Sustainable chromium removal by nanofiltration membranes: application of pore flow model

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Abstract

Pure water availability has become a real dilemma in last few years owing to the growing water consumption. Contaminated water treatment techniques are developed with various efficiencies. This differences in efficiencies are mainly related to operating and constructive issues. In this paper, pore flow approach was used to assess the efficiency of NF membrane (AFC 80) in removing chromium ion from aqueous solution. Moreover, it is also benefit to address the sustainability aspect of NF separation process. In this regard, DSPM-DE model combined with concentration polarization model (CP) was applied to predict Cr(VI) retention and specific energy consumption (SEC) at different operating conditions. This model allowed to characterize (AFC 80) membrane in terms of charge density, which differs from – 20 to -120 mmol/m3, and pore dielectric constant of 50. It is observed that concentration polarization effect can be avoided by using feed velocity higher than 0.4 m/s, which results in chromium retention value higher than 95%. The simulated retention values are fitted very well with the previous experimental results, which confirms the reliability of this modeling approach. At higher feed flow, SEC increased by factor of 15–19 times higher than that at lower feed flow of 0.1e-4 m3/s. Then, operation at moderate feed flow and pressure is recommended to achieve targets of high productivity and lower energy consumption. Ultimately, the proposed model can be used to predict performance of NF process at membrane scale as well as at module scale.