High-temperature drop breakup studies for the water-bitumen system

Background: This project will contribute to a larger project sponsored by the oil sands company, Syncrude Canada Limited. In the oil sands industry, the presence of water in bitumen is highly undesirable in downstream unit operations. However, conventional separation methods such as centrifugation and inclined settling are ineffective in removing extremely fine water droplets, which can form a significant fraction of the residual water content in bitumen after separation. In the interest of removing this water, it is important to comprehend how these small water drops can be generated in bitumen in the first place. Unfortunately, the mechanisms of formation of extremely fine, emulsified water droplets have remained poorly understood in the literature due to the complex nature of the bitumen system. In order to fill this gap, we have developed novel microfluidic platforms in our lab to study the emulsification mechanisms. We have already demonstrated the formation of extremely fine water droplets in bitumen via two mechanisms, tip streaming and drop fracture mechanisms at room temperature. The former study has been published in the Fuel journal. Please, follow the link given below to read more about this work.

http://www.sciencedirect.com/science/article/pii/S0016236116302186

Since the oil sands industry operates at relatively high temperature (65- 80 ^{o}C), we, now, plan to perform these breakup studies at higher temperatures. In order to achieve this, we have integrated a Peltier device with our microfluidic devices, which allows us to do experiments at higher temperatures. Some preliminary tip streaming experiments at a higher temperature have successfully been conducted in the lab.

Objective: This project includes performing tip streaming and drop fracture experiments using in-house developed microfluidic devices at a higher temperature. This study will aid to locate the operating conditions, which can facilitate the formation of the extremely fine water droplets in concentrated bitumen solutions.

Deliverables:

- Conducting tip streaming experiments at higher temperatures for different bitumen concentrations and pH of water
- Performing drop fracture experiments at higher temperatures for different bitumen concentrations and pH
- Analyzing and compiling experimental data

Work Experience: Experience with experimental work in a research lab is desirable.

Work Load: Approximately an average of 20 hours per week for 8 months. The last two months will be used to compile the thesis and do additional experiments and analysis to complete the thesis.

The project start date is January 2018.

Contact: Arun Ramchandran at arun.ramchandran@utoronto.ca