Computational fluid dynamics analysis of a tubular pervaporation membrane module for ethanol dehydration

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In this study, a computational fluid dynamics (CFD) technique is applied to model and analyze the transport of a fluid flow through a tubular pervaporation membrane module for ethanol dehydration using FLUENT. A compressible multiphase model is chosen for continuity, Navier-Stokes, and energy balance equations, and a turbulent flow is assumed for the liquid phase. Partial permeate fluxes are determined for given operating conditions with a permeance model based on the sorption-diffusion mechanism with an Arrhenius term for the temperature dependency. For this numerical method, the geometry creation and mesh generation are done with GAMBIT preprocessor for the module, and the mass fluxes through the membrane are defined with custom developed user-defined functions (UDFs). The results of CFD modeling show the flowfield on feed and permeate sides of the membrane that is characterized in terms of velocity, pressure, temperature, and mass fraction profiles.