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Use of nanofiltration membrane technology for ceramic industry wastewater treatment

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Summary

Water management has become an increasingly critical issue in most traditional industrial sectors, owing to the large quantities of wastewater they produce. In the case of the ceramic tile industry, most of the wastewater arises in the washing operations of the facilities used for the preparation and application of glazes and other coatings.

The composition of these ceramic industry wastewaters varies widely and may include suspended solids and electrolytes of very different nature, as well as organic substances that mostly come from the additives used in decorating the tiles. However, the treatment techniques that are currently used (generally physico-chemical treatments) are not entirely effective, in particular with regard to non-biodegradable organic compounds that increase the water COD, certain ions such as alkaline and alkaline-earth cations, boron compounds, chlorides, sulphates, etc. This inadequate wastewater treatment makes it impossible to reuse this water in the same production process and may even impede water discharge. As a result, this water needs external handling or additional treatment, entailing high economic costs and/or environmental impact.

A study has therefore been undertaken of an advanced wastewater treatment approach using polymer nanofiltration membranes, in an attempt to obtain water of sufficient quality to allow it to be reused in the same production process or, alternatively, to be discharged without any problems into the receiving medium.

Based on the chemical composition of several samples of wastewater from the ceramic sector, the present study has initially focused on the removal of organic matter (reduction of COD) and the most representative ions present in the wastewater, such as Na^+, Mg^{2+}, Cl^-, and SO_4^{2-}. Boron compounds were not included in the study because the wastewater containing these needs to undergo a pre-treatment.

In a first part of the study, with a view to optimising the experimental phase, a simulation has been performed of the nanofiltration process using the Nanoflux® software. Among other things, the simulation allows the most suitable membranes to be selected as a function of the permeate flow rate and desired level of retention in the substances to be removed. The subsequent experimentation was carried out in a laboratory tangential filtration system that works with flat membranes.

In the experiments conducted with different wastewaters, using two membranes with different characteristics, it was found that, under optimum operating conditions, retention values of about 90% were obtained for the studied substances, with a good permeate flow rate, using low operating pressures compared with those of the reverse osmosis process. These results demonstrate the feasibility of the studied technology and its potential as a treatment for improving ceramic industry wastewater quality.

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