FILTERABILITY TESTS FOR THE CHARACTERIZATION OF THE WASTEWATER INFLUENT TO A MBR PROCESS.

Beatriz Veces-Gadea[1], José-Antonio Mendoza-Roca[1], Francisco-Juan Martínez-Francisco[2], Carlos Ferrer-Torregrosa[3]

[1]Instituto de Seguridad Industrial, Radiofísica y Medio Ambiente. Universidad Politécnica de Valencia. Camino de Vera s/n. 46022 Valencia. (e-mails: beavega@etsii.upv.es, jamendoz@iqn.upv.es)

[2]Entidad Pública de Saneamiento de Aguas residuales. Generalitat Valenciana. Álvaro de Bazán 10, entlo. 46010 Valencia. Spain. (E-mail: *martinez_frafra@gva.es*)

[3] Sociedad de Fomento Agrícola castellonense (FACSA). c/Mayor, 82-84. 12001 Castellón. Spain. (e-mail: cferrer@facsa.com)

ABSTRACT

The key point in the implementation of MBRs for the biological wastewater treatment is the membrane life duration. Fouling phenomena reduce the membrane performance and chemical cleanings to recover the design operating flux shorten the membrane life. Among the factors that are responsible for the fouling, the characteristics of the wastewater to be treated may play an important role. It seems clear that the presence of hairs and fibres and oil and greases in the membrane feed diminishes the membrane permeability. In this work, the wastewater characteristics of three small wastewater treatment plants (sWWTPs) have been compared and subjected to ultrafiltration in order to evaluate the filterability of the samples as a first approach to evaluate the treatability of a wastewater by a MBR. In the test, R_c had the most important contribution to the total resistance. The highest R_f percentage corresponded with the sample from sWWTP 2 (35.5 %), what was related with the highest oil and greases concentration. The wastewater with the lowest total resistance was the sample from the sWWTP3.

Keywords: MBR, membrane resistances, municipal wastewater, ultrafiltration

INTRODUCTION

A membrane bioreactor (MBR) is a process that combines the biological degradation of a wastewater by activated sludge and direct solid-liquid separation by membrane filtration. Many advantages are provided using ultrafiltration or microfiltration instead of the secondary clarifier. (Stephenson et al., 2000). The implementation of a MBR in a small municipal wastewater treatment plant (sMWWTP) will mainly depend on the operation costs. A long membrane life and the minimization of chemical cleanings, i.e. the minimization of the membrane fouling, are of paramount importance to make economically feasible a MBR.

The parameters influencing membrane fouling can be divided into four groups: membrane module design, operation of the membrane filtration, biological treatment characteristics and membrane material. Within the biological treatment characteristics, the characteristics of the raw wastewater

have to be considered. Although in the literature a great number of papers relating membrane fouling with sludge properties can be found in the last decade (LeClech et al., 2006; Drews, 2010), the influences of the pretreatment and especially of the wastewater composition on the membrane fouling have been hardly studied.

The objective of this work is the evaluation of the characteristics of the wastewater, especially the filterability as a first approach to compare the treatability of different wastewaters by a MBR.

METHODS

In order to compare the characteristics of three municipal wastewaters in view to a MBR implementation, hair and fibres, suspended solids, oil and greases and membrane resistances were analysed.

Wastewater samples were taken from three sMWWTPs. They were collected both from the influent (sample point A) in order to observe hair and fibres and after the pretreatment (sample point B). Hairs and fibres were observed qualitatively after filtration by stainless steel sieves from FILTER-LAB (mesh sizes of 150, 500 and 900 µm). Cellulose acetate membrane filters (0.45 µm, 47 mm of diameter) from LABSCIENCE were used to quantify the suspended solids. Oil and greases analyzed were measured gravimetrically.

For the filterability analysis, the membrane resistances were measured according to Bae and Tak (2005). In this way, membrane resistance (R_m), fouling resistance (R_f) and cake layer resistance (R_c) were determined according to the resistances in series model. For it, an ultrafiltration laboratory module Rayflow x 100 from Tech-sep with a UP150P membrane from Microdyn Nadir was used. The membrane active surface was 100 cm^2.

RESULTS AND DISCUSSION

Figure 1 shows a picture of the three sieves used for the hair and fibres separation from the sample A of the sWWTP 1. It can be observed that most of the solids are separated with the wider mesh size (900 µm). From a qualitatively point of view, no differences were observed among the three studied wastewaters.

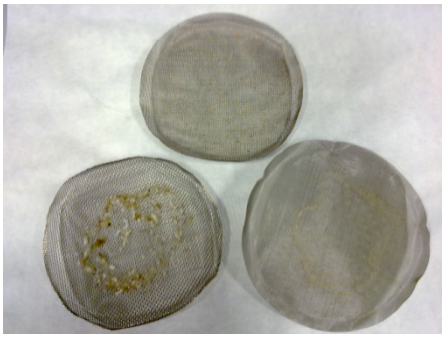


Fig 1. Mesh stainless steel sieves after the filtrations

It has to be commented that there not a standard parameter to measured hairs and fibres (Frechen et al., 2008). According to the experiences from MBRs in operating, it can be stated that a sieving of 500 µm can minimizes the risk of membrane fouling by these solids.

Table 1 shows the characteristics of the pretreatments of the three sMWWTPs selected for this study. Suspended solids and oil and greases measured for the samples after the pretreatment (B) are also included in this table.

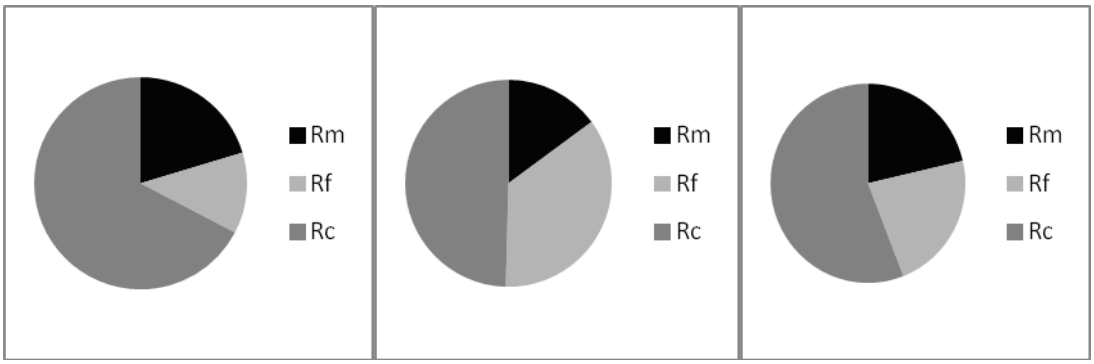
It can be observed that the mesh sizes of the sieves are practically equal for the three sMWWTPs. Suspended solids are also similar, ranging the values between 170 and 190 mg/L. However, significant differences can be observed if oil and greases concentrations are compared. In order to confirm these differences a sampling period of four months was established for the measurement of this parameter. Results confirmed that the oil and greases concentrations were always the highest in sMWWTP 2 and the lowest in sMWWTP 3.

Figure 3 shows the distribution of the membrane resistances for the wastewaters influent to the biological treatments in the three sMWWTPs. For the three samples, Rc had the most important contribution to the total resistance. The highest R_f percentage corresponded with the sample from WWTP 2 (35.5 %), what was related with the highest oil and greases concentration.

Comparing the resistances values, it has to be commented that the lowest value of R_f + R_c (R_m is intrinsic to the membrane) was $1.7 \cdot 10^{10}$ cm^{-1}, corresponded with the sWWWTP 3, i.e. with wastewater with the lowest suspended solids and oil and greases concentrations.

Table 1. Pretreatment characteristics of the studied sWWTPs and suspended solids (SS) and oil and greases concentrations after the pretreatment stages.

	Pretreatment characteristics	SS (mg/L)	Oil and greases (mg/L)
sMWWTP 1	40 mm bar screen. 3 mm sieve. Sand removal /Degreasing. Equalization tank	172	27
sMWWTP 2	50 mm bar screen. 2 mm sieve Sand removal /Degreasing	190	40
sMWWTP 3	150 mm bar screen. 3 mm sieve Sand removal/Degreasing.Equalization tank	180	10



sMWWTP 1 sMWWTP 2 sMWWTP 3

Figure 3. Contribution of the R_m, R_c and R_f to the total membrane resistance (Rt) in the ultrafiltration

CONCLUSIONS

Hair and fibres, suspended solids and oil and greases are parameters that determine the filterability of the wastewater. The membrane resistances are influenced by these parameters and their values can give valuable information in view to a further wastewater treatment by means of a MBR. The biological treatment will diminish the membrane resistances, but as part of them will remain and it will play an important role in the membrane fouling. Further studies are necessary to obtain more information about the influence of the wastewater composition to the membrane fouling in a MBR.

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