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Relationship between physical and chemical characteristics of a mbr mixed liquor: Influence of the EPS on the filtration resistance and other physical parameters

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Introduction

Nowadays, the implementation of membrane bioreactors (MBR) both in urban as in industrial wastewater treatment plants is increasing due to the better quality of the treated water [1].

MBR is an activated sludge process for biological wastewater treatment that consists of a reactor, where wastewater is mixed with the microorganisms responsible of depuration (mixed liquor) and ultrafiltration/microfiltration membrane modules (instead of secondary clarifiers used in the conventional treatments), where treated water is separated from microorganisms.

The main disadvantage of MBR technology is membrane fouling, causing higher operating costs due to cleaning necessities and membranes replacement. Some works point out that the main cause of membrane fouling are extracellular polymeric substances (EPS) [2], which consist of the sum of the soluble microbial products (SMP) and the extracted extracellular polymeric substances (eEPS). These substances can be found on the bacterial cell surface and can be quantified as proteins and polysaccharides. Because of this, several techniques have been studied to reduce membrane fouling in MBR process.

In this work, fouling characteristics were studied by testing an ultrafiltration membrane with activated sludge mixed liquor from an MBR. The filtration resistance was related with the EPS obtained through two methods, by means of a detergent (0,5% Triton X-100) and a cation exchange resin (CER). In addition, other physical parameters were also studied.

Materials and methods

The application of an extraction protocol is necessary to determine the eEPS. Two extraction methods have been applied in order to obtain the EPS of the activated sludge: 0,5% Triton X-100 and cation exchange resin (CER), both in two stages.

To quantify the concentration of proteins and carbohydrates in EPS, BCA and Dubois methods were applied for proteins and carbohydrates, respectively. Bovine serum albumin (BSA) and glucose were used as the protein and carbohydrate standards.

Filtration resistance of the mixed liquor was measured by tests carried out in a cross-flow ultrafiltration laboratory plant. The membrane module used in this study was Rayflow 100 (Figure 1). The effective area of the membrane was 100 cm^2, with a pore size of 0,04 □m. The total filtration resistance (R_t) was calculated as the sum of the membrane resistance (R_m), the

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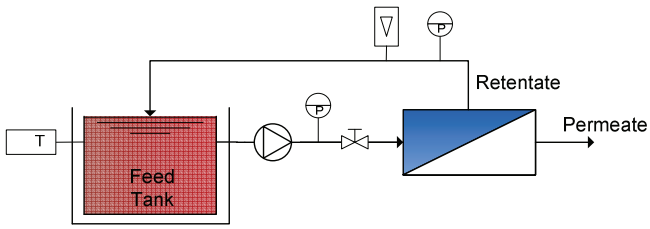
cake layer resistance (R_c) and the fouling resistance (R_f) [3]. There were also measured other physical parameters as the mixed liquor suspended solids (MLSS) and the capillary suction time (CST) (Triton Electronics). The viscosity was determined with a rheometer Haake Rheo Stress1 (Thermo). Particle size distribution of sludge was determined by Mastersizer 2000 particle size analyzer (Malvern), which is based on laser diffraction scattering.

Figure 1: Scheme of the laboratory plant used in the tests



Results

Figures 2 and 3 show that as increases the filtration resistance, increases the EPS concentration. These results confirm that the polymeric substances influence on membrane fouling. Besides, the EPS concentrations obtained with Triton X-100 protocol were higher than the ones obtained with the CER (92,4 and 28,2 mg/gVSS, respectively). Similar results were found in bibliography.

Figure 2: Relationship between total filtration resistance and EPS

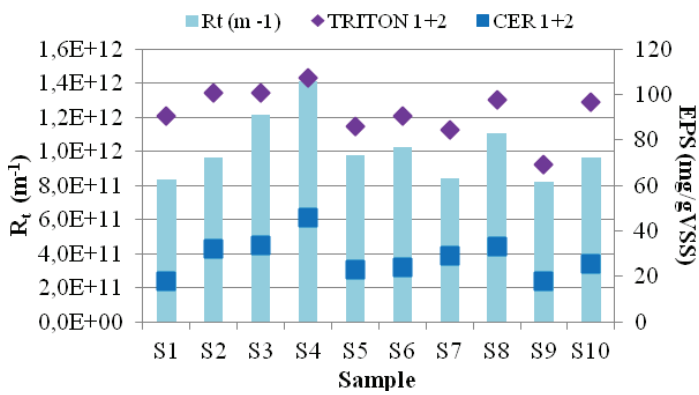
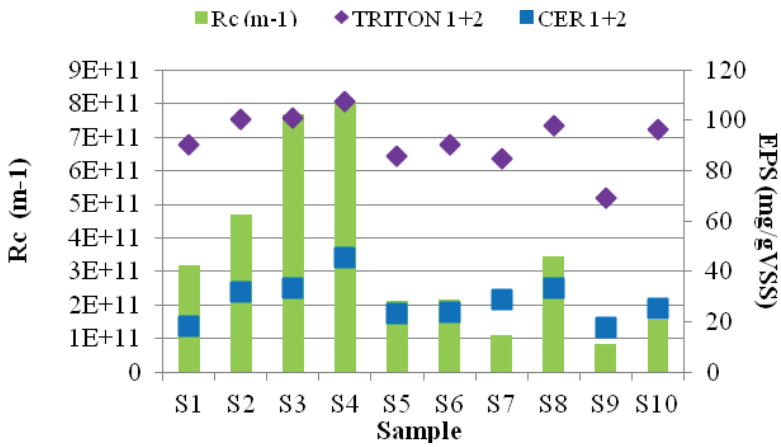


Figure 3: Relationship between cake layer resistance and EPS



In table 1 the mean values of the mixed liquor physical study are shown. Viscosity results showed that activated sludge was behaving as a non-Newtonian fluid. There wasn't observed relation between filtration resistance and viscosity. By contrast, the more MLSS concentration, the higher the viscosity is. Capillary suction time was determined to evaluate the filterability of sludge. There is no high evidence on the relation between this parameter and the EPS concentration, although the highest values of CST correspond to the highest EPS concentrations. The 50% of particle size are below 29,45 □m in volume. The specific resistance of the cake layer has a close relationship with particle size and MLSS. This is mainly due to the deposition of small particles and colloids on the membrane surface.

Table 1: Mean values of the sludge physical characteristics (n=10)

MLSS (g/L)	MLVSS (g/L)	η(mPa·s) (γ=800 s-1)	CST (s)	D[4,3] (□m)	d(0,1) (□m)	d(0,5) (□m)	d(0,9) (□m)
10,281	7,457	7,12	29,94	47,56	10,11	29,45	78,25

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