Executive summary on Ceramic membranes – Case related protocol for optimal operational conditions to treat filter backwash water

Introduction

Inorganic membranes are resistant to mechanical, chemical and thermal stress. They have a high porosity and a hydrophilic surface. These properties may open new fields for applications in water treatment, such as the treatment of residuals from drinking water production or the direct treatment of surface waters. However, today ceramic membranes are still much more expensive with respect to the membrane area compared to membranes produced from organic materials. Costs of organic membranes showed a sharp decrease in recent years leading to the assumption that a similar development for ceramic membranes may occur in the future. Moreover, higher fluxes for ceramic membranes will decrease the required membrane area for a given water flow. Longer membrane life time is another factor which may compensate the higher investment costs compared to organic membranes.

Importance

Waterworks using surface water for drinking water production may include several filtration steps by conventional filters such as for particle removal. The backwash water of these filters contains the particle load of the raw water including added flocculants. Innovative methods for the treatment of these backwash waters, such as the treatment with ceramic membranes, are helpful to allow an environmentally friendly disposal.

Approach

Within this project examinations were conducted to implement inorganic membranes for treatment of backwash waters. A pilot plant was developed to pick up various inorganic membrane elements, such as different cut-offs and channel diameters in cross-flow and dead-end operation. The pilot plant was designed to operate fully automated in cross-flow as well as in dead-end mode. Online sensors and data loggers were installed to monitor flow, pressure and temperature. The pilot plant was operated in a waterworks with real backwash water. High loaded backwash waters (e.g. turbidity up to 560 NTU, aluminium concentration up to 256 mg/L) were treated with inorganic membranes in dead-end and cross-flow mode. Micro- and ultrafiltration membranes made from Al_2O_3 or SiC were used.

Result

Results indicated that the ceramic membranes tested were efficient to improve the backwash water quality.

Among the membrane types tested SiC and Al_2O_3 membranes tend to show a similar fouling behaviour.

Cross-flow filtration with the inorganic membranes resulted in good operational behaviour even for treatment of high loaded backwash water. However, energy consumption for cross-flow mode was considered as too high in relation to the achieved filtrate flow.

Al_2O_3 ultrafiltration membranes showed only a slightly higher total membrane resistance compared to microfiltration membranes, even the removal efficiency is better.

The intermediate results demonstrated that inorganic membranes may make full scale applications not implausible. Further research is necessary to investigate open questions including the influence of the feed water type, long term intervals for chemical cleaning of the membrane and the cost-benefit ratios compared to organic membranes.

More information

Deliverable number: D 2.3.3.5.a
Name of author(s): Uwe Mueller and Marco Witte
Organization: DVGW Water Technology Center (TZW) http://www.TZW.de
Contact person: Uwe Mueller
Telephone number: +49/(0)721-9678-257
Email: mueller@tzw.de

TECHNEAU Knowledge Integrator (TKI) categorisation

Categorisation of Knowledge Packages

TKI Categorisation

Classification									
Supply Chain		**Process Chain**		**Process Chain (cont'd)**		**Water Quality**		**Water Quantity (cont'd)**	
Source		**Raw water storage**		**Sludge treatment**	X	**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	X	- 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	X	**Analysis**		- Turbidity		**Willingness-to-pay/acceptance**	

- Pumps		- Adsorption		- Chemical		- Colour		- For safety	
- Supply pipe / main		- Disinfection		- Microbiological		- Taste		- For improved taste/odour	
Tap (Customer)		- 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				**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)*					
Database		Simple technology		*Organisation(s)*					
Spreadsheet		No/low skill requirement		*Contact name*					
Model		No/low energy requirement		*Contact email*					
Research		No/low chemical requirement		*Quality controller name*					
Literature review		No/low sludge production		*Quality controlerl organisation*					
Trend analysis		Rural location		Source					
Case study / demonstration	X	Developing world location		*Date prepared*					
Financial / organisational				Date submitted (TKI)					
Methodology				Date revised (TKI)					

Legislation / regulation									
Benchmarking									