Untapping the energetic potential of grey water: Microbiological safety and downstream re-utilization routes

Shuoguang Yang
shuoguang.yang@wetsus.nl

Motivation

In the context of global warming, reducing greenhouse gases emission has become one of the most important topics nowadays. European Union recognized wastewater as a renewable energy source in 2018[1]. Energy harnessing from wastewater formulates a promising strategy to decrease the consumption of fossil fuels and the emission of greenhouse gases.

This research focuses on a district-level greywater reuse and heat recovery system (Fig. 1). In this system, greywater will be first treated through aerobic biological processes combined with a nanofiltration unit. Subsequently, with the help of a heat pump, the heat energy within greywater can be harnessed, stored, and finally reused in households. After the heat extraction, greywater will be directed to the households for different purposes of reuse. However, the microbial quality of the reclaimed greywater, especially after a certain period of storage time, remains unknown. Therefore, the assessment of microbial safety is vital for the development of a sustainable system.

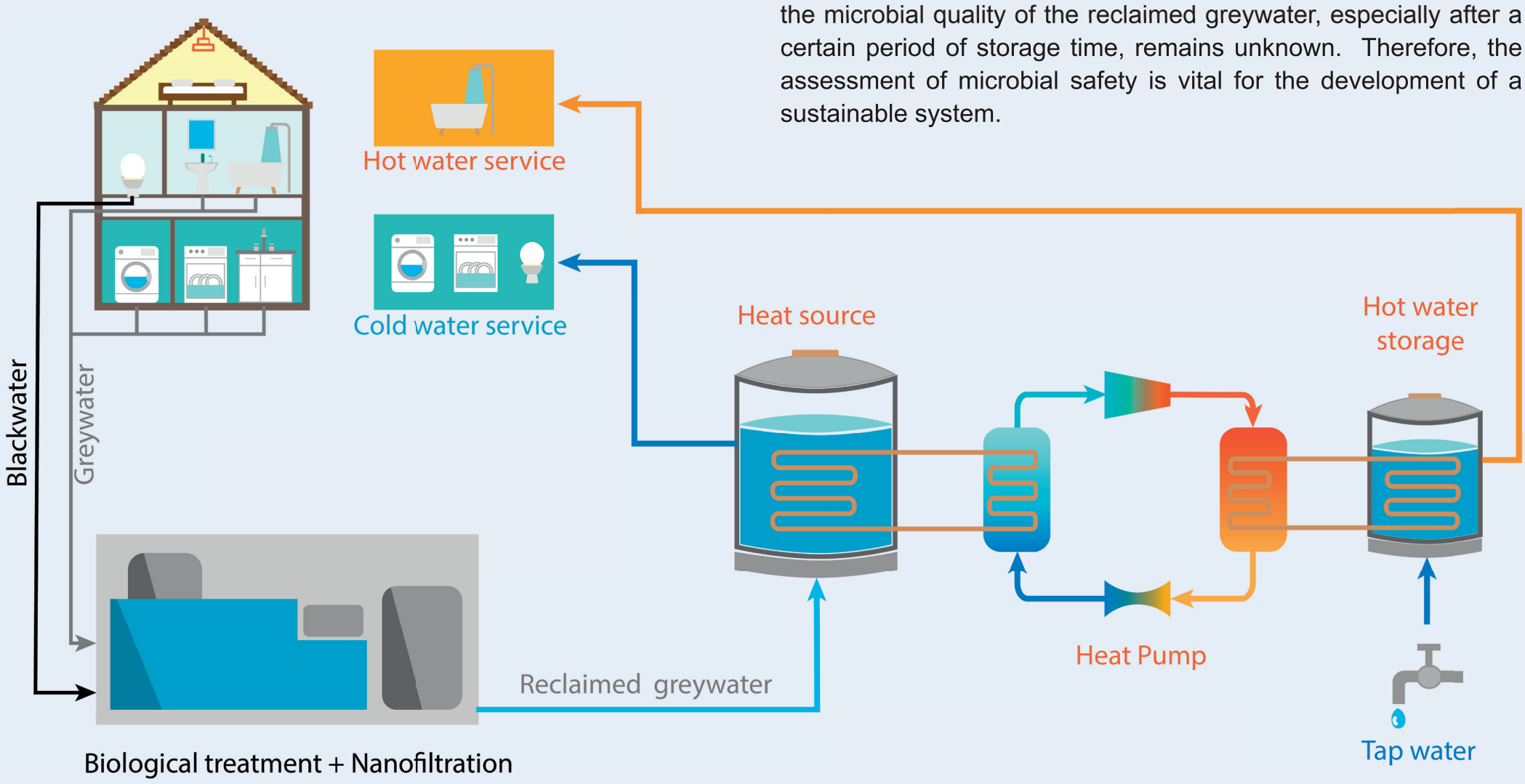

Fig 1. A potential greywater reuse and heat recovery system

Separating wastewater into black water and greywater can facilitate energy recovery. Black water can generate biogas through anaerobic treatment processes, while greywater holds excellent potential for high-quality water and heat recovery. As greywater remains at a high temperature after being discharged into the sewage network, a heat pump can extract large quantities of heat from greywater.

Technological challenge

The direct heat recovery from greywater has the following limitations: 1. The biofilm formation on the heat exchanger's surface will inhibit the heat pump's availability and performance[2]. 2. The potential of greywater reuse cannot be exploited entirely due to the lack of microbiological safety. To maximize the energetical and reuse potential of greywater, an advanced system containing greywater treatment, heat recovery, and greywater reuse needs to be developed and investigated.

Research goals

- Investigation of the physical, chemical and microbial quality of the greywater after biological treatment and nanofiltration
- Evaluation of the bacterial regrowth within the system
- Optimization of the heat recovery system and assessment of the heat efficiency of the entire system.
- Development of the greywater reuse strategy in households
- Assessment of the necessity and feasibility of different disinfection methods in the system

[1] Directive (EU) (2018). Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the Promotion of the Use of Energy from Renewable Sources (Recast).
[2] Zhao, Q., et al. (2005). Chemical Engineering Science, 60(17), 4858–65.

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