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Selective separation of contaminants from paper mill effluent using nanofiltration

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ABSTRACT

Biologically treated newsprint mill effluent containing 57 mg L^{-1} DOC and 1430 TDS was used in a screening study of nine commercial NF membranes for use as pretreatment for reverse osmosis in an end of pipe water recycling application. A salt-organic-separation (SOS) efficiency factor was developed to help rank the performance of the membranes. The SOS measures the ratio of the sum of the percentage rejection of organics and divalent cations over the percentage rejection of monvalents. It can be used to discriminate between NF membranes that are not too permeable to divalent cations or organics in which case the NF permeate will have a high chlorine demand due to the carryover of organics, or too retentive in which case all the material in the effluent will be retained and fouling problems are likely to occur. The optimum SOS efficiently for this study appeared to range from 3.5 to 5.6 for six membranes, DK, HPA-150, ESNA1-LF2, DL, TFC-SR2 and NF-270, which were categorised as membranes with an intermediate rejection. Out of these membranes ESNA1-LF2, TFC-SR2 and NF-270 were capable of operating up to 90% recovery with high permeabilities ranging from 17.7 to 22.3 L m^{-2} h^{-1} bar^{-1}.

Additionally, impact of membrane surface properties, such as molecular weight cut-off, surface charge and hydrophobicity, was assessed on the fouling and SOS efficiency. The molecular weight cut-off was found to have a correlation with the fouling potential of the membranes, while none of the surface properties had any correlation with the SOS efficiency.

Keywords: Nanofiltration; Paper mill effluent; Salt-organic-separation; Recycling; Membrane

1. Introduction

The paper manufacturing industry is the third largest industrial water user in Australia (Australian Bureau of Statistics, 2007). For example one mill, the Norske Skog (NSA) newsprint mill, located on the river Murray in southeast Australia consumes between 8.5 and 9.0 m^3 of water per tonne of paper produced (Richardson et al., 2008). Even though NSA's water consumption is below industrial best practice of 12–20 m^3 per tonnes of paper produced (Thompson et al., 2001), recent drought conditions in south east Australia have motivated the company to further reduce the use of surface water. Consequently, NSA is assessing the possibility of using membrane technology in an end of pipe solution to minimise fresh water consumption by reusing the biologically treated effluent that is currently discharged into the river.

Newsprint mill effluent is a complex mixture of organic compounds and inorganic salts. The reuse of effluent for boiler make up and steam generation requires the removal of both salt and colour (Mänttäri and Nyström, 2007), while removal of organics is important for reuse in pulp bleaching and chemical make up applications. Therefore, it is necessary to remove both salts and organics to maximise reuse potential in the newsprint mill.

Biological treatment does not remove the organics which contribute to colour or chlorine demand in the treated effluent. Reverse osmosis and nanofiltration can be used on internal waste streams as well as the end of pipe in the paper

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