A method for the concentration of large volumes of water

The research of large volumes of water is necessary for a reliable assessment of the elimination of micro-organisms during purification, and for an estimate of the infection risk by such organisms in drinking water. The currently available methods all have their downsides (see below). Simmons [2001] describes a cross flow ultrafilter (Hemoflow-filter) that is used for renal dialysis, but can also be used for the concentration of micro-organisms in water. An important advantage of this filter is, that it concentrates parasitic protozoa, bacteria, spores and viruses/phages. This report describes the validation of concentration of micro-organisms with the Hemoflow-filter in several types of water samples.

Importance

Since the amount of pathogenic micro-organisms in surface water is low, particularly after one or more purification processes, concentration methods are necessary to detect and quantify these organisms.
For this purpose, in 1996 the MF-sampler was designed, an adequate method for the concentration of indicator bacteria for fecal contamination.
For the sampling of *Cryptosporidium* and *Giardia*, a method is available using an Envirochek filter. Among the disadvantages of this method are the usually low output and the variable results. For these reasons, quantification is a problem and the assessment of viability as well as genotyping of the isolated organisms is not very useful.
In addition, the demand is rising for the detection of F-specific RNA-bacteriophages and somatic coliphages in large volumes. These organisms can not be concentrated with the two methods mentioned. Research of phages is conducted in order to gain insight into the elimination of viruses. With the available method of analysis, the volume to be examined for phage research can not be larger than 10 ml.

Approach

We studied the attainable recovery rate at filtration of different volumes and the question whether the recovery rate is the same for different micro-organisms. Also, we examined the reproducibility of the findings.
In addition, we investigated to what extent the Hemoflow-concentrate can be concentrated further to as little as some millilitres. Two techniques were used for this purpose: centrifugation and Centricon®-concentration.
The study was divided into phases, and the first phase was designed for the assessment of the recovery rate of bacteriophages at concentrating 2000 litters to 500 ml.
In the second phase, the recovery rates of several other micro-organisms were measured at concentrating 2000 litters to 500 ml.
The third phase comprised a post-concentration process for further reduction of the original volume.

Results
The most important findings of the study are:

- The concentration of maximum volumes of 2000 litres produces high recovery rates ($\geq$ 65%; range 7-33%) for all organisms except *Campylobacter*,
- The efficiency of the detection of *Cryptosporidium* and *Giardia* is much higher and more reproducible than with the existing Envirochek concentration method,
- Concentrates obtained with the Hemoflow-installation can be post-concentrated without a significant reduction of the recovery rate,
- For the assessment of F-specific and somatic phages, the examinable volume has been increased from 10 ml to 2000 litters,
- The Hemoflow concentration method makes it possible to simultaneously concentrate the organisms that are to be examined.

Recommendations are:

- For every unknown water type to produce at least one recovery rate assessment for one of the micro-organisms, since there have been water types shown to produce a smaller recovery rate than usual,
- To use the Hemoflow-method in assessment programs since this method comprises a profound improvement relative to the concentration methods currently used.

More information
This study and its results have been described in the report covering D3.2.4: *A method for the concentration of large volumes of water* by H.R. Veenendaal & A.J. Brouwer-Hanzens (Kiwa Water Research).

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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		- Supply reservoir		- Settlement		- Raw water (source)		- Recycle	
- Groundwater		- Bankside storage		- Thickening		- Treated water			
- Surface water		**Pretreatment**		- Dewatering		**Chemical**			
- Spring water		- Screening		- Disposal		- Organic compounds			
- 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**			
Water treatment		- Dune infiltration		**Control/instrumentation**		- Viruses		Consumers / Risk	
- Pretreatment		**Secondary treatment**		- Flow		- Parasites			
- Primary treatment		- Coagulation/flocculation		- Pressure		- Bacteria		**Trust**	
- Secondary treatment		- Sedimentation		- pH		- Fungi		- In water safety/quality	
- 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		- Membrane treatment		**Analysis**		- Turbidity		**Willingness-to-pay/acceptance**	
- Pumps		- Adsorption		- Chemical		- Colour		- For safety	
- Supply pipe / main		- Disinfection		- Microbiological	X	- Taste		- For improved taste/odour	
Tap (Customer)		- Dechlorination		- Physical		- Odour		- For infrastructure	
- Supply (service) pipe		**Treated water storage**						- For security of supply	