Amgen Seminar Series in Chemical Engineering

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Characterization of Structured Packing via Computational Fluid Dynamics

By

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CFD simulations were used to study single phase and multiphase flows through structured packing. Simulations utilizing a high fidelity, digital copy of a packing element were validated against experimental results for both single phase and multiphase flows. Single phase simulations were carried out on a variety of periodic packing elements to examine the impact of packing channel geometry on pressure drop. Multiphase simulations on periodic elements were used to examine the effect of hydrodynamic properties and boundary conditions.

Single phase simulations of nitrogen flow through the high fidelity geometry produced via X-ray CT scans showed average deviations less than 15% when compared to experimental measurements. This error was reduced to 7% when a mesh utilizing prism layers to accurately resolve the boundary layer was used. With a validated model mfor single phase flow, the application of CFD to packing design was investigated on periodic geometries with varied packing parameters (e.g. channel corrugation angle and channel side length). It was found that current industrial packings have channel geometries maximizing pressure drop, indicating some degree of optimization around channel geometry is possible depending on separation needs.

Multiphase simulations using the Volume of Fluid model examined the effects of liquid density, viscosity, surface tension, and contact angle on small-scale packing geometries. Contact angle had the most pronounced influence on predicted wetting, and simulations demonstrated that using experimentally determined static contact angles was not an appropriate choice for the simulation contact angle. The predicted influence surface tension qualitatively matched experimental data for wetted area. Liquid viscosity and density also demonstrated qualitative agreement with semi-empirical models derivedfrom experimental data.

Experimental data collected via absorption of CO2 into 0.1 mol/L NaOH was compared to simulation predictions using a geometry generated via X-ray CT scans. Wetted area predictions matched experimental data best when a fully wetting static contact angle (0°) was used, yielding predictions that were 3.4% lower than experimental data on average. Irrigated pressure drop and holdup predictions were significantly higher than experimental data.

Bio: Dr. Eldridge currently serves as Program Head of the James R. Fair Process Science and Technology Center and as a Distinguished Senior Lecturer in the Department of Chemical Engineering at The University of Texas at Austin. In his capacity as PSTC Program Head, he coordinates the activities of a full-time technical staff and oversees a research effort with a yearly budget exceeding $ 1mm. As Distinguished Senior Lecturer, Eldridge teaches courses covering traditional chemical engineering concepts in fluid flow, heat and mass transfer, and process design.

Outside the university, Eldridge is a Fellow of AIChE and has served as Chair of the AIChE Separations Division and Chair of the Bartlesville, Oklahoma AIChE chapter. Awards include Young Engineer of the Year from the Oklahoma Society of Professional Engineers, membership in the University of Arkansas Academy of Chemical Engineering, and recipient of the Stice, Wissler, Schechter undergraduate teaching award from the UT Department of Chemical Engineering.

Eldridge and his wife, Kathleen Dyre, have two daughters. Outside interests include coordinating church related mission activities and bicycling.

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