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ABSTRACT

The PhD thesis presents the results of greywater treatment analysis with the use of polypropylene cartridge filters and ultrafiltration membranes. Greywater generated in buildings is made up of the waste water from showers, baths, hand basins, laundry tubs and washing machines. It does not include waste water from toilets. Greywater accounts for about 65-75 % of the water used in a household by volume. The use of dual water supply system should theoretically reduce the cost of water supply and sewage disposal, ensuring return on investment. Greywater contains varying levels of suspended solids, nutrients, organic matter, residual laundry and shower, detergents pathogens which arise from clothes and body. Elevated temperature should be also taken into consideration in case of the greywater purification. Greywater after proper purification can be used for toilet flushing. Ultrafiltration (UF) which can be classified as a low pressure process, has been recognized as a promising treatment option for wastewater reclamation. Unfortunately, membrane fouling can significantly limit the economical operation of this technique. Pre-treatment has to be applied to prevent membrane against excessive fouling. The simplest way is to protect UF module by micro-filtration stage.

The goals of the investigation were to assess the polypropylene cartridge efficiency in pre-treatment and evaluate the effect of transmembrane pressure and fluid temperature on the UF flux and permeate quality. In addition, an economic analysis of the use of greywater treatment installation to reuse water for flushing the toilets, was performed.

The results of the preliminary purification of greywater model using 20 μm, 50 μm and 100 μm polypropylene filters were interpreted on the basis of the Ruth equation. The reduction of the permeate flux during the UF (10, 100, 1000 kDa) process was modeled using the relaxation model. For economic analysis were used economic indicators: simple payback time (SPBT) and net present value (NPV). The water recovery system was analyzed in a household and a four star hotel.

As expected, high efficiency of the TSS removal was obtained during greywater treatment in polypropylene cartridge filtration. Slightly better results were obtained in case of 20 μm filter than 100 μm cartridge filter. Nonionic detergents removal of 40 % and 31 % for 20 μm and 100 μm pore size, respectively, was also observed. High efficiency of TSS removal and relatively short effective operation time indicate the necessity of self-cleaning filters application. Permeate flux (UF) was strongly influenced by operational conditions of the purification system. The effect of transmembrane pressure increase from 1,75 bar to 2,00 bar caused permeate flux increase. Flux increase was also observed as a result of temperature increase from 25 to 38 ^{o}C. That was the result of solution viscosity decrease. Better purification results were obtained at

TMP of 2,00 bar than at 1,75 bar. It can be explained by probable accumulation of impurities on the membrane surface creating better filtration conditions. Slightly worse results concerning reclaimed water quality were obtained at elevated greywater temperature (38 °C) in spite of higher permeate flux. It is possible that the temperature increase caused the increase of the membrane pore size allowing more impurities to pass through. Finally, the UF process made it possible to reduce the COD of about 80%, BOD_5 by more than 90% and to completely remove non-ionic detergents. It was finally determined that the use of water recycling system in a single household is economically unjustified at the current level of unit prices for water supply and sewage disposal. In case of the hotel a positive NPV index value, was obtained and the value of SPBT was estimated approx. 5 years.

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