Evaluation of two treatment concepts for the reuse of wwtp effluent at an UF-RO plant

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Keywords: pond; reuse; SUR; UF-RO; wwtp effluent

INTRODUCTION

Ultrafiltration (UF) in combination with reverses osmosis (RO) is a world wide applied and accepted technique to upgrade effluent of wastewater treatment plants (wwtp) (Bixio and Wintgens, 2006). Treated wwtp effluent can be used for several purposes, depending on the required water quality. In the Netherlands, Evides Industriewater is operating an UF-RO plant (figure 1) to produce demi water of wwtp effluent. The treatment process of the wwtp effluent consists of: ferric chloride dosing; dual-media filter (anthracite – sand); ferric chloride and chlorine dosing before UF; RO; degassing tower and a second RO.

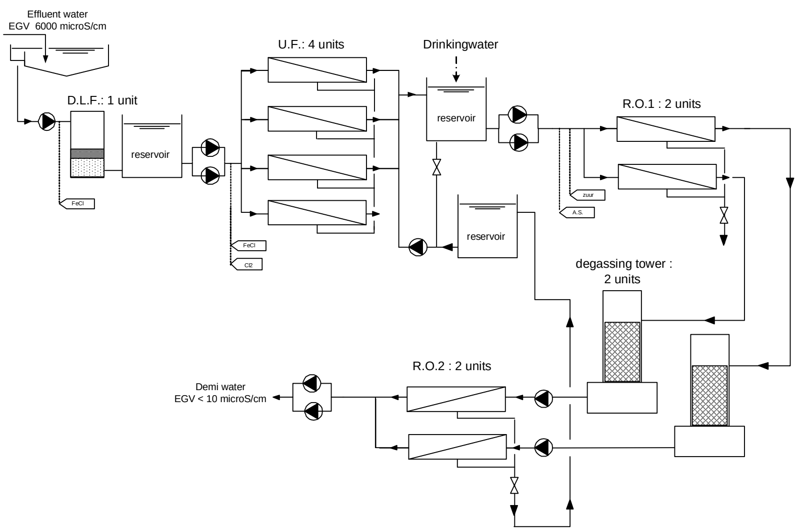

Figure 1. Process flow diagram of UF-RO plant.

The UF-RO plant treats industrial effluent from a foods producing factory. Unfortunately the wwtp effluent quality varies a lot and therefore it is not always suitable for (re)use. Many reasons can explain the variation e.g. poor operation of the wwtp, discontinues discharge from batch processes, difficult biodegradable batches (new products), wastewater coming from incidental clean processes, etc. Those 'bad quality' events results in a poor quality of wwtp effluent and influence the performance of the UF-RO plant negatively. Therefore during 'bad quality' events other water sources have to be used. Till now drinking water is used during these 'bad quality' events. But the use of (expensive) drinking water makes the UF-RO plant economically less attractive. Therefore the use of wwtp effluent after buffering in a pond is an potential alternative. Normally, the UF-RO plant is fed with wwtp effluent directly taken after the clarifier (secondary settler). This paper evaluates the performance of the UF-RO plant and pre treatment steps (ferric chloride – dual media filtration – ferric chloride) when wwtp effluent after buffering in a pond was used.

METHODS

During 1.5 month (August, 31 – October, 12 2006) the UF-RO plant was fed by wwtp effluent after pond passage. The residence time of the wwtp effluent in the pond is 2 to 3 days. Because of the systems design (the water intake criteria) a heat exchanger is used to stabilize the feedwater temperature above 20°C.
The filterability of wwtp effluent from the clarifier (normal feedwater) and after pond passage was monitored approximately four times a week. To measure the filterability the Specific Ultrafiltration Resistance (SUR) parameter is used. This parameter developed by Roorda (2004) provides useful information about the filterability within a short time (30 minutes) and can be measured with a simple laboratory set-up (figure 2). With the SUR value a rough indication of the performance of an UF plant can be predicted (Janssen et al., 2007).

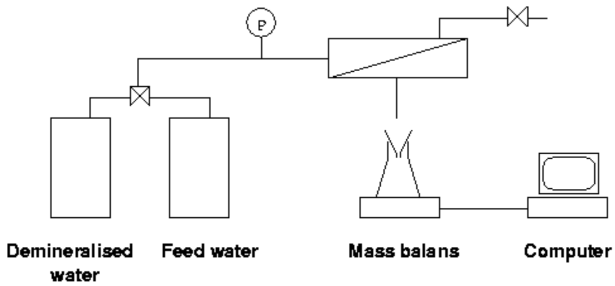

Figure 2. Schematic drawing of the laboratory test set-up.

Besides the filterability the water quality of the two different sources was monitored. The concentration of extracellular polymeric substances (EPS), humic acids, colour and dissolved organic carbon (DOC) were analysed. These parameters are defined as the major foulants of membranes during ultrafiltration (Te Poele, 2005).
The effect of pre treatment was investigated with SUR measurements. The filterability before the first ferric chloride dosing and after the second ferric chloride dosing (feedwater UF) was measured four times a week during the period of study.

RESULTS

Water quality

In Table 1 the average concentrations of the quality parameters of both sources during this study are presented.

Table 1. Average concentration of foulants of wwtp effluent from clarifier and pond during August, 31 till October, 12.

Foulant	Unit	Clarifier (average)	Pond (average)
Proteins	mg/l	32,7	18,7
Polysacharides	mg/l	7,5	7,3
EPS	mg/l	40,2	26,1
DOC	mg/l	23,9	22,7
Humic Acids	cm^{-1}	0,52	0,43
Colour	mg Pt/l	87,0	63,9

Table 1 shows a varying picture for the different substances. Opposed to the polysaccharide concentration the concentration of proteins is significantly lowered by pond passage. The amount of EPS is also lowered but this is mainly caused by the decrease of proteins. The humic acids and colour presents the same trend as proteins and EPS. However, the DOC concentration did not decrease during the pond passage. A clear explanation for this contradiction is difficult but probably the presence of algae in the pond plays a role. The algae were clearly visible in the water. During DOC analyses all dissolved carbon (including possible rests and products of algae) is measured instead of certain parts of DOC.
Nevertheless, the decrease of proteins is an interesting aspect of this study. From previous research (Te Poele, 2005) it is well known that proteins are mainly responsible for the long term fouling.

Filterability

Figure 3 presents the SUR values of both sources during the study period. The SUR values of the wwtp effluent after pond passage are significantly higher compared to wwtp effluent after the clarifier. The SUR values of the wwtp effluent after clarifier were almost always distinctly below 10×10^{12} m^{-2} during the study period. This means that the water is well filterable (Roorda, 2004). Unfortunately, the SUR values of the wwtp effluent after pond passage are in the range of 13 - 20 × 10^{12} m^{-2} most of the time. It is predictable that the presence of algae is responsible for the difference in SUR values. During a few measurements relatively high concentrations of chlorofyl were observed (Trampé, 2007). The concentrations were in the range of 90-1420 µg/l (chlorofyl-a).

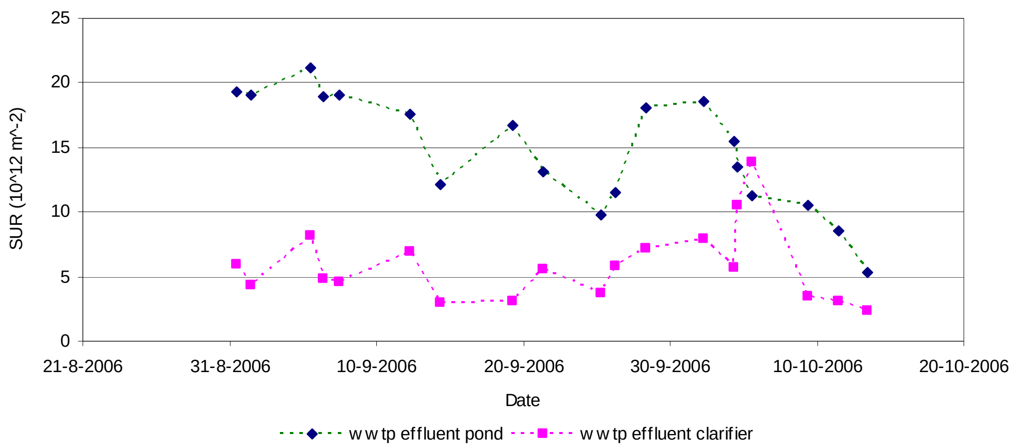

Figure 3. SUR values of the wwtp effluent from the clarifier and from the pond during August, 31 till October, 12.

Pre treatment

Figure 4 shows the overall effect of the pre treatments steps.

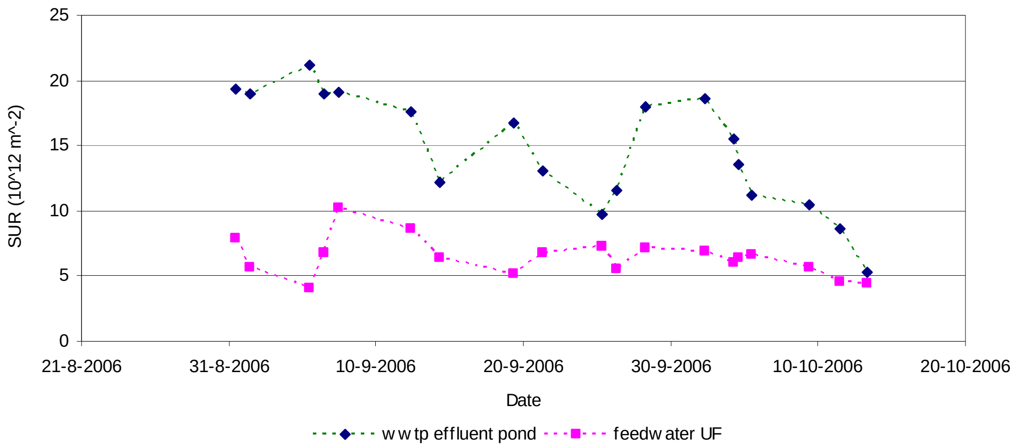

Figure 4. SUR values of the wwtp effluent from the pond and filtrate dual media filter during August, 31 till October, 12.

The filterability of wwtp effluent after pond passage improved significantly by pre treatment. Considering the definition of well filterable water (SUR < 10×10^{12} m^{-2}) it seems that wwtp effluent after buffering in a pond and pre treatment is suitable for reuse. But, it should be considered that the SUR values of wwtp effluent after the clarifier were relatively low (figure 3). Normally, the variation of filterability is higher which include higher SUR values of wwtp effluent after the clarifier.

CONCLUSION

In spite of the lower foulants concentrations the SUR values of the wwtp effluent after the clarifier are significant lower compared to the wwtp effluent after pond passage. It is obvious that the presence of algae in the pond explains this contradiction. A reason for the presence of algae could be the residence time (2 to 3 days) in the pond. A shorter residence time (± 1 day) will probably prevent the bloom of algae (Kampf, 2007). Also the prevention of possible dead zones in the pond could prevent the bloom of algae.

The wwtp effluent after pond passage seems to be suitable for reuse. Unfortunately during the period of this study no ‘bad quality’ event occured. Therefore, to make this conclusion stronger the research should be repeated during a ‘bad quality’ event.

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