Dispersion of particles induced by microdroplet impact on a liquid film

Contract : Post-doctorate

Duration : 18 months

Laboratory : Institut de Mécanique des Fluides de Toulouse (collaboration with TotalEnergies)

Context of the study:

TotalEnegies owns several deep-sea oil wells connected to underwater ducts in cold environment. The circulating fluid contains paraffin, whose solidification temperature is higher than the fluid temperature but can be smaller than the wall duct temperature. Thus, in specific condition, a solid deposit can grow at the duct wall by solidification of the paraffin. It is important to predict the development of such solid deposits as they can reduce the apparent section of the duct. The model used by TotalEnergies is strongly dependent on the paraffin flux to the duct wall which is not well understood leading to inaccurate predictions.

In the duct, the flow pattern corresponds to an annular film that is sheared by a high-velocity gas flow that entrains small oil droplets. These droplets, that contain paraffin crystals, eventually impact the annular liquid film inducing dispersion of the paraffin crystals. This project aims to study the consequence of such an impact on the paraffin distribution inside the oil annular film.

Objective and scientific approach:

This study aims to qualify experimentally how small solid particles contained in droplets are dispersed by the impact on a liquid film. The liquid film of thickness H is formed in a transparent container and droplets of diameter D, containing solid particles of diameter d (d<<D) will be launched at velocity V on the liquid film with an angle ϴ thanks to a piezoelectric device that induces a shock wave[1]. This phenomenon is controlled by the Weber number $We = \frac{\rho V^2 D}{\sigma}$, the Ohnesorge number $Oh = \frac{\eta}{\sqrt{\rho \sigma D}}$, the relative depth *h*/*D* and the impact angle ϴ, where ρ , η and σ are the liquid density, viscosity and surface tension, respectively. Depending on the value of these parameters, the droplet impact can result or not in a splashing[2,3,4]. In this study, we will vary the droplet size (around 100 µm), velocity (~1m/s), the impact angle and the liquid film thickness (from 100 µm to a few mm). For the different impact regimes, the solid particles distribution in the liquid film will be studied to better understand the contribution of droplet impact on the enrichment of solid particles near the container wall.

Required profile:

In this project, we seek for a highly motivated candidate with a strong background in fluid mechanics and in the associated experimental techniques (High speed imaging, image processing…). The post-doctorate will have to:

- Participate in the building and characterization of the experimental setup
- Perform the experimental campaigns
- Analyze and model the results

Interested candidates have to contact Julien Sebilleau (julien.sebilleau@imft.fr), Frédéric Risso (frederic.risso@imft.fr) and Thierry Ondarçuhu (thierry.ondarcuhu @imft.fr).

Références :

1. Visser, C. W., Tagawa, Y., Sun, C. & Lohse, D. Microdroplet impact at very high velocity. *Soft Matter* 8, 10732 (2012).
2. Che, Z., Deygas, A. & Matar, O. K. Impact of droplets on inclined flowing liquid films. Phys. Rev. E 92, 023032 (2015).
3. Castrejón-Pita, J. R., Muñoz-Sánchez, B. N., Hutchings, I. M. & Castrejón-Pita, A. A. Droplet impact onto moving liquids. *J. Fluid Mech.* **809**, 716–725 (2016).
4. V. Gielen et al, Oblique Drop impact onto a deep pool, *Phys. Rev. Fluids*, **2** (2017) 08360