Modeling growth in drinking water

Introduction

A simple monoculture-and-single-substrate approach was used for understanding and modeling planktonic and biofilm growth of bacteria in drinking water treatment and distribution systems. For the monoculture, *Pseudomonas fluorescens* P-17 was chosen, and for the single substrate, acetate was chosen.

Importance

Although there are several multi-species bacterial regrowth models available, of which the two best known are the SANCHO model and the PICCOBIO model, these models are not widely used by the water industry. One of the reasons is that they are proprietary objects, which implies that they are not useful for further improvements by third parties. Secondly, there is urgent necessity for a powerful hydraulic model which can be operated due to diurnal variations in water demand. Thirdly, there is lack of wide verification of models against empirical research data.

Approach

Planktonic growth was followed in batch cultures at different temperatures and different substrate concentrations, using fluorescent staining and flow cytometric enumeration of the grown cells. Biofilm growth was studied in a Propella™ biofilm reactor using fluorescent staining and epi-fluorescence microscopy for enumeration of the grown cells. The data from these two separate sets of experiments were subsequently combined in a model developed by RTU.

Result

A mathematical model written for biofilm reactor Propella™ was verified with coefficients obtained from batch experiments with a monoculture, *P. fluorescens* P17, with acetate as a substrate. One of the main conclusions was that the yield for biofilm growth should probably be lower than that for planktonic growth, and that growth in drinking water is not restricted to biofilm growth alone.

More information

Full details on this deliverable can be found under D5.5.9. Further information can be requested from:

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TECHNEAU Knowledge Integrator (TKI) categorisation

Categorisation of Knowledge Packages

Categorisation (i.e. classification, contains and constraints) of knowledge packages (KPs) can be carried out by 'checking' the appropriate boxes in the attached tables. For example, for a KP investigating point-of-use treatment suitable for a developing world country, the following might be checked:

Classification: Process chain – Tap (Customer) – Point-of-use (POU).
Contains: Report; Literature review.
Constraints: Low cost; Simple technology; No/low skill requirement; No/low energy requirement; No/low chemical requirement; No/low sludge production; Developing world location.

Note that only the lowest level classification needs to be checked, e.g. Point-of-use (POU) in the above example.

Meta data can be included under the 'More Information' section of the Executive Summary Report, i.e. Author(s), Organisation(s), Contact details (name and email), Quality controller (name and organisation) and Date prepared. (The TKI administrator can enter Source (= TECHNEAU), Date submitted (TKI) and Date revised (TKI)).

TKI Categorisation

Classification									
Supply Chain		**Process Chain**		**Process Chain (cont'd)**		**Water Quality**		**Water Quantity (cont'd)**	
Source	X	**Raw water storage**		**Sludge treatment**		**Legislation/regulation**	X	- Leakage	
- Catchment		- Supply reservoir		- Settlement		- Raw water (source)		- Recycle	
- Groundwater	X	- Bankside storage		- Thickening		- Treated water	X		
- Surface water	X	**Pretreatment**		- Dewatering		**Chemical**			
- Spring water		- Screening		- Disposal		- Organic compounds	X		
- Storm water		- Microstraining		**Chemical dosing**		- Inorganic compounds			
- Brackish/seawater		**Primary treatment**		- pH adjustment		- Disinfection by-products			
- Wastewater		- Sedimentation		- Coagulant		- Corrosion			
Raw water storage		- Rapid filtration		- Polyelectrolyte		- Scaling			
- Supply reservoir		- Slow sand filtration		- Disinfectant		- Chlorine decay			
- Bankside storage		- Bank filtration		- Lead/plumbosolvency		**Microbiological**	X		
Water treatment		- Dune infiltration		**Control/instrumentation**		- Viruses		**Consumers / Risk**	
- Pretreatment		**Secondary treatment**		- Flow		- Parasites			
- Primary treatment		- Coagulation/flocculation		- Pressure		- Bacteria	X	**Trust**	
- Secondary treatment		- Sedimentation		- pH		- Fungi		- In water safety/quality	X
- Sludge treatment		- Filtration		- Chlorine		**Aesthetic**		- In security of supply	
Treated water storage		- Dissolved air flotation(DAF)		- Dosing		- Hardness / alkalinity		- In suppliers	
- Service reservoir		- Ion exchange		- Telemetry		- pH		- In regulations and regulators	
Distribution	X	- Membrane treatment		**Analysis**		- Turbidity		**Willingness-to-pay/acceptance**	
- Pumps		- Adsorption		- Chemical		- Colour		- For safety	
- Supply pipe / main	X	- Disinfection		- Microbiological		- Taste		- For improved taste/odour	
Tap (Customer)	X	- Dechlorination		- Physical		- Odour		- For infrastructure	
- Supply (service) pipe		**Treated water storage**						- For security of supply	

- Internal plumbing		- Service reservoir				**Water Quantity**		**Risk Communication**	
- Internal storage		**Distribution**						- Communication strategies	
		- Disinfection				**Source**		- Potential pitfalls	
		- Lead/plumbosolvency				- Source management		- Proven techniques	
		- Manganese control				- Alternative source(s)			
		- Biofilm control	X			**Management**			
		Tap (Customer)				- Water balance			
		- Point-of-entry (POE)				- Demand/supply trend(s)			
		- Point-of-use (POU)				- Demand reduction			

TKI Categorisation (continued)

Contains		**Constraints**		**Meta data**					
Report	X	Low cost		*Author(s)*	Frederik Hammes, Janis Rubulis				
Database		Simple technology		*Organisation(s)*	EAWAG, RTU				
Spreadsheet		No/low skill requirement		*Contact name*	Talis Juhna				
Model	X	No/low energy requirement		*Contact email*	talisj@bf.rtu.lv				
Research	X	No/low chemical requirement		*Quality controller name*	Sergejs Nazarovs				
Literature review		No/low sludge production		*Quality controlerl organisation*	RTU				
Trend analysis	X	Rural location		Source					
Case study / demonstration		Developing world location		*Date prepared*	17/09/07				
Financial / organisational				Date submitted (TKI)	26/09/07				
Methodology				Date revised (TKI)					
Legislation / regulation									

Benchmarking									