

MEMBRANE BIOREACTOR TECHNOLOGY FOR THE REMOVAL OF ORGANIC POLLUTANTS. COMPARISON WITH CONVENTIONAL WASTEWATER TREATMENT

D. Camacho-Muñoz^{1*}, J. Martín¹, J.L. Santos¹, I. Aparicio¹, E. Alonso¹, T. de la Torre², C. Rodríguez², J.J. Malfeito²

¹Department of Analytical Chemistry, University of Seville, C/ Virgen de África, 7. E-41011 Seville (Spain), ealonso@us.es

²Acciona Agua S.A.U. Avda. de les Garrigues, 22. E-08820, El Prat de Llobregat, Barcelona (Spain)

Abstract

One of the major issues in the aquatic environment is the presence in wastewater of several micropollutants at trace concentration levels. In this work, the removal of several families of microcontaminants during wastewater treatment processes based on membrane bioreactor technologies (MBR) has been evaluated. The families of micropollutants studied were linear alkylbenzene sulphonates, nonylphenols, di(2-ethylhexyl)phthalate and pharmaceutically active compounds. The results showed that the MBR showed slightly higher removal rates than those found in the conventional WWTP. No significant differences were observed between the removal of both studied membrane configurations (hollow fiber and flat sheet).

Keywords: micropollutants; wastewater treatment plants; membrane bioreactor

Introduction

At present, one of the most relevant aspects in the environment is the water quality. The quality of surface water is seriously affected by the discharge of wastewater treatment plants (WWTPs). During wastewater treatment, the organic matter present in wastewater is removed; however, there are a lot of pollutants that the conventional wastewater treatments are not able to eliminate. The treatment of wastewater requires some complementary techniques that could efficiently remove pollutants and enable the wastewater to be discharged into receiving water, especially in small communities in which wastewater effluent are frequently discharged to streams affecting agricultural or sensitive areas. The membrane bioreactor (MBR) technology integrates biological degradation of organic matter present in wastewater with membrane filtration. These membrane processes achieve

high efficiencies in removing organic and inorganic pollutants and can replace or even may operate together with the traditional methods for advanced treatment of wastewater in small communities.

In this work, our research group together with Acciona Agua has studied the removal of several families of microcontaminants during wastewater treatment processes based on membrane bioreactor technologies. These results have been compared with the removal achieved during conventional wastewater treatment. The studied compounds were di(2-ethylhexyl) phthalate (DEHP), nonylphenol (NP) and nonylphenol ethoxylates with one (NP10) or two (NP2EO) ethoxy groups (NPEs), the LAS homologues C10, C11, C12 and C13 and 16 pharmaceutically active compounds.

Methods

The experimentation has been carried out in two pilot-scale bioreactors operating in parallel and treating real wastewater from an urban area sited in Andalusia region (South of Spain). The two membrane bioreactor technologies (SRT 20 days) studied were hollow fibre membrane (HFM) and flat plate membrane (FPM). Results obtained during membrane bioreactor processes were compared with those obtained in conventional wastewater treatment plants (SRT 10 days) operating in the studied area.

Influent and effluent wastewater samples from each of the membrane processes studied were analyzed from July 2009 to May 2010. Influent and effluent samples from conventional WWTP were analyzed during September 2009. Analysis of LAS, NPE and DEHP was based on solid phase extraction and determination by high-performance liquid chromatography with diode array and fluorescence detectors as previously is reported by González *et al* (2010). Analysis of pharmaceutically active compounds was carried out according to the method reported by Camacho-Muñoz *et al.* (2009).

Results and discussion

All the families of organic compounds studied were detected in influent and effluent samples from all wastewater treatment processes. LAS were the micropollutants found at the highest concentration, followed by DEHP, NPE and pharmaceutically active compounds, in that order. All pharmaceutically active compounds, except the antibiotics trimethoprim, and the estrogen estrona, were detected in influent and effluent wastewater. The highest concentration levels were found for anti-inflammatory drugs, especially acetaminophen and ibuprofen. The hormones 17 α -ethynylestradiol, 17 β -estradiol and estriol were found in the 46, 23 y 27 % of the analyzed wastewater influent samples at concentration levels up to 2.97, 0.93 y 1.68 $\mu\text{g}/\text{L}$, respectively.

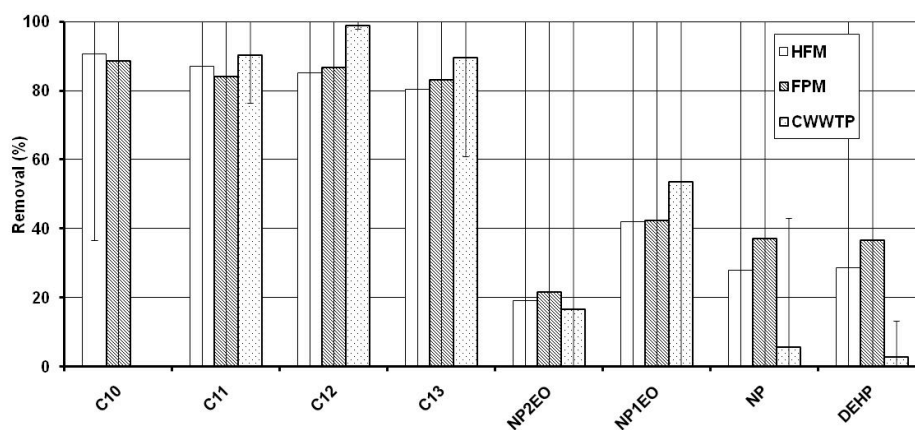


Figure 1. Removal rate of LAS, NPE and DEHP in HFM, FPM and conventional WWTP (CWWTP).

Figures 1 and 2 show the removal rate of LAS, NPE and DEHP and pharmaceutically active compounds, respectively, achieved with the MBR and with the conventional wastewater treatment plants. The membrane processes studied showed higher removal rates than those measured with the conventional WWTP. The highest removal rates were found for LAS homologues (higher than the 83 %). Nonylphenolic compounds NP, NP1EO and NP2EO, showed removal ranges of 19–28 % and 22–37 in HFM and FPM, respectively. Pharmaceutically active compounds were removed in the ranges 25–99 % and 7–99 % for HFM and FPM processes, respectively. Carbamazepine showed the lowest removal rates, while antiinflammatory drugs showed removals higher than 53 %. These removals were higher than those measured in conventional WWTP, especially for those compounds with the lowest removal rates, such as ketoprofen, carbamazepine and propranolol.

With regards to both MBR technologies, significant differences in the removal efficiencies were not observed in the case of the studied families of organic compounds.

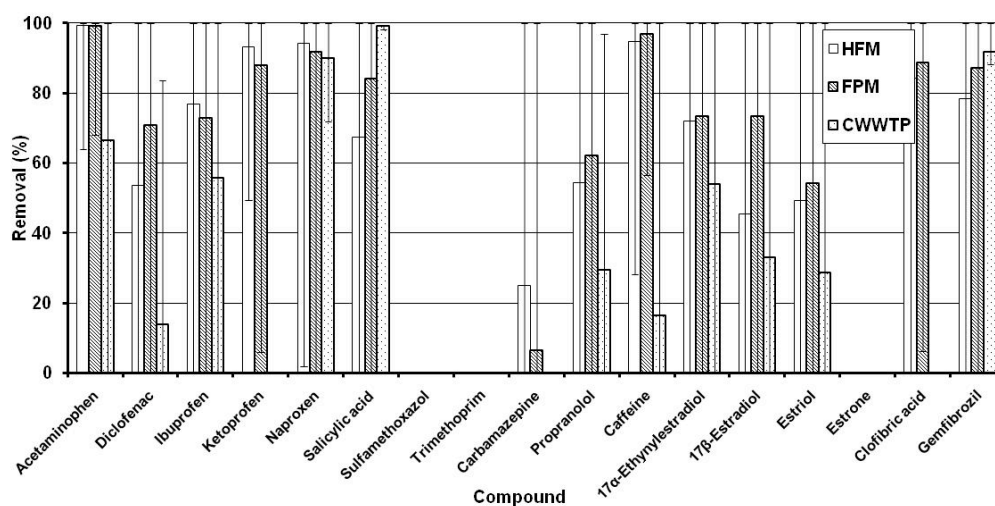


Figure 2. Removal rate of pharmaceutically active compounds in HFM, FPM and conventional WWTP (CWWTP).

Conclusions

The occurrence of several families of organic compounds including LAS, NPE, DEHP and pharmaceutically active compounds has been studied in conventional wastewater treatment plants and in membrane bioreactor technologies. All studied families of compounds were detected in wastewater influent and effluent. With regards to the removal of contaminants during wastewater treatment, the results showed that MBR technologies presented removal rates slightly higher than those found in conventional WWTP. However, significant differences were not observed in the removal of organic compounds measured in HFM and FPM.

Acknowledgements

The authors thank Acciona Agua for the financial and technical support of this work.

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