Contribution ID: **442** Type: **Oral Presentation**

Spatio-temporally Resolved Dynamical Transitions in Flow of Pickering Emulsions through Porous Media

Thursday, 25 May 2023 09:45 (15 minutes)

Imaging fluid flows provides valuable physical insight, especially for complex fluids as emulsions, foams and dispersions. Unfortunately, high temporal and spatial resolution of flow in porous media still poses a grand challenge. In this study, we present a multiscale approach to study the spatio-temporal flow dynamics in realistic porous media of Pickering emulsions stabilized using attractive desulfated cellulose nanocrystal nanoparticles.

We take advantage of the rapid scan rate of a laser scanning confocal microscopy (LSCM) to capture flow through 3D granular porous media at high spatial and temporal resolution. We show that steady flow of such emulsions exhibits large-amplitude oscillations in pressure gradient which cannot be explained by geometric straining models, filtration models, or continuum rheological models. Using a custom-built micro-sandpack apparatus coupled with confocal microscopy, we present measurements that reveal localized spatio-temporal flow patterns of emulsions characterized by: particle attachment and deposition to nearby grains, droplet deposition, jamming of droplets within the throat, and release. The deposition/jamming/release is cyclical and corresponds precisely to the gradual-then-rapid changes in pressure gradient. The relative influence of particle loading on reducing the overall permeability of porous media and pressure gradient signature was evident. With higher particle loadings, the existence of nanoparticle deposits leads to more effective reduction of relative permeability of porous media and substantially higher pressures gradients were required to release the emulsion plugs.

Photonic force microscopy confirms the strength of droplet-droplet attraction and also reveals a new phenomenon, the formation of chains of nanoparticles which tether droplets together. The chains preserve strong attraction between droplets at nonzero separation distance and are likely to contribute to the persistence of droplet attachment to grains and of droplets deposited on droplets, which facilitates jamming.

These observations contribute to a growing body of evidence indicating complex spatiotemporal dynamics of Pickering emulsion flow through porous media, which cannot be described by the existing models. Flow of emulsions through porous media is important across a spectrum of scientific fields and applications including drug delivery, agriculture, oil and gas, and water treatment. With an initial application of a powerful multiscale approach, we provide measurements of evolving emulsion microstructure, local droplet velocity, precise measurement of droplet-droplet interaction, and lay a foundation to answer open questions about Pickering emulsion flow through porous media.

Participation

In-Person

References

MDPI Energies Student Poster Award

No, do not submit my presenation for the student posters award.

Country

Canada

Acceptance of the Terms & Conditions

Click here to agree

Energy Transition Focused Abstracts

This abstract is related to Energy Transition

Primary authors: TRIFKOVIC, Milana; BRYANT, Steven; MEIMANOVA, Aigerim; MARTIN-ALARCON, Leonardo; YANG, Guofeng; KINKEAD, Brandy; GOVEDARICA, Aleksandra

Presenter: TRIFKOVIC, Milana

Session Classification: MS10

Track Classification: (MS10) Advances in imaging porous media: techniques, software and case studies