Contribution ID: **769** Type: **Oral Presentation**

Pore-scale simulations of water droplet interaction with a hydrophobic wire screen for purpose of Water-Diesel separation

Thursday, 3 June 2021 15:25 (15 minutes)

The new constraints for reducing hazardous emissions and sustainable fuel production led to an increased usage of ultra-low-sulfur diesel (ULSD) and bio-diesel. Such fuels have a significantly lower surface tension coefficient in comparison to Diesel. Consequently, the design of separators in diesel fuel filters meeting today's performance requirements imposes a challenge to the developing engineer and for suitable simulation techniques. The challenge in modeling and simulation of such systems is that different parameters of the microscale control the overall performance of water-diesel separators. On the microscale, the fiber radius is considered as the dominant length scale. Droplet sizes and shapes should be resolved for accurate computation of the pressure and velocity fields. A sequence of successive coalescence on the microscale leads to the formation of large droplets, which fall down through the gravitational force. This transport is known as drainage. In the case of high adhesive force, the droplets do not fall down. Large droplets that do not have enough gravitational force are ruptured and the overall pressure drop increases significantly.

The presentation is devoted to the modeling and simulation of the interaction between the water droplets and the separator screen taking into account different parameters: geometric properties of the mesh, contact angle, surface tension coefficient, inflow velocity, and droplet radius. First, we quantify the shape of the droplet in different flow scenarios. Secondly, we fit the drag coefficient and the overall pressure drop for a single water droplet partially clogging a wire mesh based on the shape of the droplet. We also quantify the maximum pressure drop at which rupture of droplets occurs. Finally, we quantify the largest droplet that can be held by a mesh before drainage occurs and its corresponding drainage velocity. The simulations are carried out using the finite volume computational fluid dynamics library OpenFOAM®. We use a new scheme for the accurate computation of surface tension force [1].

These results help to develop a simplified description of the dynamics of water droplets interacting with a mesh screen. Applying a proper mathematical averaging technique will lead to an averaged description of the collective dynamics and building a macroscopic model that is capable of estimating the performance of the Water-Diesel separator in a specific application.

Time Block Preference

Time Block B (14:00-17:00 CET)

References

O. Elsayed., S. Antonyuk., R. Kirsch., and S. Osterroth., "Computer-aided study of the Diesel-water separation efficiency of screen meshes,"in FilTech, 2019.

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