Freshwater saving by seawater use with accessory wastewater treatment advantages

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Abstract

To help relieve global water stress, sanitation systems can be adapted by using less potable water resources. Introduction of seawater as secondary quality water for flushing toilets can save a third of fresh water consumption (Table 1). The presence of seawater in wastewater enables the SANI process (Sulphate reduction, Autotrophic denitrification and Nitrification Integrated) with advantages such as lower energy demand and reduced surplus sludge.

Introduction

A very small fraction (± 0.1%) of global water reserves is easily accesible for potable water production, but fresh water use is rising due to population growth and increased wealth.

Table 1. Drinkwater use for household usage in the Netherlands (L/day), adapted from Foekema et al. (2008). A substantial proportion of the municipal fresh water consumption is actually used during the transportation of waste.

	2004	2007
Personal hygiene	51.6	57.6
Washing clothes	19.5	17.2
Cooking and cleaning	8.7	8.5
Drinking	1.6	1.8
Flushing toilet	35.8	37.1
Other	6.4	5.3
Total	**123.8**	**127.5**

A significant fraction of municipal water requirements can be derived from secondary quality water, for example flushing the toilet. This water has only a transportation function in this case. Introduction of secondary quality water would require a dual distribution system to supply both freshwater and seawater.

Advantages of seawater as secondary quality water

- Population density is highest in coastal areas (Figure 1)
- Seawater is an almost infinite water resource
- Saves potable water (at least 1/3)
- As seawater is salty, cross connections are detected more easily
- Less sanitation problems compare to grey-water reuse.

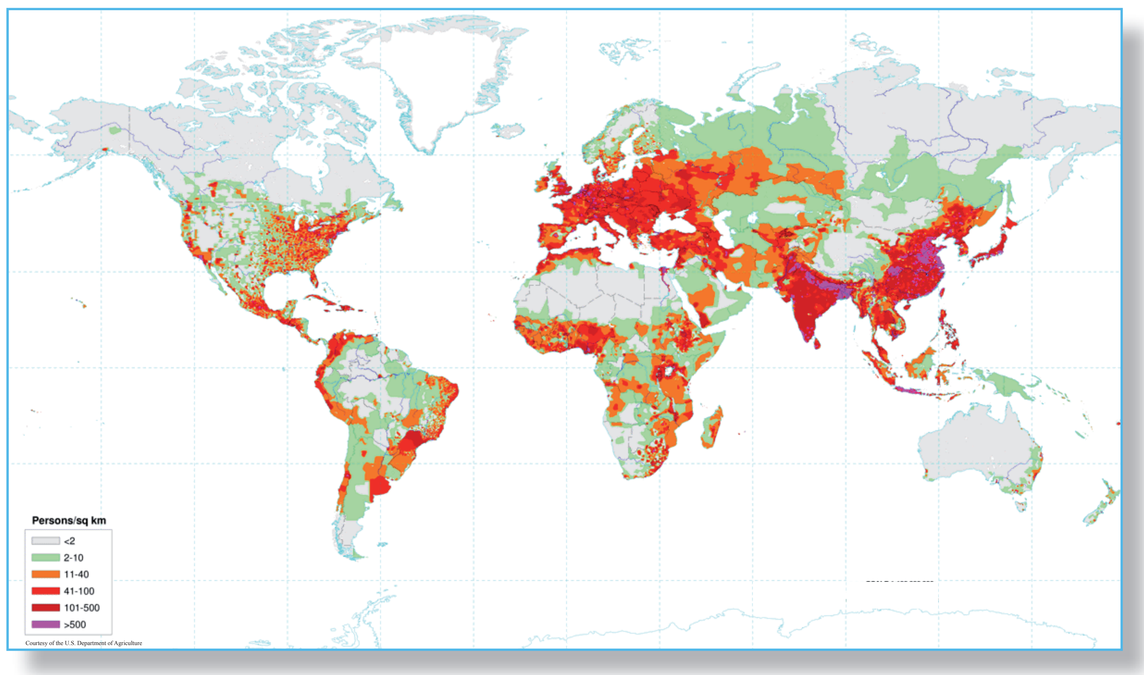

Figure 1. Global population density. Coastal areas have the highest population density [Foekema et.al. 2008].

Sources

Foekema, H., L. van Thiel and B. Lettinga (2008). *"Watergebruik thuis in 2007."* P.138 (9).

Lu, H., D. Wu, D. T. W. Tang, G. H. Chen, M. C. M. Van Loosdrecht and G. A. Ekama (2010). *"Pilot scale evaluation of SANI process for sludge minimization and greenhouse gas reduction in saline sewage treatment."*

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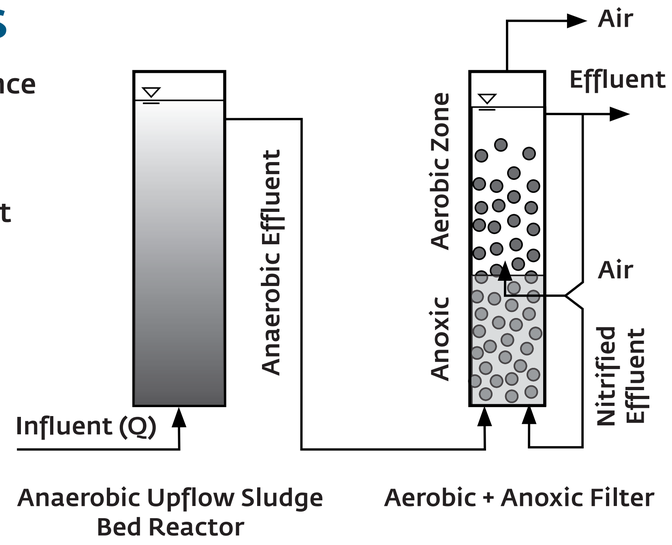
The SANI process

Hong Kong has 50 years experience operating a dual water supply system and using seawater as secondary quality water for toilet flushing.

Figure 2. Schematic overview of the SANI process. Sulphate reduction for COD removal occurs in the first reactor leading to the production of sulphide, while nitrogen removal occurs in the second reactor based on the produced sulphide [Lu et.al. 2010].



Seawater has on average a sulphate and salt concentration of 2.7 g/L and 35 g/L, respectively. When seawater is used as secondary quality water, the composition of municipal wastewater will change, experiencing an elevation in salt and sulphate concentrations. The presence of this substantial sulphate concentration presents an opportunity to use sulphate reducing bacteria, converting sulphate into sulphide, while removing COD (first reactor). As sulphide is produced, autotrophic denitrification becomes possible, and nitrogen removal can be completed with nitrification (second reactor). This process is called SANI (Sulphate reduction, Autotrophic denitrification and Nitrification Integrated), Figure 2 shows the schematic overview.

Advantages of the SANI process for the treatment of municipal waste water

- A third of freshwater is saved
- Reduced sludge production
- Reduced oxygen demand during treatment → energy saving
- Applicable in (dense populated) coastal regions
- Cheaper in investments and supply (in Hong Kong)

Figure 3. A pilot plant, operating successfully, using the SANI process in Hong Kong to treat municipal wastewater containing significant amounts of seawater [Lu et.al. 2010].

The research project

The research project is a collaboration between KWR, TU Delft, UNESCO-IHE, Hong Kong University of Science and Technology and the University of Cape Town.

The research as performed at KWR is focused on sulphate reduction for COD removal and sulphide production. The concentration of seawater (salt), temperature and wastewater composition is analysed kinetically and with molecular techniques to demonstrate the specific species present.

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