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Optimal aggregate size distribution for the formation of highly efficient nanosheet dynamic membranes

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Abstract

In this work, intrinsically-porous aggregates of nanosheets having mono-, di-, and tri-modal particle size distributions were synthesized to produce densely-packed dynamic membranes. Alumina nanosheets were synthesized in 0, 25, and 50 vol% ethanol-water mixtures (Al-0, Al-25, and Al-50, respectively). Using dynamic image analysis, it was determined that the alumina nanosheets twinned to form aggregate superstructures of distinct size distributions at each synthesis condition. The aggregates were intrinsically porous with three-dimensional pore connectivity. Dynamic membranes (DMs) were formed by the deposition of these aggregates on a substrate. The effect of ethanol content in the synthesis mixture on the performance of the DMs was investigated during the constant-pressure filtration of a bentonite solution. The results show that the Al-50 DM had the best performance based on flux and turbidity removal. The Al-50 DM reached the required turbidity level of <0.10 NTU at a flux that was 177% and 12% higher than the fluxes obtained by the Al-0 and Al-25 DMs, respectively. The superior performance of the Al-50 DM was explained by the presence of three aggregate size distributions providing optimal packing in the synthesized material. This reduced interstitial pores and resulted in a packing density of 74.7 –78.5% versus 54.0 – 54.2% for Al-0.

Keywords: alumina nanosheets; dynamic membrane; sphere packing; bentonite; turbidity