PhD Seminar Abstract

Morgan Lehtinen

"Developing Janus Filters for Real-World Separation of Oil from Surfactant-Stabilized Emulsions"

According to the United Nations Sustainability Development Goals, which address global challenges that require immediate attention to ensure a prosperous and peaceful planet today and in the future, a common theme is the need for sustainable water resources. A major industrial problem that directly impacts our water quality is the difficulty in separating oil and/or water from contaminated, surfactant stabilized, oil-in-water emulsions. These stable emulsions can occur in the ocean after an oil spill, in restaurant wastewater polluted with greases and fats, or as lubricant or metal cutting fluid discharged in automotive manufacturing. Lacking the appropriate technology to separate these industrial emulsions on site, they are either sent away for tedious, expensive treatment processes, or as a last resort disposed of directly into our environment.

Janus filters, named for the Roman God of Two Faces to depict their asymmetrical structure, have shown tremendous potential as a low-cost, green alternative for rapid emulsion separation. Existing Janus filters that bear a de-emulsifier on one side and a hydrophobic polymer on the opposite side can break oil-in-water emulsions and selectively separate the coalesced oil. Though effective, the early generations of Janus filters were not ideal for real-world application due to the tedious syntheses of the polymers used and the troublesome fabrication protocols of the coatings as well as lack of perfect control in the structures and properties of the produced filters.

This seminar will cover a commercialization-directed approach to designing, optimizing, and externally validating a portfolio of Janus filters for real-world applications. Filter development focused on integrating new findings from a detailed study of the Janus filtration mechanism, with features to address common membrane challenges, such as biofilm formation; and fast, industrially approved coating procedures on various substrates. To broaden our understanding and provide an additional perspective, we have combined both science and business by assessing the commercial viability through supplementary techno-economic analysis, market research and customer discovery.