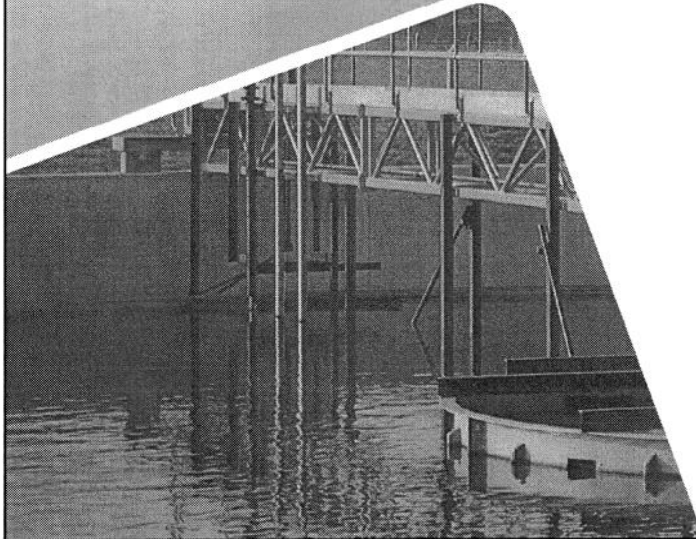


## Clarification

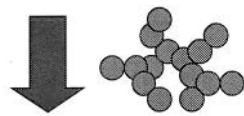
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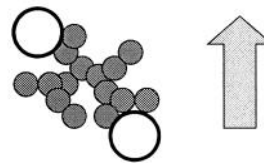
## Basic principle

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$$\rho_{\text{floc}} > \rho_{\text{water}}$$

Sedimentation



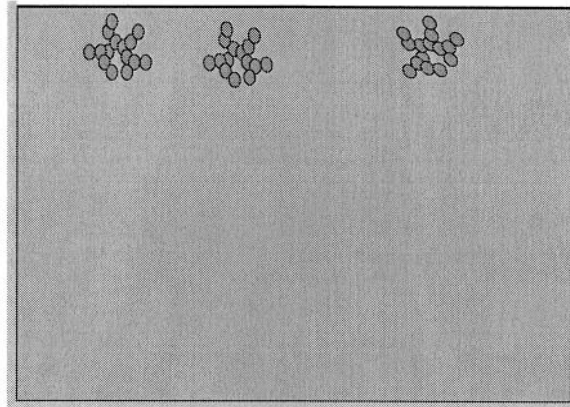
$$\rho_{\text{bubble-floc}} < \rho_{\text{water}}$$

Dissolved air flotation

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Oldest form of treatment in the world

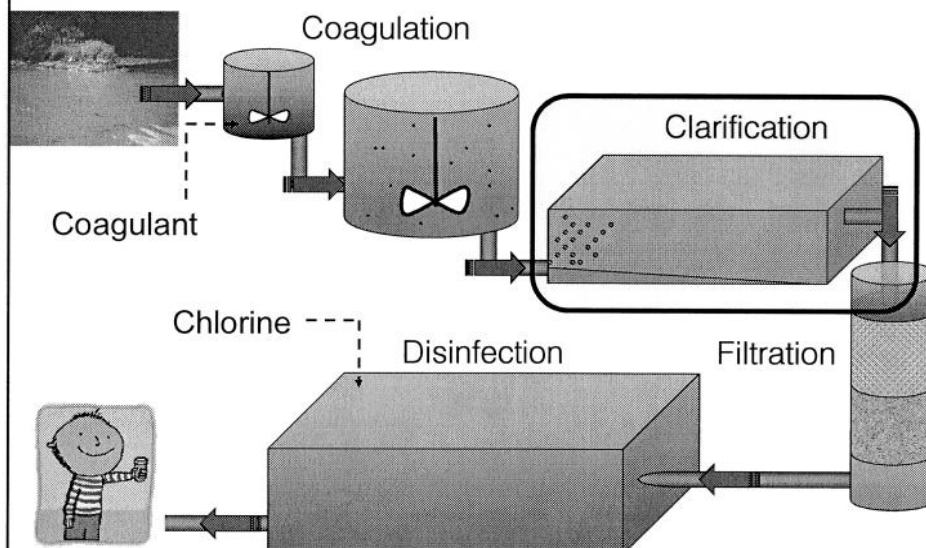
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Where is Clarification in the flow sheet

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## Process Science Stokes' Law

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$$v_t = \frac{g(\rho_p - \rho)d^2}{18\mu}$$

Annotations:

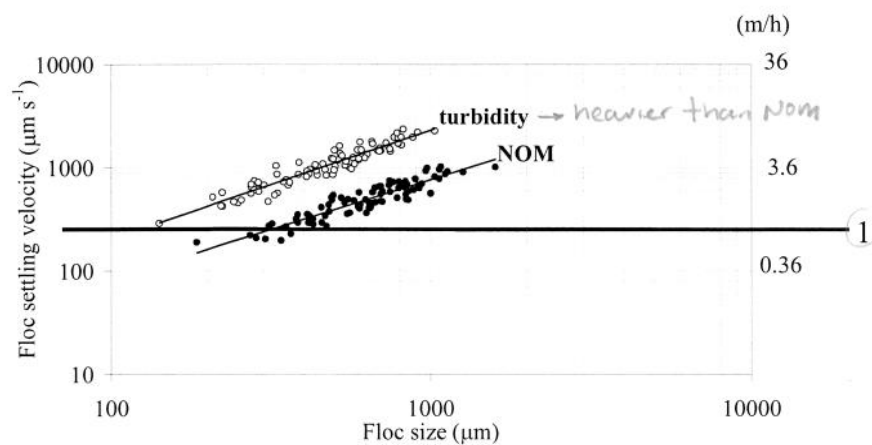
- $v_t$ : Rate of settling
- $g(\rho_p - \rho)$ : Density difference
- $d^2$ : Particle size
- $\mu$ : Viscosity

Only true for low concentrations: 1000 mg.L<sup>-1</sup>

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## Settling

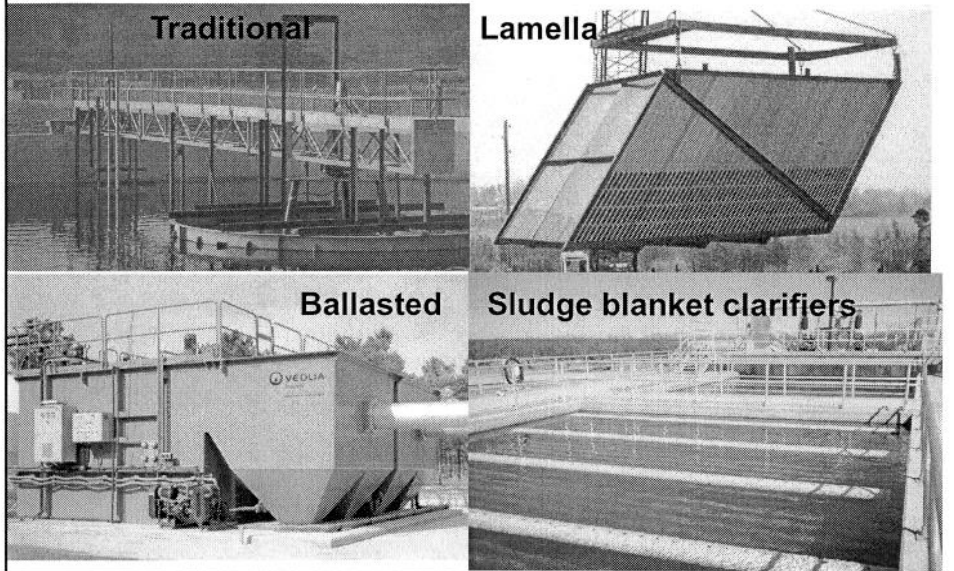
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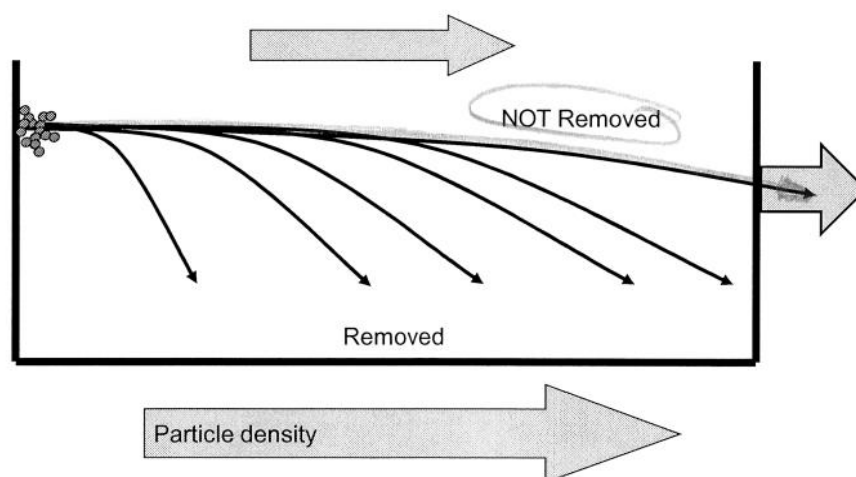
## Technology options

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## How they work

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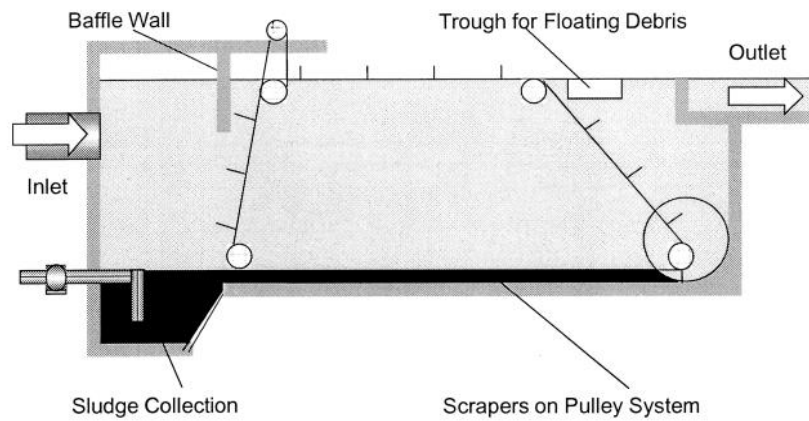


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1.-

## Horizontal flow clarifier

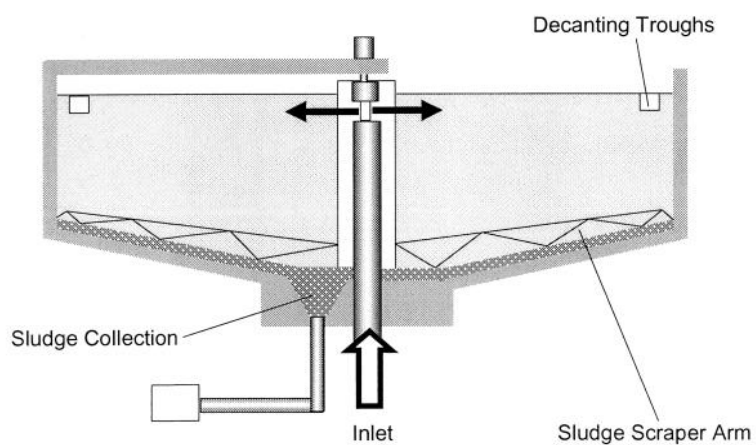
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2.-

## HFC: circular

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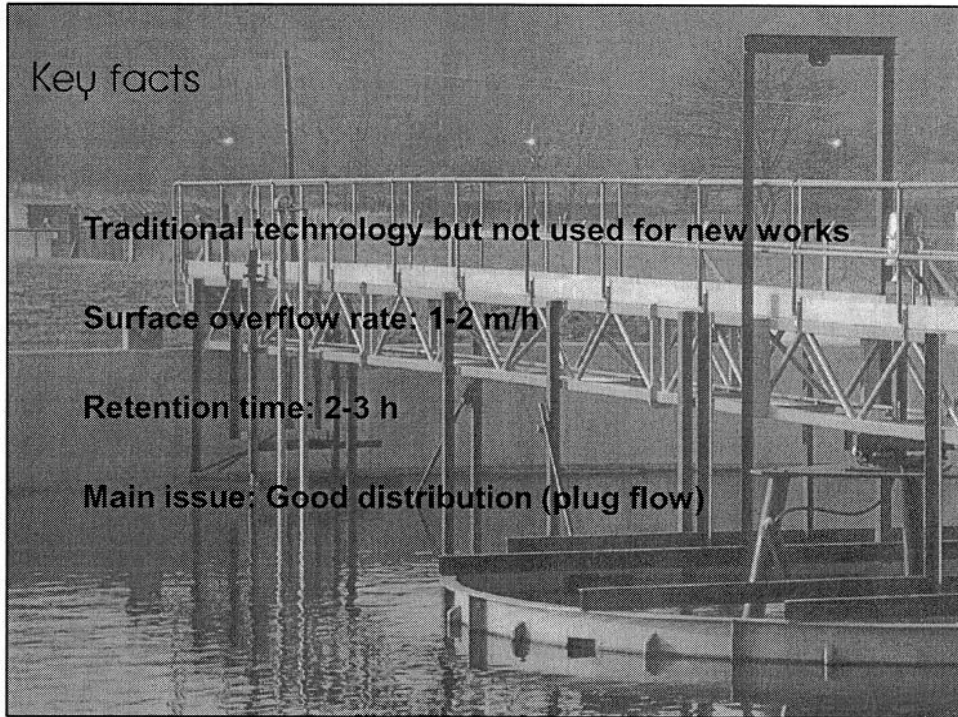
## Key facts

Traditional technology but not used for new works

Surface overflow rate: 1-2 m/h

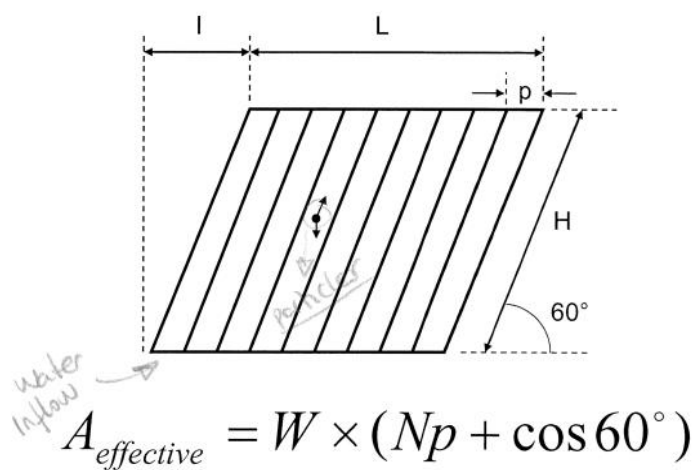
Retention time: 2-3 h

Main issue: Good distribution (plug flow)



## Lamella clarifiers

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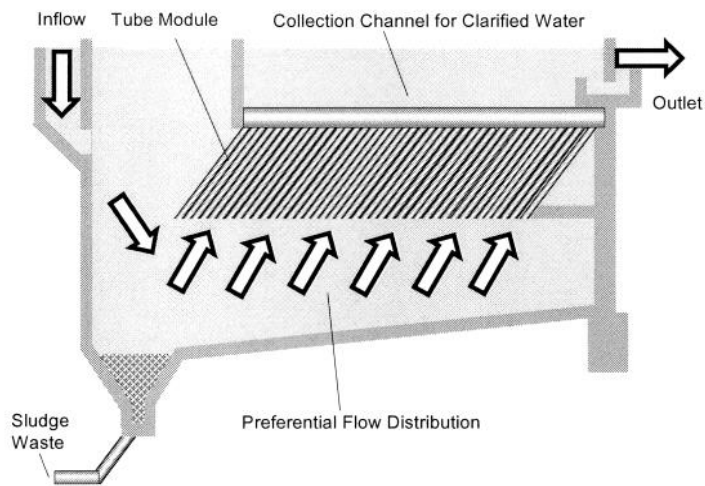


$$A_{\text{effective}} = W \times (Np + \cos 60^\circ)$$

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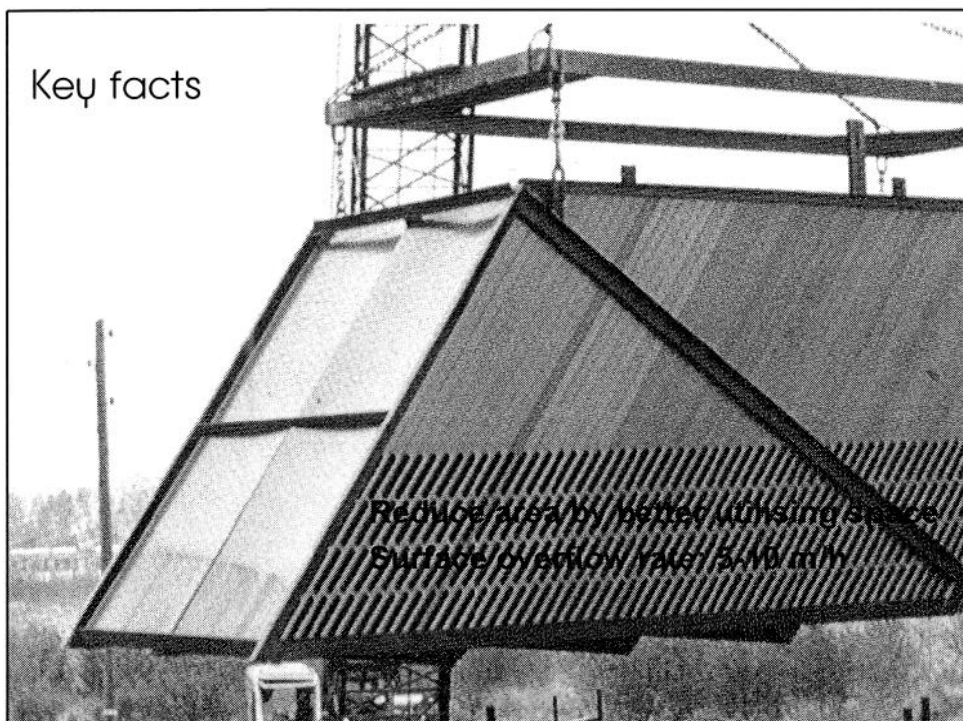
## Lamella processes

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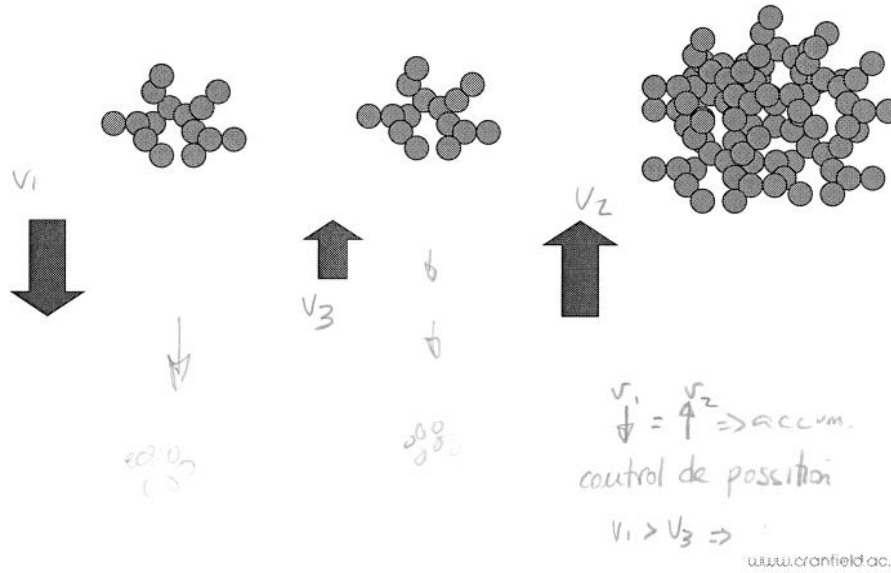
[www.cranfield.ac.uk](http://www.cranfield.ac.uk)

## Key facts



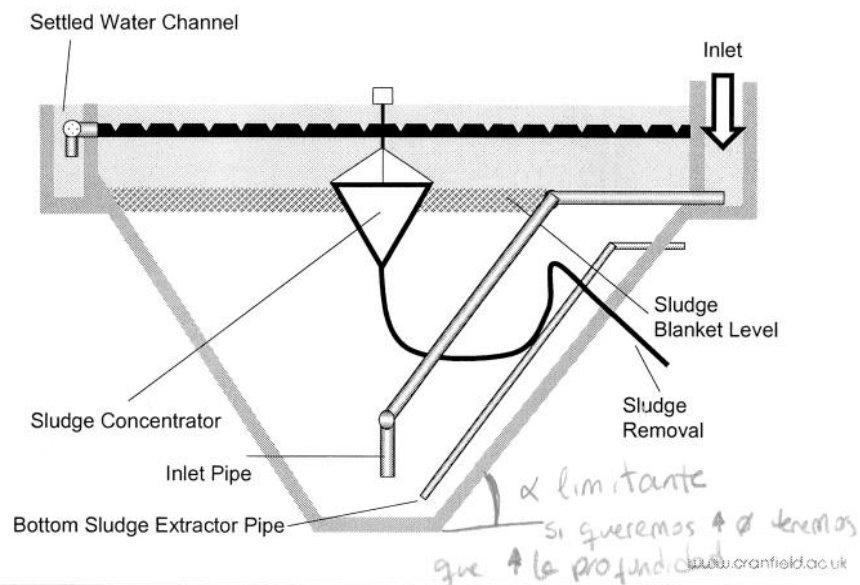
## Sludge blanket clarifiers

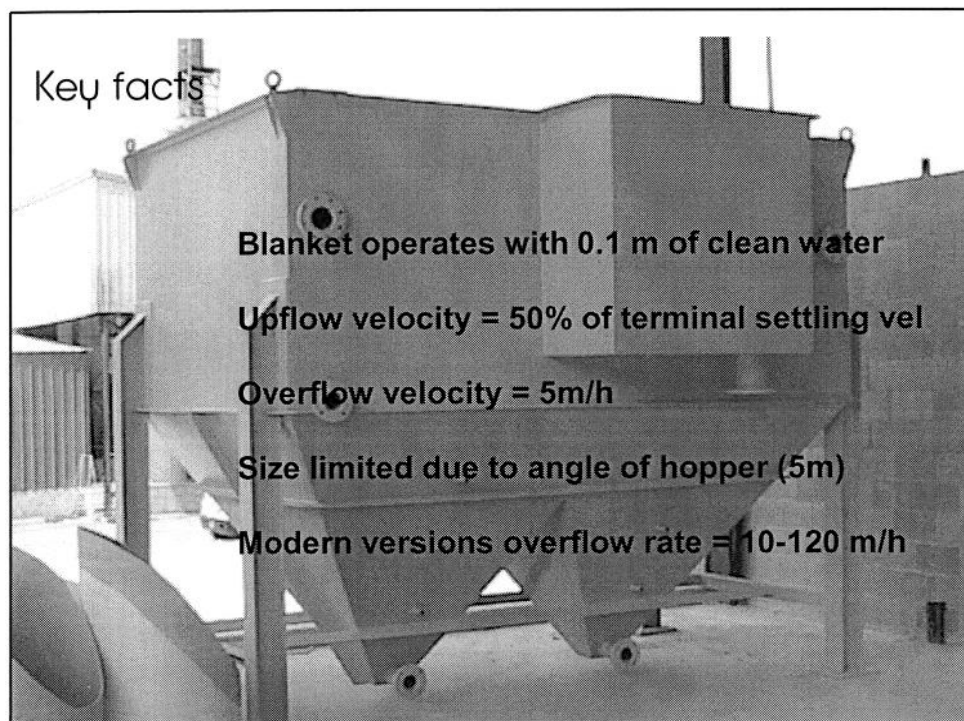
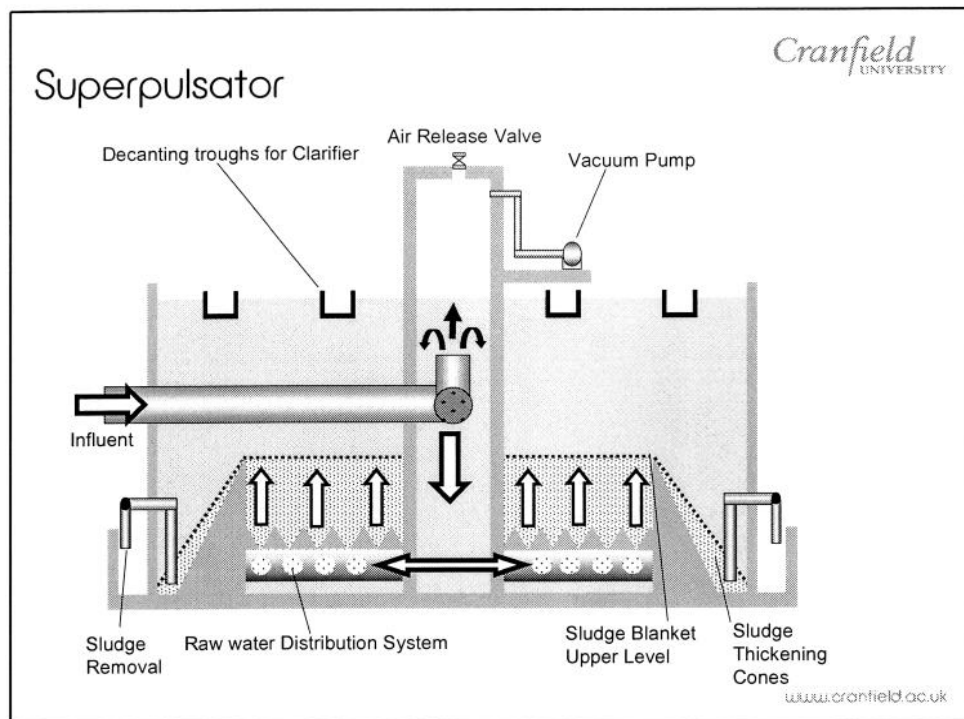
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## Sludge blanket clarifiers

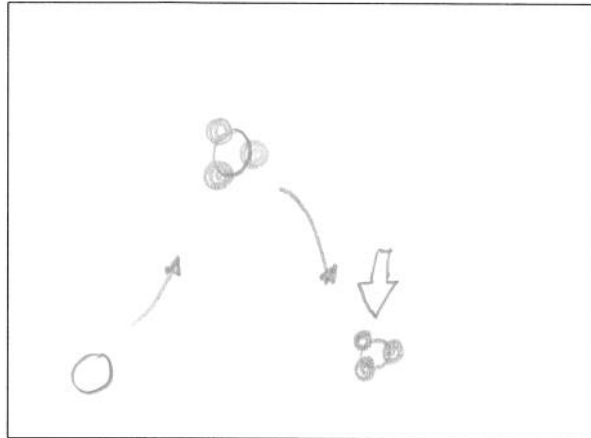
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## Ballasted settling

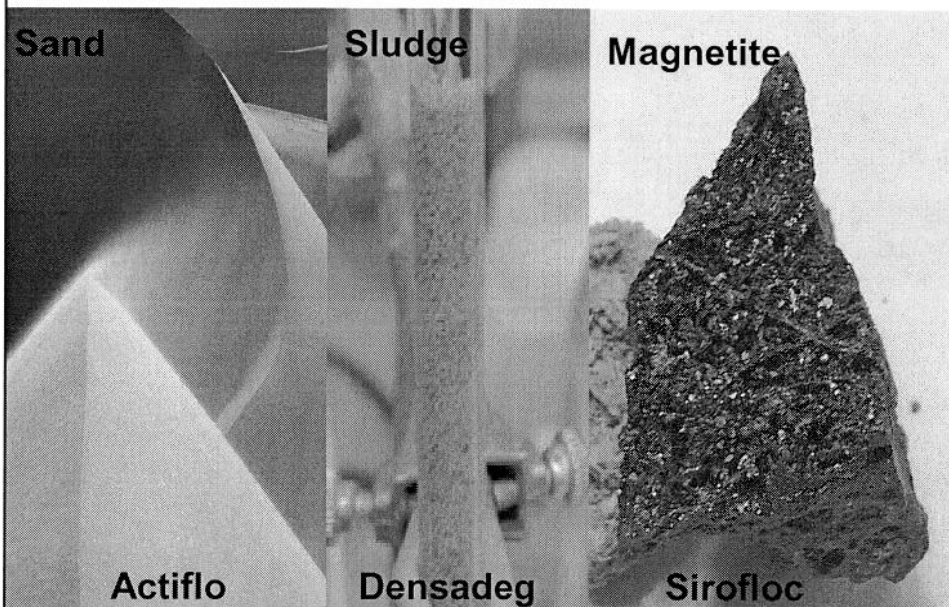
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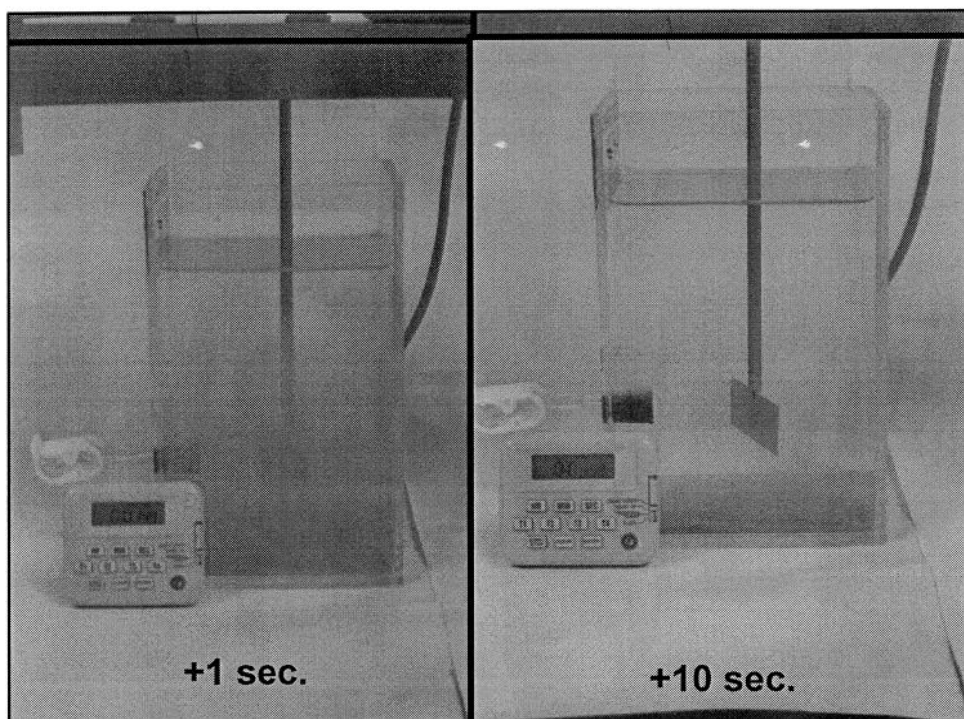


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## Ballasting agents

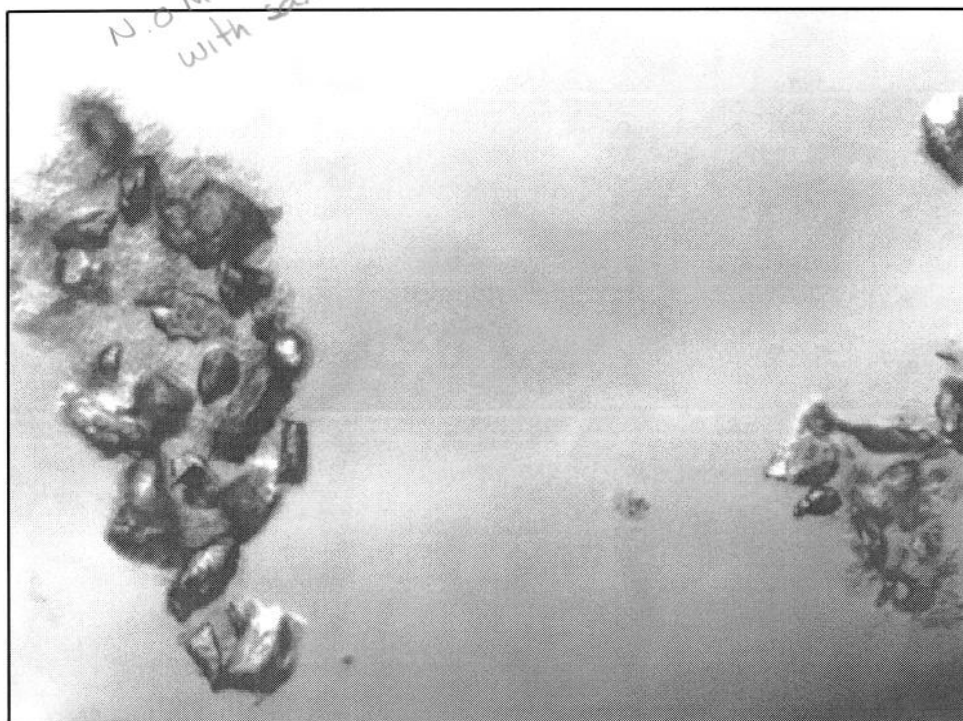
Cranfield  
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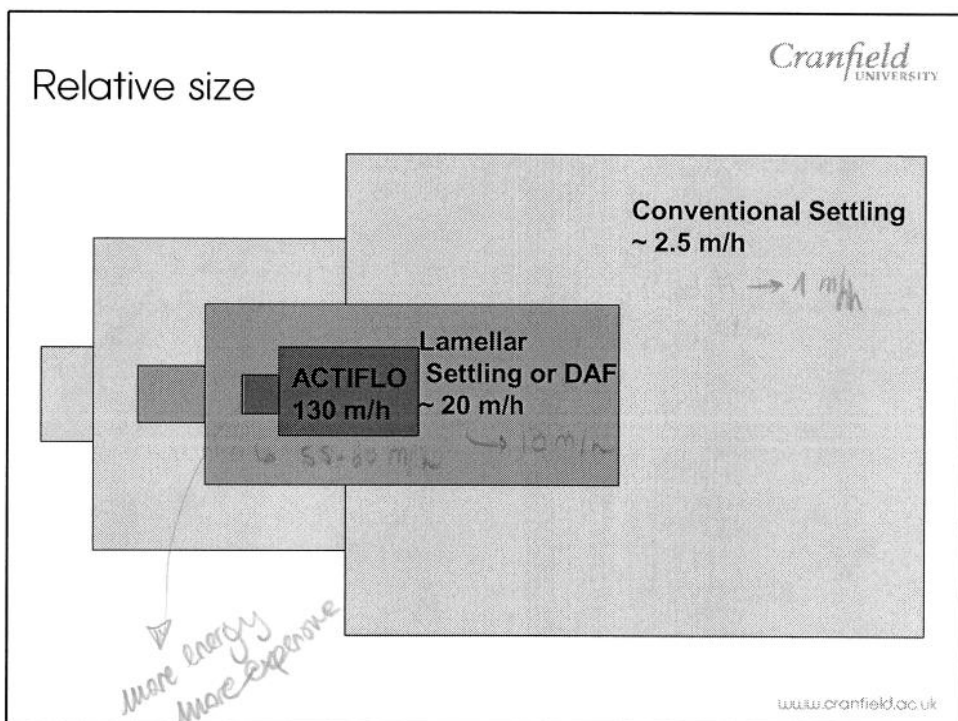
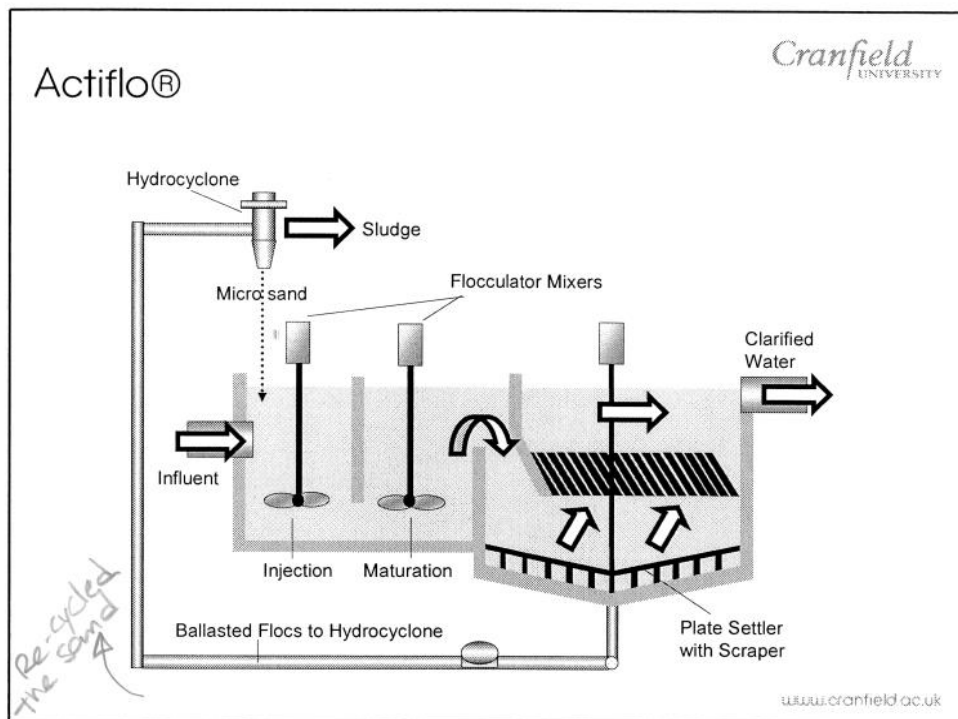


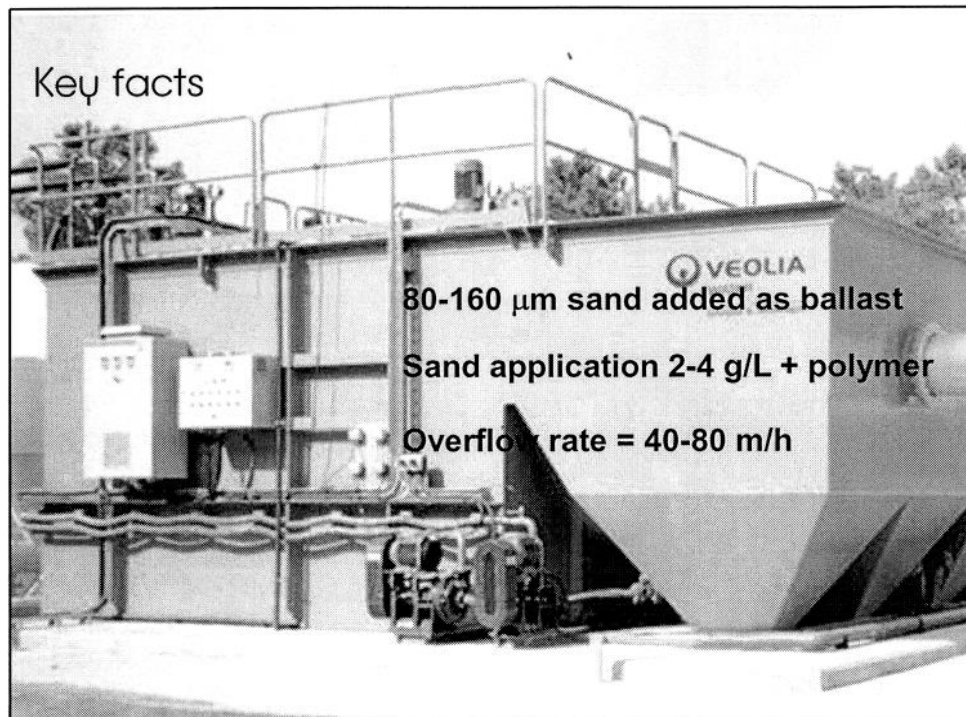


-Act.4b-

N.O.M floc  
with sand particles





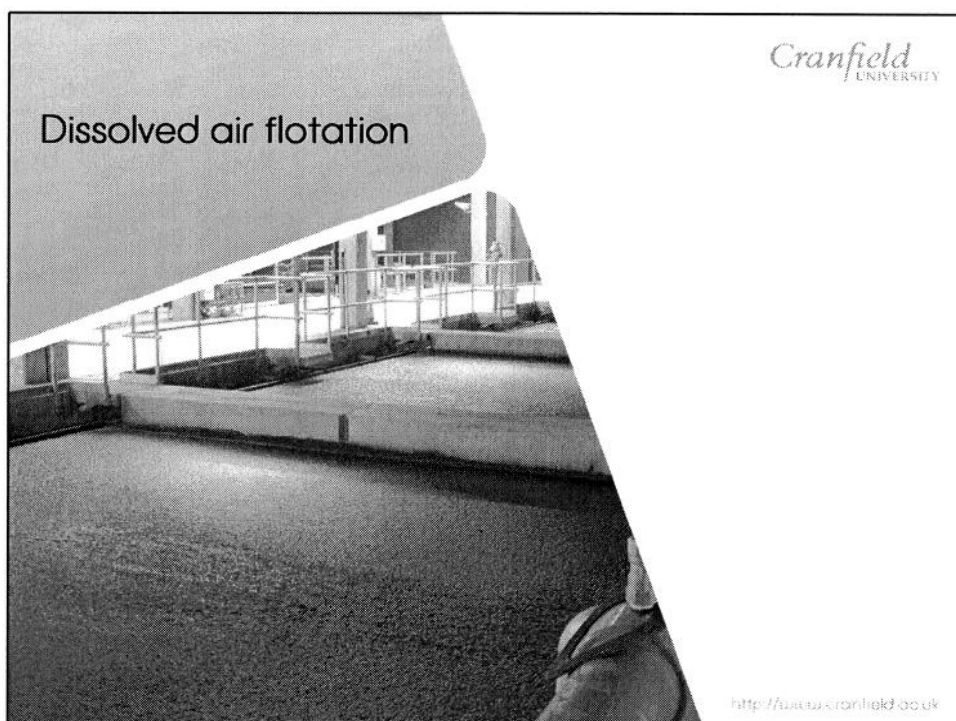


## Technology comparison

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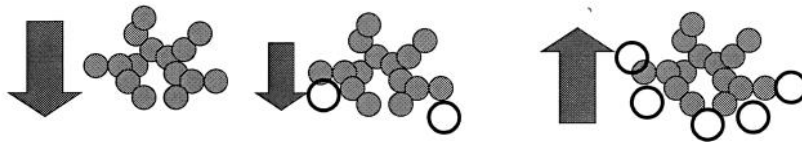
| Clarifier      | Overflow rate<br>(m.h) | Retention<br>time (min) | Turbidity removal<br>efficiency (%) |
|----------------|------------------------|-------------------------|-------------------------------------|
| Rectangular    | 1-2                    | 120-180                 | 90-95                               |
| Circular       | 1-3                    | 60-120                  | 90-95                               |
| Floc blanket   | 1-3                    | 120-180                 | 90-95                               |
| Lamella plates | 5-12                   | 60-120                  | 90-95                               |
| Actiflo®       | <200                   | 5-7                     | 90-99                               |
| Densadeg®      | <120                   | 10-16                   | 90-99                               |
| Sirofloc®      | <30                    | 15                      | 90-99                               |

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# The beauty of bubbles

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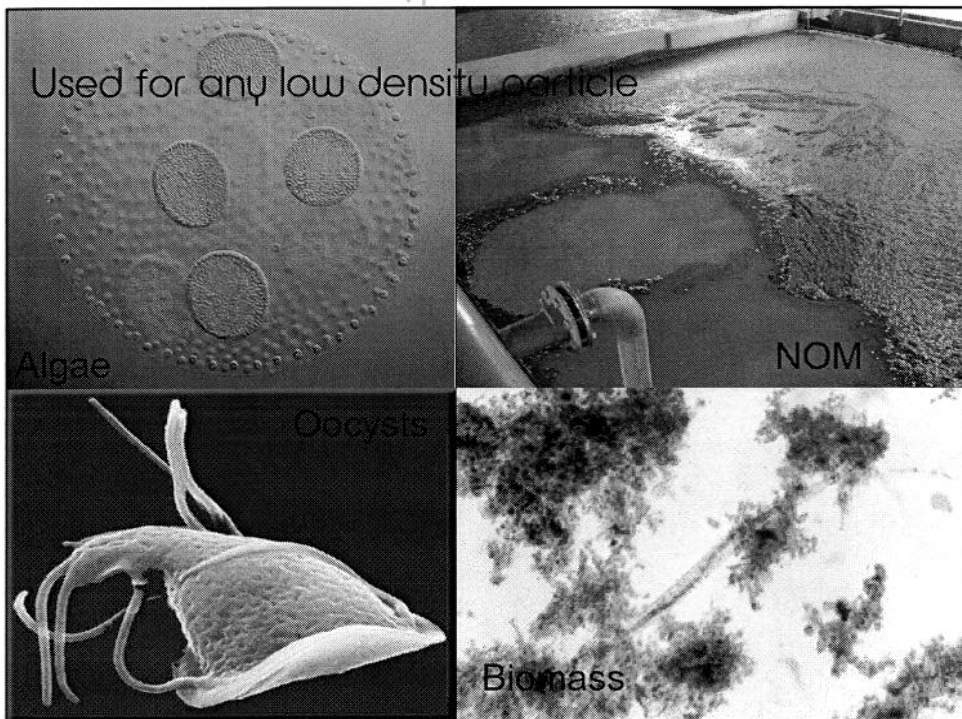


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LOW DENSITY PARTICLES

$\rho_{LOW} \rightarrow \text{float}$   
 $\rho_{HIGH} \rightarrow \text{sink}$

Used for any low density particle



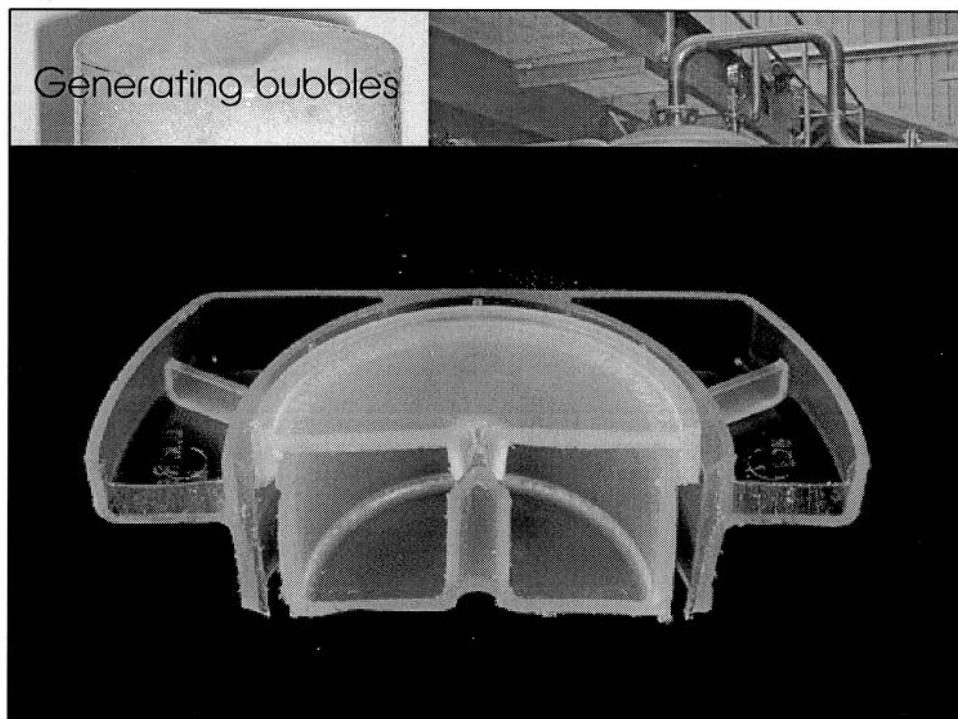
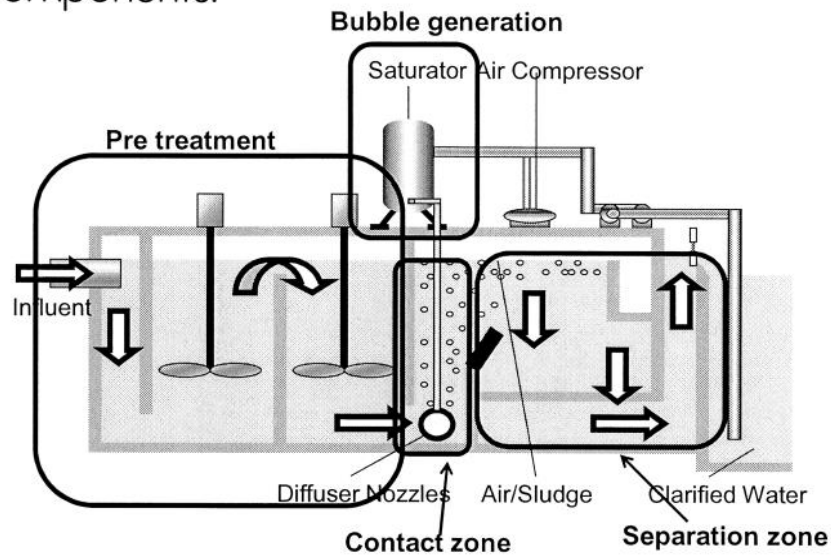
Algae

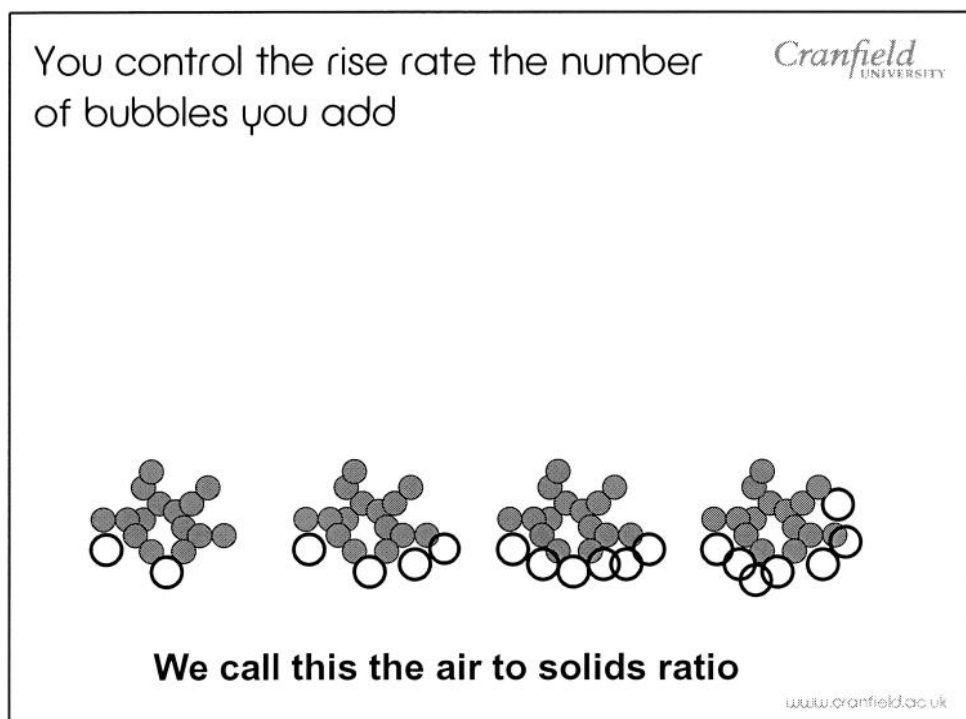
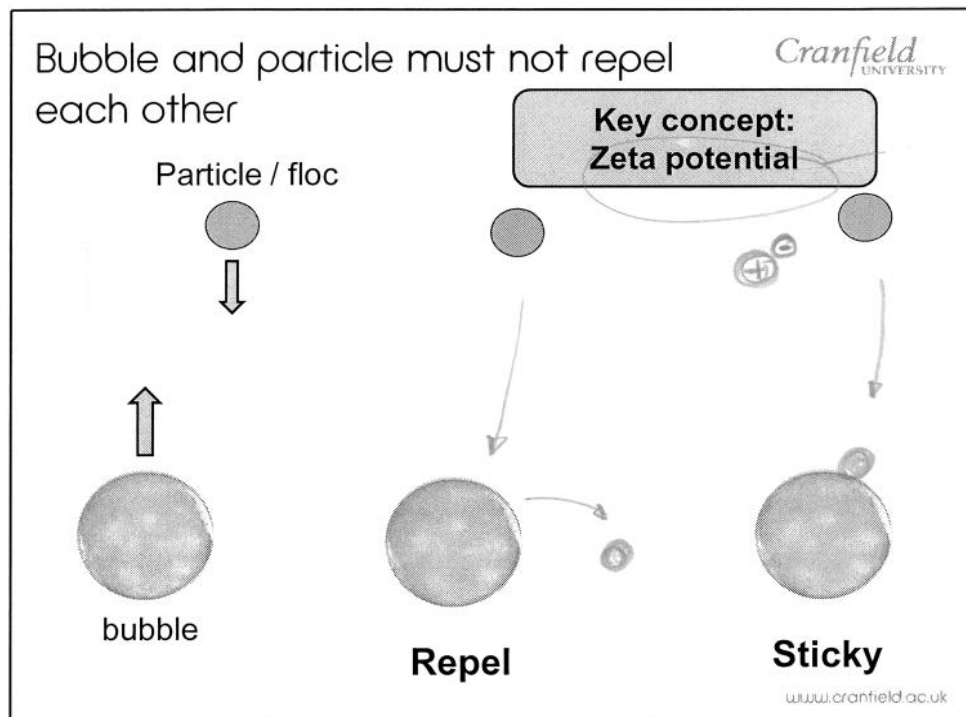
NOM

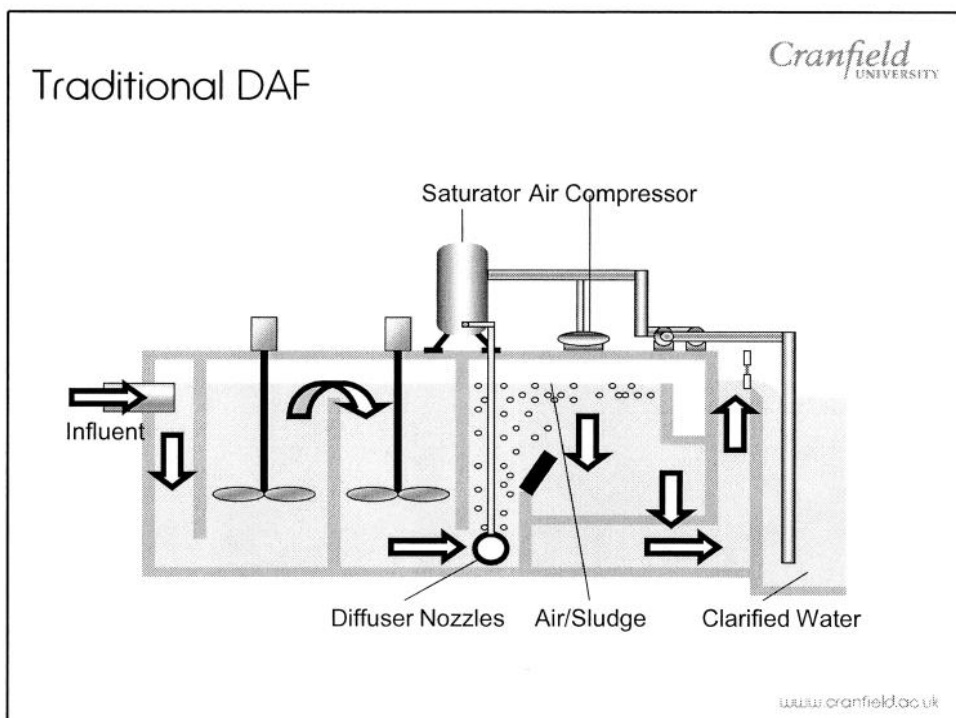
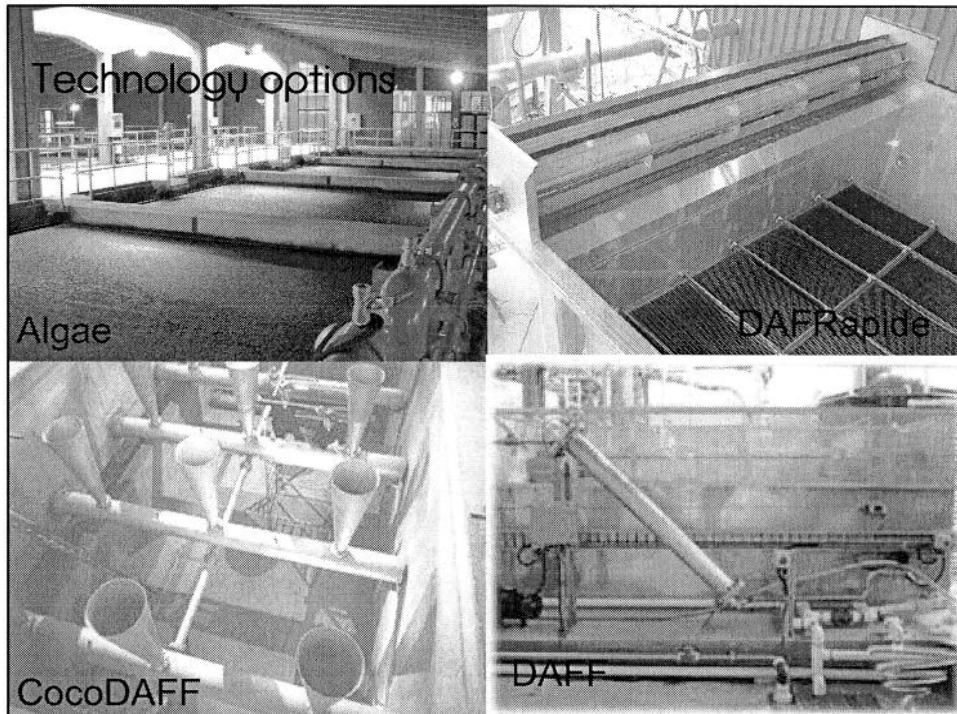
Oocysts

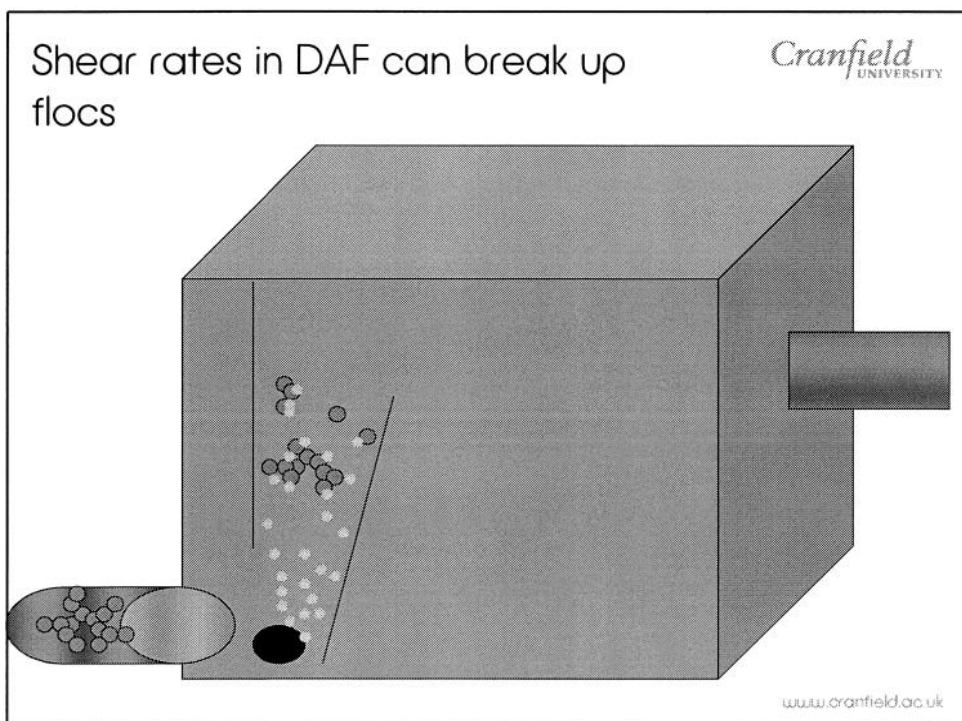
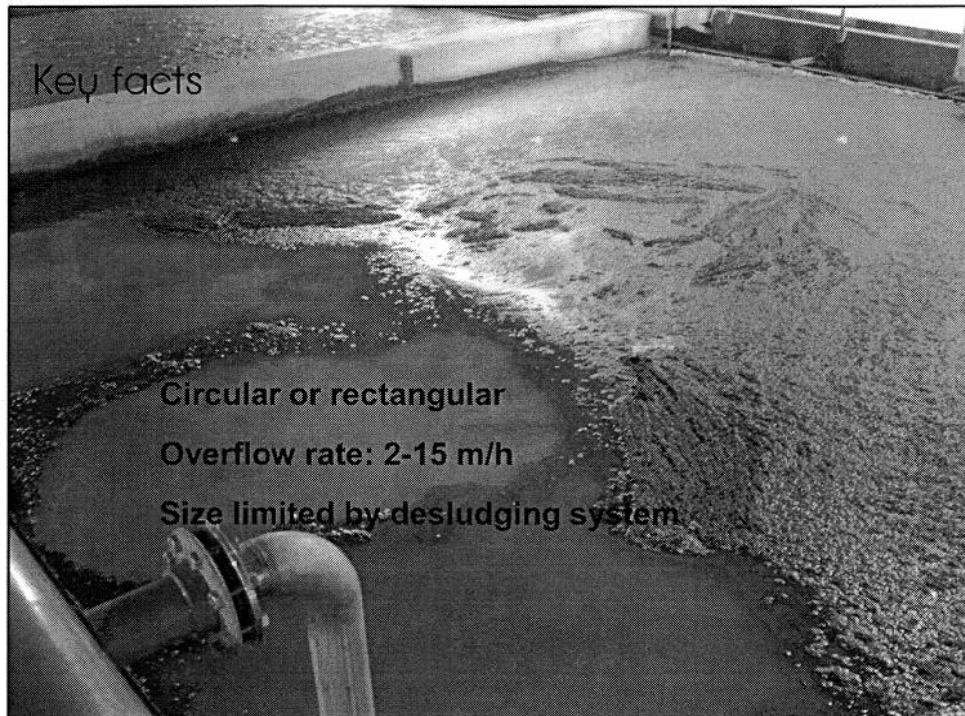
Biomass

The process is made up for 4 components:

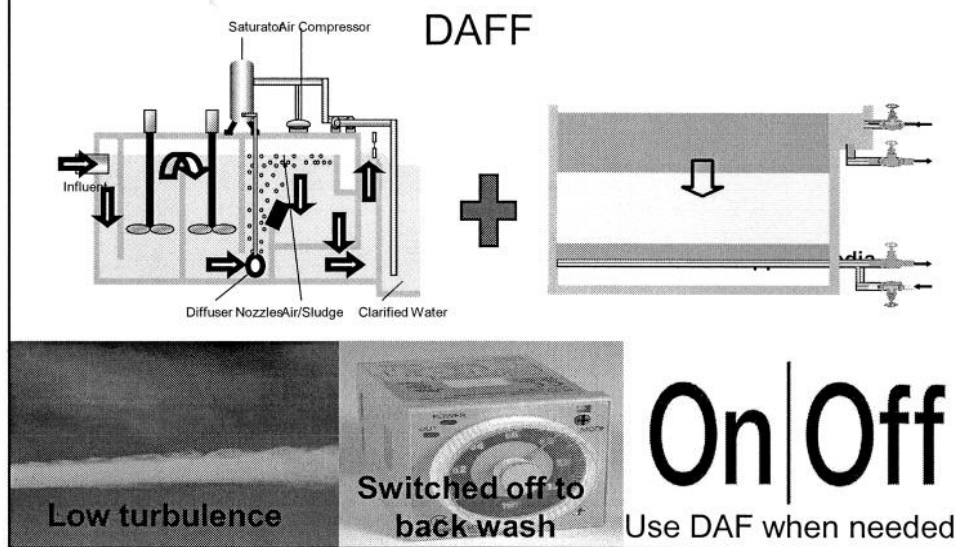




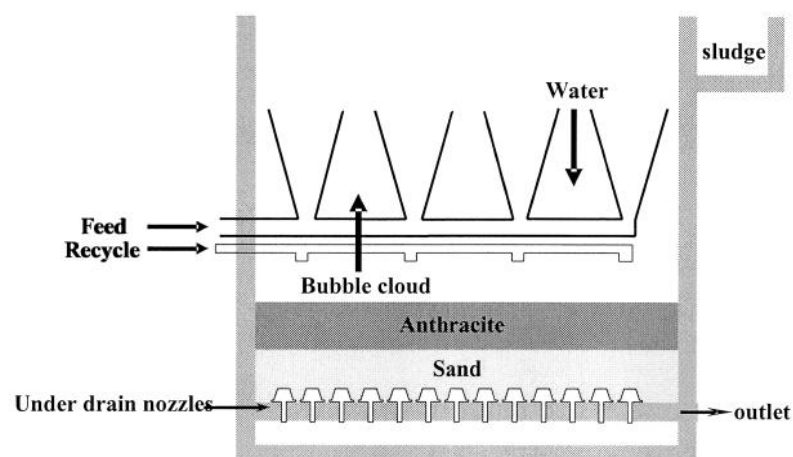


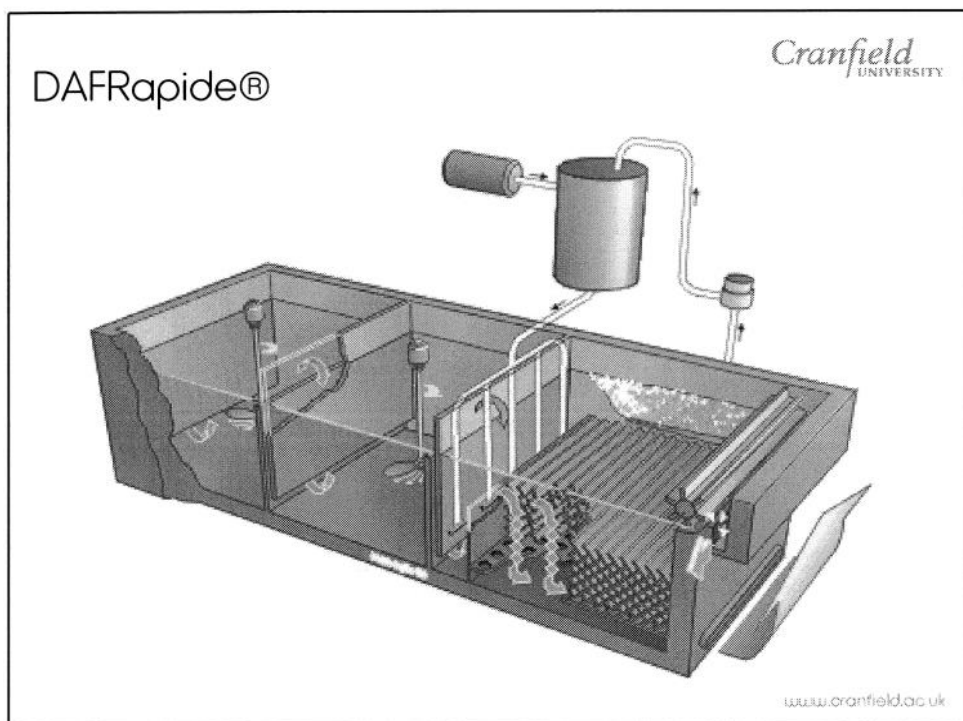
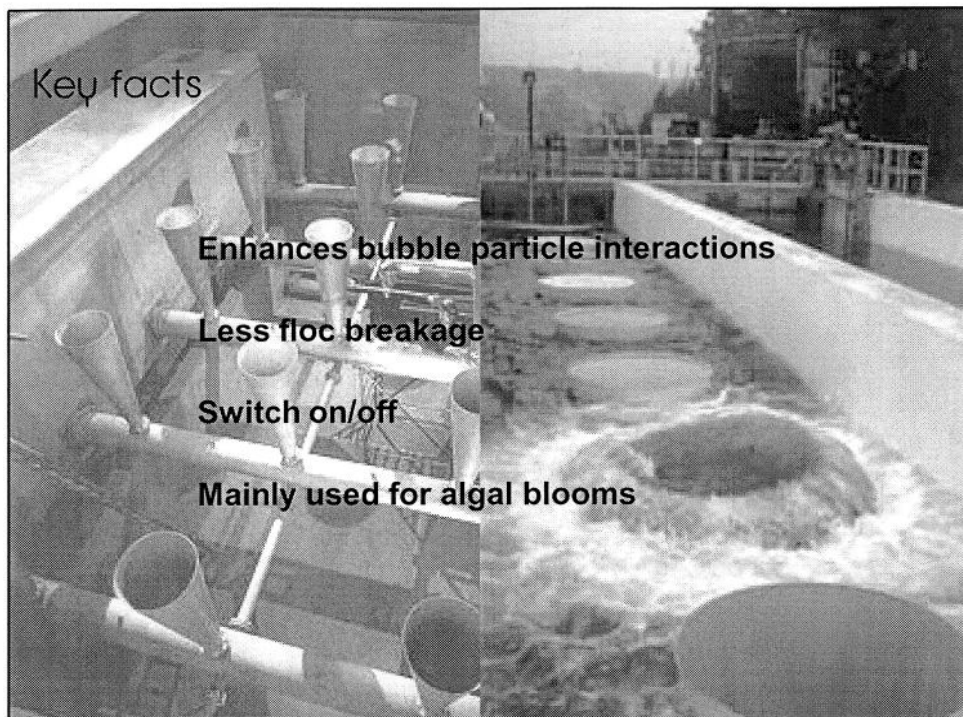


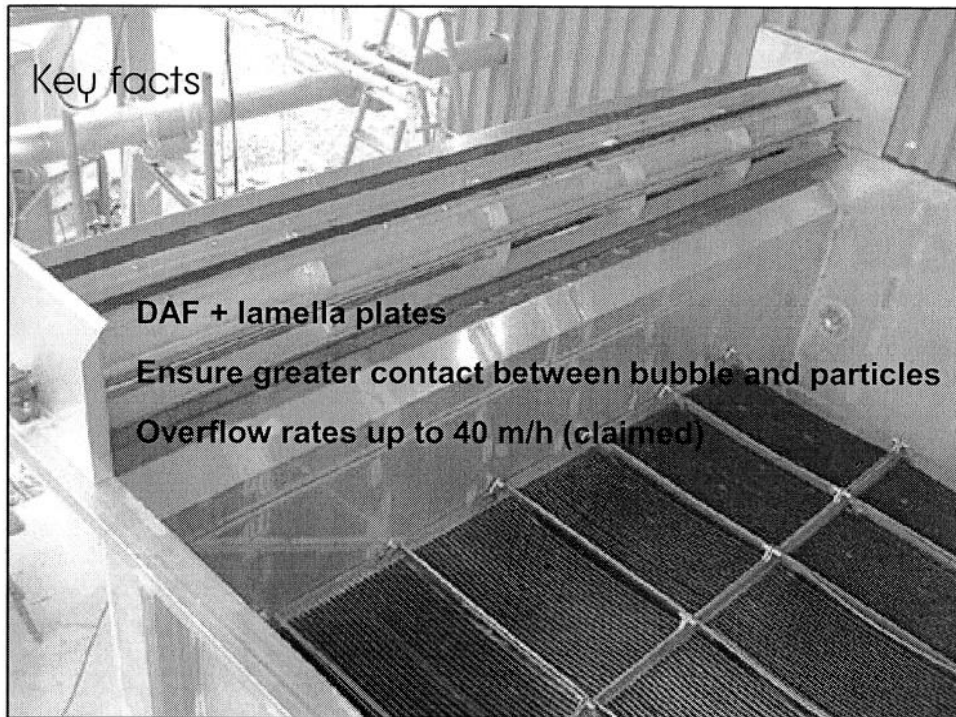
## Combine DAF and Filtration



## CocoDAFF







Application

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| Water   | Type        | Rate<br>m/h | R<br>% | Removal (%) |         |       |
|---------|-------------|-------------|--------|-------------|---------|-------|
|         |             |             |        | Turb        | DOC     | Algae |
| Upland  | Traditional | 8.5         | 7-10   | -           | -       | 98.6  |
| Upland  | Traditional | 16          | -      | 82          | 64      | -     |
| Lowland | Traditional | 6           | 8      | -           | -       | 89.9  |
| Lowland | Traditional | 5.2         | 11     | -           | -       | 54.1  |
| Lowland | CoCoDAFF®   | 9.2         | -      | 96          | 97.5    | 98    |
| Lowland | DAFF        | 8-12        | 5-12   | 96.5        | 98      | →100  |
| River   | DAFRapide®  | 15          | 7      | 90          | 84 (UV) | -     |

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