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A multiphase approach to model ultrafiltration of deformable colloids MALAVIKA HARIBABU, DAVE DUNSTAN, MALCOLM DAVIDSON, DALTON HARVIE, Department of Chemical Engineering, The University of Melbourne — Ultrafiltration (UF) is widely used in the dairy industry to fractionate and concentrate proteins, during the manufacture of milk protein concentrate and cheese. The protein build-up, comprising casein micelles (CM) and whey proteins, at the membrane surface during UF increases the resistance of the membrane system, thereby decreasing the performance of the process unit. CM have a complex structure that hydrodynamically behaves as a hard-sphere when dilute, but deforms beyond the random packing limit, forming a shear-thinning gel. This study employs a mixture model, based on the mixture phase continuity, Navier-Stokes equations, and solids continuity equation, to predict the solid concentration and velocity distribution during UF of CM. Micelle deformation is modelled as a function of volume fraction and dependent on its elastic modulus and particle size. The effect of deformation on gel permeability is implemented via Happel's permeability for hard spheres. Under crossflow conditions, the gel thickness is observed to increase along the membrane length, followed by a decrease towards the end of the membrane, resulting in an increase in flux at the latter section of the membrane. This study demonstrates that the membrane end-effects are important in determining UF performance.

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