SOURCE SEPARATION TECHNOLOGIES IN WESTERN EUROPE

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Abstract

This paper was review different technologies for source separating sanitation systems. Two main groups have been indicated: dry sanitation and source separating systems using water flush toilets. Dry sanitation based solutions are widely applied in developing countries, however are struggling with the high comfort expectations of citizens in Europe and other industrialized countries. Different water flush based systems have therefore been developed. Most common are vacuum toilets in combination with separate sewers and treatment systems for greywater. While different greywater treatment technologies are available on the marked is blackwater treatment still under research. However, in recent years, different promising technologies such as compost filters, anaerobic reactors and membrane bioreactors have been developed and seems close to the implementation on the marked.

Keywords: Source separating, blackwater, greywater, dry toilets, vacuum toilets, urine diverting

Introduction

The daily water use in industrialized countries ranges from 150 to 250 liters per capita, the volume of our excreta (urine and faeces) amounts to a mere 1.5 liters per capita per day, constituting less than 1% of the wastewater volume. This 1% excreta contributes the majority of the pathogens in wastewater (WHO 2006), about 90% of the nitrogen, 80% of the phosphorus and roughly 60% of COD (Meinzinger & Oldenburg 2009). These are the major substances of concern regarding health problems and water pollution from sewage. Wastewater handling using source separation takes advantage of this and collects human excreta using a minimum amount of water and treats this independent of the rest of the household wastewater.

Source separating technologies offer interesting possibilities for both reuse of resources and water saving. Especially phosphorus is a limited resource. The European Fertilizer Manufacturers Association predicts demand to exceed production in the year 2040, hence, recycling of phosphorus may become crucial to sustain future high yields (Cordell et al. 2009). When mineral phosphorus fertilizer production declines human excreta can become one of the major sources of phosphorus for agriculture.

Over the last decades an increasing interest has therefore been given to source separating technologies (Jenssen et al. 2003; Jönssen & Vinnerås 2007; Regelsberger et al. 2007; Todt et al. 2010). Goal of this paper is to give an overview of source separating technology applied in Western Europe and points to future development needs.

Dry sanitation

Dry toilets are the most simple and most efficient systems regarding retaining of nutrients, especially in combination with urine separation. Dry sanitation got a high attention in developing projects (Heeb et al. 2006). In industrial countries however, such systems are unfortunately generally perceived as old-fashioned and insufficient regarding hygiene and comfort. Nevertheless those concerns dry toilet have been successfully implemented on many remote houses and infrastructure, especially in Scandinavia, but also on mountain lodges in the Alps (Abegglen 2004).

Systems using flushing toilets

Source separating sanitation systems using flushing toilets meet a higher user acceptance and are therefore the main focus of ongoing research and implementation projects in Western Europe.

Urine diverting toilets are the simplest form of source separation sanitation using flush toilets. Such systems have already been widely implemented on different places in Europe, especially in the country side of Sweden (Jönssen & Vinnerås 2007). Urine contains approximately 80% of nitrogen and 50% of phosphorous (Meinzinger & Oldenburg 2009) and can relatively simply be processed into a save fertilizer for agriculture (WHO 2006). Advantage of urine diverting toilets is the relatively easy implementation, disadvantage is that more than 90% of COD (Meinzinger & Oldenburg 2009) remains with the feces and greywater in the wastewater stream.

Establishing two separate sewer- and treatment systems for greywater GW and blackwater BW is another option for source separating. Greywater is significantly less contaminated than normal wastewater. Several technologies are available for treating greywater locally into an effluent quality that can be reused for toilet flushing or irrigation (Li et al. 2009). Separate treatment of GW gives not only new opportunities for water recycling, it also results in a concentrated BW stream that opens new options for biogas production such as implemented successfully in the Mediterranean area (Halalsheh & Wendland 2008; Regelsberger et al. 2007).

Most efficient regarding is combining source separation with low flush toilets. The most common and promising solution for this kind of source separating sanitation are vacuum toilets. The technology that has been widely applied on ships provides the same comfort than a traditional water toilet and reduces flushing water consumption on more 90%. It has been successfully implemented in Norway (Jenssen et al. 2003), Germany (Bernal et al. 1998; Elmitwalli & Otterpohl 2007; Gajurel et al. 2003; Oldenburg et al. 2002) and Netherland (Hernández Leal et al. 2010; Zeeman et al. 2008).

Main challenge is to develop appropriate technologies for the treatment of the concentrated blackwater. Different technologies have been assessed. Compost filter systems or so called Rottebehälter are a cheap and effective solution for separating solids into a compost that can be used as fertilizer in agriculture (Gajurel et al. 2003; Todt et al. 2010) Recent lab experiments indicate that such systems can retain up to 80% of COD and 60% of total phosphorous (Todt et al. 2010). Anaerobic treatment systems are another option that enables to produce bioenergy if large enough amounts of blackwater are available (Halalsheh & Wendland 2008; Zeeman et al. 2008). Recent research is focusing on combining anearobic treatment with struvite precipitation to get both energy and nutrient recycling (Zeeman et al. 2008). Membrane bioreactors MBR reach a high treatment performance, especially regarding COD and pathogens (van Voorthuizen et al. 2008). However, MBR are often too sophisticated and too expensive, especially regarding decentralized and small scale applications (Masi et al. 2010).

Combining low flush toilets with recycling of greywater reduces fresh water consumption up to 90% (Jenssen et al 2010). Such a system has recently been developed for mountain lodges and is getting tested at Britannia lodge on 3000 meter in Switzerland. It combines fixed film biofilters for greywater recycling with 0.5 liter flush vacuum toilets a novel based blackwater treatment system implementing greenhouse technology for composting an recycling solid fraction an nutrients (Todt et al. 2010).

Conclusion

In recent years various treatment systems have been developed to meet the challenge of source separating sanitation, nutrient recycling and high user comfort requirements. For GW treatment, different technologies are already available on the market. For BW treatment different technologies have been implemented successfully in pilot systems on different scales. However for a widespread implementation further research need to be done, especially regarding nutrient recycling and health aspects.

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