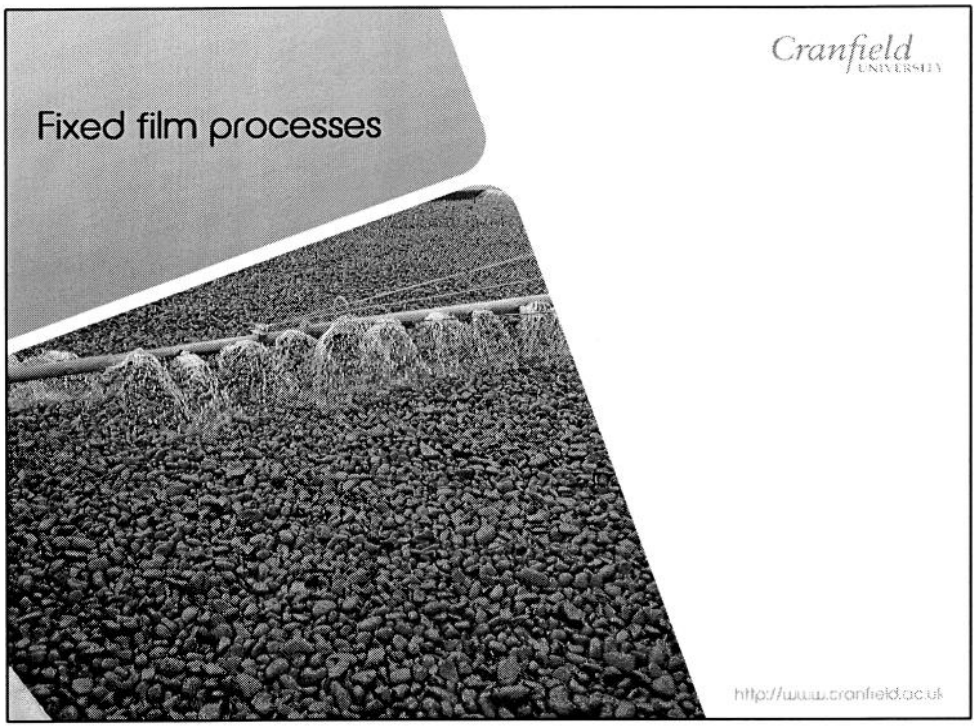
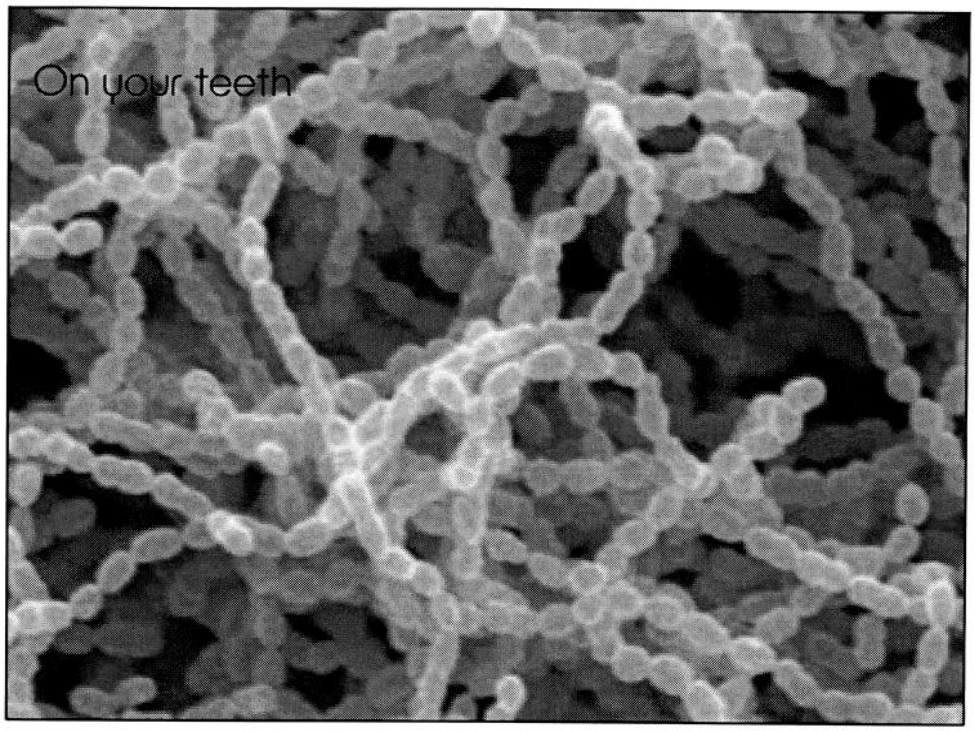
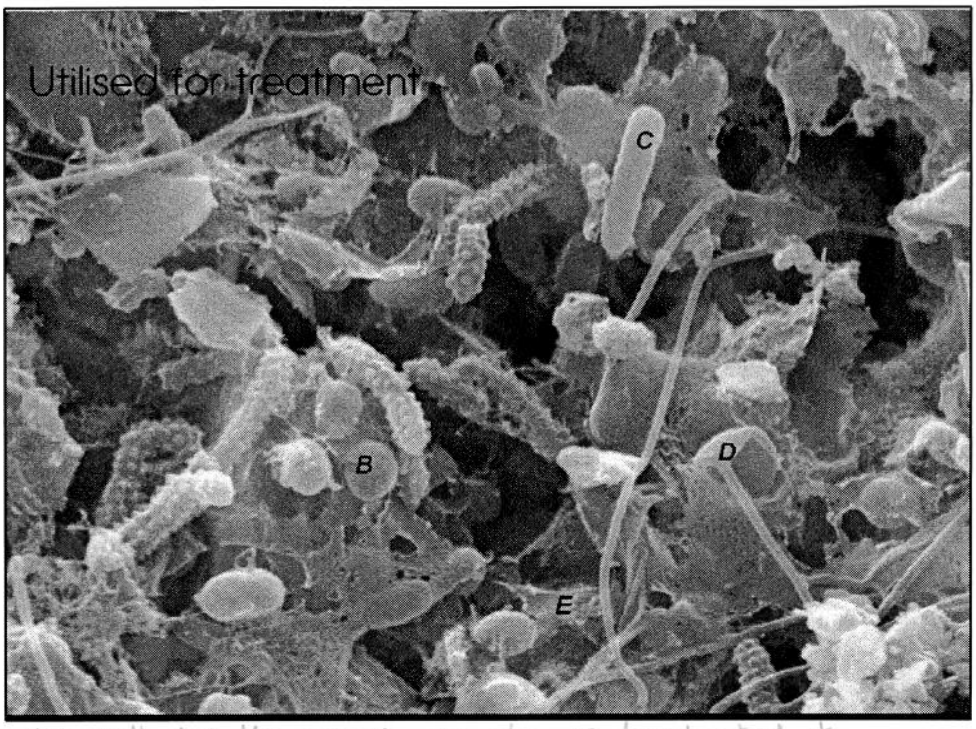


So what is a biofilm: 4 statements for the biologists

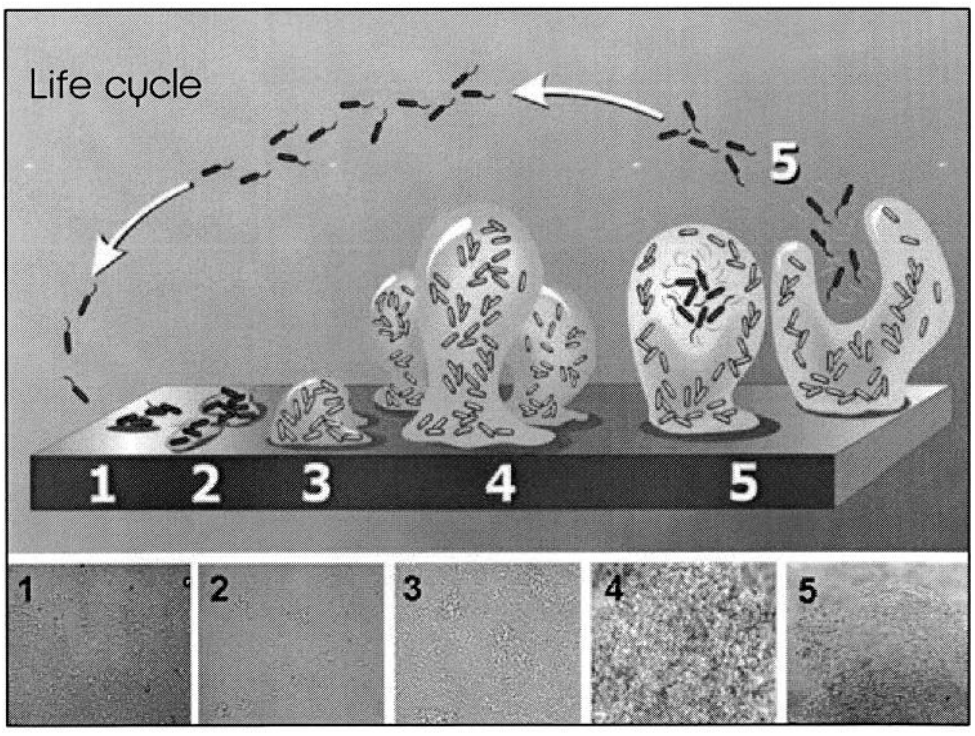
1. Biofilms are composed of microbial communities that are attached to an environmental surface
2. These micro-organisms usually encase themselves in an extracellular polysaccharide or slime matrix
3. Biofilms may be found on any environmental surface where sufficient moisture and nutrients are present
4. Their development is most rapid in free flowing systems where adequate nutrients are available

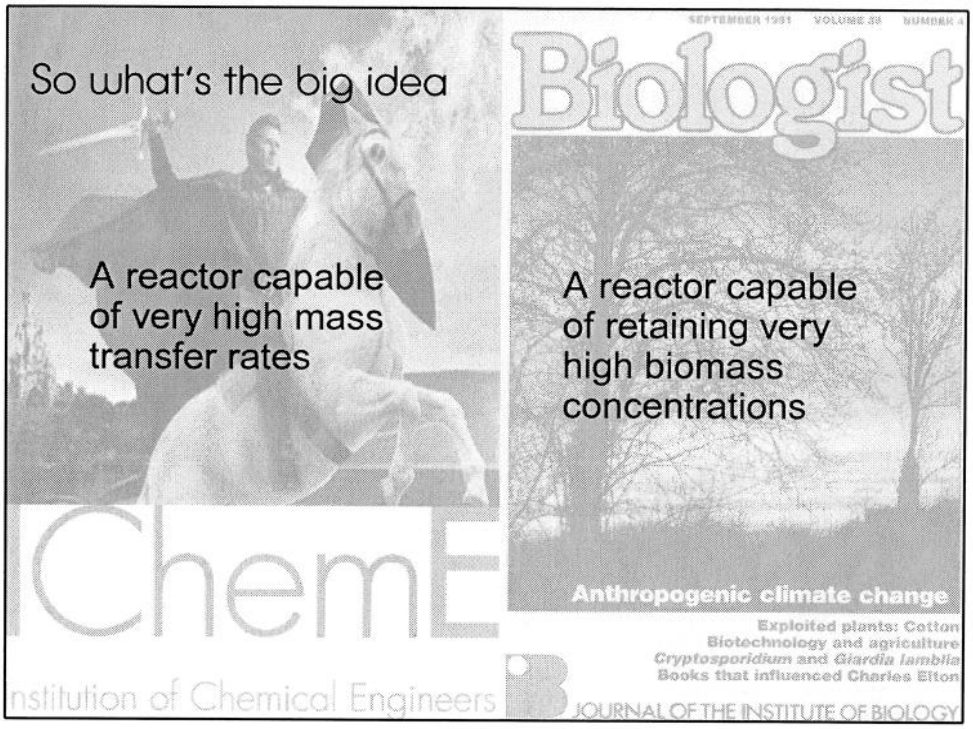

On your teeth


Or a catheter



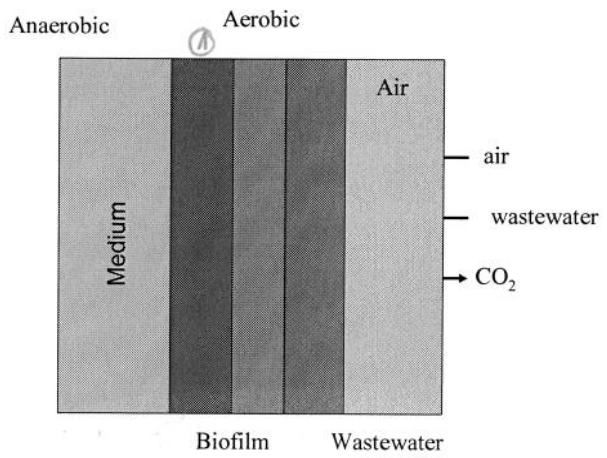
We can't stop the growth, the idea is how to control it





Biofilm structure

Cranfield UNIVERSITY



www.cranfield.ac.uk

So what's so good about biofilms

High concentration of biomass kept in reactor

Thickness naturally regulated

Diversity of micro-organisms

Low sludge production

Less energy for aeration (trickling filters)

So what's so good about biofilms

Poorer effluent quality

Less controllable

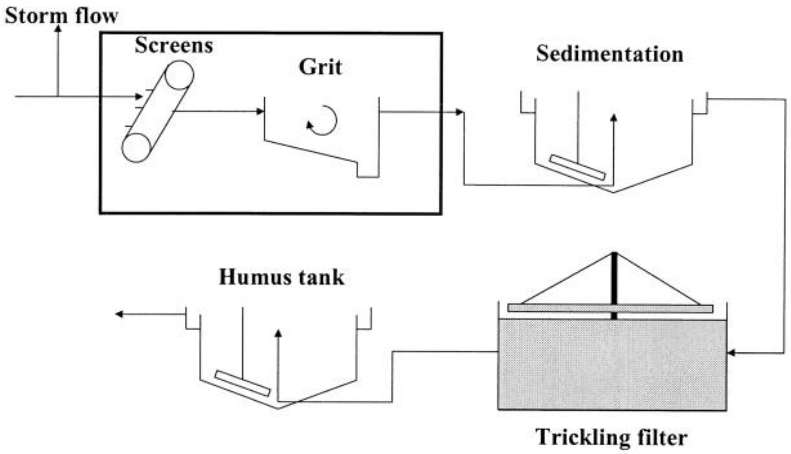
Greater sensitivity to temperature No too cold countries!

Uncontrolled solids release

Nutrient removal is more difficult

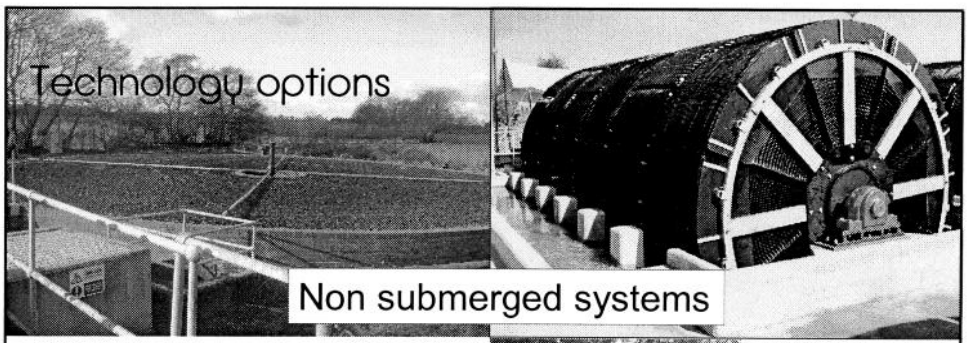
So where do they go

Cranfield UNIVERSITY



www.cranfield.ac.uk

Technology options

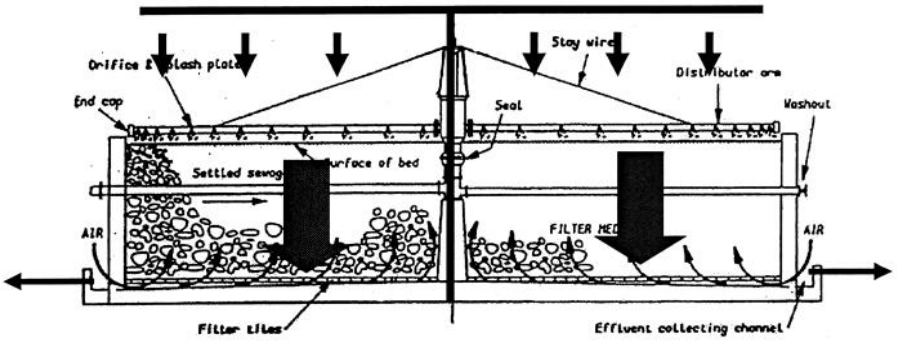


Non submerged systems

Submerged systems

Trickling filters

Cranfield UNIVERSITY

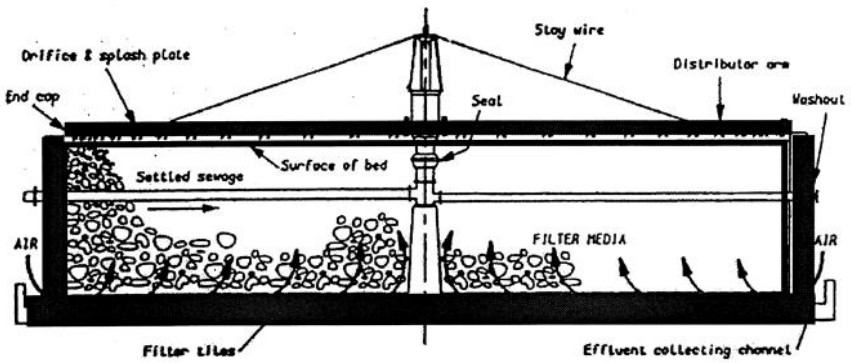


www.cranfield.ac.uk

There are 4 components in a trickling filter

Cranfield UNIVERSITY

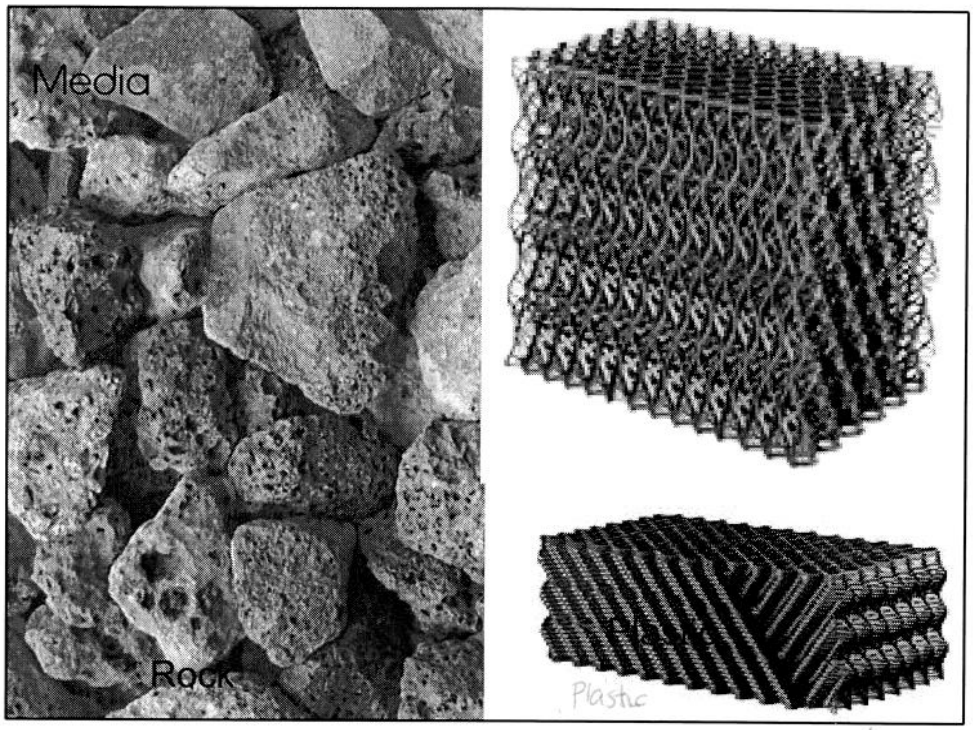
1. **Distribution**

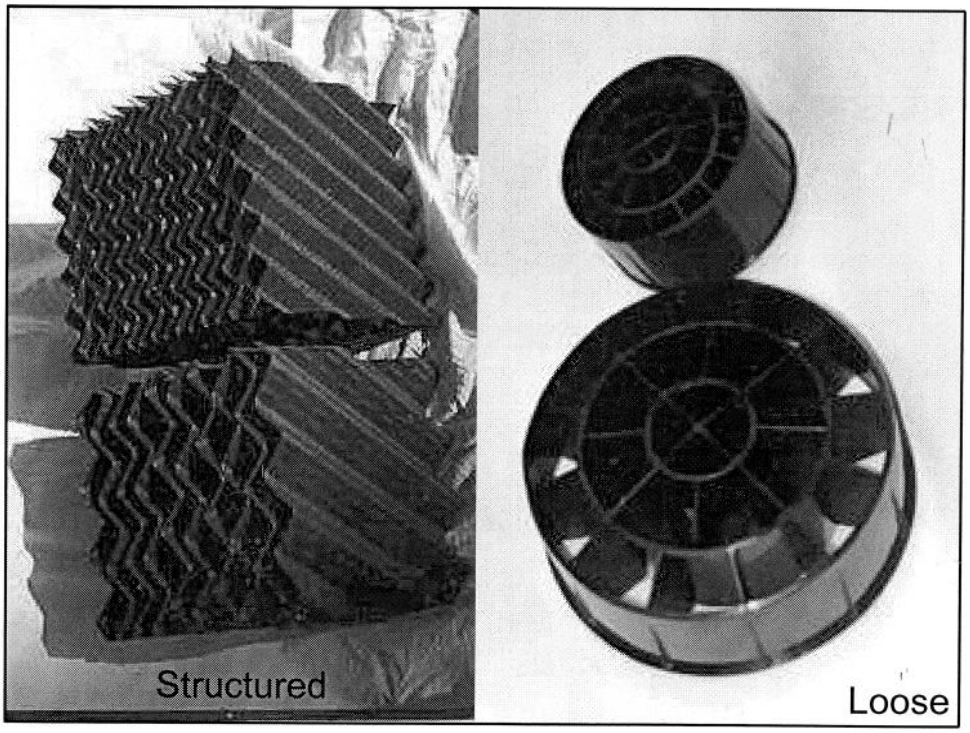


2. **underdrain** 3. **Tank** 4. **Media**

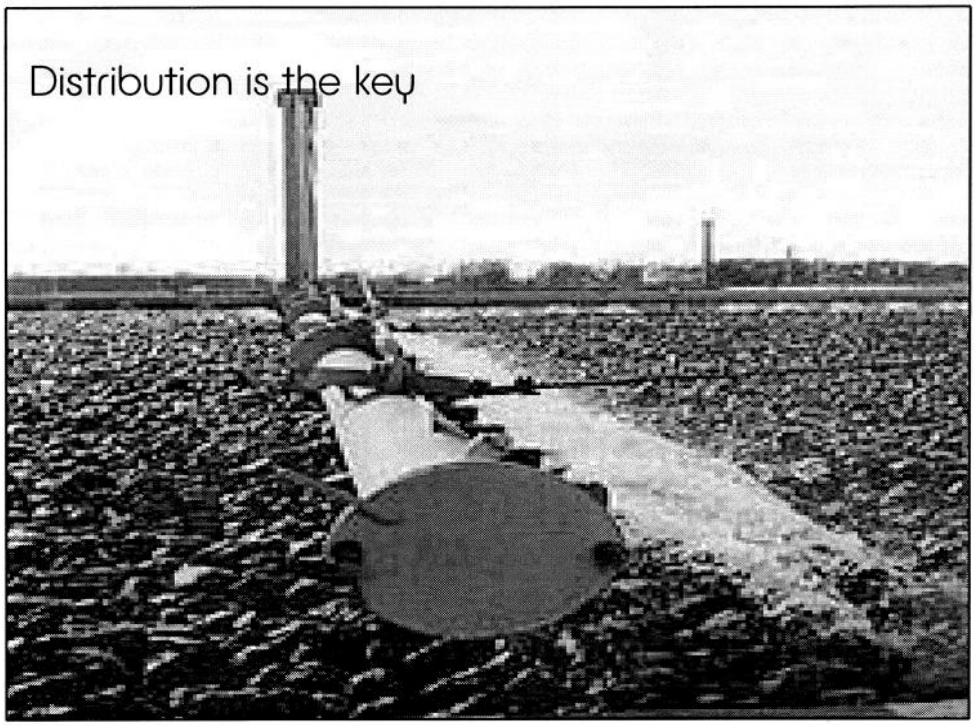
www.cranfield.ac.uk

- MEDIA -





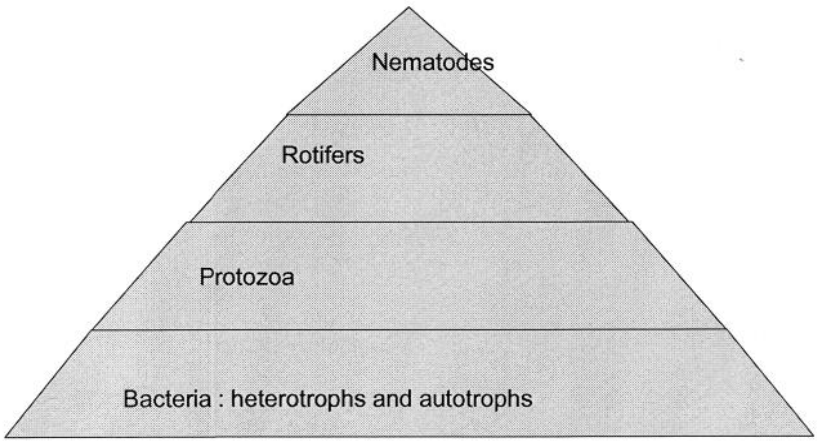
Distribution is the key



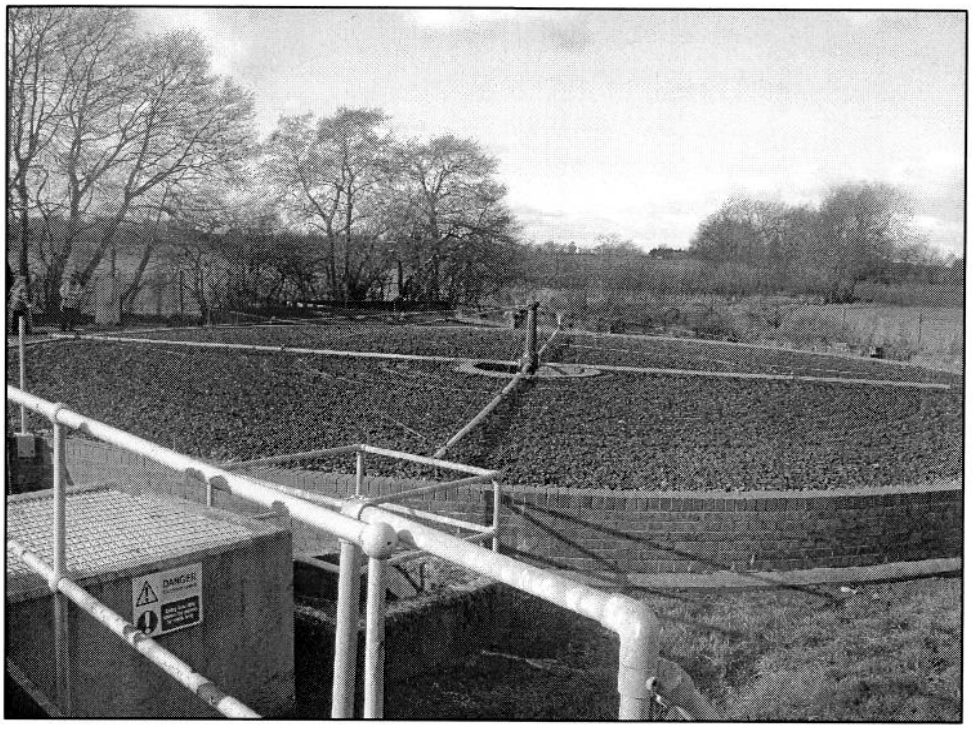
A whole ecological system

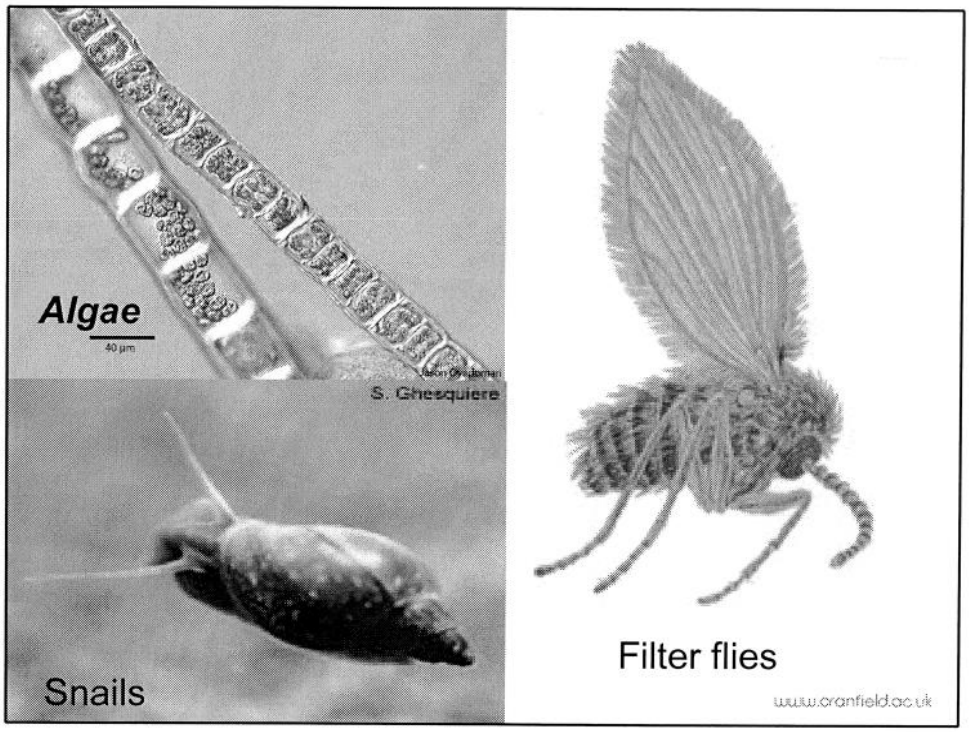
Cranfield UNIVERSITY

A whole ecological system…..



www.cranfield.ac.uk

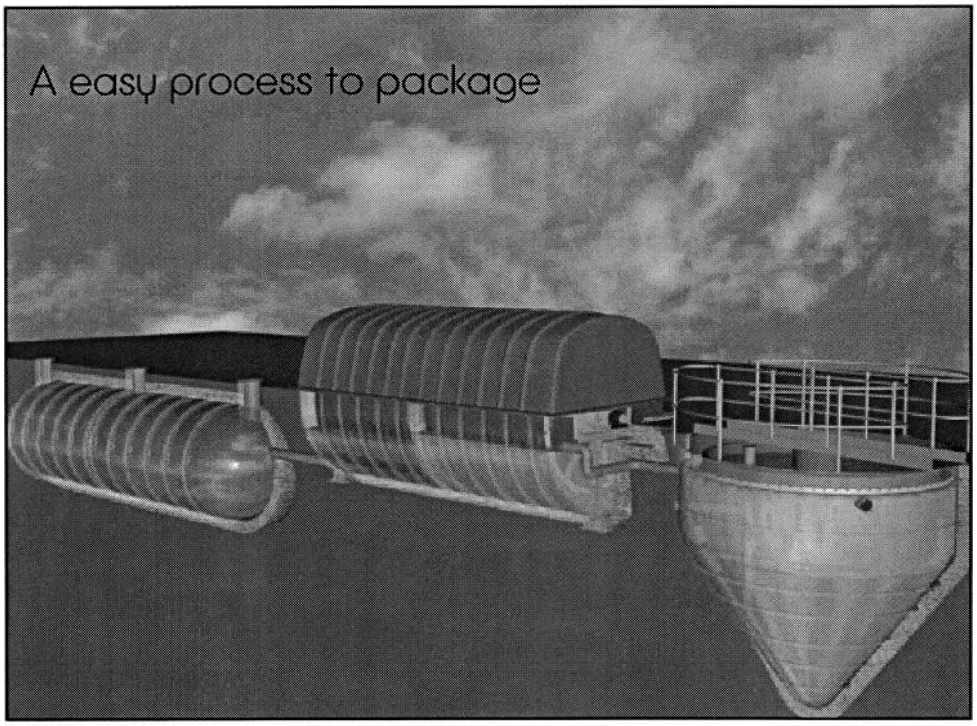


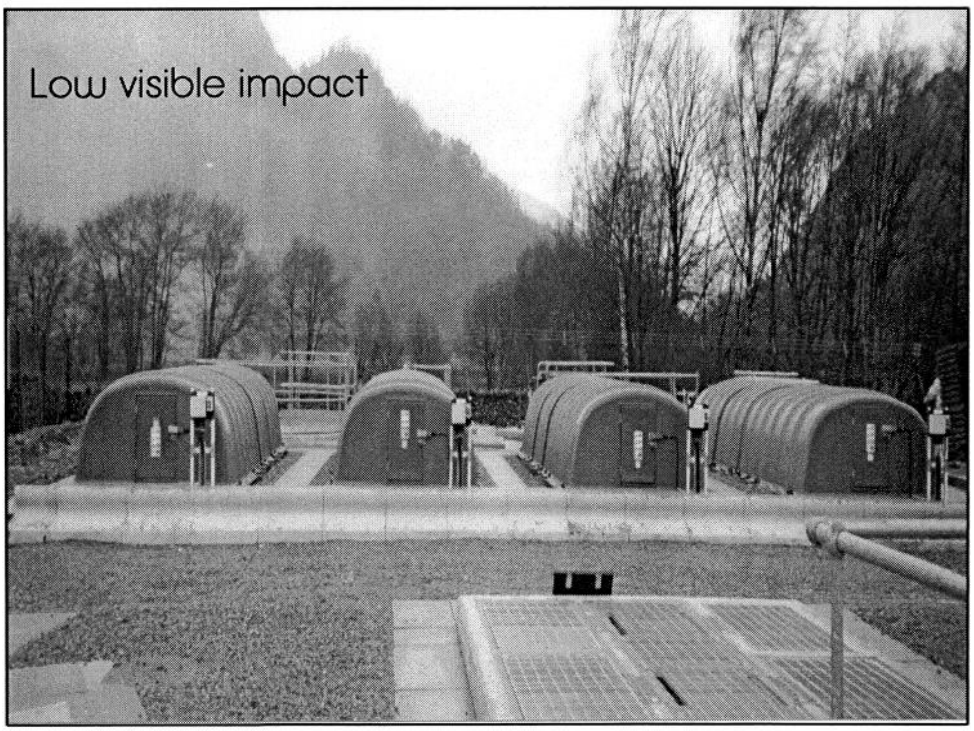


No only the biofilm growth, there are another algae, snails and flies that also growth.

Snails infection affect the biofilm.

Filter flies affect the general environment.


A easy process to package


Low visible impact

RBC: key facts

Biofilm attached to rotating discs

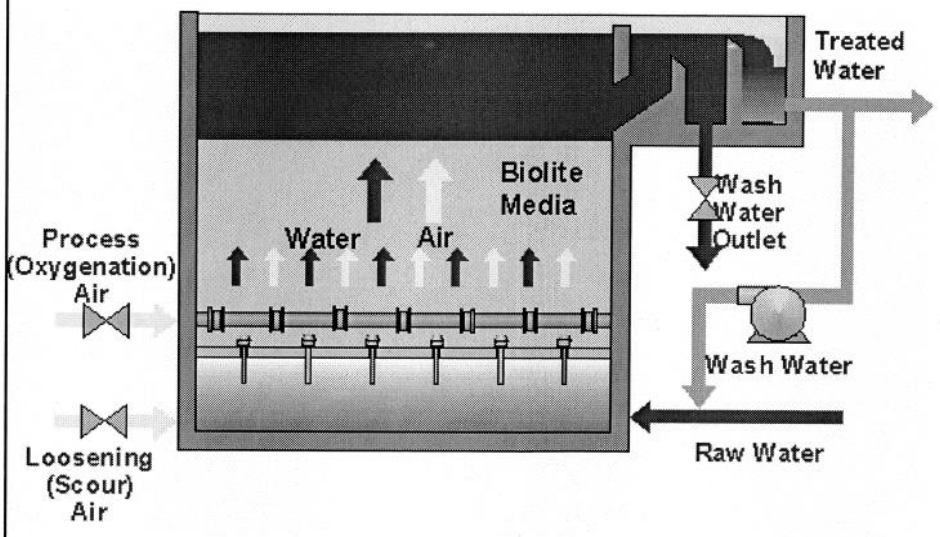
Less land than a trickling filter

Often used for small works (<2000 pe)

Good for package treatment

Biological aerated filter (BAF)

Cranfield UNIVERSITY



www.cranfield.ac.uk

Trickling filters: So why does the water industry love TFs

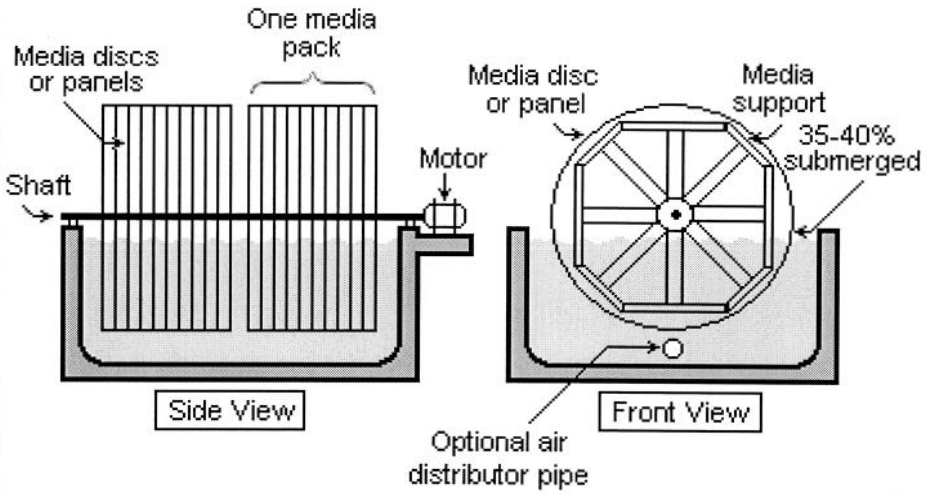
- No aeration costs
- Simple to operate (for operators)
- Known
- "Robust"
- Lots of them already in the ground

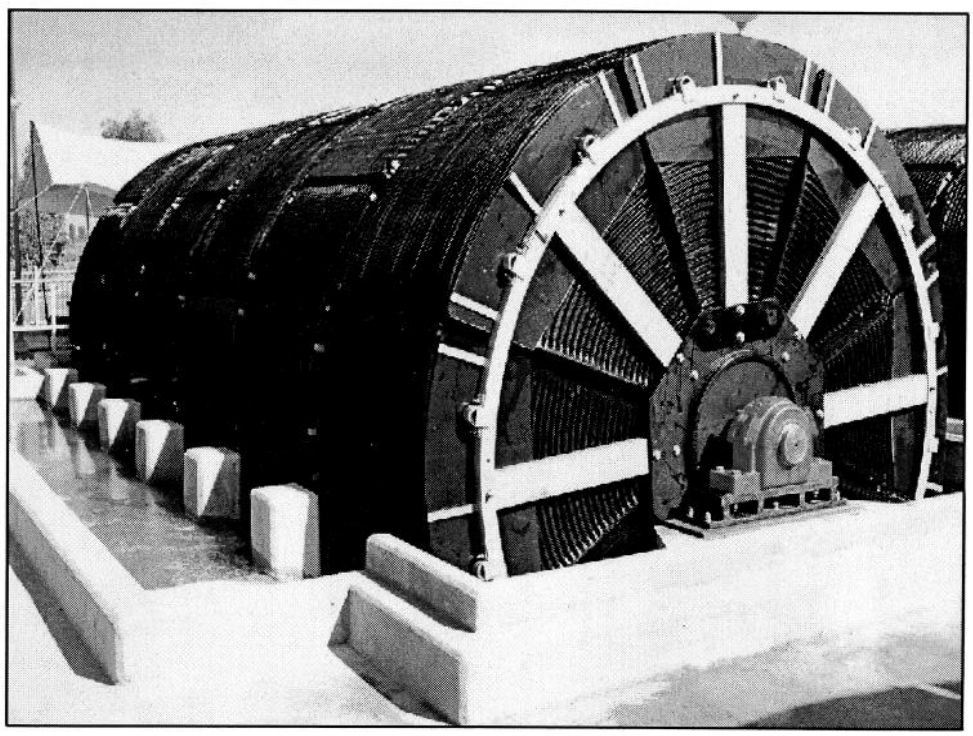
- Modern version of trickling filter

Reason ⇒ more compact less visible impact

Rotating biological contactor (RBC)

Cranfield UNIVERSITY





title

Cranfield UNIVERSITY

Oxygen at effluent

Nitrification advantage

Surface cleaning easy

DOWNFLOW

UPFLOW

Influent nozzle blockage

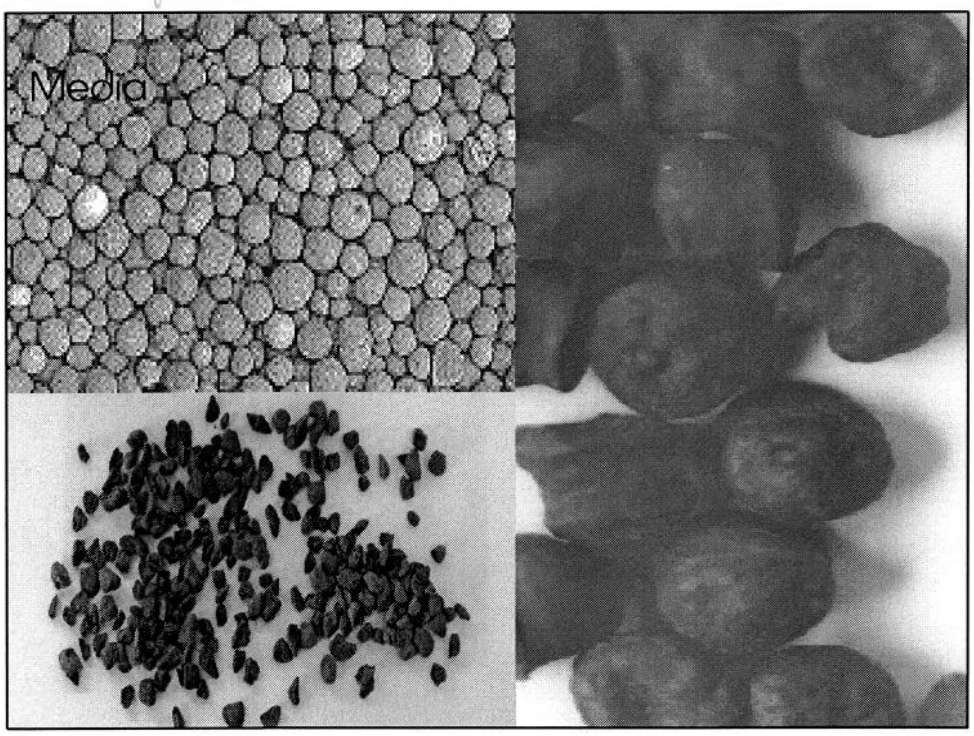
Higher influent flows

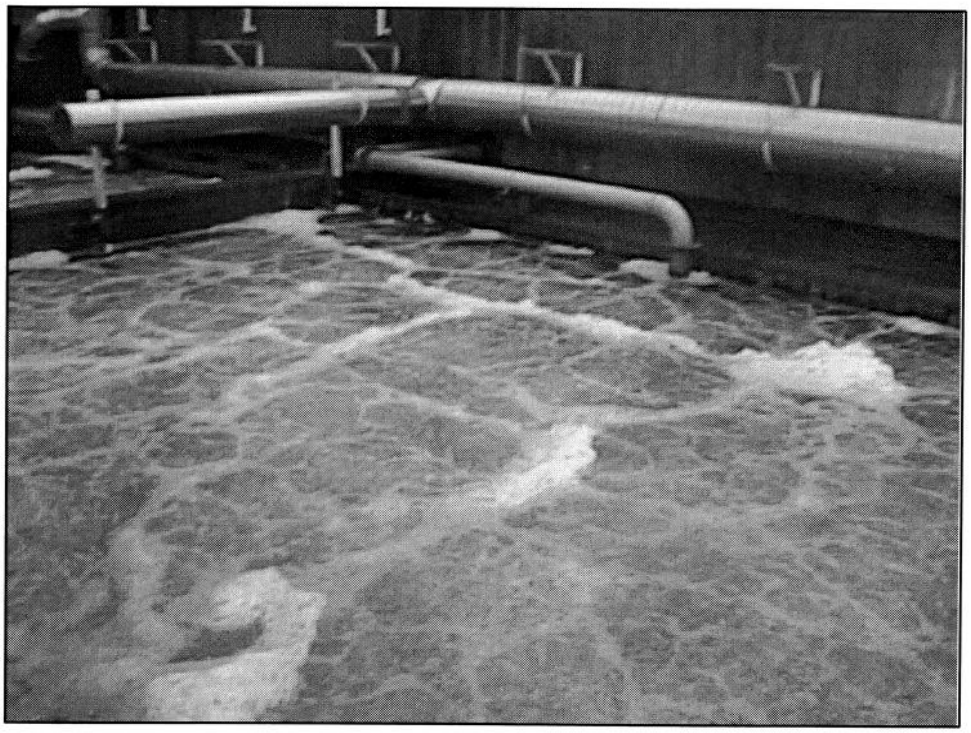
Reduced odour

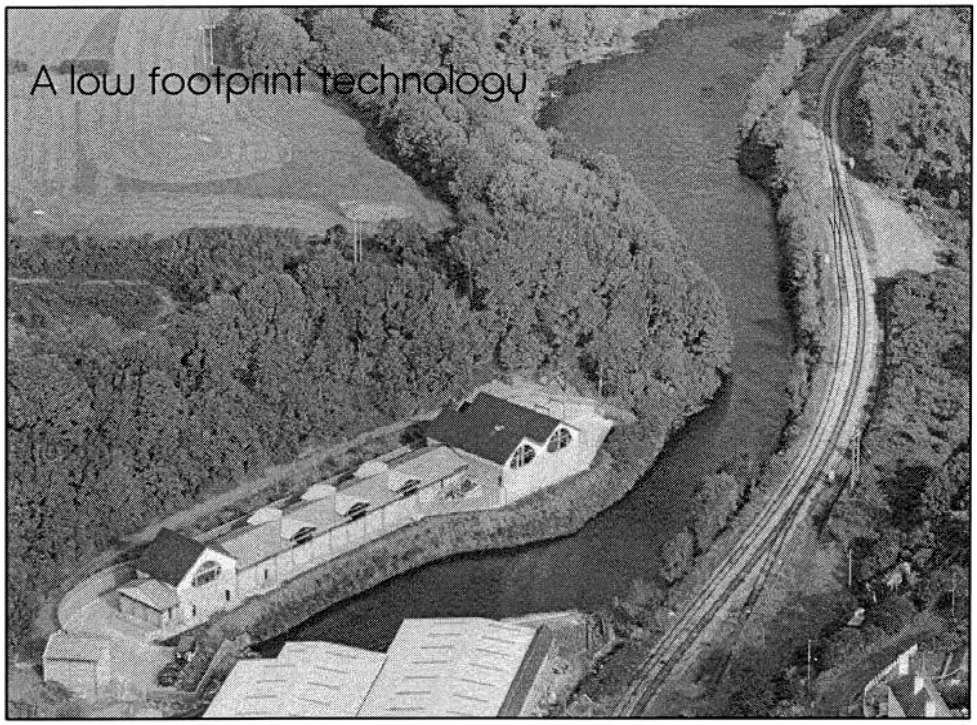
Increased filter run time

www.cranfield.ac.uk

low density medias







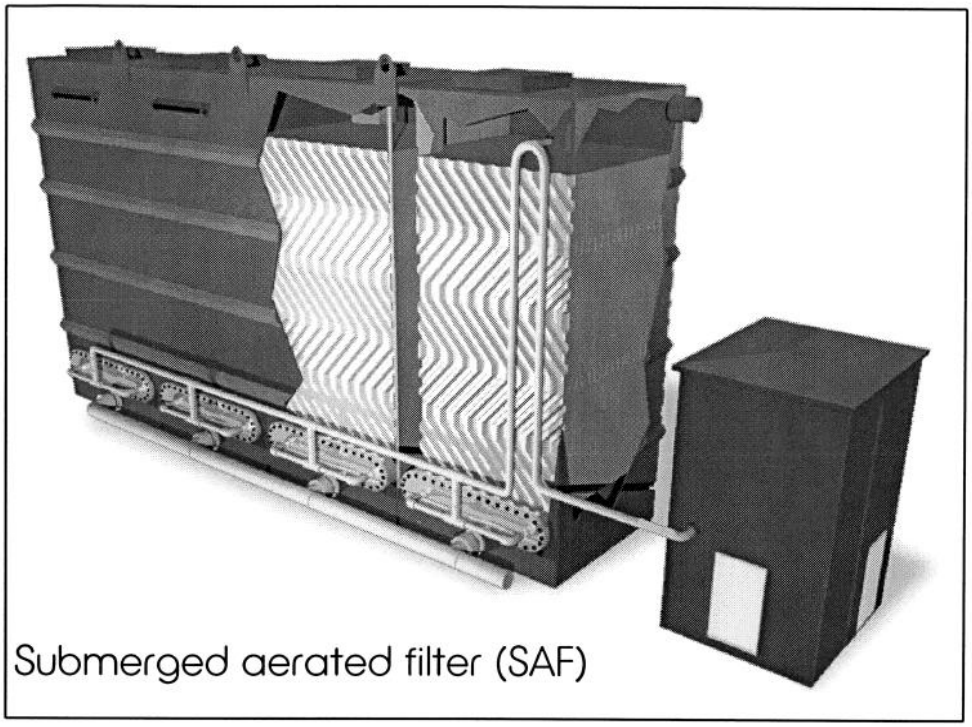
BAF: key facts

Combine biological treatment and subsequent biomass separation from effluent

Flexible: BOD, nitrification, denitrification

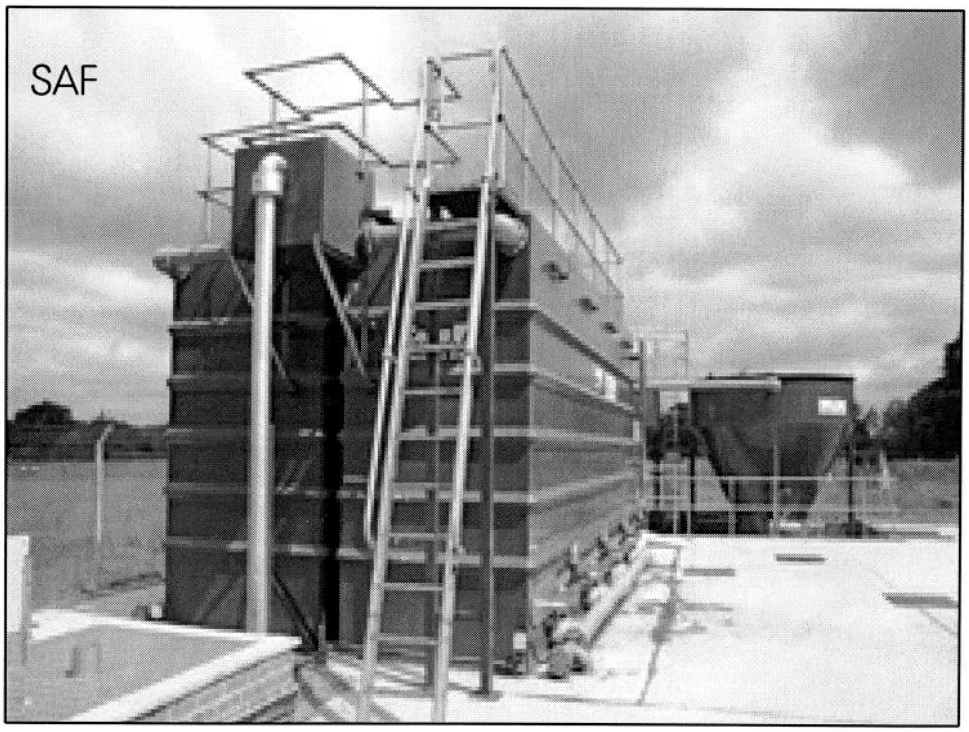
High rate: biofilm version of MBR

Regular backwash



Submerged aerated filter (SAF)

SAF use bigger media than BAF
& No Backwashing



SAF

Process comparison

Cranfield UNIVERSITY

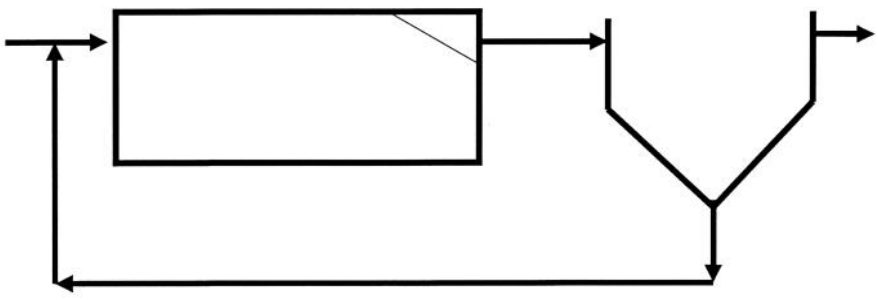
Process	Organic loading rate kgBOD.m^{-3}.d^{-1}	HRT (h)	Removal
Trickling filter	0.1-0.4	2-20	80-90%
RBC	n/a	0.7-1.5	80-90%
BAF	0.7-2.8	<2	80-95%
AS	0.3-0.6	2-6	80-95%

www.cranfield.ac.uk

SAF cheaper than MBR.

Biofilms in activated sludge

Cranfield UNIVERSITY



Moving bed biofilm reactor (MBBR)

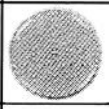
Integrated fixed film activated sludge (IFAS)

More important

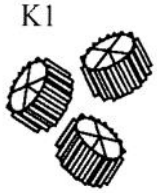
www.cranfield.ac.uk

Media used

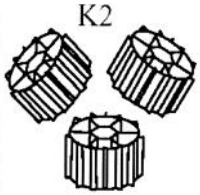
Cranfield UNIVERSITY

Carrier	K1	K2	K3	Biochip
Design				
Diam/Length (mm)	9/7	15/15	25/12	48/2,2
Specific biofilm area - Effective in bulk - Effective at 67 % filling fraction	(m^2/m^3) 500 335	(m^2/m^3) 350 235	(m^2/m^3) 500 335	(m^2/m^3) (1200) -

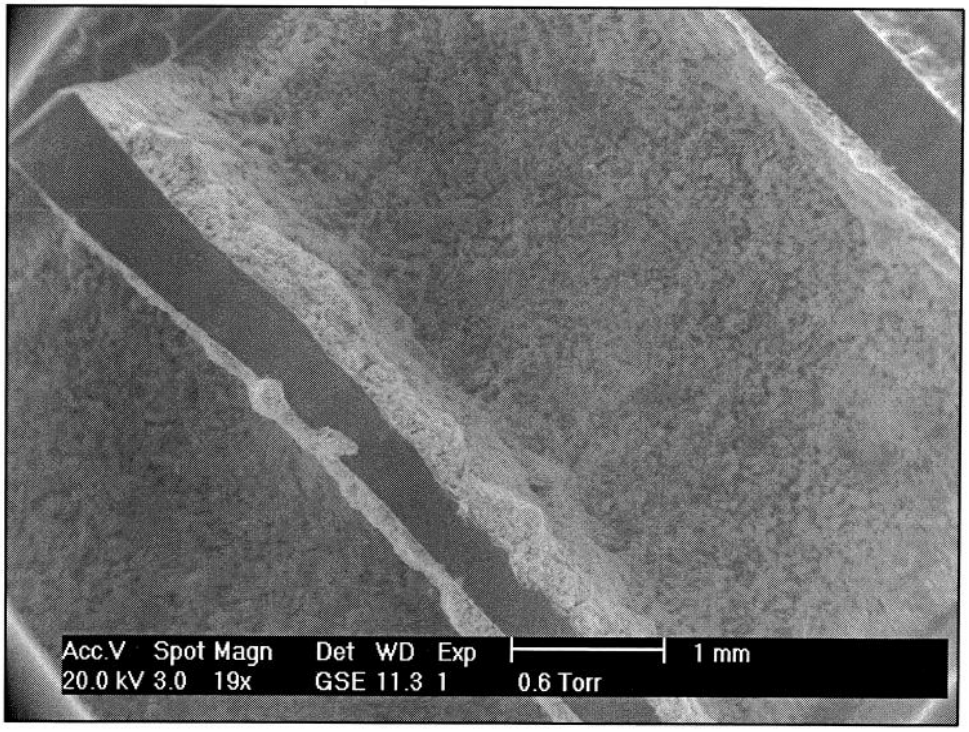
K1

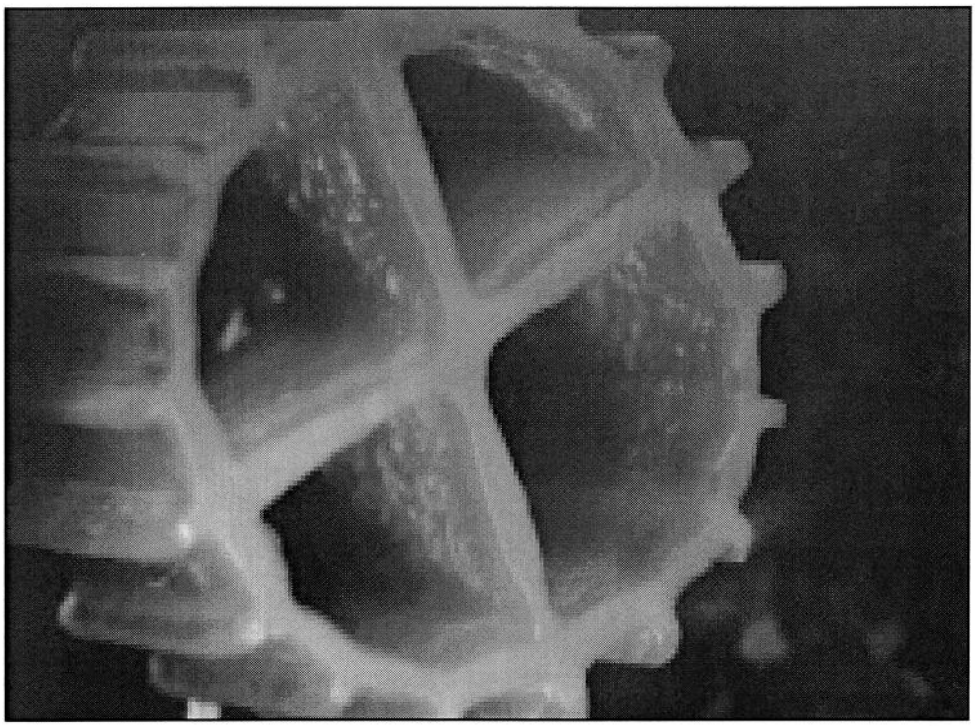


K2

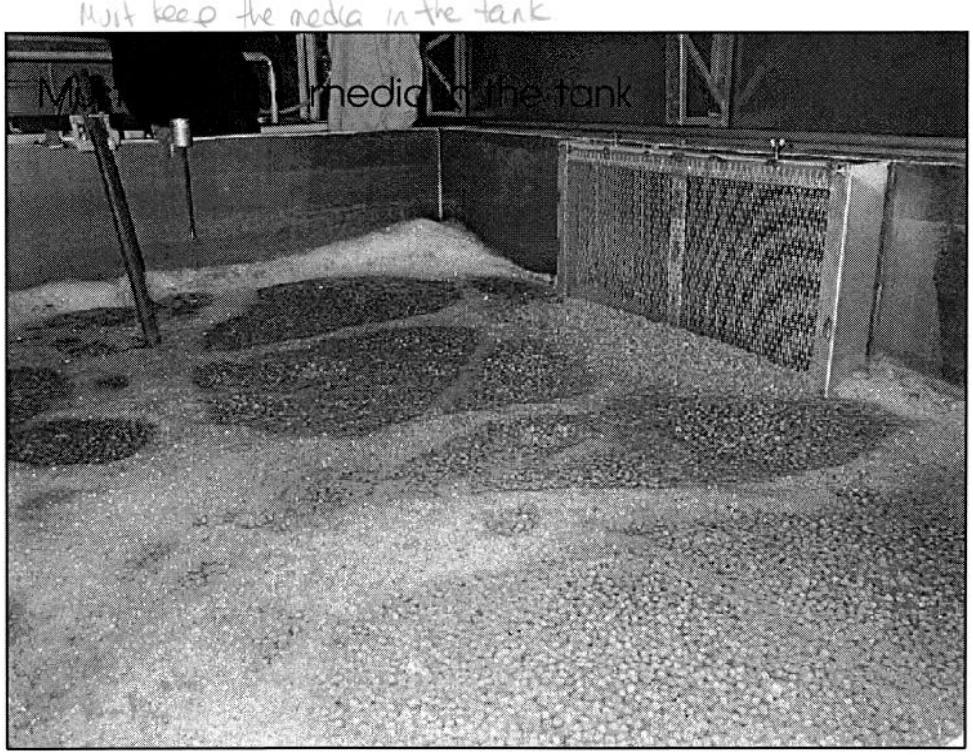


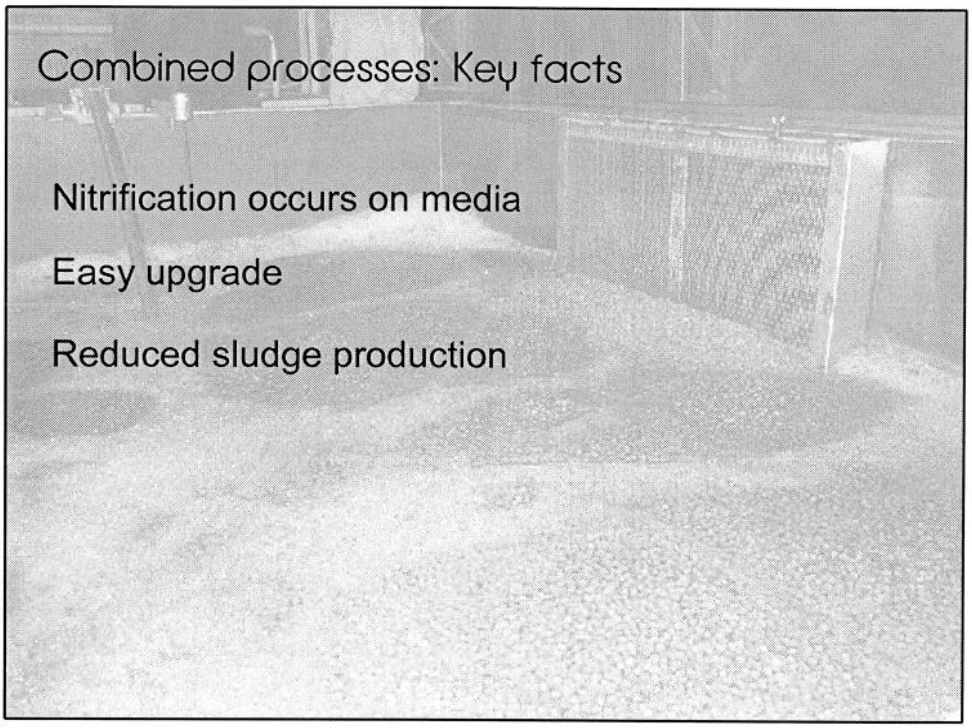
www.cranfield.ac.uk





Must keep the media in the tank




Combined processes: Key facts
Nitrification occurs on media
Easy upgrade
Reduced sludge production