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Characteristics of ion exchange and filtration processes in the zeolite-enhanced membrane microfiltration

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ABSTRACT

Ion exchange between the sodium ions from zeolite A and calcium ions from solution was studied as a part of planned water cleaning and softening process which combines zeolite ion exchange with constant flux membrane microfiltration. In the process the membrane provides a positive barrier to high concentrations of both natural solids and zeolite, while the added zeolite simultaneously assists in the removal of dissolved compounds such calcium divalent ions. Both the kinetics and the equilibrium were determined by measuring concentrations of Ca^{2+} ions in the liquid phase during the exchange process. The capacity of the zeolite studied [synthetic zeolite ZP-4A (SILKEM, Kidričevo, Slovenia)] was around 100 mg/g as Ca^{2+}. The ion exchange process was rapid and non-linear. The equilibrium was well described by UNILAN model and the kinetics by Ho–McKey's model. The specific resistance of zeolite filtration cake which was created on the membrane surface decreased significantly from 5.5×10^{10} m/kg to 1×10^{10} m/kg with the increasing amount of calcium ions loaded inside the zeolite particles. Measurements of ζ-potential and the size of zeolite particles have been carried out to examine the reason for the decrease of specific filtration cake resistance. -potential of zeolite particles increased from –60 μV for fresh sodium loaded zeolite to nearly zero for fully calcium loaded particles. The decrease of the particles surface charge resulted in agglomeration into large clusters. The size of the original zeolite particles was in interval from 2 μm to 10 μm while agglomerates were larger than 100 μm. Filtration cake formed from these agglomerates was more permeable and the specific filtration cake resistance decreased.

Keywords: Ion exchange; Microfiltration; Zeolite; Hollow fiber; Water; Softening

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