SDT Study Tour, November 2011: Effluent Treatment Options

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SDT Study Tour: Effluent Treatment Options

Think about untreated sewage….. For a moment!

Toilets? Smells? Flies? Pollution? Nasty Sludge?

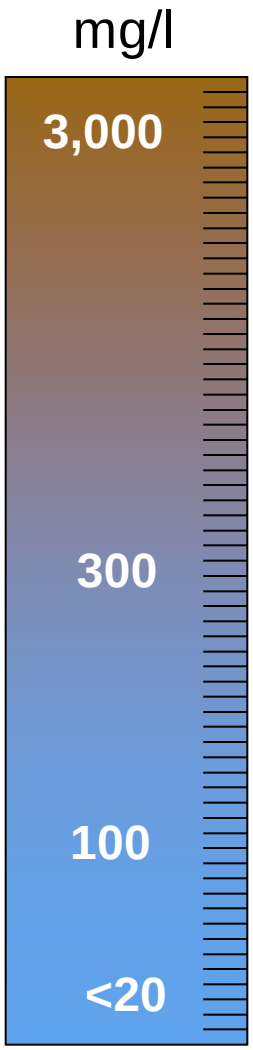
Now think about wastewater from a cheese factory…

Effluent from a cheese factory is c. up to 10 times MORE polluting than untreated sewage!!!

Thus dairy effluent requires a large resource for effective treatment…

Even small cheese factories can produce more pollution than 10,000 people!!

Dairy Wastewater: Chemical Oxygen Demand (COD)



Crude Dairy Effluent

Approximately
10 times stronger

Crude Sewage

Typical River Consent

Class 1 Trout Stream

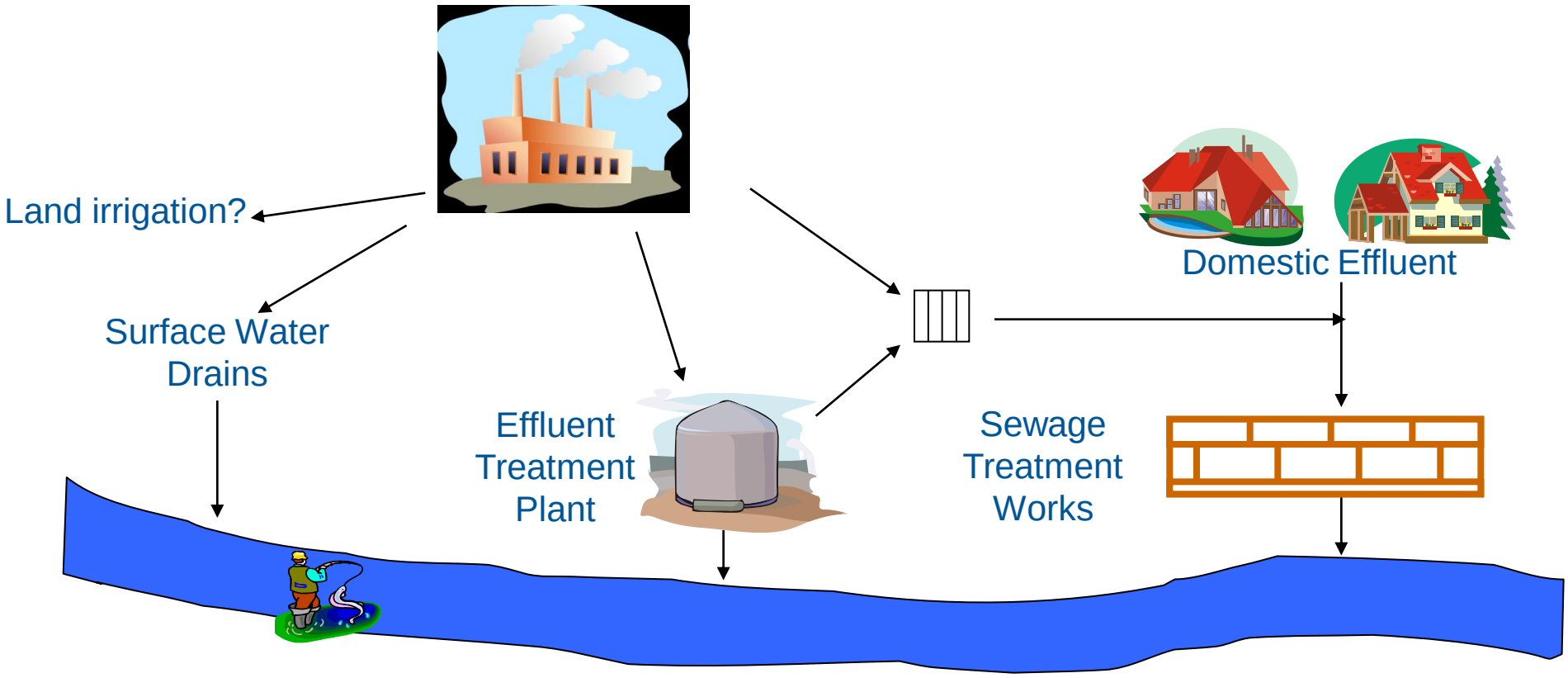
COD testing is quick
and easy

- Dairies usually large volumes (c. 500 m^3/day)
- High Strength (COD c. 3,000 mg/l)
- High Loadings (1,500 kgCOD/day)
- Large Population Equivalent (15,000pe)
- Large Environmental Impact

COD Chart – Some common products

Product	Approx. COD mg/l
Whole milk	220,000
Cream 50% BF	1,550,000
Custard	362,000
Coca-Cola	136,000
Diet Coke	2,400
Raw whey	82,000
Separated whey	62,000
Press whey	150,000
Whey concentrate (32% TS)	368,000
Whey cream	725,000
Whey buttermilk	42,000
Beer (IPA)	90,000

Effluent Discharge Options

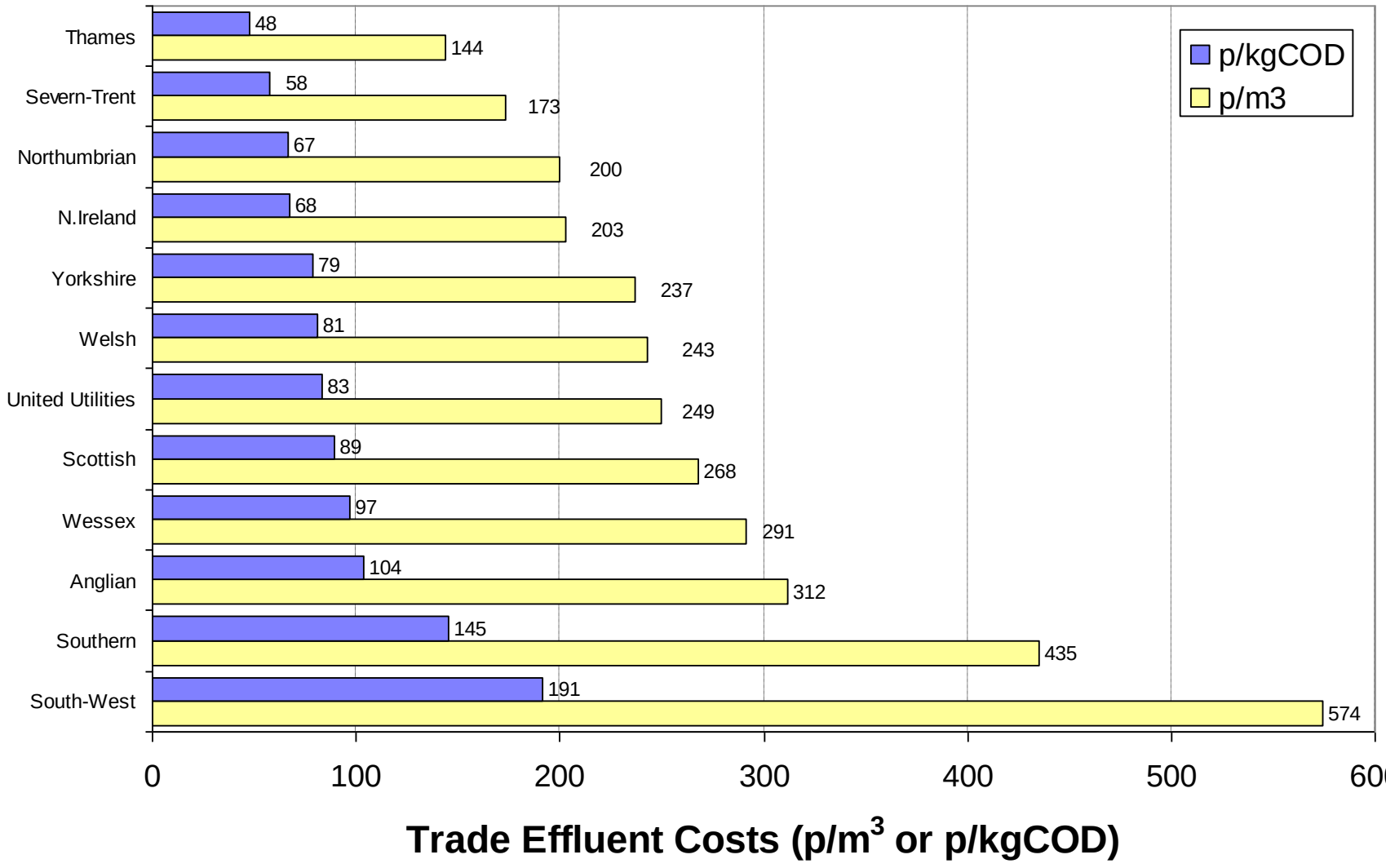


Effluent Discharge Options

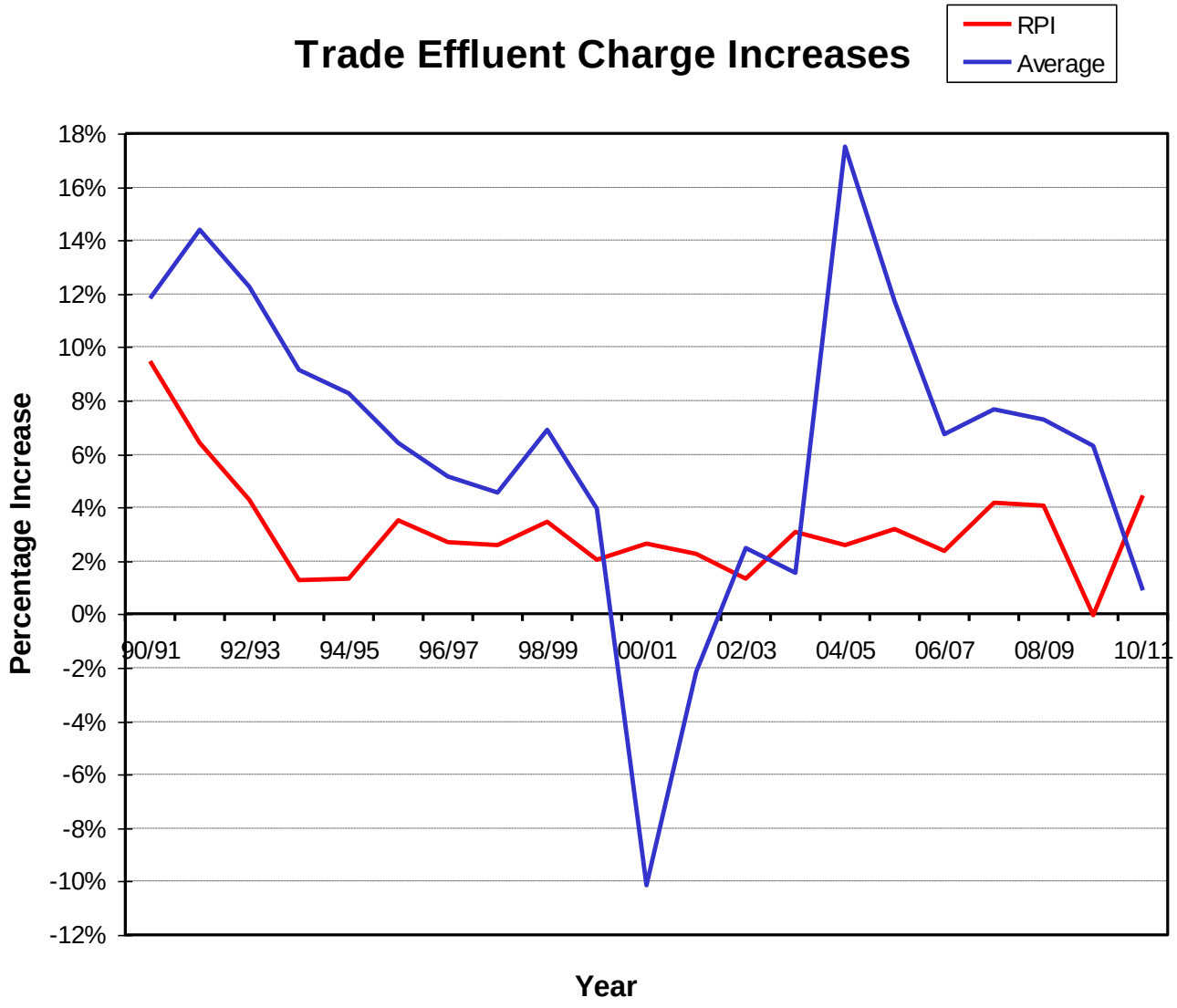
- Removal of land disposal (irrigation) option
- Tightening legislation on river discharges
- Greater risk of prosecution
- Tightening controls on sewer discharges
- Increased Trade Effluent Charges
- IPPC

Standard Trade Effluent Charges (2010/11)

Based on an effluent with a COD of 3,000 mg/l, and Suspended Solids of 800 mg/l



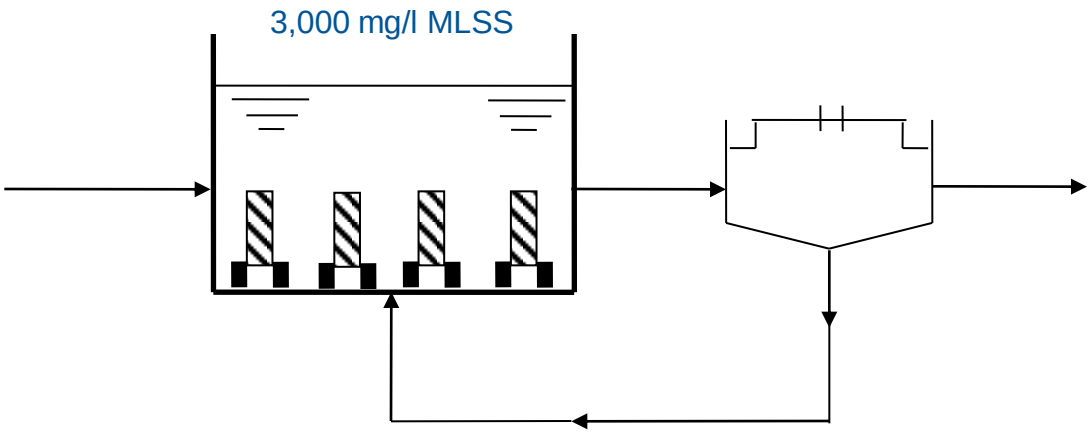
Trade Effluent Charges (2010/11)



Effluent Treatment Requirements

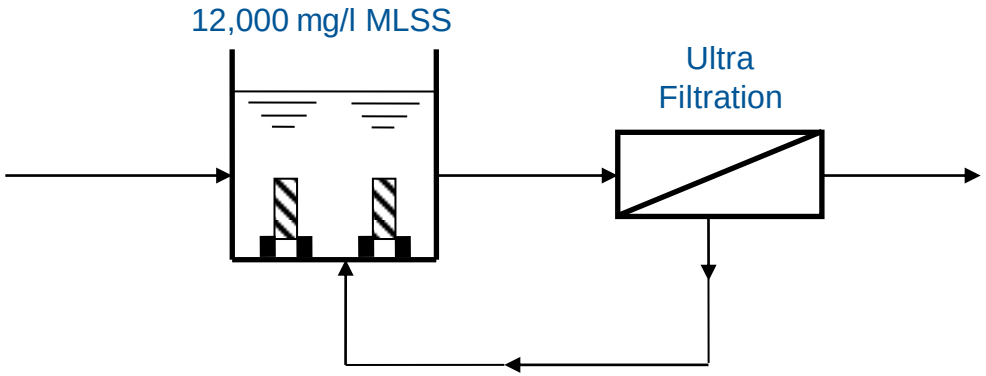
- None!! Now rare…your days are numbered!
- Balancing and pH correction
- Screening and solids removal
- Dissolved Air Flotation (widely used for dairy effluent)
- Biological treatment
  - Anaerobic
  - Aerobic

Activated Sludge – Aerobic Treatment



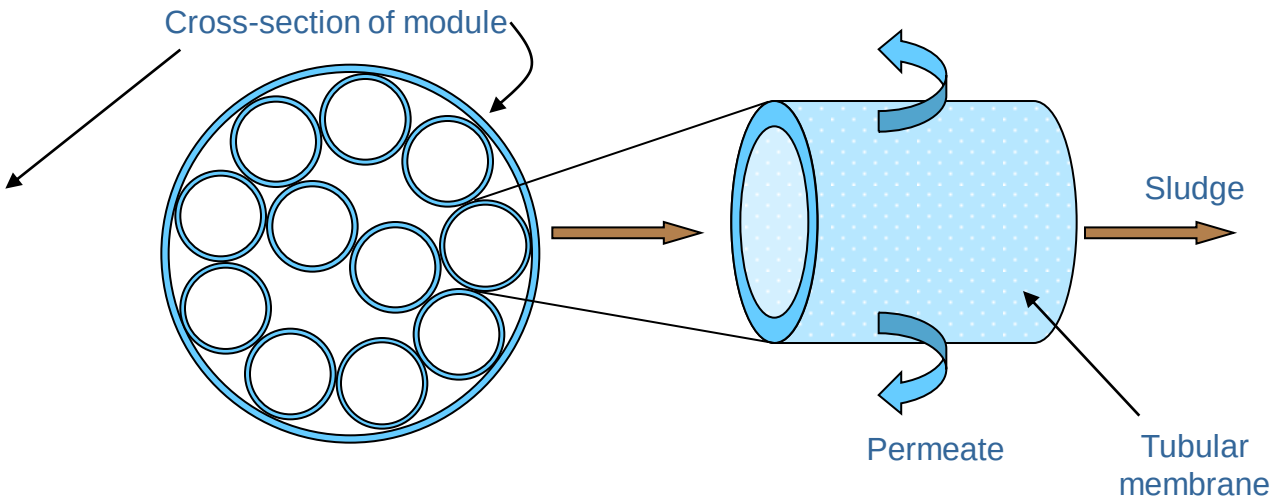
- Robust and has large buffering capability
- Provides good effluent quality
- Minimal odours
- Large aeration tank footprint (typically 2 m^3 for every kgCOD)
- Need to consider the biology for good settlement

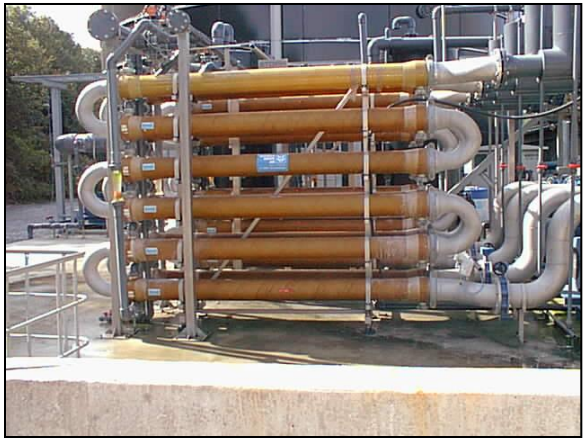
MBR, Membrane Bioreactor – Aerobic Treatment



- Robust and has large buffering capability
- Provides superb effluent quality
- Minimal odours
- Small aeration tank footprint (typically 0.4 m^3 for every kgCOD)
- Don’t need to consider the biology ?
- Water re-use possibilities….

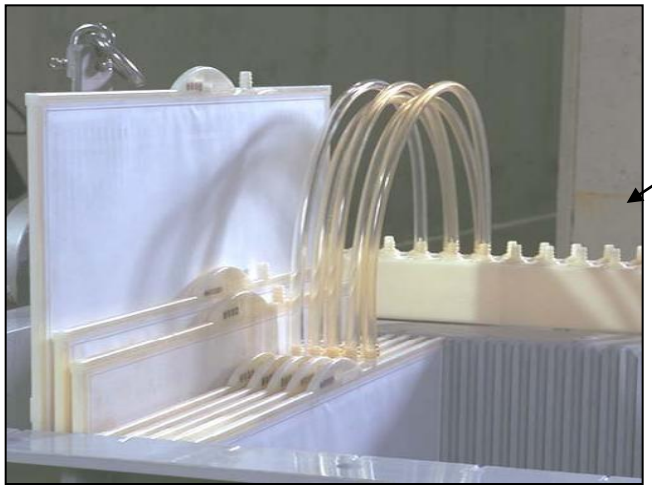
Crossflow MBR: In to out flow…

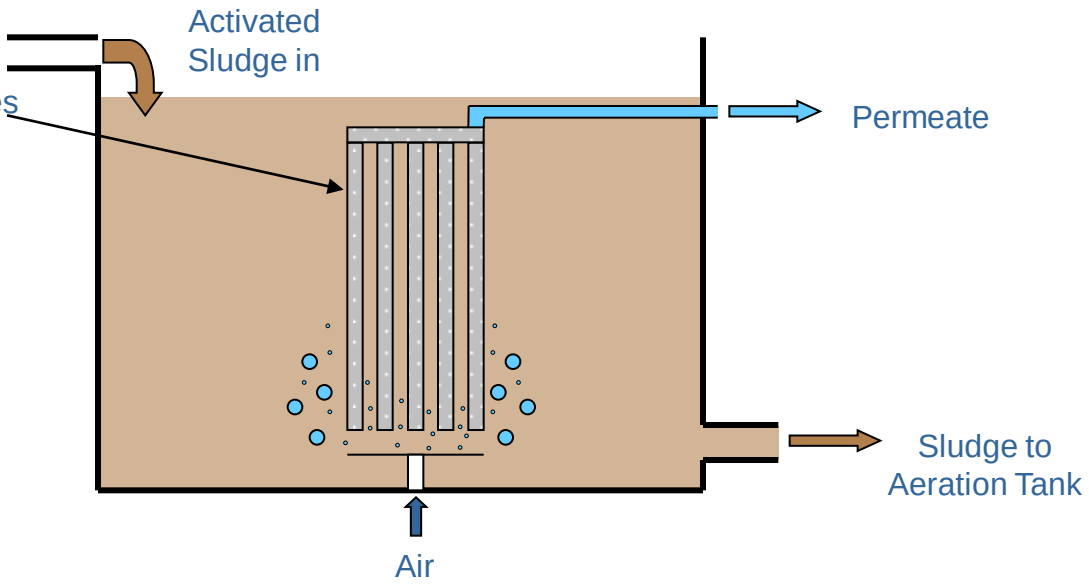




MBR Crossflow plants

Submerged MBR: Out to in flow….





MBR submerged flat-sheet plants

Submerged vs. Crossflow MBR – which is best?

- **Crossflow (In to Out)**
  - Biomass is forced down membrane tubes (c. 5 to 8mm diameter)
  - Permeate passes out of the membrane tubes into collection headers
  - Critical to have good solids screening to avoid tube blockage
  - Must maintain high “crossflow” velocities down the tubes to avoid fouling
  - High crossflow velocity results in high energy cost
  - Membrane failure results in solids being pushed from inside of tubes into permeate
  - Membranes external to tank so very easy access for maintenance

- **Submerged (Out to In)**
  - Biomass is kept mixed within the MBR tank
  - Permeate passes gently through from mixed liquor to collection header of the membrane sheets under gravity (or slight positive suction pressure)
  - Risk of blockage is small as permeate stream has virtually no solids
  - Simple air mixing/scour is used to keep outside of the membrane sheets clear
  - Submerged structure so maintenance is not as straightforward

Submerged vs. Crossflow MBR

General Point

- 80% of all MBR plants installed in the USA are submerged type MBR

Flux Rates

- Crossflow much higher (2.9 m^3/m^2/day vs. 0.6 m^3/m^2/day for submerged)
- Submerged requires c. 5 times more membrane area

Capital Costs

- Price per m^2 is less for the submerged type
- All membrane capital costs have reduced exponentially over the past 20 years
- Prices for complete systems are now similar as membrane cost difference is offset by large pumps and lines & building requirements

Space Requirements

- Crossflow requires less for the membrane part
- But…. the bulk of the area required is for the aeration tanks
- Therefore, overall space requirement is similar

Submerged vs. Crossflow MBR

Energy Requirements

- Crossflow typically in the range 2.7 kWh/m^3 to 5.0 kWh/m^3
- Some contractors now quoting 2.0 kWh/m^3
- Low Energy Crossflow – 0.4 kWh/m^3 ?
- Submerged typically 0.8 kWh/m^3 to 1.2 kWh/m^3
- 8 years data Almarai dairy (submerged MBR) - 0.54 kWh/m^3

Membrane Life Expectancy

- Crossflow typically 3 years (guarantee 1-2 years)
- Submerged typically 10 years (guarantee 3-4 years)
- Dairy Factory Example – less than 100 Kubota membrane sheets out of 11,100 replaced in 6 years (0.9%)

MBR Option for Effluent Treatment - Summary

- Exciting “new” technology with new and **retrofit** applications
- Capital costs on a par with conventional treatment for new systems
- Revenue costs only marginally above conventional activated sludge
- Very low space requirements
- Excellent final effluent quality with potential for water re-use…..

- *MBR systems should be considered for any new effluent project*
- *Should consider both crossflow and submerged types*
- *Should consider professional assistance with choice of plant, etc!*

SDT Study Tour: Effluent Treatment Options

Thanks for your attention….. Any questions?

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