



Introduction to Water Treatment

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Principal Process Engineer

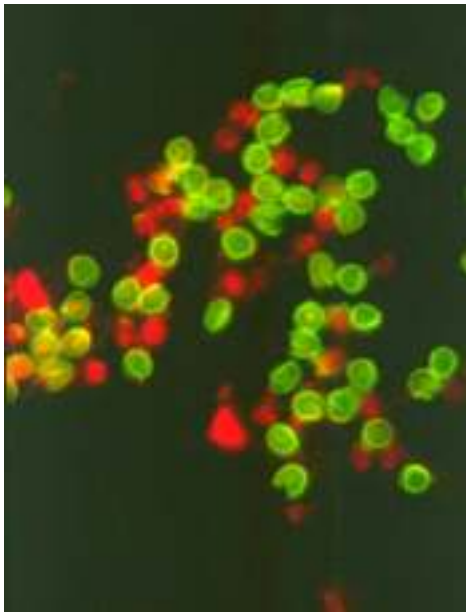
United Utilities



Why do we treat water?

- Protect Public Health
- Provide Safe Drinking Water
- Waterborne disease
 - Cryptosporidium
 - E.Coli
 - Cholera
 - Giardia
 - Polio
 - Typhoid
 - Malaria
 - Botulism
 - Hepatitis
 - Legionellosis

“water utilities should ensure that the design and operation of treatment plants is optimised in a cost effective way for particle removal, taking into account the level of the risk at each plant”



recommendation 22 of second Badenoch Report



Infectious diseases caused by pathogenic bacteria, viruses, and protozoa or parasites are the most common and widespread health risk associated with drinking water.

WHO Guidelines for Drinking Water Quality

Cases of cryptosporidiosis

- 1993 – Milwaukee – 403,000 ill with 10% hospitalised
- 1995 – Torbay, Devon – 575 cases of illness
- 1996 – Cranbrook British Columbia – 2,000 cases of illness
- 1996 – Kelam, British Columbia – 15,000 cases of illness
- 2000 – Clitheroe, Lancashire – 46 cases of illness
- 2001 – North Battlefield, Saskatchewan – 7,100 cases of illness
- 2005 – Anglesey – 200 cases of illness – 61,000 people on a boil water advice
- 2008 – Anglian Water – 250,000 customers on boil water for over 1 month

How do we treat water?

- Holistic approach
- Start at the source
- Protection of catchment
- Prevention of contamination
- Intake protection
- Monitoring

Water Treatment Processes

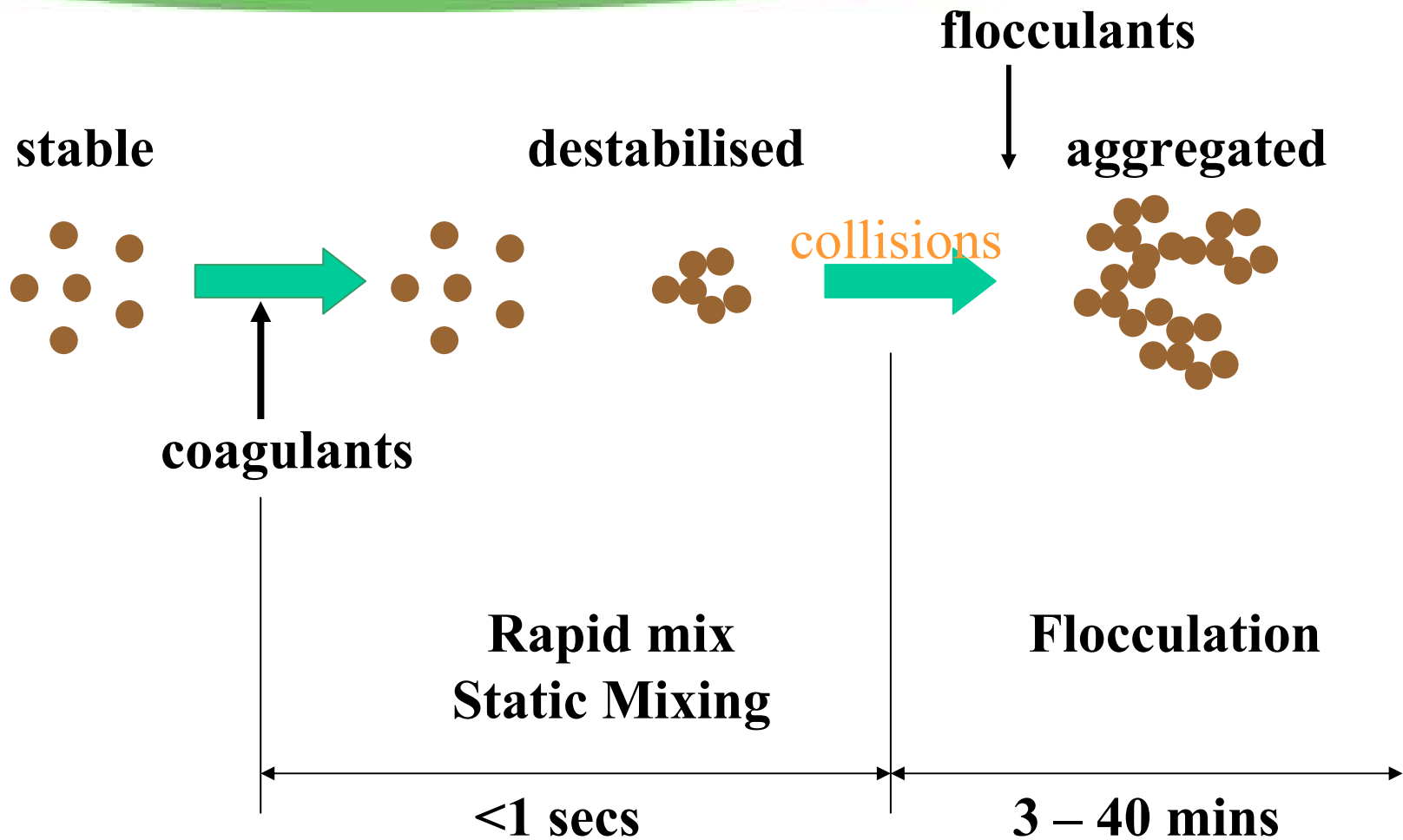
- Inlet works
- Fish screens
- Band screens - mm
- Microstrainers - micron



Coagulation - Definitions

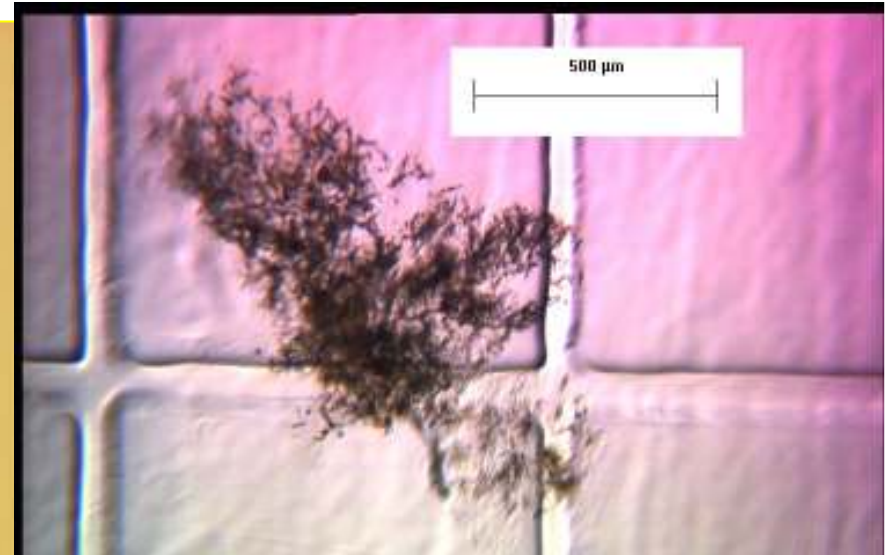
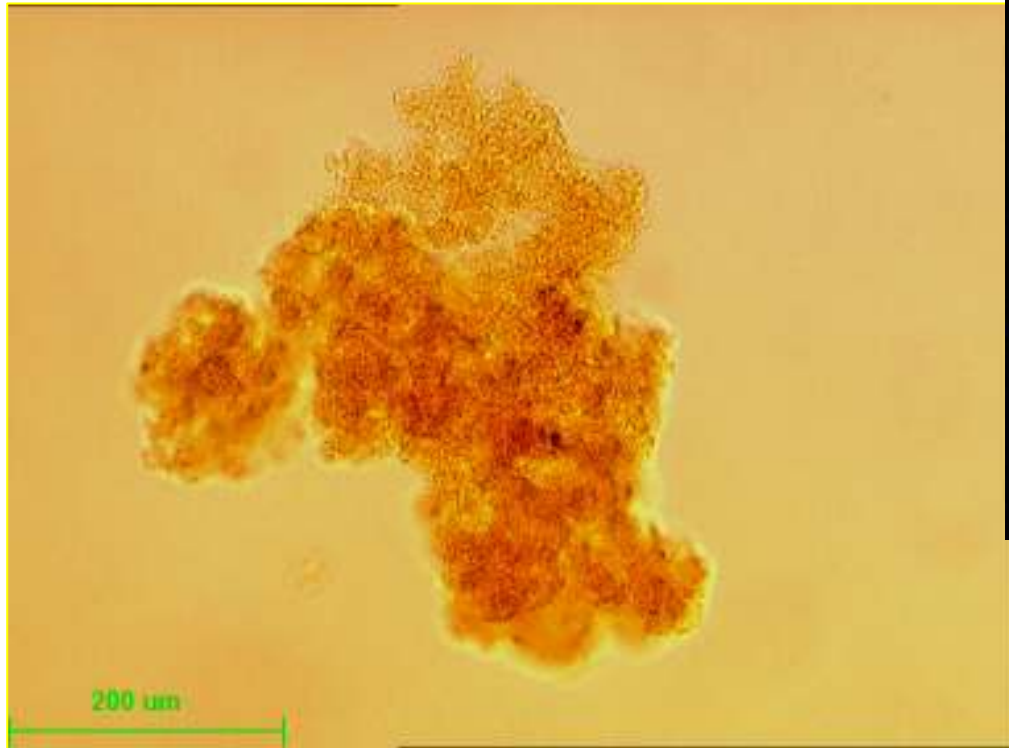
- **Coagulation:** destabilisation of particles / formation of microflocs
- **Coagulants:** chemicals which destabilise particles and colloids
- **Flocculation:** aggregation of destabilisation particles/ microflocs into larger aggregates (Flocs)
- **Flocculants:** Chemicals which assist in the formation of large aggregates.

Definitions





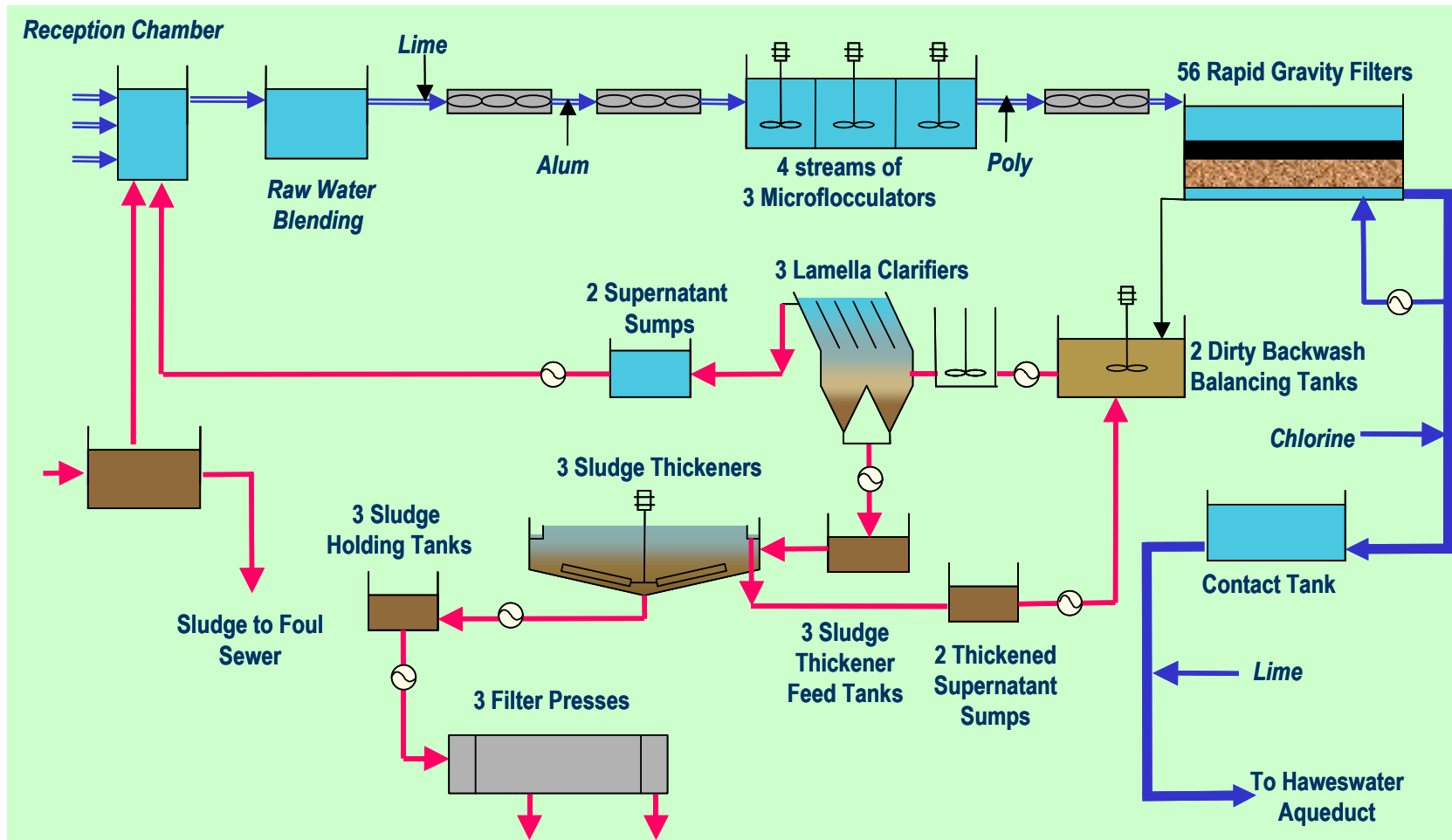
Individual Floccs



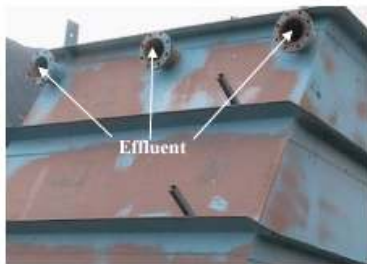
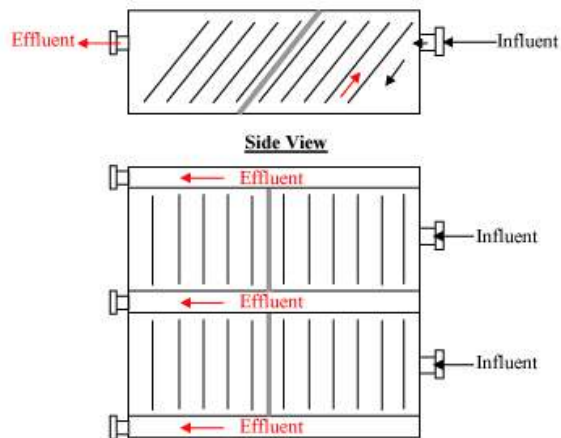
Separation Processes

- Removal of floc material
- Physical processes
 - Clarification – Settlement processes – Settlement Tanks, Lamella's, Actilfo, Dissolved Air Flotation
 - Filtration – Rapid Gravity Sand Filtration, Direct Filtration, Microfiltration (Membranes)

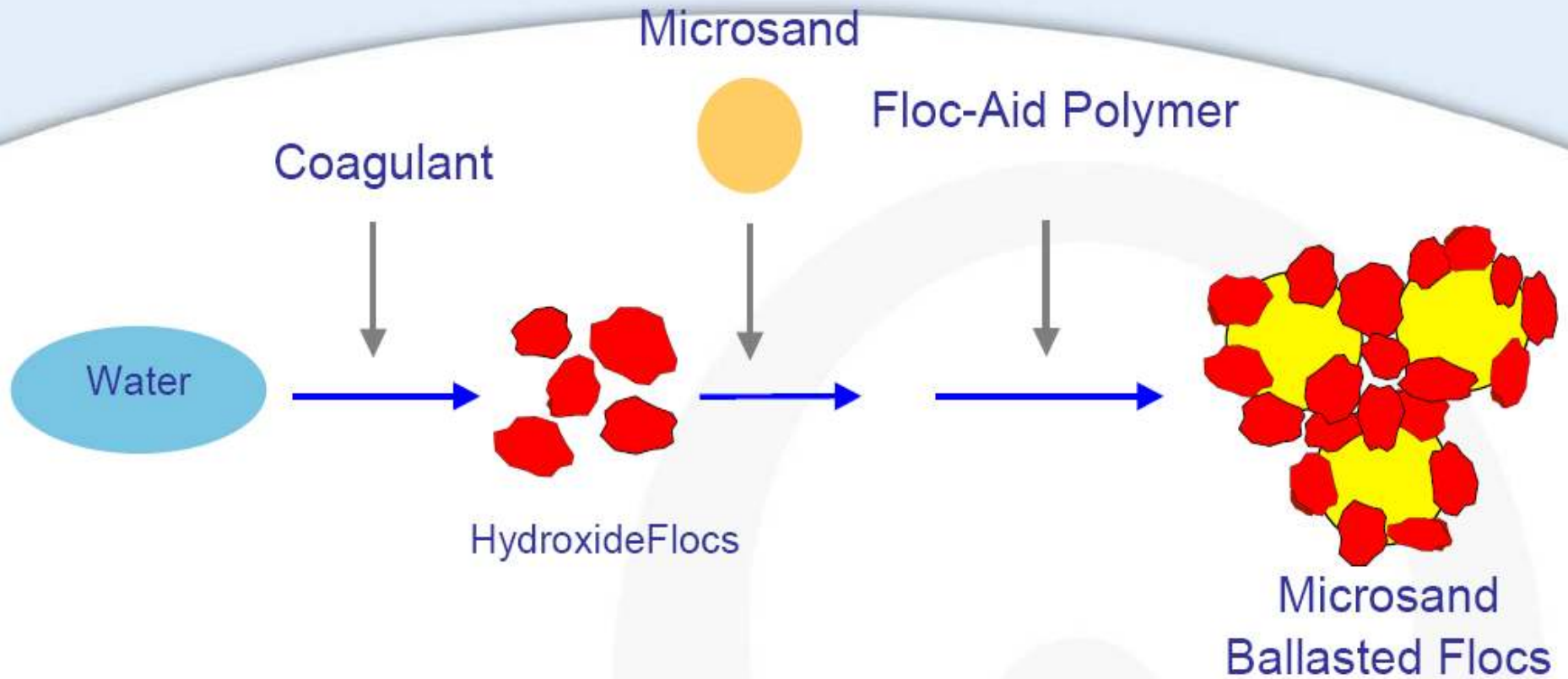
Direct Filtration – Watchgate WTW



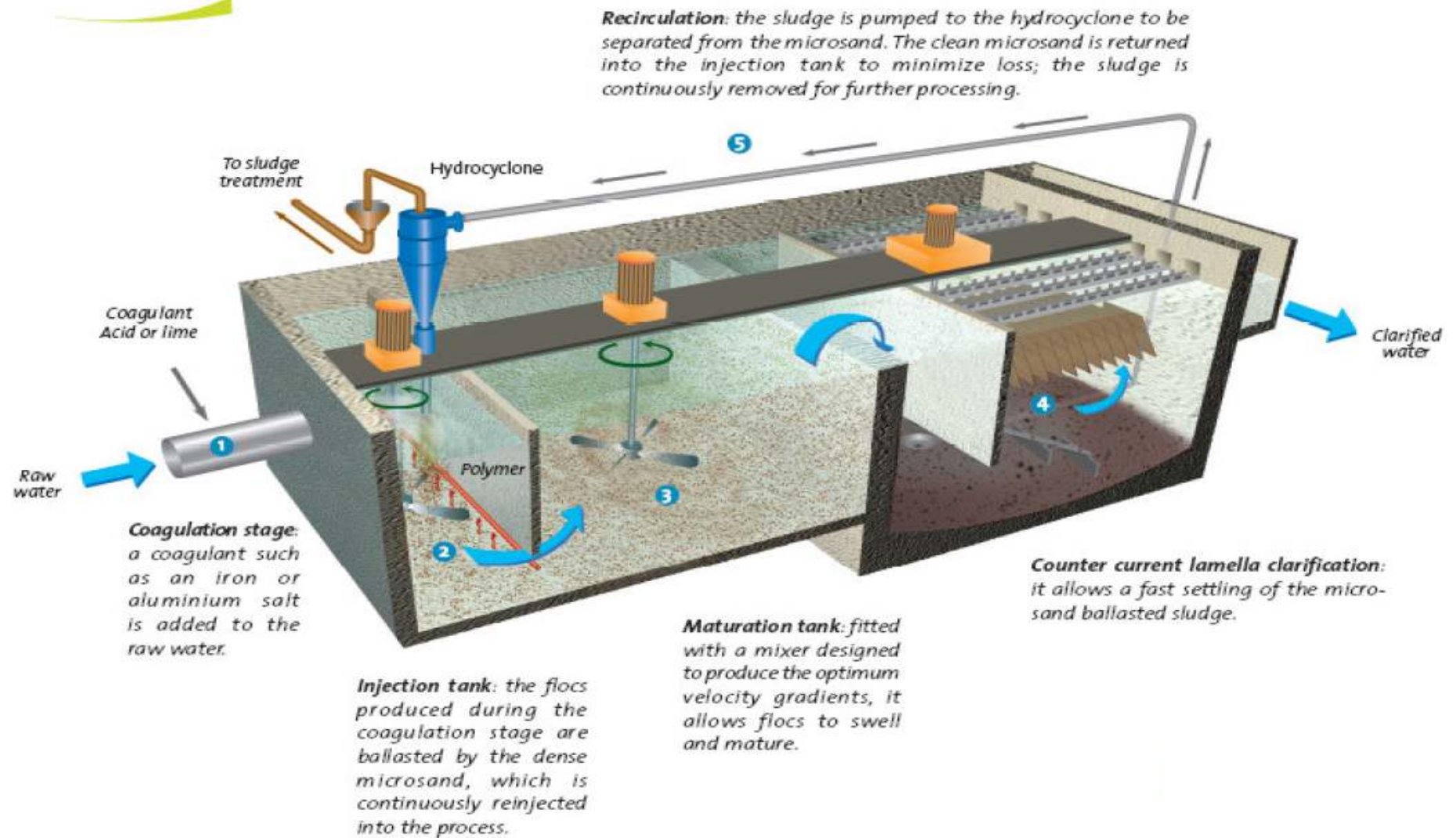
Lamella Clarifier



ACTIFLO® Principle



The Actiflo® process



Raw

Clarified/Filtered

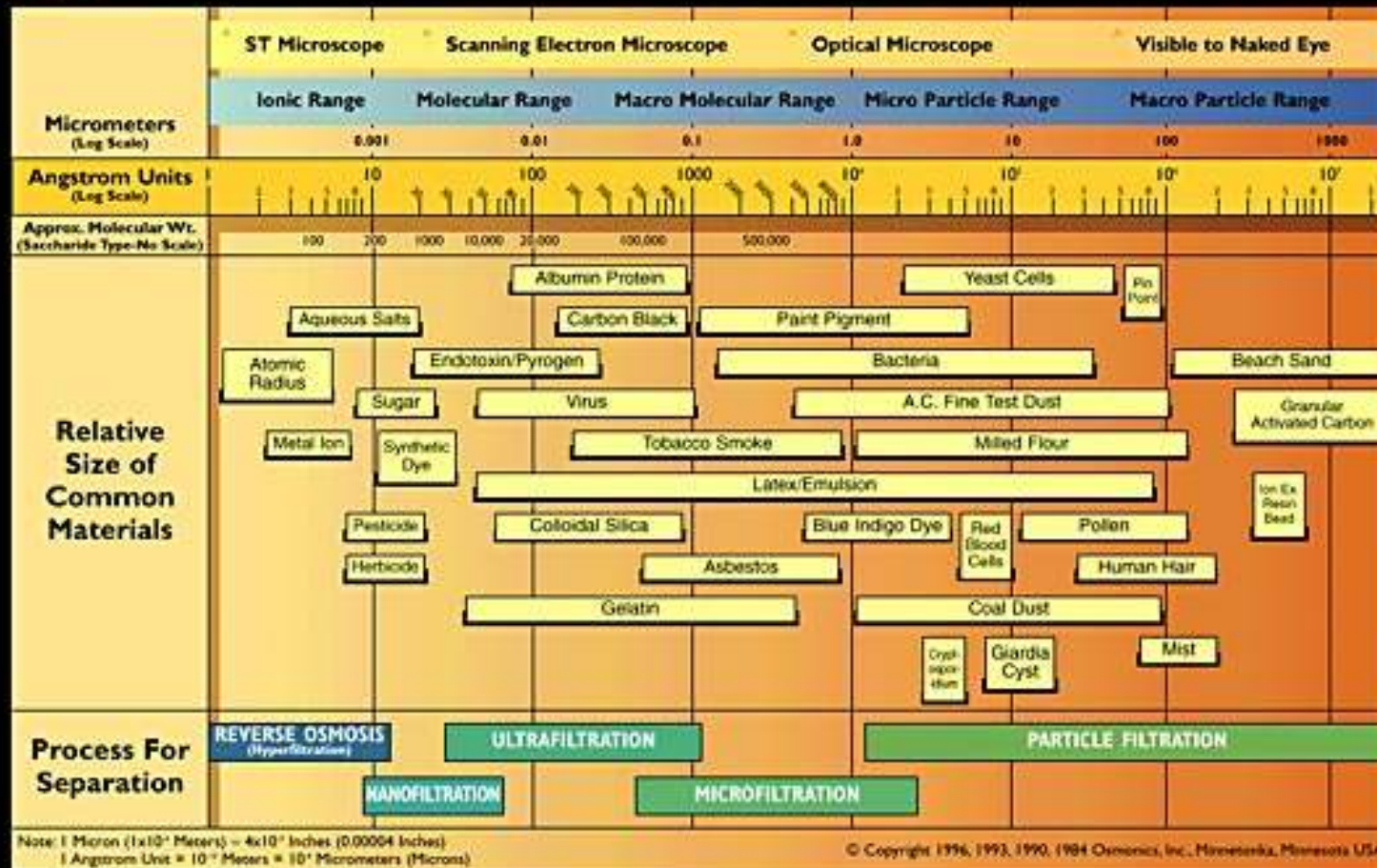


Membranes



OSMONICS

The Filtration Spectrum



Osmonics, Inc.
Corporate Headquarters
5561 Clearwater Drive • Minnetonka, Minnesota 55343-8990 USA
Toll Free: 800/848-1750 Fax: 612/933-0141

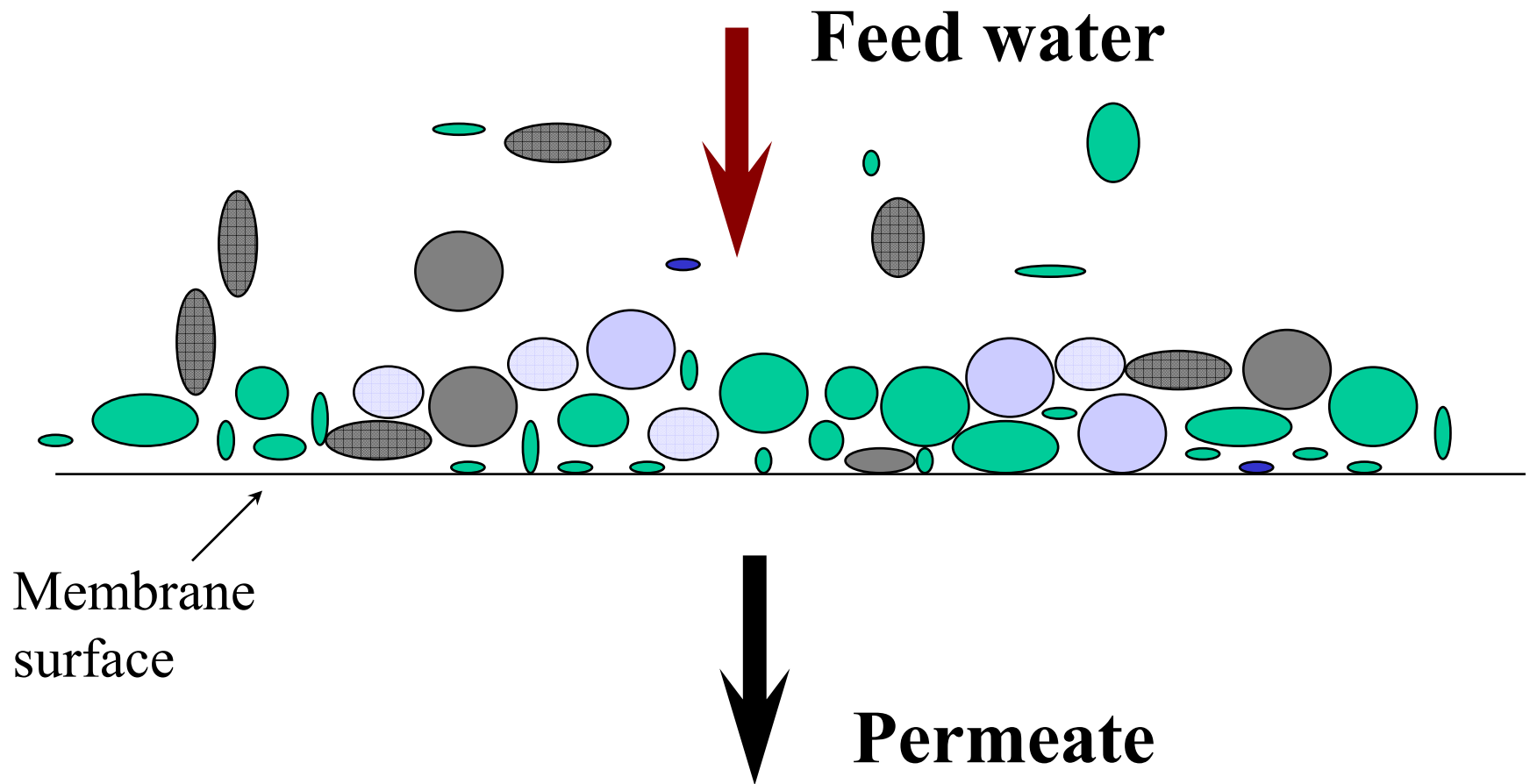
Osmonics Asia/Pacific, Ltd.
Bangkok, Thailand Fax: 011-66-2-39-18183
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Osmonics Europa, S.A.
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Membrane Microfiltrration





Secondary Processes

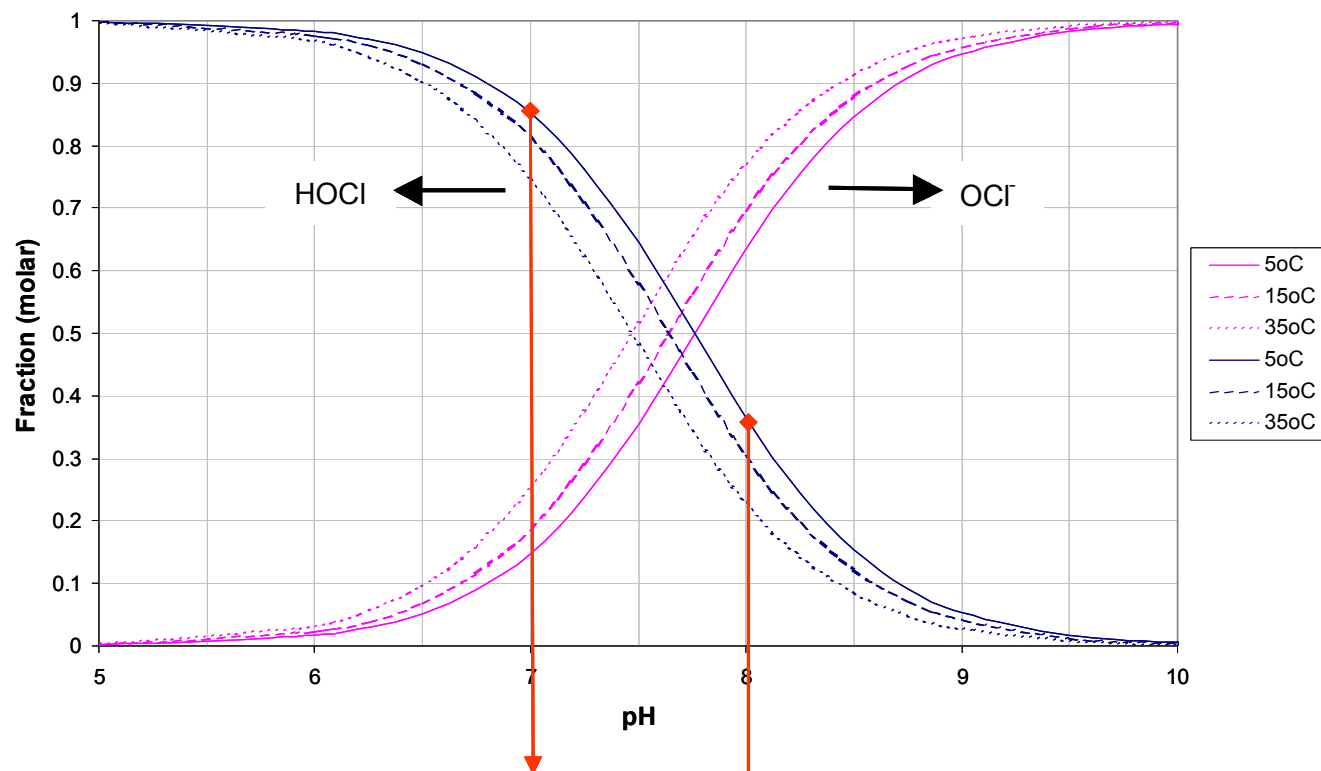
- Removal of inorganic contaminants
 - Manganese
 - Iron
 - Aluminium
 - Arsenic
 - Micropollutants

Disinfection

- Process of removing harmful organisms from water supply
- Starts at the beginning of the process – catchment
- Continues through removal of particles
- Final Disinfection
 - Chlorine
 - UV
 - Ozone
 - Chlorine Dioxide
 - Chloramination



Chlorine



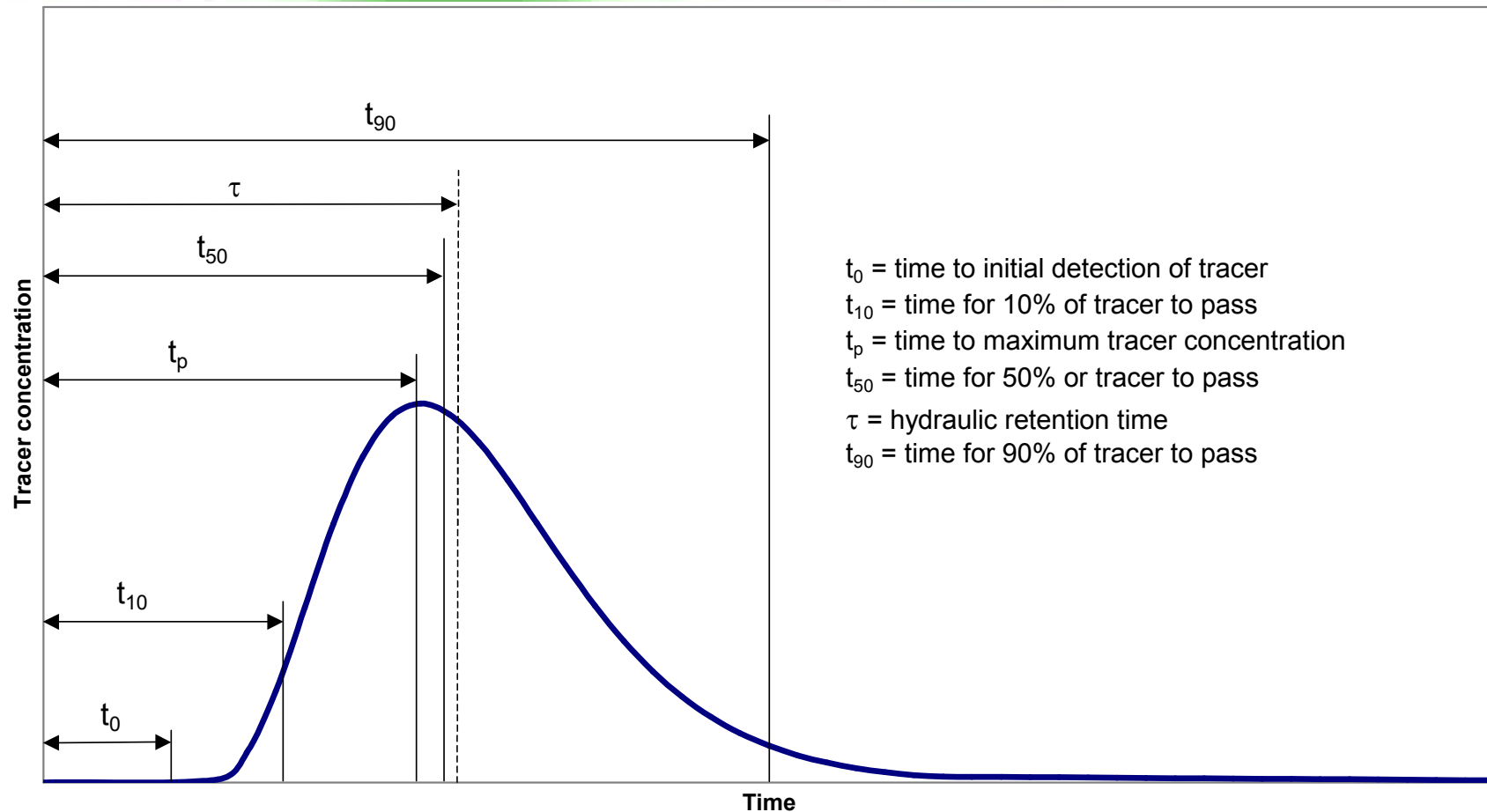
pH 7 85% HOCl

pH 8 35% HOCl

Chlorine Contact Time

- CT Principle
- Concentration (mg/l of Chlorine) * Time (mins)
- WHO guidelines – 30 mg.min/l i.e. 1 mg/l of chlorine for 30 minutes
- UU Standards – Effective CT Principle
- Effective Disinfectant
- Effective time
- 15 mg.min/l surface water
- 5 mg.min/l secure groundwater

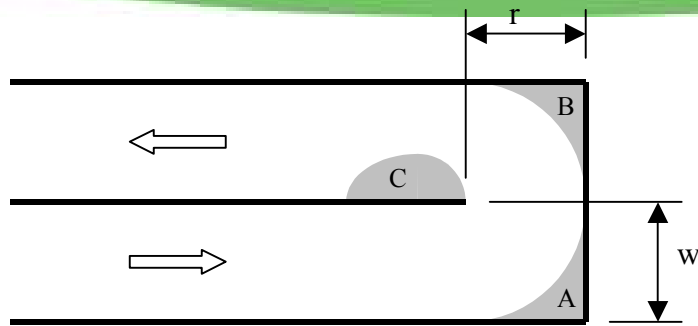
Defining Contact Tank Performance



Tank performance based on t_x

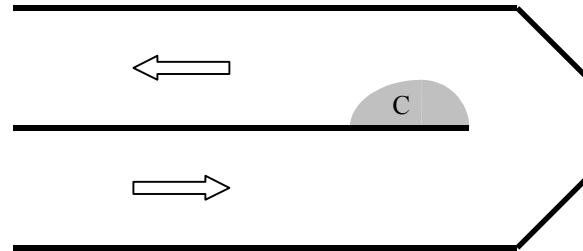
Baffling	t_1/τ	t_5/τ	t_{10}/τ
Poor	0.14	0.27	0.37
Average	0.30	0.44	0.52
Superior	0.55	0.66	0.73

Contact tank chamber profile

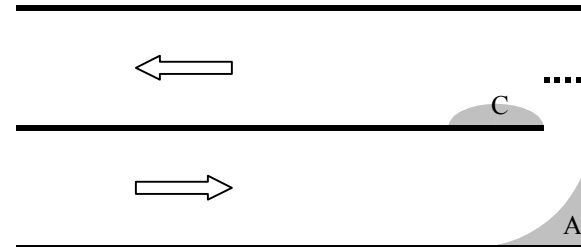


r/w influences extents of dead zones at A, B and C

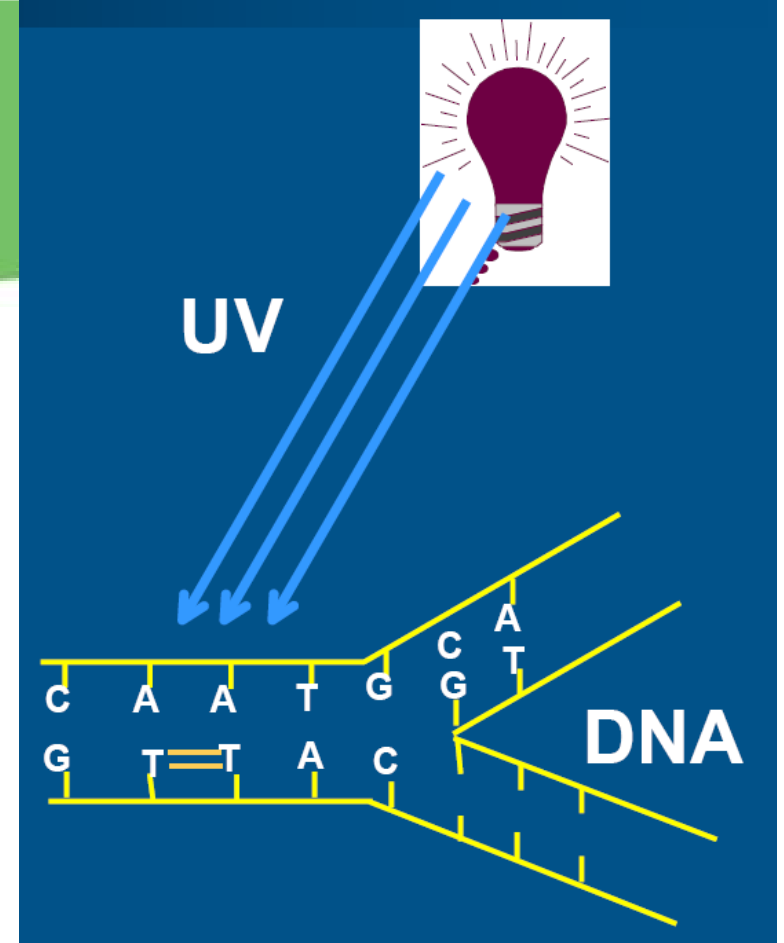
Corner fillets to reduce dead zones



Perforated baffles with low r/w ratio

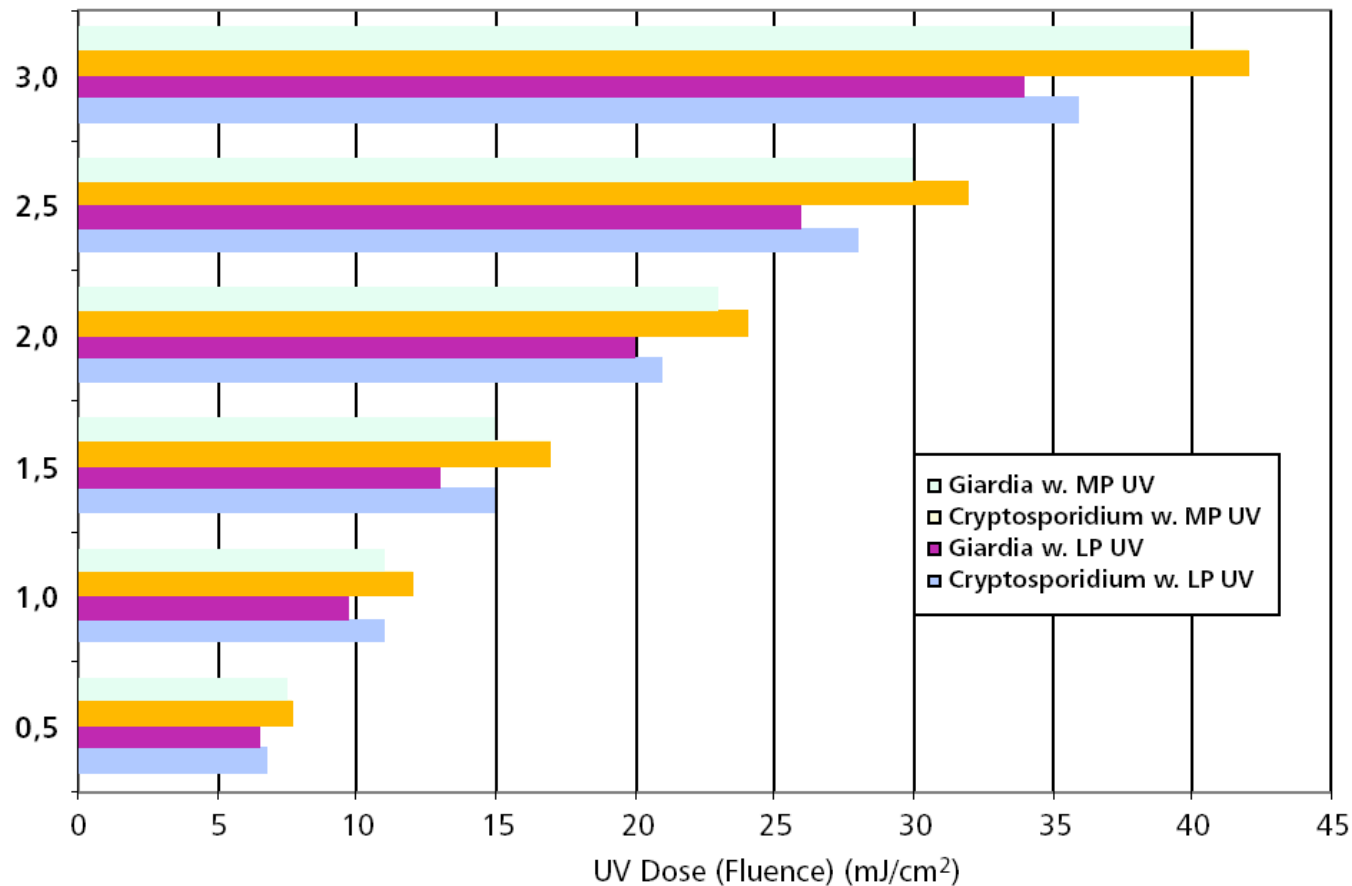


UV Disinfection

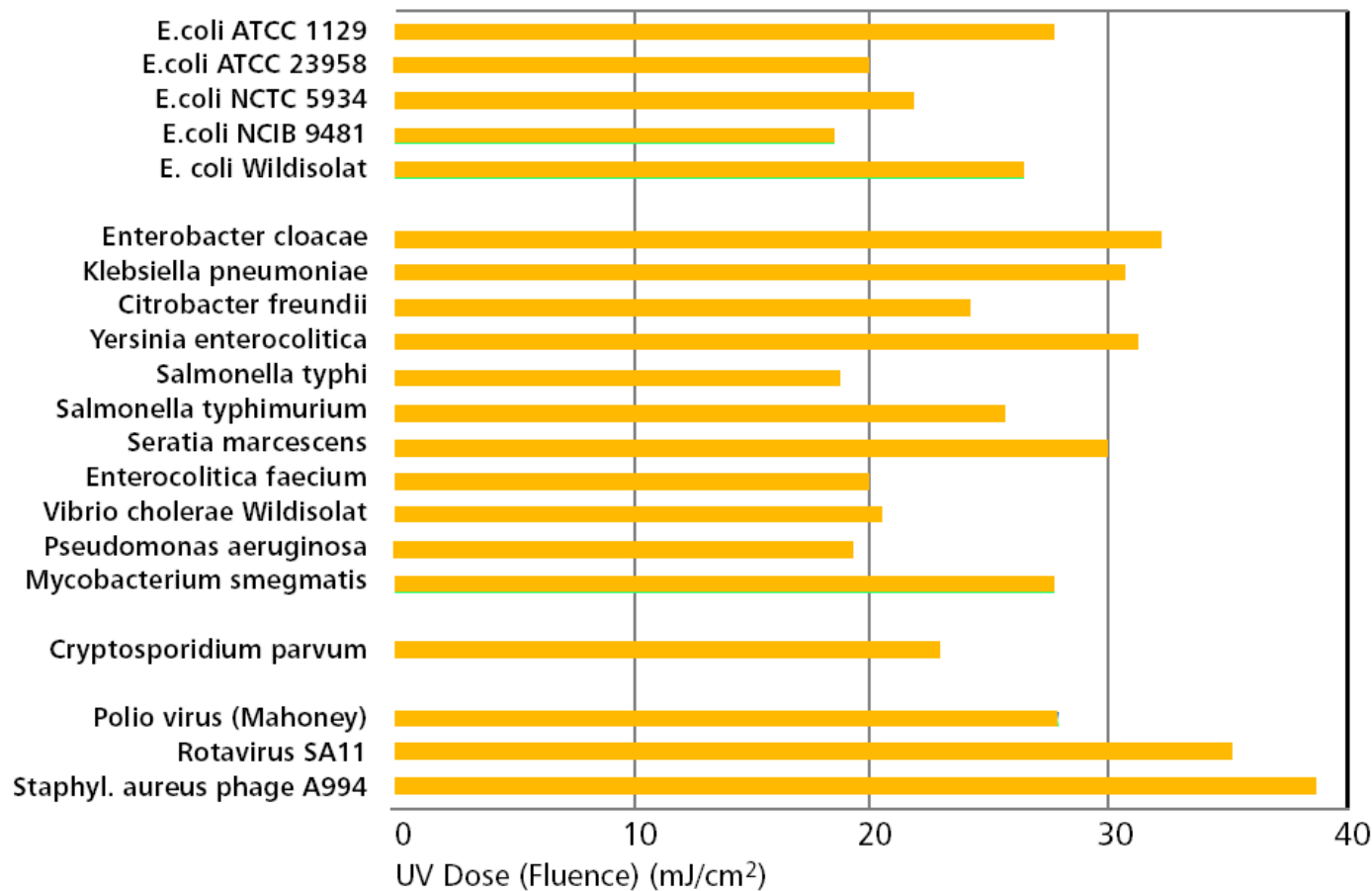


- Physical Process
- Light energy is absorbed by DNA of organisms
- Inhibits replication
- Organism that cannot replicate cannot infect

Cryptosporidium Inactivation



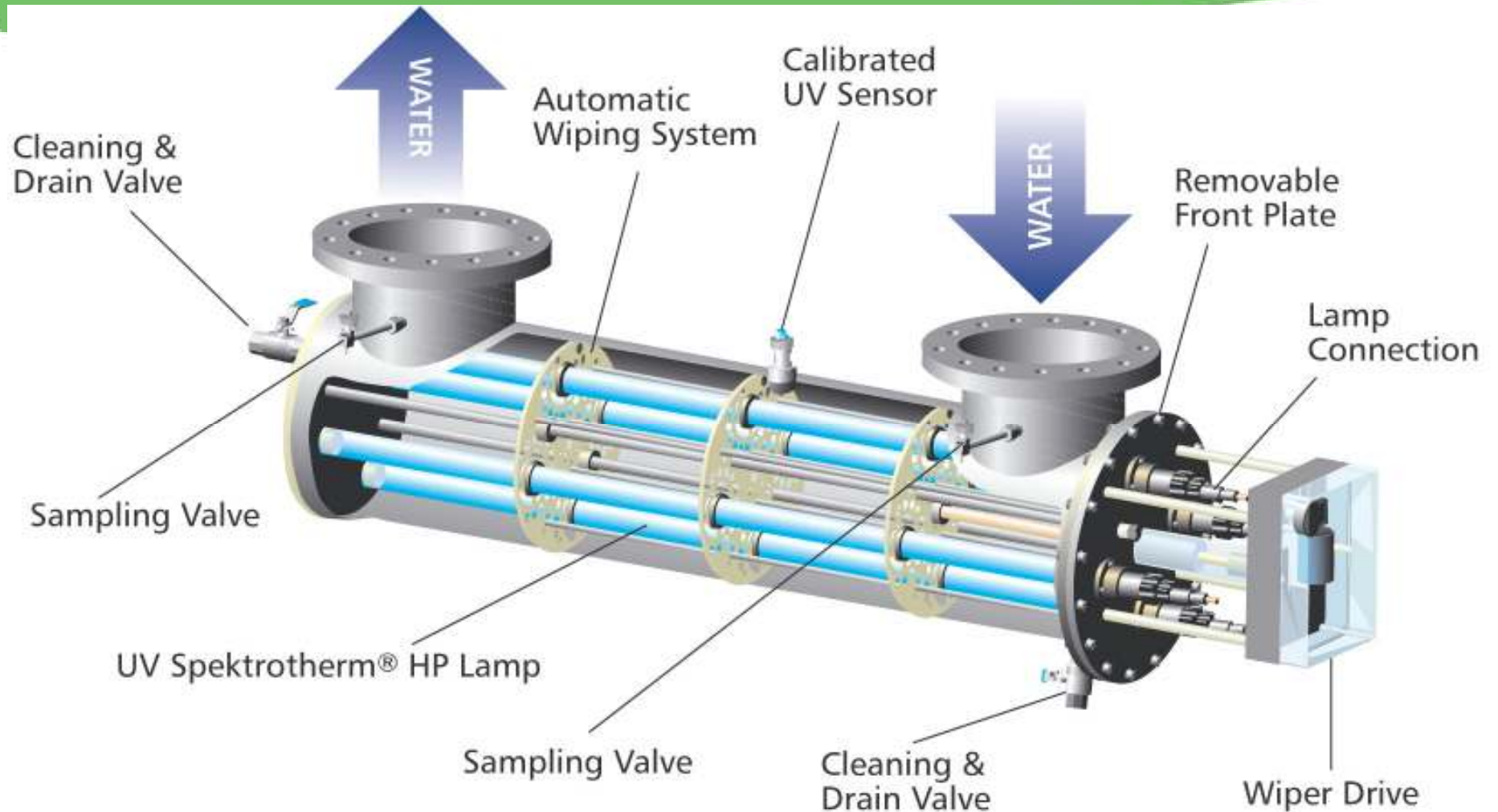
UV Disinfection



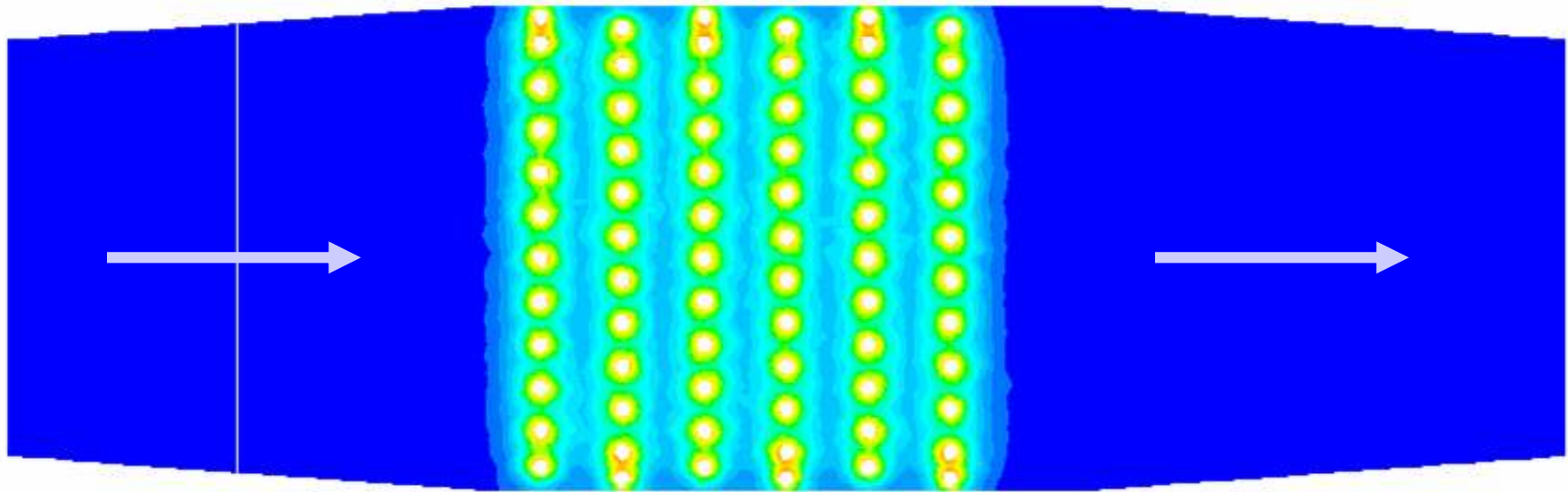
UV dose requirements include effects of photoreactivation

Source: University of Bonn

UV Disinfection



Irradiation Field



UV Plant – Clay Lane



Summary

- Primary objective to protect public health
- Water Treatment starts at source
- Multi-barrier approach
- Source to tap approach