Executive summary

Introduction

Ceramic membranes are known to be durable compared with other polymeric membranes. Having high resistance against mechanical, thermal and chemical conditions it becomes more attractive in surface water treatment applications. Despite being more expensive than other membranes, its long life in combination with optimization of pre-treatment conditions might offer the economic value.

Ceramic membranes can remove completely suspended particle and bacteria but unable to remove dissolved substances like disinfection by-products and their precursor like NOM as well as taste and odour compounds without pre-treatment. In order to enhance the capability of these contaminants, PAC is used to assist removal by adsorption. Moreover, pre-treatment is important for reducing the membrane fouling in ceramic membrane

To understand the removal of NOM and pesticides through adsorption with pre-coat layer of S-PAC and N-PAC for improving the quality of water is major target of this research.

Importance

Ceramic membrane is an in-organic micro-filtration membrane (MF) with the typical pore size of 0.1µm. The surface of Ceramic membrane is hydrophylic. The limitation of MF membranes is that they can not remove Natural organic matters (NOM), Synthetic Organic Compounds (SOCs) and colour alone without pre-treatment.

The past researches on hybrid ceramic membranes (MF-PAC) were basically focused on mixed chambers and not pre-coat approach. The use of S-PAC was found to be more effective than N-PAC using less contact time in removal of NOM. In plug flow the situation might be better. Therefore, this study went through and compares the efficiency of S-PAC and N-PAC pre-coats on removal of NOM (DOC), UV and atrazine.

Approach

Super ground Powder activated carbon (S-PAC) with effective size of 0.3µm and Normal Powder activated carbon (N-PAC) with effective size of 2µm was used to form pre-coat layers. 180ml of PAC solutions containing 70mg/l of S-PAC and N-PAC each were filtered through 0.1µm PVDF membrane placed Amicon unstirred cell until it is completely dry at constant pressure of 0.2bars. The layers of S-PAC or N-PAC containing 12.6mg or 0.025cm^3 are formed at the top of MF PVDF membrane.

Atrazine (100µg/l) was added to either Milli Q or pre-filtered delft water canal for adsorptive and non adsorptive filtration experiments respectively. DOC, UV_{254} and atrazine removal efficiencies with pre-coat layers of S-PAC and N-PAC were measured. The average Flux of 145L/m^2.h was applied for these experiments

However, in a ceramic membrane experiments a Flux of 150L/m^2.h was applied. The inline dosing of S-PAC with concentration of 7500mg/l was dosed for 2 minutes (pre-coat) at the beginning of each cycle with a dosing rate of 5L/h.

UV absorbance machine was used to measure the UV absorbance intensity at a wavelength of 254nm. The DOC of raw water and the permeate samples were measured in a TOC analyser. The atrazine content in water was measured by using the Atrazine ELISA (Microtiter Plate). The prepared samples are put together with standards in duplicate and the wavelength is set to 450nm.

Result
S-PAC showed better removal efficiency for atrazine, DOC & UV_{254} in both situations (with and without adsorptive competition) at the same dose and lower dose than N-PAC. The removal of micro-pollutants from canal water with S-PAC pre-coat layers was very attractive whereby gradual declined to 70% after 45minutes.

The rapid increase of resistances was observed when Canal water was filtered through S-PAC pre-coat layer and the LC-OCD test showed significant removal of biopolymers with S-PAC compared to N-PAC pre-coats. This is because the bed porosity of S-PAC is 0.045µm (0.15d) and therefore suggesting that biopolymers are subject to physical removal by micro-straining formed by bed porosity of S-PAC. Moreover, Stimela Model is promising a chance for prediction of breakthrough curve behavior for S-PAC.

More information

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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		- 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	√	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 controller organisation*	√				
Trend analysis		Rural location		Source					
Case study / demonstration		Developing world location		*Date prepared*	√				
Financial / organisational				Date submitted (TKI)	√				
Methodology	√			Date revised (TKI)					
Legislation / regulation									
Benchmarking									