TWO-PHASE HOMOGENEOUS SHEAR TURBULENCE

Marco E. Rosti[1], Zhouyang Ge[1], Suhas S. Jain[2], Michael S. Dodd[2] and Luca Brandt[1,3]
[1] *Linné Flow Centre and SeRC, KTH Mechanics, Stockholm, Sweden*
[2] *Center for Turbulence Research, Stanford University, USA*
[3] *Department of Energy and Process Engineering, Norwegian University of Science and Technology (NTNU), Norway*

The understanding of turbulent two-phase flows with bubbles and/or droplets is important in many natural and industrial processes, e.g. rain formation, liquid-liquid emulsion, spray cooling and spray atomization in combustors. In these flows the turbulence is altered by the droplet feedback on the surrounding fluid and by droplet-droplet interactions. We simulate the flow of two immiscible and incompressible fluids separated by an interface in a homogeneous turbulent shear flow at a shear Reynolds number equal to 15200 with a volume of fluid method [1]. The viscosity and density of the two fluids are equal, and various surface tensions and initial droplet diameters are considered in the present study. Using a number of post-processing techniques, we will discuss the turbulence modulation in terms of statistics and flow structures. We show that the two-phase flow reaches a statistically stationary turbulent state sustained by a non-zero mean turbulent production rate due to the presence of the mean shear. Compared to single-phase flow, we find that the resulting steady state conditions exhibit reduced Taylor microscale Reynolds numbers owing to the presence of the dispersed phase, which acts as a sink of turbulent kinetic energy for the carrier fluid. At steady state, the mean power of surface tension is zero and the turbulent production rate is in balance with the turbulent dissipation rate, with their values being larger than in the reference single-phase case. The interface modifies the energy spectrum by introducing energy at small-scales, with the difference from the single-phase case reducing as the Weber number increases. This is caused by both the number of droplets in the domain and the total surface area increasing monotonically with the Weber number. This reflects also in the droplets size distribution which changes with the Weber number, with the peak of the distribution moving to smaller sizes as the Weber number increases. We show that the Hinze estimate for the maximum droplet size, obtained considering breakup in homogeneous isotropic turbulence, provides an excellent estimate notwithstanding the action of significant coalescence and the presence of a mean shear.

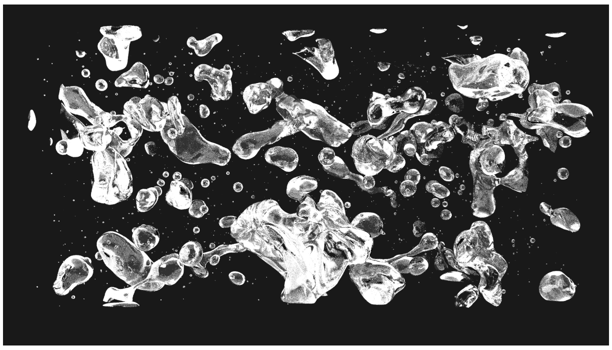

Figure 1. Visualisation of the droplets in the homogeneous shear turbulent flow.

References

[1] M E Rosti, F De Vita, and L Brandt. Numerical simulations of emulsions in shear flows. *Acta Mechanica*, **in press**, 2019.

[2] M E Rosti, Z Ge, S S Jain, M S Dodd, and L Brandt. Emulsions in homogeneous shear turbulence. Technical report, Center for Turbulence Research, Stanford University, 2018.