Determination of microbial total cell concentrations in drinking water with FCM

Introduction

High concentrations of planktonic bacterial cells (> 1 x 10^4 cells mL^{-1}) of broadly diverse populations are commonly found in both bottled mineral water and tap water The conventional approach to characterize the general microbial quality of drinking water is the use of heterotrophic plate counts (HPC), which enumerate the bacterial cells which can grow up to form visible colonies on specific semi-solid media at selected incubation temperatures within a selected time period. On average, about 1 % of the total bacteria in drinking water are culturable with standard HPC methods.

Importance

The value of accurate total cell counting is evident, e.g. when treatment plant operators aim to monitor the affectivity of specific processes such as membrane filtration or ozonation, or when regrowth during treatment (e.g. GAC filtration) is studied.

Approach

We have developed a protocol based on fluorescent staining of microbial nucleic acids with SYBR Green I, coupled with flow cytometric absolute cell counting, as a fast and accurate method to determine the total cell number in drinking water.

Result

The FCM method was shown to be fast, with 10 minutes required for the fluorescent staining step and 3 minutes for the analysis. The calibrated flow cytometer has an instrument error of 2%, which, combined with operator error gave an overall error of less than 5%. It is possible to detect cell concentrations as low as 200 cells/mL, but all evidence up to now suggests that this is well below the typical range of drinking water (c.a. 1 x 10^5 cells/mL).

More information

Full details on this deliverable can be found under D3.3.5. 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		**Raw water storage**		**Sludge treatment**		**Legislation/regulation**		- Leakage	
- Catchment	x	- Supply reservoir	x	- Settlement		- Raw water (source)		- Recycle	
- Groundwater	x	- Bankside storage	x	- Thickening		- Treated water	x		
- Surface water	x	**Pretreatment**		- Dewatering		**Chemical**			
- Spring water	x	- Screening		- Disposal		- Organic compounds			
- Storm water	x	- Microstraining		**Chemical dosing**		- Inorganic compounds			
- Brackish/seawater	x	**Primary treatment**		- pH adjustment		- Disinfection by-products			
- Wastewater	x	- Sedimentation		- Coagulant		- Corrosion			
Raw water storage		- Rapid filtration	x	- Polyelectrolyte		- Scaling			
- Supply reservoir	x	- Slow sand filtration	x	- Disinfectant		- Chlorine decay			
- Bankside storage	x	- Bank filtration	x	- Lead/plumbosolvency		**Microbiological**			
Water treatment		- Dune infiltration	x	**Control/instrumentation**		- Viruses		**Consumers / Risk**	
- Pretreatment	x	**Secondary treatment**		- Flow		- Parasites			
- Primary treatment	x	- Coagulation/flocculation		- Pressure		- Bacteria	x	**Trust**	
- Secondary treatment	x	- Sedimentation		- pH		- Fungi		- In water safety/quality	x
- Sludge treatment		- Filtration	x	- Chlorine		**Aesthetic**		- In security of supply	x
Treated water storage		- Dissolved air flotation(DAF)		- Dosing		- Hardness / alkalinity		- In suppliers	x
- Service reservoir		- Ion exchange		- Telemetry		- pH		- In regulations and regulators	
Distribution		- Membrane treatment	x	**Analysis**		- Turbidity		**Willingness-to-pay/acceptance**	
- Pumps		- Adsorption		- Chemical		- Colour		- For safety	
- Supply pipe / main		- Disinfection	x	- Microbiological	x	- Taste		- For improved taste/odour	
Tap (Customer)		- Dechlorination	x	- Physical		- Odour		- For infrastructure	
- Supply (service) pipe	x	**Treated water storage**						- For security of supply	

- Internal plumbing		- Service reservoir				**Water Quantity**		**Risk Communication**	
- Internal storage		**Distribution**						- Communication strategies	
		- Disinfection	x			**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)	x			- Demand/supply trend(s)			
		- Point-of-use (POU)	x			- Demand reduction			

TKI Categorisation (continued)

Contains		**Constraints**		**Meta data**					
Report	x	Low cost		*Author(s)*		Frederik Hammes			
Database		Simple technology		*Organisation(s)*		EAWAG			
Spreadsheet		No/low skill requirement		*Contact name*		Frederik Hammes			
Model		No/low energy requirement		*Contact email*		Frederik.hammes@eawag.ch			
Research	x	No/low chemical requirement		*Quality controller name*					
Literature review		No/low sludge production		*Quality controlerl organisation*					
Trend analysis		Rural location		Source					
Case study / demonstration		Developing world location		*Date prepared*		26-06-2007			
Financial / organisational				Date submitted (TKI)		28-06-2007			
Methodology	x			Date revised (TKI)					
Legislation / regulation									
Benchmarking									