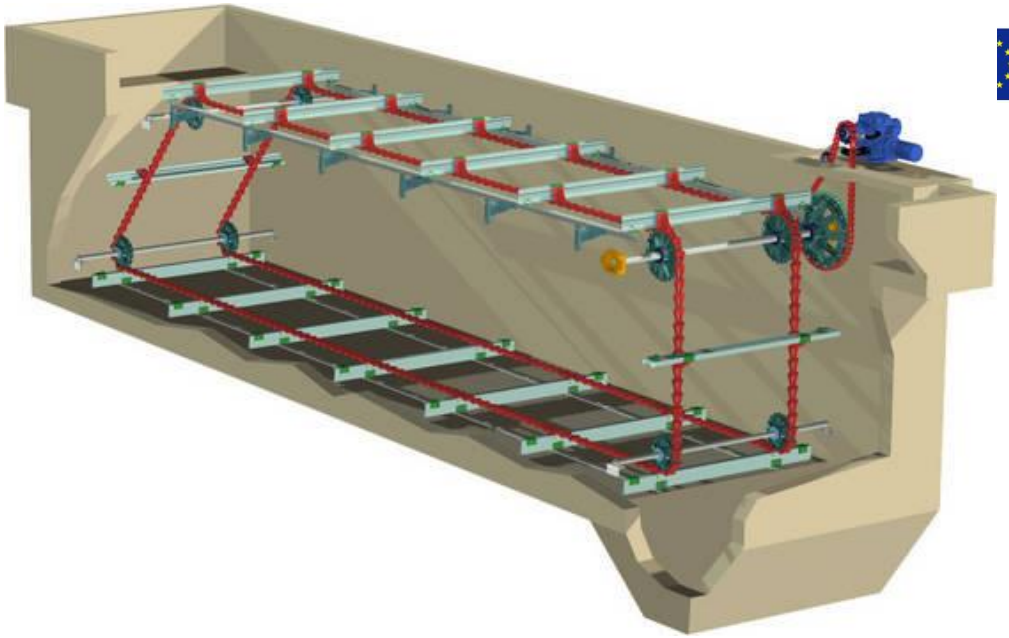
# Troubleshooting – primary settling

| Problem | Probable causes | Solutions |
|---|---|---|
| **Floating sludge** | Sludge decomposing in tank | Increase sludge removal rate or frequency |
| | Sludge withdrawal line clogged | Flush or clean lines |
| | Decomposition of accumulated sludge in dead zones | Clean tank bottoms and improve design |
| **Black and odorous septic** | Improper sludge removal pumping cycles | Increase sludge removal rate or frequency |
| | Inadequate pre-treatment of organic industrial wastewater | Improve pre-treatment or/and pre-aeration |
| | Sewage decomposing in collection systems | Add chemicals or aerate collection systems |
| | Recycle of excessive strong digester supernatants | Improve sludge digestion to obtain better quality supernatants |
| | Sludge withdrawal line clogged | Clean line |
| | Too high septic dumping | Regulate septic loading rates |
| | Inadequate run time for sludge collectors | Increase run time or run continuously |
| **Scum overflow** | Frequency of removal inadequate | Increase removal frequency |
| | Too high industrial wastewater loads | Limit loading of industrial wastewater |
| | Improper alignment of skimmer | Adjust alignment |
| | Inadequate depth of scum baffle | Increase baffle depth |





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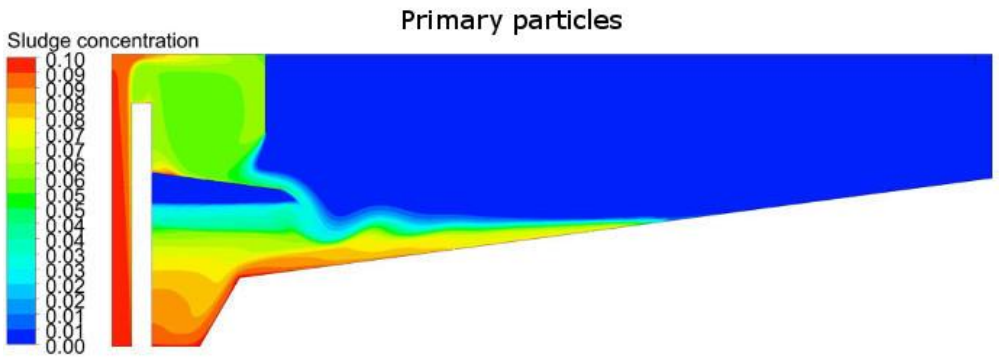
| Problem | Probable causes | Solutions |
|---|---|---|
| **Sludge hard to remove from hopper** | Low velocity in withdrawal lines | Increase velocity |
| **Undesirable low solids content in sludge** | Hydraulic overload | Provide more even flow distribution in all tanks, consider equalization tank |
| | Too high sludge removal rate | Reduce frequency and duration of sludge pumping |
| | Reduced tank vol. (dead zones) | Clean tank bottoms, improve design |
| **Short-circuiting of flow through tanks** | Uneven weir setting | Change wear setting |
| | Damaged/missing inlet line baffles | Repair or replace baffles |
| | Design weakness | Improve design using CFD simulations or pilot tests |
| **Surging flow** | Improper programming of influent flow | Improve programming |



| Problem | Probable causes | Solutions |
|---|---|---|
| | | |
| Excessive sedimentation in inlet channel | Velocity too low | Increase velocity (by closing some of tanks) or agitate with air or water |
| Poor suspended solids removal | Hydraulic overloading | Use more tanks or equalisation tanks, or add chemicals |
| | Short-circuiting | See “short-circuiting of flow through tanks” |
| | Inadequate removal of sludge | Increase sludge removal rate and frequency |
| | Industrial waste | Eliminate industrial waste which cause problems |
| | Density currents due to temperature differences | Eliminate storm flows from sewers |
| | Density currents due to winds | Install wind barriers |
| Excessive growth on surface weirs | Accumulation of wastewater solids and resultant growth | Frequent and thorough cleaning |

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# Troubleshooting - Filtration

| Problem | Probable causes | Solutions |
|---|---|---|
| **Frequent break-through** | Insufficient coagulation | Optimize coagulation condition |
| | Too small particles/flocs | Optimize polymer dosing |
| | Too high or fluctuating hydraulic load | Equalize and/or reduce load |
| **Too high headloss** | Too large particles/flocs | Optimize polymer dosing |
| | Too high hydraulic load | Reduce load |
| **Mud-balls** | Insufficient backwashing | Optimize backwashing |
| | | Chlorination of filter |
| **Insufficient particle removal** | Insufficient coagulation | Optimize coagulation condition |

# Troubleshooting - Flotation

| Problem | Probable causes | Solutions |
|---|---|---|
| **Insufficient flotation** | Too low air bubbles concentration | Increase recycle flow |
| | Too large and/or dense flocs | Optimize coagulant and/or polymer dosing |
| | | Optimize flocculation |

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# Troubleshooting: Flocculation tanks

| Problems | Probable causes | Solutions |
|---|---|---|
| Floatables | • Air bubbles lifting sludge to the surface | Look for air suction whirls or weirs |
| | • Decomposed deposits form black floatable cakes | See “Deposits” |
| Deposits | • Insufficient preliminary or primary treatment | By direct or pre-precipitation plants the preliminary or primary treatment can be insufficient. Control the performance of screens, grit chambers and primary settling tanks |
| | • Undissolved precipitant | Control precipitant dissolver function |
| | | Control that precipitant dose point has good mixing conditions. Alternatively increase agitation velocity in the first flocculation tank. |
| | Low agitation velocity | Low velocity of agitators may cause sedimentation in the flocculation tanks. Try to increase the velocity, but be aware of destroyed and poor removal rates. |

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# Coagulation stage

| Problem | Probable causes | Solutions |
|---|---|---|
| **Floating sludge** | See “sedimentation tanks” | See “sedimentation tanks” |
| **Deposits in flocculation tanks** | Undissolved coagulants, if solid coagulants used | Control coagulant dissolver function |
| | Too low agitation velocity or too low flow | Increase agitation velocity or flow rate, but be aware of floc breakage at too high speeds |
| **Bad flocculation** | Coagulation pH outside optimum range | Adjust coagulant dosing to keep pH within optimal ranges |
| | | Use an alternative coagulant more suitable for pH / alkalinity |
| | Insufficient coagulation/ precipitation | Increase dosing if pH not too low |
| | | Add or increase flocculent dosage |
| | Insufficient mixing of coagulant with wastewater | Control dosing point. Add precipitants to a point with more intensive mixing |
| | | Increase mixing speed in the first flocculation chamber |
| | Too high hydraulic overloading in flocculation tank | Flocculation time should be more than 10-15 minutes |
| | Too low hydraulic overloading in flocculation tank | Too long flocculation periods may destruct flocs. Reduce retention time by reducing number of flocculation chambers |
| | Short-circuiting in flocculation tanks leading to too low retention times | Use baffles or improve design of channels |

| Problem | Probable causes | Solutions |
|---|---|---|
| Too small flocs at the end of flocculation | Inadequate coagulant or flocculent dosage | Adjust dosage |
| | Inadequate mixing of coagulants | Improve mixing by adjusting dosing point and dosing conditions |
| | Poor flocculation conditions | Improve velocities in flocculation stage |
| | Floc breakage when entering sedimentation tank | Control velocities in narrow passages, weirs, bends. Velocities should be <0.2 m/s preferably <0.1 m/s. |
| Bad separation | Too high surface loads | Reduce surface load by increasing sedimentation tanks |
| | | Reduce surface loads by adding polymers |
| | Erosion of sludge blanket | Let sludge scrapers run continuously. Control scarper velocity is >0.5m/min |
| | Turbulent flow regime in settling tank | Control the wastewater distribution among multiple settling tanks |
| | | Design improvement |
| Bad treatment efficiencies | Too low coagulant dose | Adjust dosing |
| | Too high coagulant dose | Adjust dosing |
| | Coagulation pH outside optimum range | Adjust coagulant dosing to keep pH within optimal ranges |
| | | Use an alternative coagulant more suitable for pH / alkalinity |

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# Simultaneous precipitation

| Problems | Probable causes | Solutions |
|---|---|---|
| Unsatisfactory precipitation | Too low dosing rate | • Control molar ratio. Control pH after increasing dosing rate! |
| | Too low pH | • Control molar ratio |
| | | • Control nitrification by analyzing nitrate and nitrite in the aeration tank |
| | | • If nitrification – control alkalinity |
| | | • Add lime, soda or sodium bicarbonate |
| | Malfunctioning dosing system | • Dosing should be flow proportional or time proportional. Manual, ambient dosing is not recommended. |
| Unsatisfactory sedimentation | Floc size and weight may depend on dosing point. | • Try other dosing points:<br>– Aerated grit chamber inlet<br>– Aeration tank inlet<br>– Aeration tank outlet<br>– Return sludge |
| Unsatisfactory separation | See sedimentation | |
| Aeration equipment clogging | This is often a problem by iron dosing in aeration tanks. See “Aeration” | |

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# Troubleshooting: Aeration tanks

| Problems | Probable causes | Solutions |
|---|---|---|
| White and fluffy foam | Low sludge age caused by too low MLSS in aeration tanks (e.g. plant start up) | Control settled sludge volume. If too low: Increase recycled flow and decrease sludge wasting. |
| | Poisoning caused by harmful discharges to the plant | • Control oxygen uptake rate and assess the result using Figure 6.5<br>• Find the source of the poisoning<br>• Empty the aeration tanks and start once again. |
| Dark, greasy foam | High sludge age causes growth of bacteria that secretes a fat-material. This material forms the foam. | • Control MLSS and sludge age<br>• Increase sludge wasting rate |

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# Troubleshooting: Aeration tanks

| Problems | Probable causes | Solutions |
|---|---|---|
| Other foaming problems | Discharge of fat, soap, detergents and various types of industrial wastewater may cause different types of foaming. It is impossible to say if the foaming is harmful to the process without further investigation. |     |
| Sludge accumulation | Bad mixing | • Increase aeration<br>• Control that aerators are not clogged |
| | Bad tank design | • Improve tank design |
| Aeration system failures | | • Improve aeration system |
| Sludge bulking | Filamentous bacteria or fungi | • See Table for sludge bulking |

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# (Post) sedimentation tanks

| Problem | Probable causes | Solutions |
|---|---|---|
| Floating sludge | Air bubbles lifting sludge to the surface | Stop air suction whirls or weirs; |
| | Decomposed deposits | Increase sludge pumping frequency |
| | | Increase sludge scraper velocities or running times |
| | Sludge accumulation in dead zones | Clean and reduce accumulation in dead zones |
| Too high suspended solids in effluent | Sludge escape | Improve sedimentation performance by increase settling time or chemicals |
| | Poor settable flocs | Increase chemicals |
| | Dead zones in the tank | Clean and reduce dead zones |
| | Short-circuiting | Improve design |
| Low sludge solids concentration | Inadequate sludge thickening time in sludge hoppers | Reduce sludge pump starting frequency |
| | Water follows sludge during removal | Reduce sludge pumping frequency and increase pump starting frequency |
| | Too high sludge concentration may cause water channels in sludge | Improve sludge scarping and increase pump starting frequency or rate |
| Difficult to remove sludge | Too high sludge solids concentration | Increase sludge pump start frequency or rate |
| | Sand and other coarse particles in sludge | Improve pre-treatment (sand trap etc |

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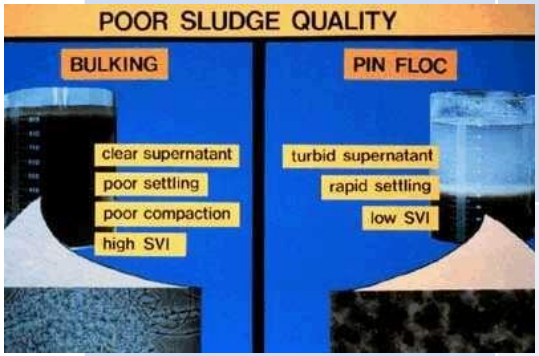
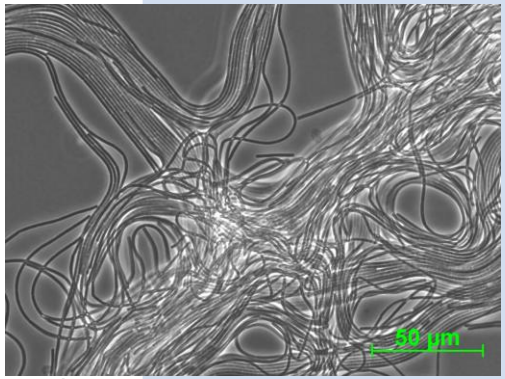
# AS-Sludge bulking due to filamentous bacteria

| Problems | Probable causes | Solutions |
|---|---|---|
|  | Low oxygen content of aeration tank (<0.5 g $O_2/m^3$) | • Increase total air supply or regulate distribution in tanks or between multiple tanks to bring oxygen content at all places above the minimum level. |
| | Discharge of wastewater with high carbohydrate content | • Usual by food industry effluents. Equalize the discharges throughout the day at the source or at the treatment plant. Distribute the influent all over the aeration tank – step aeration. |
| Sludge bulking caused by filamentous bacteria | • Nutrient deficiency | • This may be the case at plants with industrial discharge. This is out of question when influent nutrients are higher than:<br>○ Tot-N 5% of $BOD_5$<br>○ Tot-P 1% of $BOD_5$<br>○ Fe 0.5% of $BOD_5$<br>○ If there are shortage of any of these, they may be added |
|  | • Flushing of accumulated materials from the sewer system | • More frequent flushing of pipes with little slope |

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# AS-Sludge bulking NOT due to filamentous bacteria

| Problems | Probable causes | Solutions |
|---|---|---|
| Sludge bulking caused by other means then filamentous bacteria | • High and even sludge loading | • If sludge loading exceeds 0.5 kg BOD5/kg SS d, it should be decreased. The loading may be decreased, or the total biomass of the system increased (by decreased sludge wasting). |
| | • Low pH caused by nitrification | • Decrease nitrification by decreasing the biomass of the system (by increased sludge wasting), if nitrification is not intended<br>• Increase alkalinity by sodium bicarbonate adding |
| Sludge bulking caused by other means than filamentous bacteria. | • Low influent pH | • Find the source and neutralize before discharging |
| | • Temperature changes | • Experience shows that some plants are exposed to temporarily bulking every spring and autumn. |

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# AS- Poor effluent

| Problems | Probable causes | Solutions |
|---|---|---|
| Unsatisfactory decomposition | • Peak loads of organic matter ($BOD_5$). Even if the average loading during a day is not higher than normal, peak loads at short time intervals will cause lac of oxygen | • Increase total air supply<br>• Regulate air supply by oxygen content or time<br>• Equalize $BOD_5$ - discharges |
| | • Too low MLSS content in aeration tank | • Increase MLSS by reducing sludge wasting |
| | • General organic overload | • Improve preliminary treatment<br>• Introduce pre-precipitation<br>• Increase aeration tank volume |
| | • Sludge bulking | • See sludge bulking |
| | • Poisoning | • Find the source and stop the discharges |

# AS- Poor effluent

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| Problems | Probable causes | Solutions |
|---|---|---|
| Unsatisfactory settle ability of activated sludge | • Deflocculation caused by too strong turbulence | • Decrease air supply to the outlet part of the aeration tank<br>• Remove hydraulic jumps or weirs if there are any between aeration tanks and settling tanks |
| | • Poisoning | • See “Unsatisfactory decomposition” |
| | • Sludge bulking | • See sludge bulking |
| | • High sludge age may cause “pin point flocs”, which means a turbid effluent | • Increase sludge wasting |
| | • Low sludge age may lead to small, nearly transparent flocs in the effluent, even though the effluent, even though the effluent is otherwise clear | • Decrease sludge wasting |

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# AS- Poor effluent

| Problems | Probable causes | Solutions |
|---|---|---|
| Unsatisfactory separation | • Peak loads caused by uneven pumping | • Decrease pump time<br>• Differentiate pump sizes<br>• Overflow a part of the wastewater back to pumping sump |
| | • Hydraulic overload | • Build retention basin<br>• Overflow some wastewater if the total removal rate then improve<br>• Upgrade the sewer system<br>• Try to improve sludge settleability. Use polymer or other flocculants. |
| | • Too high solids loading rate | • Adjust MLSS and return sludge flow to the solids loading capacity of the settling tanks |
| | • Sludge bulking | • See own section |
| | • Improver hydraulic regime | • Check loading of multiple tanks<br>• Check that effluent weirs are horizontal and distribute flow equal over the weir length |

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# Online sensors

*Sensor without and with ultrasound cleaning system*

## Fouling

Organic – biomass, grease
Mineral - scale, iron

- Automatic cleaning
  - Mechanical wiper
  - Air or water
  - Ultrasonic
  - Combination
- Manual cleaning
  - Wipe
  - Chemical

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# Process combinations