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Treatment of wastewater. Removal of heavy metals by nanofiltration. Case study: Use of tfc membranes to separate cr (VI) in industrial pilot plant

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Introduction

Heavy metals are not degradable and therefore continue to remain in water. This feature makes them to be a major source of pollution [1], [2]. Membrane technology is a good solution to solve this problem, as it can be used to separate heavy metals from wastewater, allowing its subsequent reuse [3]. Nanofiltration (NF) helps to approach the ideal zero discharge processing of effluents in industrial applications. Membrane processes and thus NF can also compete with other traditional methods for the treatment of wastewater, both urban and industrial. NF can be used either to recycle water (or solutes) or to improve its disposal quality [4].

Several industries produce wastewater containing chrome (VI) [5]. The scientific research refers to the application of nanofiltration (NF) technologies to the treatment of this kind of wastewater to reduce fresh water consumption and environmental degradation.

Methods

Nanofiltration membranes made out of aromatic polyamide have been used. They are AFC80PCI (Paterson Candy International-Ltd., UK), made by the thin-film composite (TFC) method on a porous polysulfone substrate. According to the manufacturers, the recommended working temperature is below 60 ◦C, the maximum applied pressure is 6.0MPa and pH must be in the 2–11 range. Experiments were taken in the industrial pilot plant, designed and patented by the IPFM Research Group at the University of Cantabria [6]. With this aim, synthetic samples containing Cr (VI) ions at various concentrations (1-120 ppm) were prepared and investigated. Total recirculation was used with both permeate and concentrated returning to the feed tank to stationary conditions. Pressures up to 4MPa were used with a feed cross-flow around 800 L/h at a temperature of 25 ◦C.

Results

Table 1 shows the rejection values for Cr (VI) as a function of concentration andpressure of operation. The results achieved showed the high efficiency of NF process for the removal of heavy metals, with a high rejection R, for Cr(VI) >95% for a feed concentration from 1 - 120ppm.

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Table 1. Rejection of Cr (VI) at different feed concentrations and operating pressures.

Feed concentration (ppm)	Rejection (%) at different						
	10	15	20	25	30	35	40
1	95,5	95,5	96,1	96,4	96,9	97,4	97,6
20	97,4	97,6	97,7	97,8	97,9	98,1	98,2
40	97,9	98,0	98,0	98,2	98,3	98,4	98,4
60	98,4	98,5	98,6	98,6	98,7	98,7	98,7
80	98,3	98,4	98,4	98,5	98,6	98,6	98,6
120	98,4	98,4	98,4	98,5	98,5	98,6	98,6

Discussion

The low level of Cr (VI) concentration at the permeate, obtained in a single stage (among 0.04 and 1,9 ppm respectively), implies that water with good quality could be recovered for further reuse. In order to allow the exchange of scale and its further industrial application, tests with aromatic polyamide commercial membrane TFC- AFC80^{PCI} (thin film composite) were made in the industrial pilot plant.

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