EVALUATION AND DESIGN OF DIFFERENT MEMBRANE PLANTS

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Introduction

Nowadays treatment of industrial wastewaters represents a big issue due to very toxic and recalcitrant compounds contained therein. Because of the wide range of industrial processes whose wastewaters are delivered to industrial wastewater treatment plants (IWWTPs), it is difficult to set up a standard treatment, whereas it is likely that some unit operations have to be improved or inserted to fit the legislation requirements. Generally, UF and NF were carried out by using lab-scale plants and/or synthetic solutions.

Objectives

Two different plants combining nanofiltration and ultrafiltration are evaluated and compared, for a wastewater treatment plant at industrial scale. A design and economic analysis is developed using the experimental data of a pilot plant.

Materials and method

In the first plant, as shown in figure 1, an ultrafiltration module is followed by nanofiltration module. The retentate of the ultrafiltration is recycled to the feed, that is partially sent to the permeate of the nanofiltration module. In this way, the area of membrane is reduced. In the second scheme, as shown in figure 2, all feed is sent to the nanofiltration module. The feed stream, in the two conditions, is the current at the exit of sand filters, at the downstream of settler. From a pilot plant data, an average feed flow rate equal to 4.46 m^3/h result.

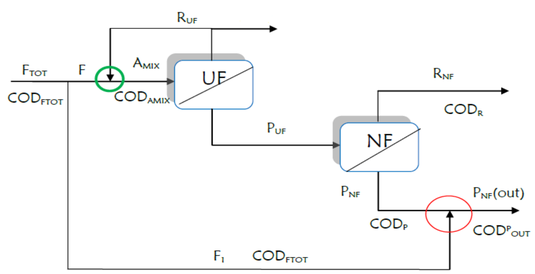

Figure 1 Process scheme of membrane plant with ultrafiltration and nanofiltration: the feed is partially sent to the permeate of the nanofiltration

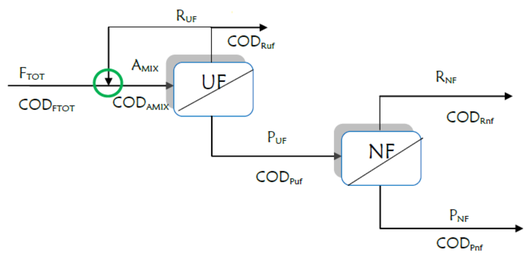

Figure 2. Process scheme of membrane plant with ultrafiltration and nanofiltration

Figure 3. Pilot plant of nanofiltration

Figure 4. Pilot plant of ultrafiltration

Results

Results from material balance show that in the first plant, it is found that for the ultrafiltration the value of retentate and permeate flow rate, membrane area and VCR are equal to 27 m^3/h, 32 m^3/h, 797 m^2 and 2.2 respectively. For the nanofiltration the value of retentate and permeate flow rate, membrane area and CVR are respectively equal to 11.4 m^3/h, 21 m^3/h, 1711 m^2 and 2.8. The COD at the exit of the system is 197 mg/l. The energetic cost is 57300 €/year.

	Temperature (°C)	pH	TDS (g/l)	Conducibility (µS/cm)	COD (mg/l)	SO_4 (mg/l)	Tensioattivi (mg/l)	Fenoli (mg/l)
Feed	24,70	7,19	5,13	9900,50	435,89	878,22	4,72	4,72
Permeate	25,73	6,10	4,74	8742,25	95,19	421,38	2,40	1,47
Retentate	25,76	6,15	5,84	11853,63	963,88	1922,25	4,47	11,58
Retention (%)			19	26	90	78	46	87

Table 1. Analysis of nanofiltration system in the first plant

In the second plant, for the ultrafiltration, the value of retentate and permeate flow rate and membrane area are respectively 33.5 m^3/h, 40.3 m^3/h and 2155 m^2. For the nanofiltration, the value of retentate and permeate flow rate and membrane area are respectively 14.4 m^3/h, 25.9 m^3/h and 2155 m^2. The COD at the exit is 95 mg/l while the energetic cost is 73200 €/year. The higher cost is due to the higher flow rate at the ultrafiltration system, however the value of COD at the exit is lower and according the legislation. Figure 6 and table 3 show the better performance of these system compared to a simple nanofiltration.

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Table 2. Analysis of nanofiltration system in the second plant.

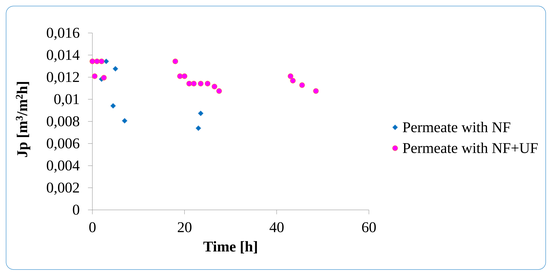

Figure 6. Permeate flux during the operation time for Nanofiltration (NF) and Nanofiltration and Ultrafiltration (NF+UF) plants

	Nanofiltration	Ultrafiltration+Nanofiltration
Media	0,0106	0,0120
Standar deviation	0,0025	0,0009
Standar error	0,0009	0,0002

Table 3. Statistical analysis of permeate flux with Nanofiltration (NF) and Nanofiltration and Ultrafiltration (NF+UF) plants

Conclusions

Future researches should verify the obtained results in a industrial plant.