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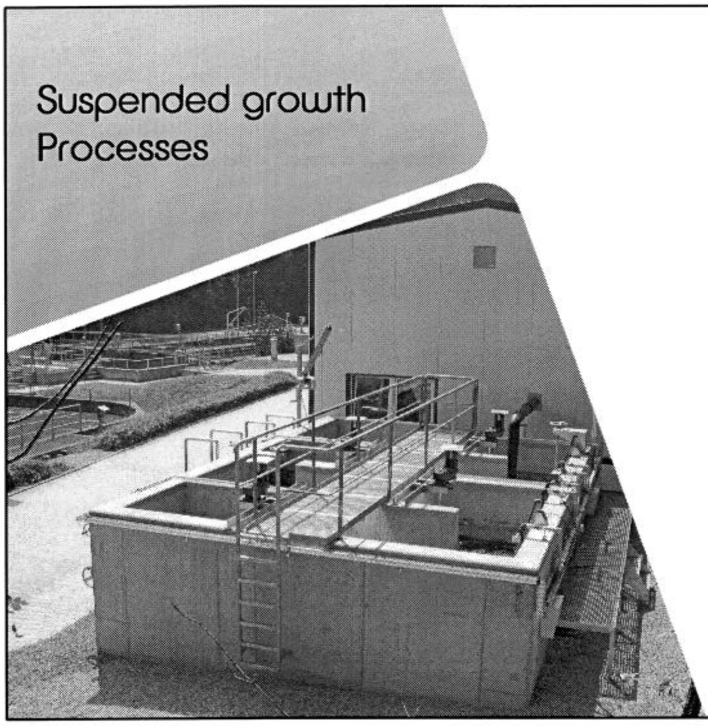
Suspended growth Processes



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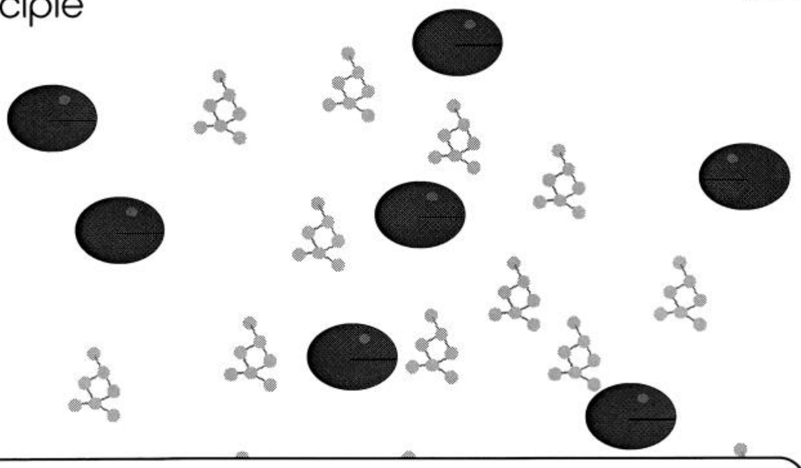
Principle



Convert organic and inorganic material into biomass

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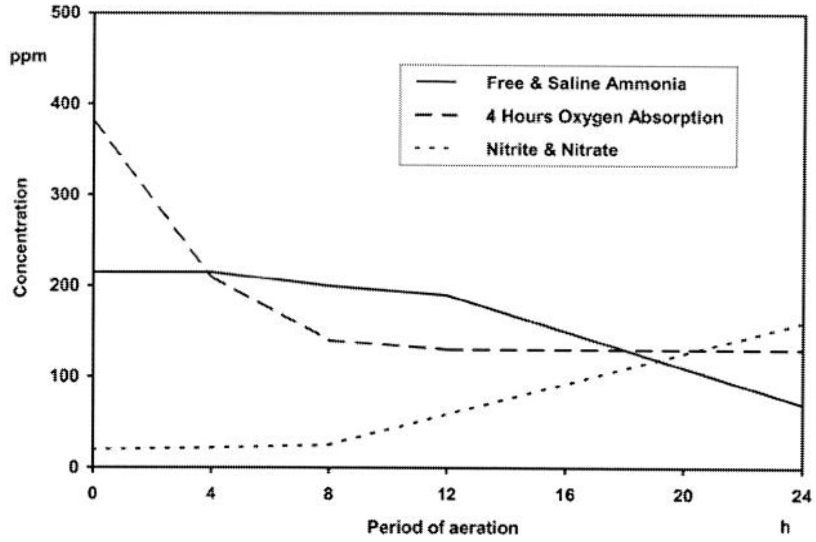
Original Arden and Lockett data



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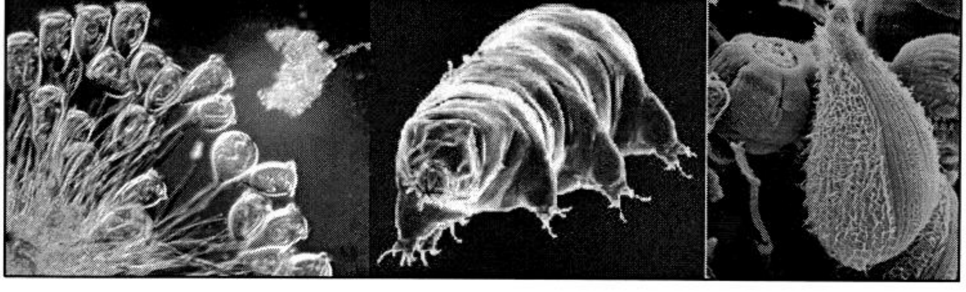
Formal definition

Activated sludge may be defined as the flocculant microbial mass which is produced when sewage is continuously aerated. It consists mainly of organisms which are able to metabolise and break down the principal contaminants of wastewater



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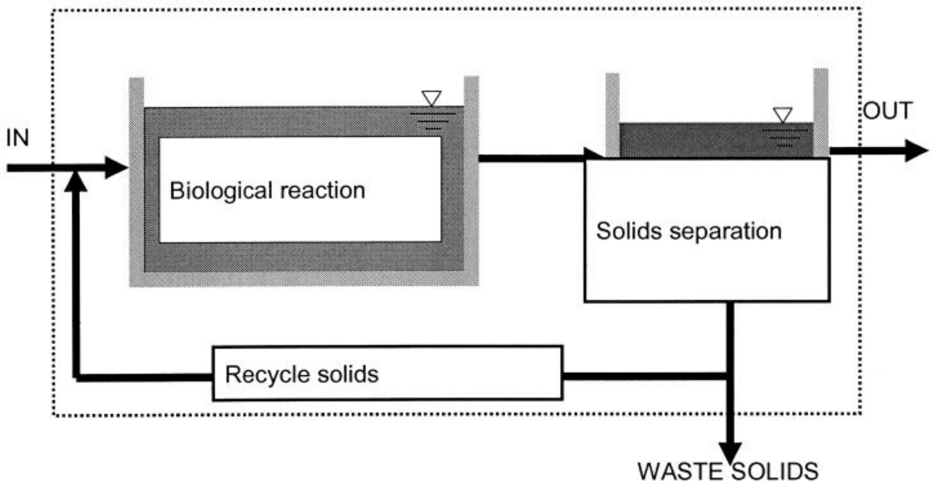
Components



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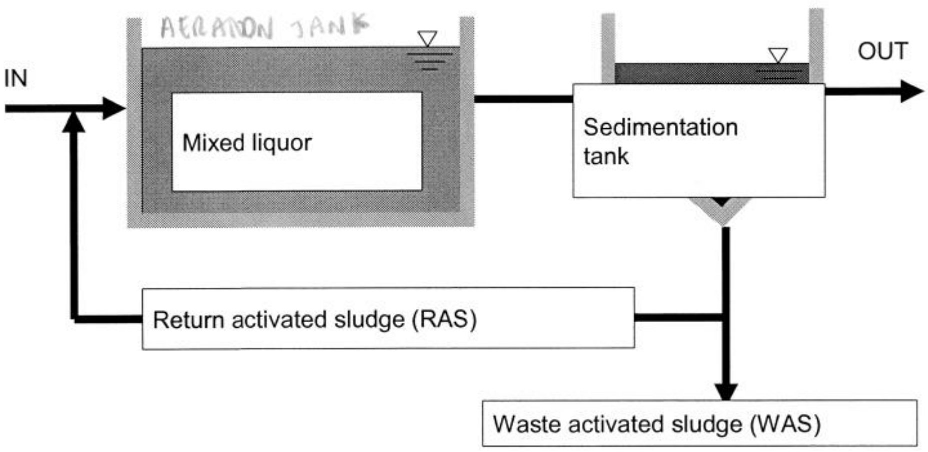
Definitions



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What does AS do

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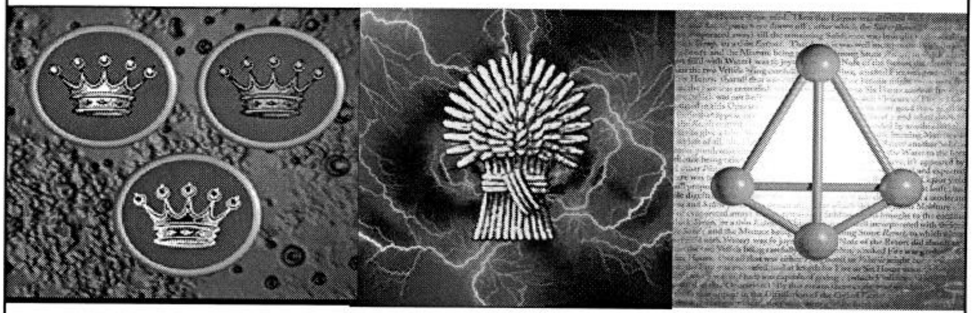
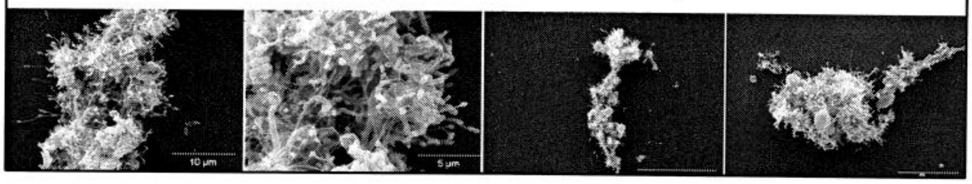


Organics (BOD, COD)

Nitrogen (Ammonia, nitrate)

Phosphorus



Residence time: but of what

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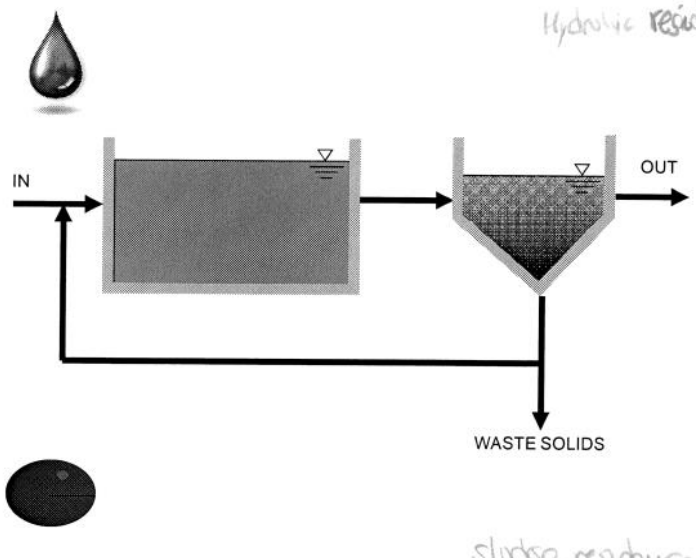
Hydraulic residence time:

HRT (hydraulic)



SRT (Sludge) [sludge age]

sludge residence tank

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How much biomass do you have?

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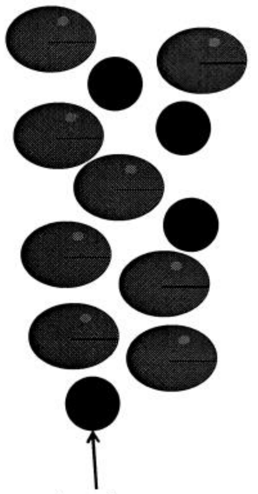

inerts

Mixed liquor suspended solids (MLSS)
[total suspended solids – mg.L^{-1}]

MLSS > MLVSS

Mixed liquor volatile suspended solids (MLVSS)
[total volatile solids]

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Food to Micro organisms ratio

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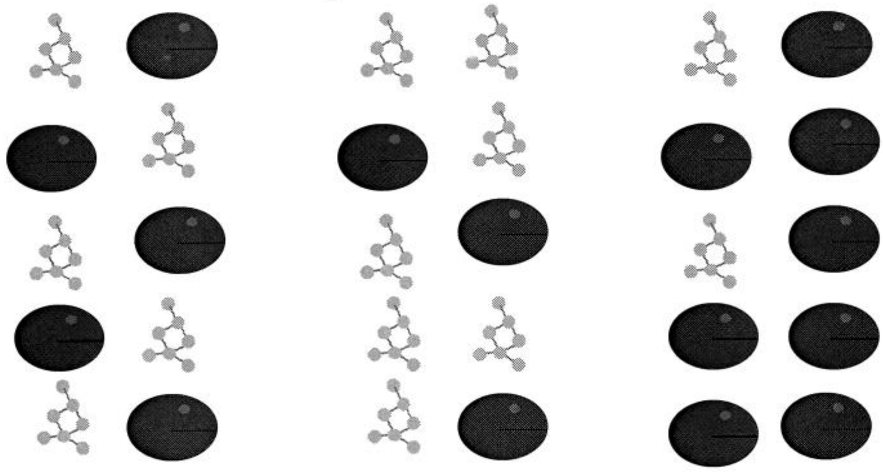

Substrate rich

Limited food (starvation)

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The process only works if the sludge settles

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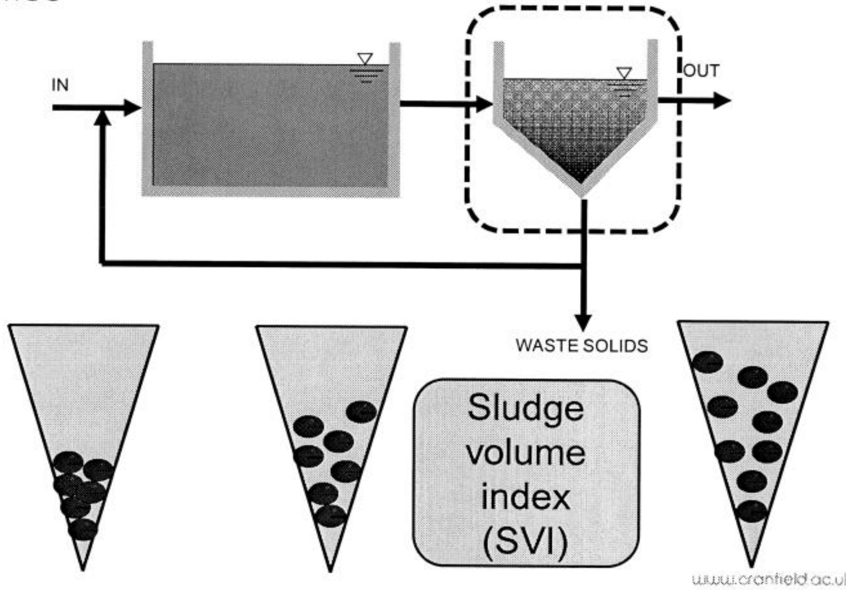

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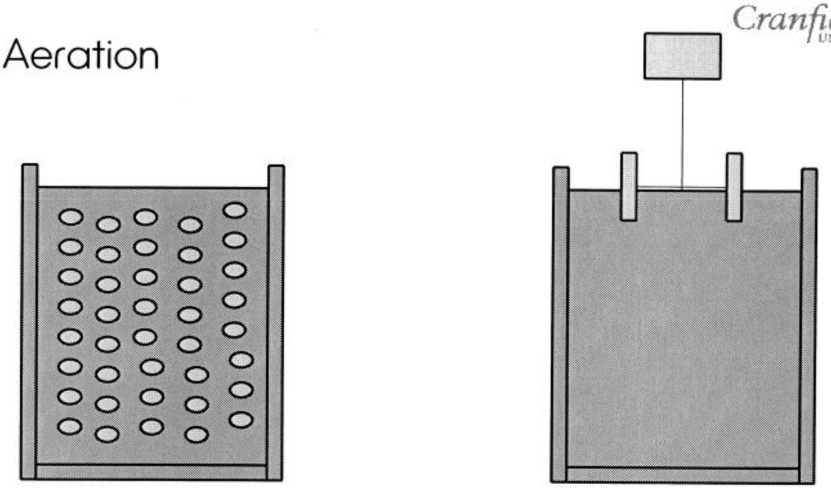
Aeration



Blow (diffused air)

Whip (surface aerator)

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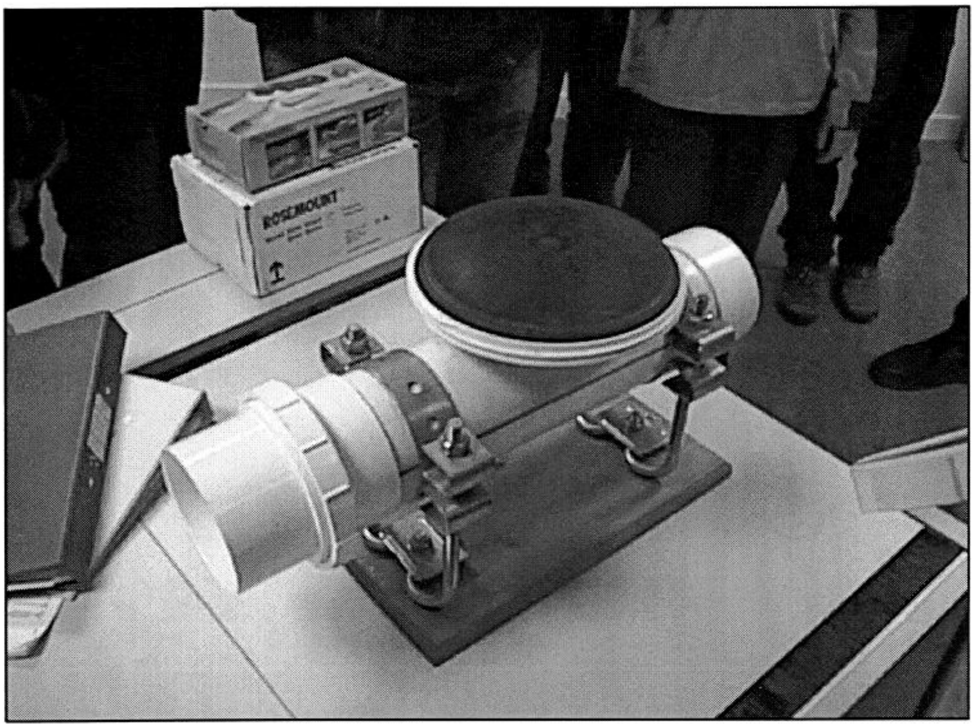
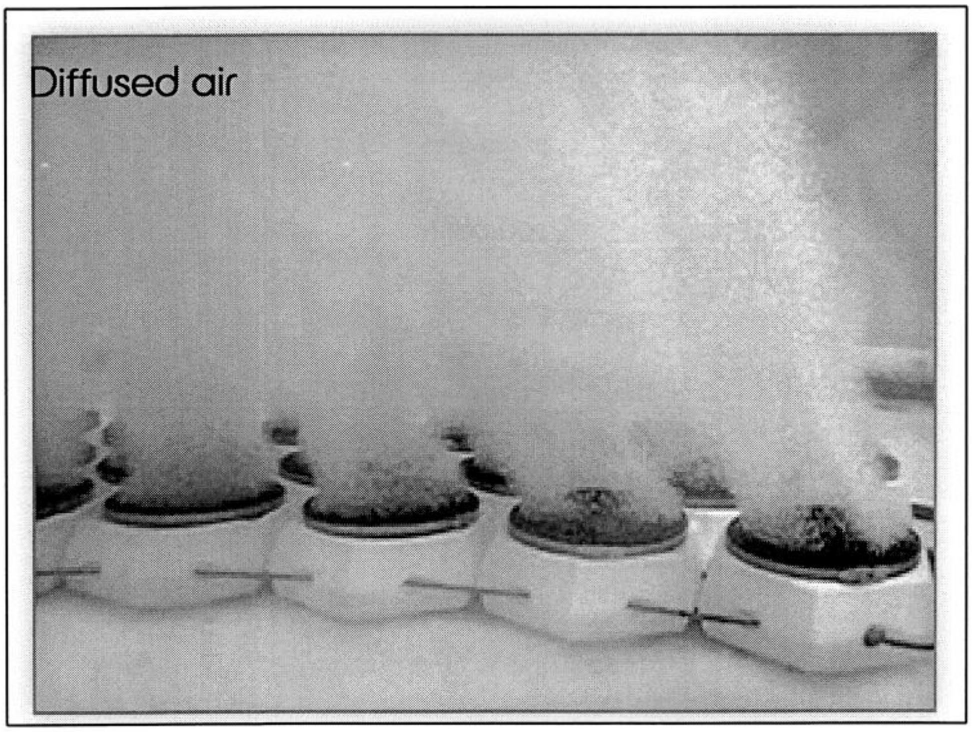
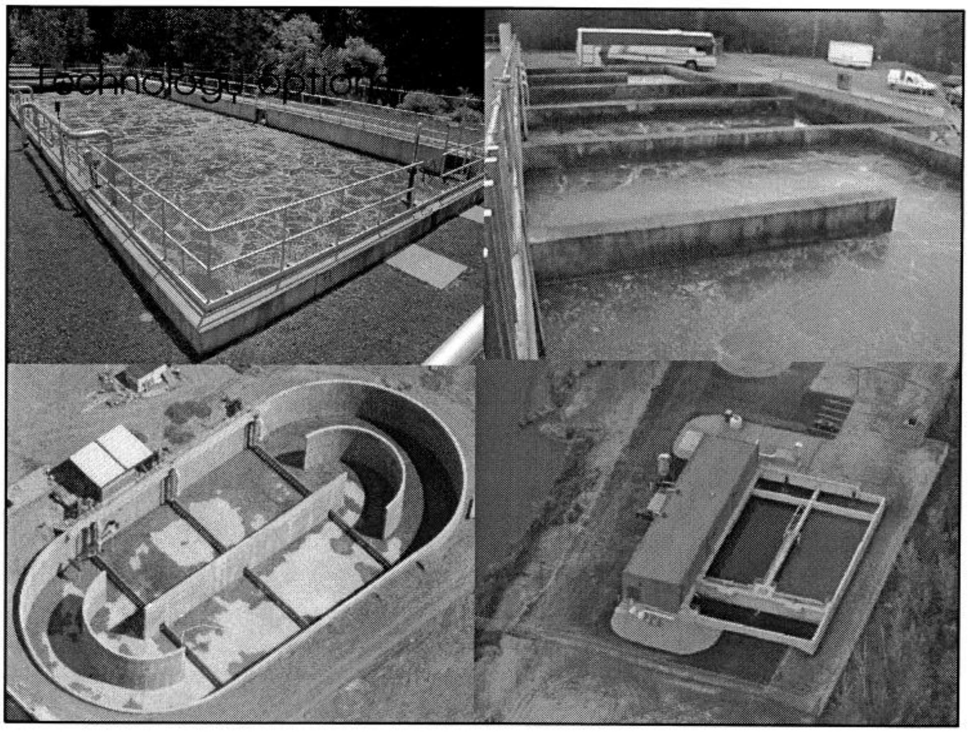

ROSEMOUNT


Diffused air


Surface aerator


Technology options

Completely mixed (standard)

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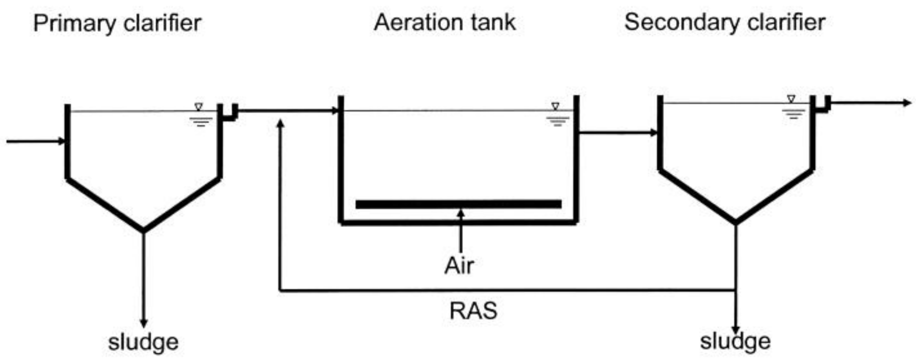

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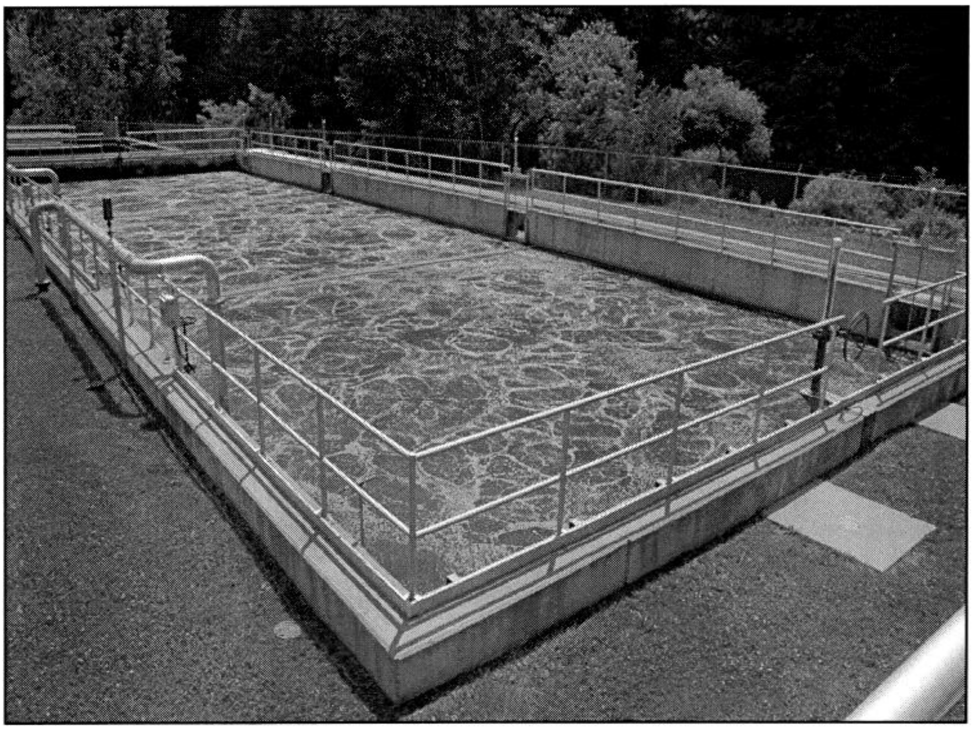
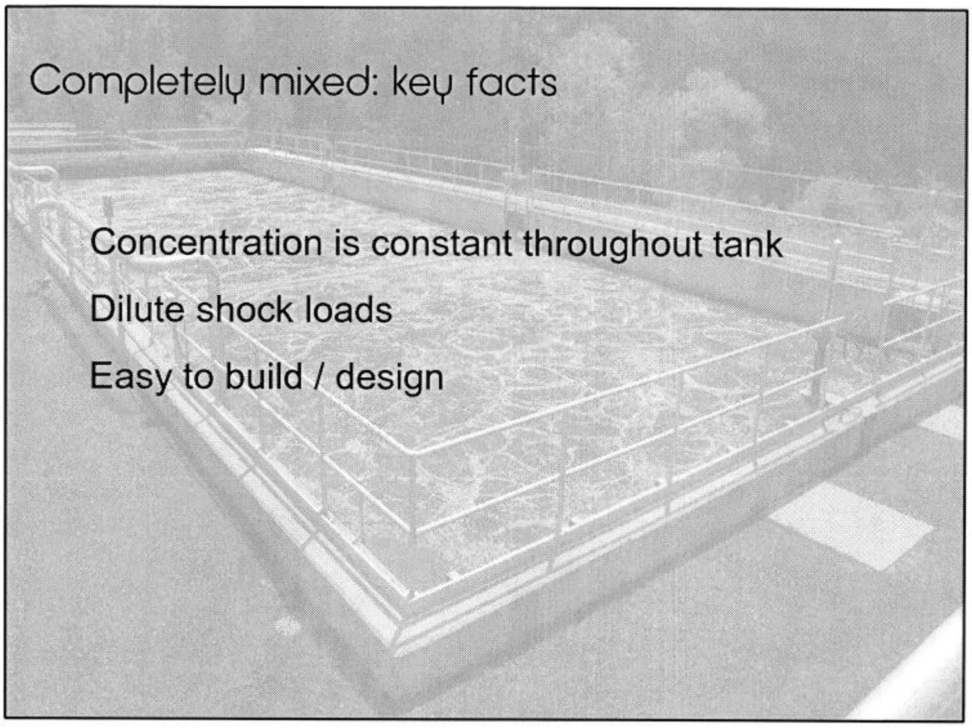


Completely mixed: key facts

- Concentration is constant throughout tank
- Dilute shock loads
- Easy to build / design



Plug flow (opposite concept to completely mixed)

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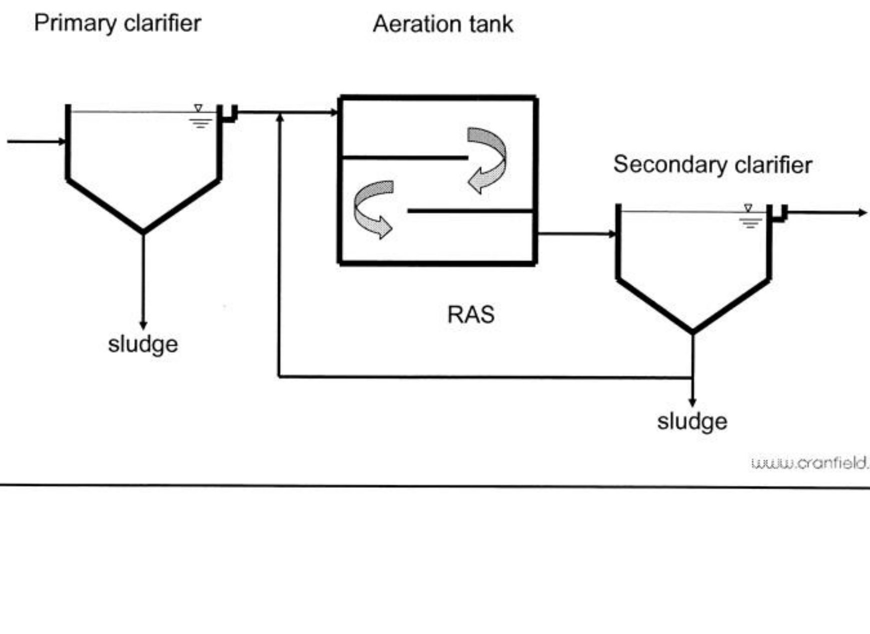

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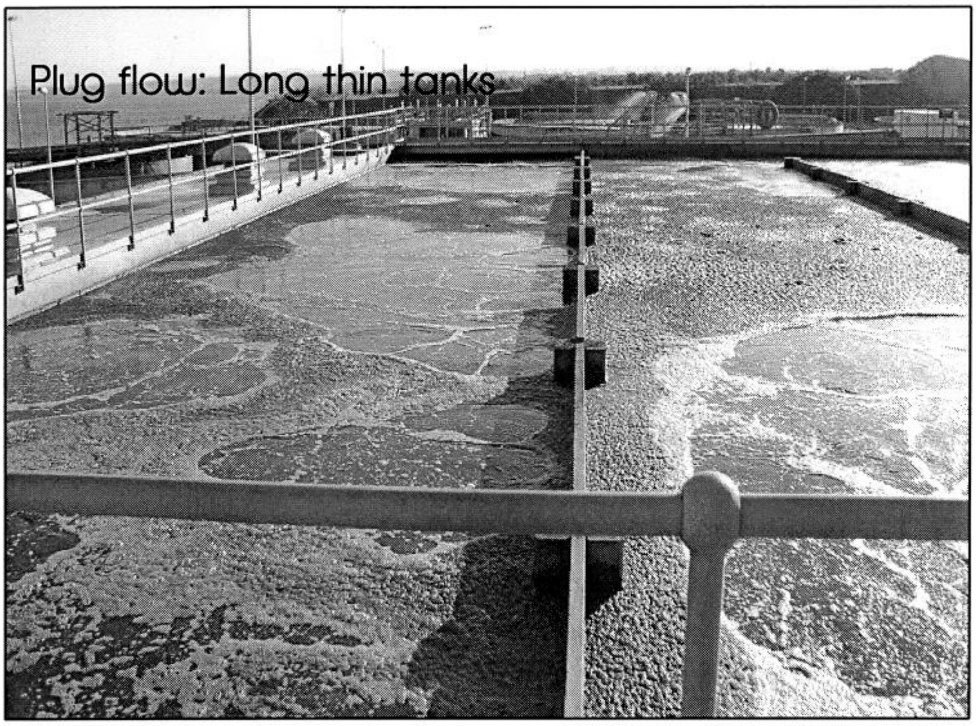
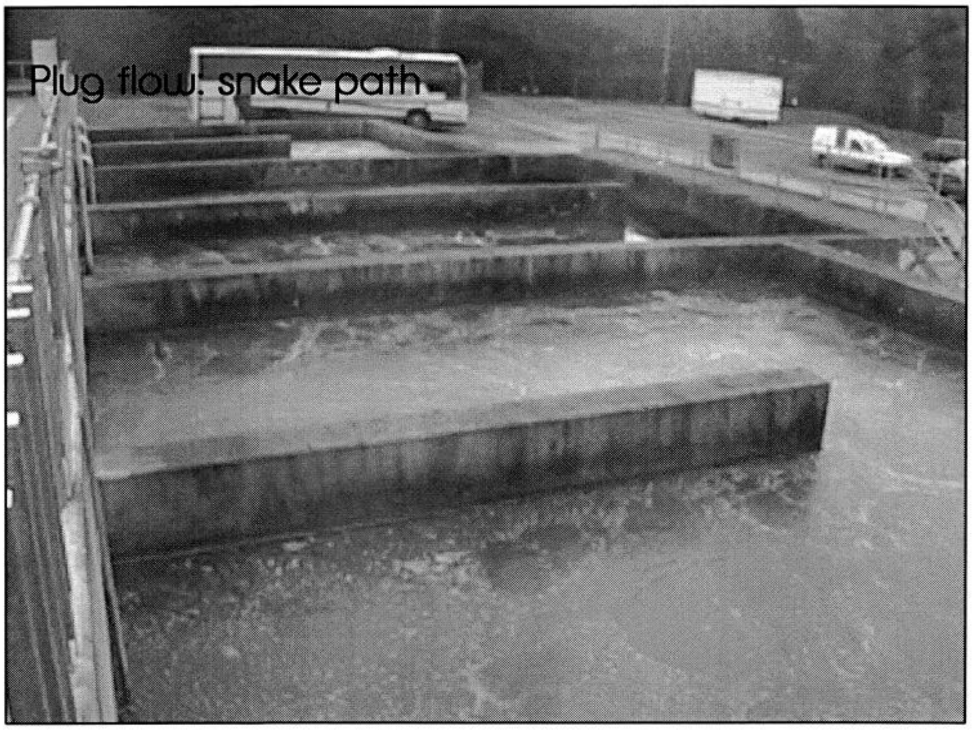

Plug flow: Long thin tanks


Plug flow: snake path

Plug flow: key facts

- Most common form (large works)
- 3-5 channels with baffles
- Concentration changes along length
- Good for nitrification

Extended aeration

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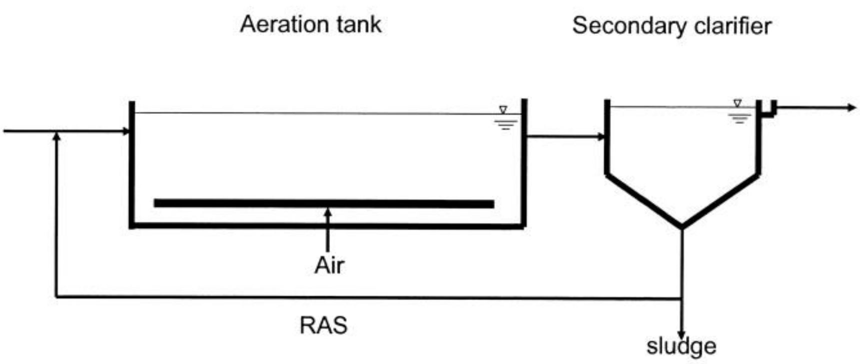
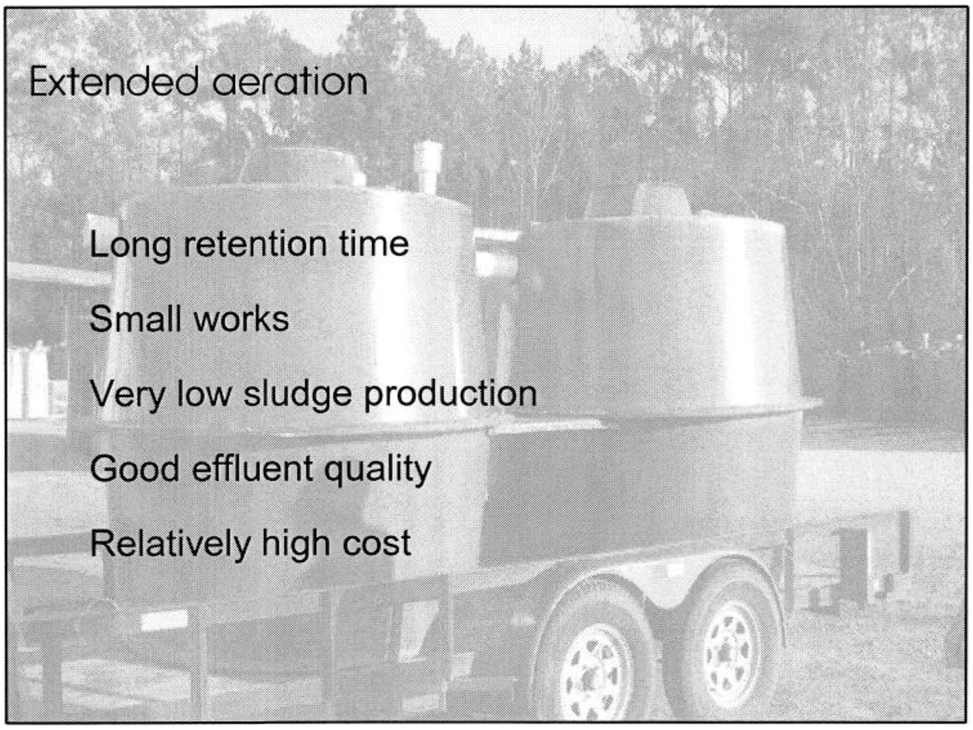
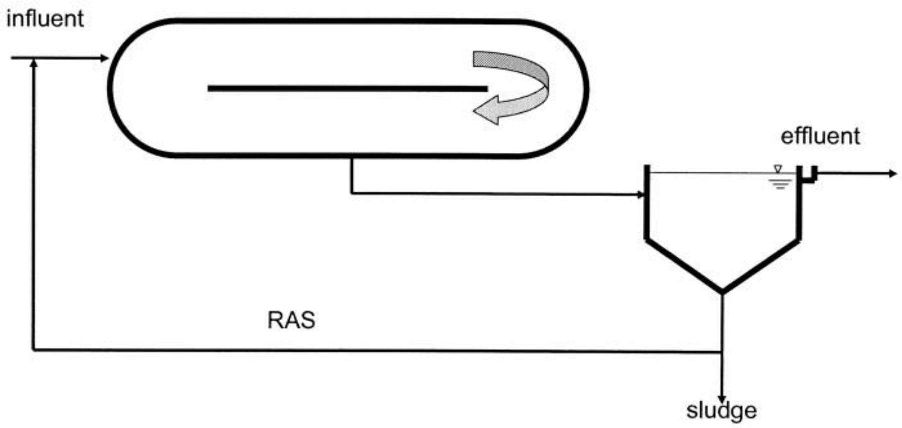
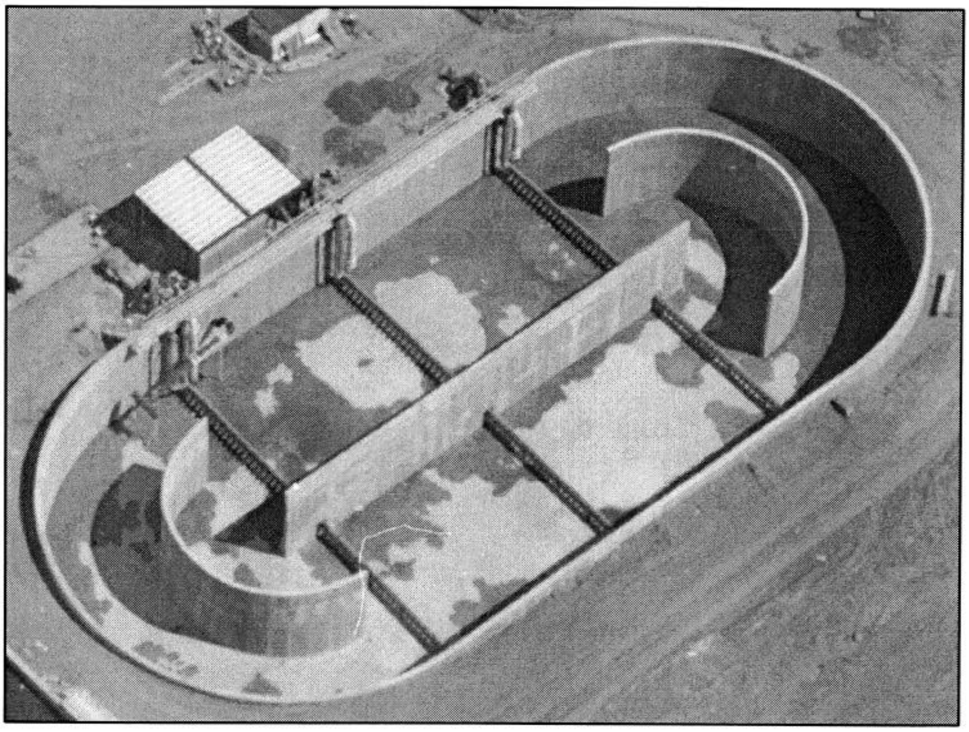



Extended aeration: long tanks


Extended aeration
Long retention time
Small works
Very low sludge production
Good effluent quality
Relatively high cost

Oxidation ditch





Oxidation ditch: Key facts

- Horizontal velocity ~ 0.3 $m.s^{-1}$
- 5-15 mins per pass
- Low sludge production
- Good nutrient removal
- High energy (lower than extended aeration)

Sequence batch reactor

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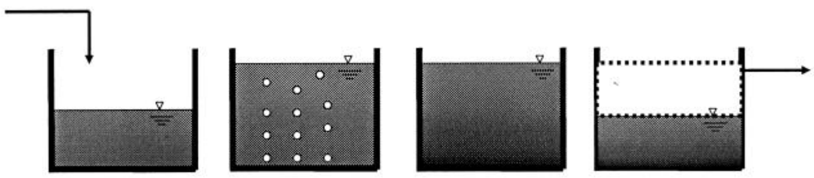
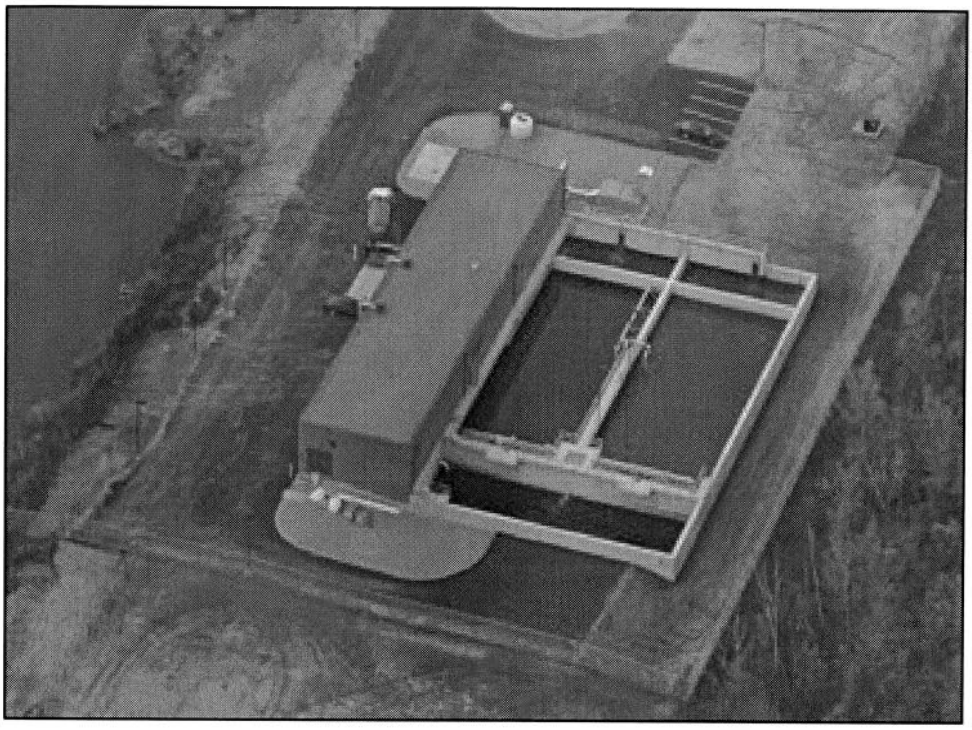


Fill	React	Settle	Decant
3 hours	2 hours	0.5 hours	0.5 hours



SBR: key facts

- All in one
- Flexible, compact
- Low sludge production
- More complicated, losing favour in some places

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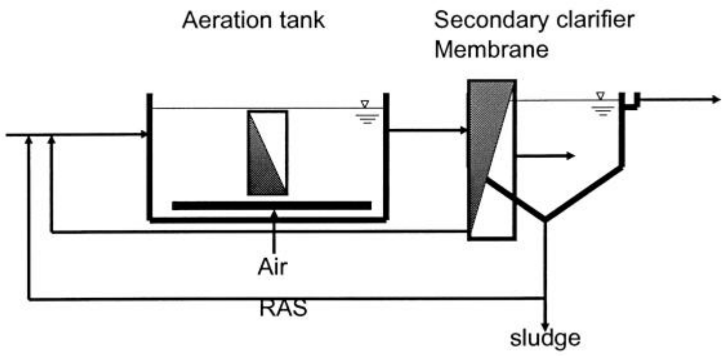
Membrane bioreactor



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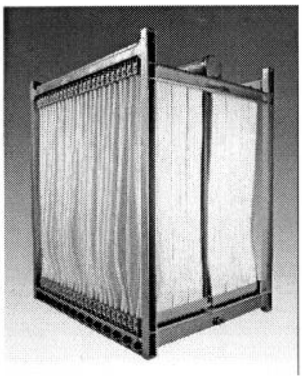
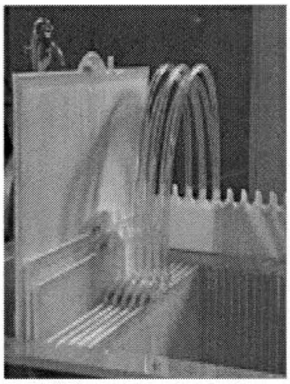
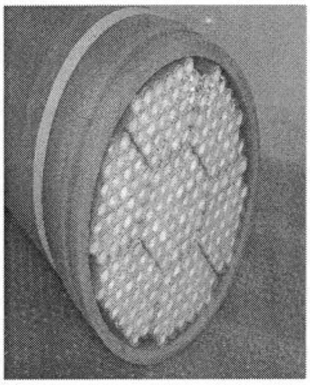
A range of membranes can be used



Hollow fibre (HF)
Zenon
0.04 μm PVDF

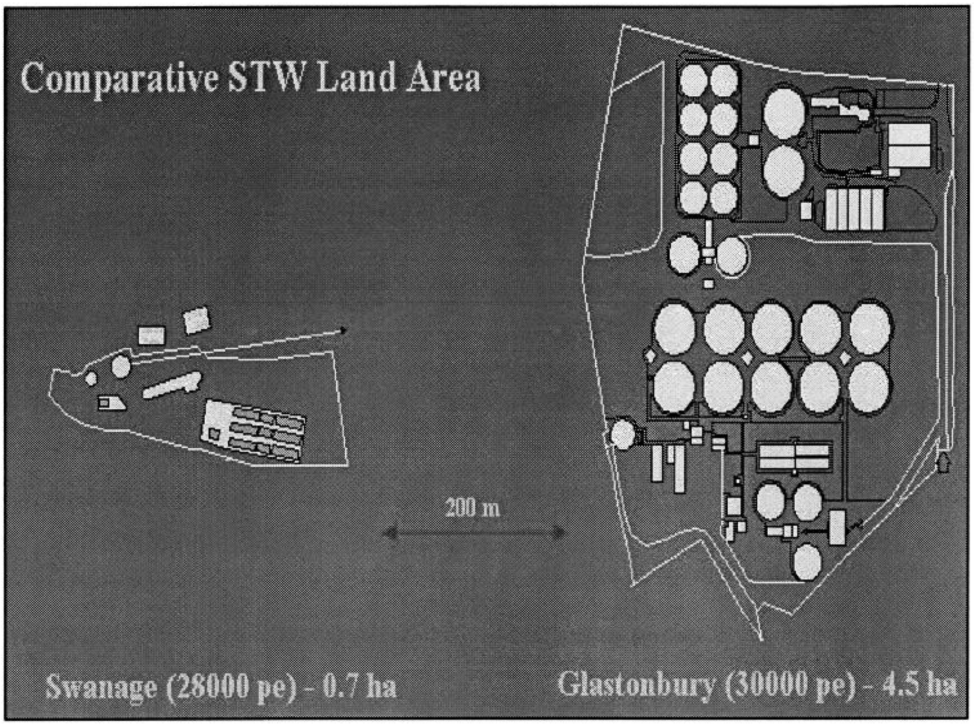


Flat plate (FP)
Kubota
0.4 μm PE

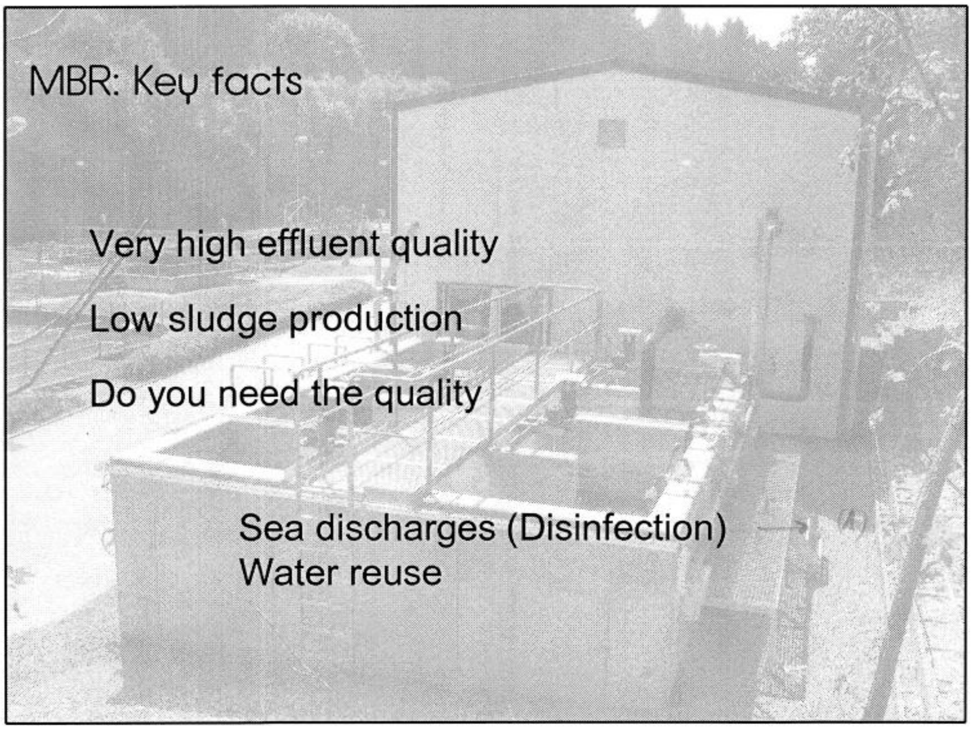


Multi tube (MT)
Berghoff
0.08μm PES


Spot the MBR
3 Oct 2000



* We use MBR when we need high quality water or small plants



Comparison of systems

	CM	Plug flow	Extended	Oxidation ditch	SBR	MBR
HRT (hours)	3-8	4-8	20-30	15-30	15-40	2-8
F/M	0.2-0.6	0.2-0.4	0.04-0.1	0.04-0.1	0.04-0.1	0.04-0.1
MLSS ($mg.L^{-1}$)	1500-4000	1000-3000	2000-5000	3000-5000	2000-5000	5000-20000
SRT (Days)	3-15	3-15	20-40	15-30	15-40	10-30
RAS (%)	25-100	25-75	50-150	75-150	n/a	Internal

Total nitrogen removal

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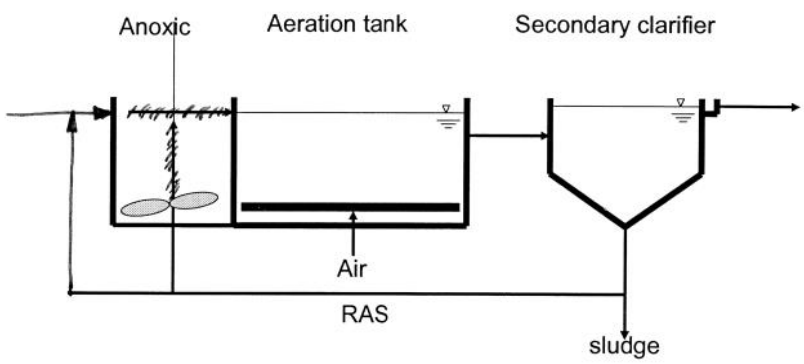
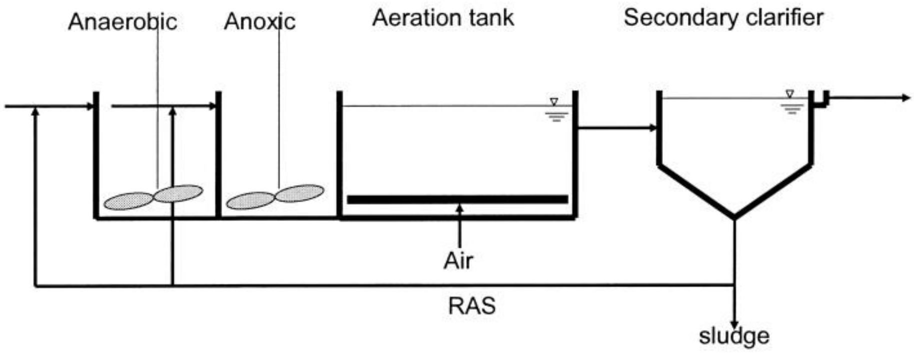
Anoxic : No air (oxygen), with NO_3

Assuming primary treatment:



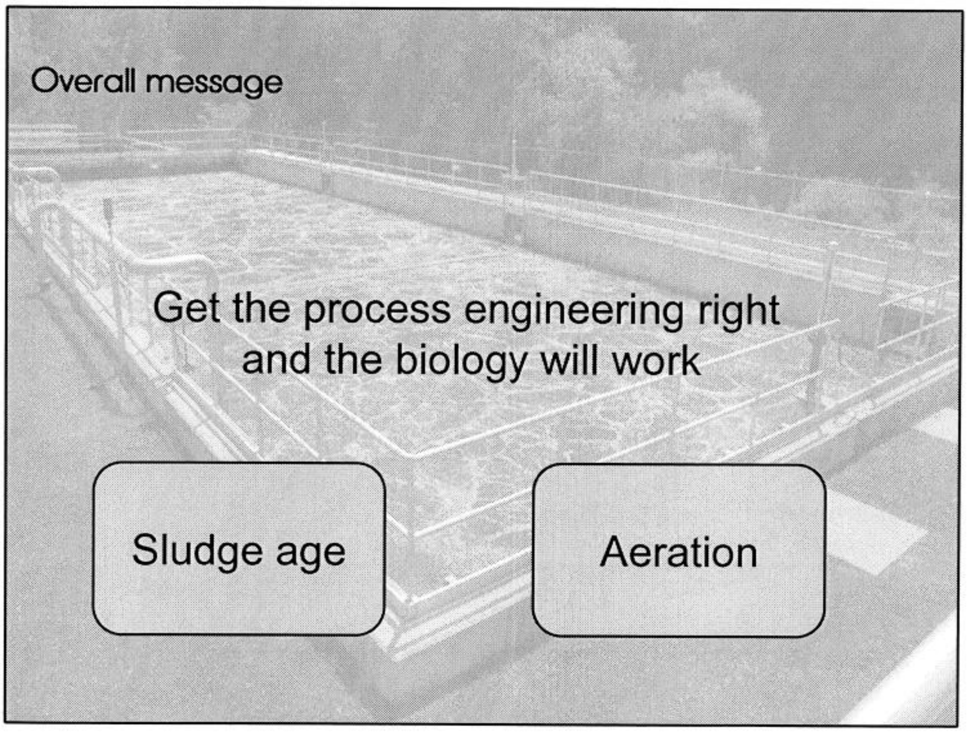
N&P removal

Assuming primary treatment:



Typical performance

	BOD	Ammonia	TN	TP
Standard	**<30 mg.L^{-1}**			
Nitrification	**<20 mg.L^{-1}**	**<1 mg.L^{-1}**		
Total nitrogen system	**<20 mg.L^{-1}**	**<1 mg.L^{-1}**	**<10 mg.L^{-1}**	
Total nutrient system	**<20 mg.L^{-1}**	**<1 mg.L^{-1}**	**<10 mg.L^{-1}**	**<1 mg.L^{-1}**


Overall message
Get the process engineering right
and the biology will work
Sludge age
Aeration