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Learning Engineering through Research on Multidisciplinary Topics

Assisting graduate students has led to participation in diverse research projects, which enhanced comprehension of engineering concepts. The projects included differential pressure measurements in partially saturated porous media flows, growing of biofilms for magnetic resonance imaging analysis of oxygen distribution and particle size distribution during hydrate formation. Two-phase flow is common in hydrology and oil recovery. The objective of this research is to compute the pressure drop across a packed bed at varying flow rates. Previous research from collaborators in Norway concluded the pressure scaling for steady-state two-phase flow in porous media is proportional to the capillary number raised to a constant β. Capillary number is a dimensionless number that relates the viscous forces to the capillary force. It was observed at the low Ca regime the experimental data scaled at 0.55 and 0.96 in the high Ca regime. Biofilms are communities of microorganisms within self-secreted extracellular polymeric substance matrices. Oxygen concentration gradients impact biofilm growth and persistence in chronic wounds. In this project, 19F MR oximetry was used to measure bulk and spatially resolved oxygen profiles in the HFB agarose gel system. The data provides the means to test classic models of reaction and diffusion in biofilm systems. Hydrates are crystalline compounds that form when hydrocarbon and water molecules come into contact at low temperatures and high pressure. However, the process of hydrate formation is not well characterized. In this project, model hydrates are made using ice and cyclopentane by increasing the temperature from -20˚C to 1˚C. NMR measurements were used to determine the diffusion coefficients and droplet size distribution through Matlab.

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