Talk 9

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Numerical and experimental studies of bubble dispersion and bubble induced drag modulation in a Turbulent Taylor Couette flow

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In a turbulent Taylor Vortex flow, bubbles can interact with the mean azimuthal flow, large scale Taylor vortices (associated with inflow/outflow jets) and small scale turbulent structures. For specific conditions, bubbles can lead to viscous torque reduction. This study deals with numerical and experimental investigations of the bubble dispersion and the viscous torque induced modifications in a Taylor Couette flow for the outer cylinder at rest.
Numerical calculations are based on Direct Numerical Simulation of the continuous phase and a Lagrangian tracking for the dispersed phase. Different ratios of the cylinder's radii (η 0.5, 0.72, 0.91) as well as different Reynolds numbers (Re 4000-8000) are investigated. Different bubble sizes normalised by the gap's width (d_b/d 4.10^{-3} and 4.10^{-4}) are tested with and without gravity effects for low void fraction (up to 1.35%). Passive dispersion evidences a competition between bubbles upward sliding motion, and trapping either by the Taylor vortices or by the low shear stress streaks organised as herringbone streaks near the inner cylinder in the outflow region. Gravity effects lead to bubble accumulation rather organised as spiral strings. Without gravity effect, active dispersion calculations, taking into account compressibility effect and momentum transfer applied on the carrying flow, show an increase in the viscous torque of the inner cylinder, ass ociated with a decrease at the outer cylinder. The attenuation of the cross correlation of the fluctuating velocities observed in the core of the flow, lets suppose that both the viscous torque and the coherent motion are strongly affected by the bubbles dispersion.
Experiments are carried out in a Taylor Couette device (η 0.9) built at IRENav. Bubbles are injected through a needle at the bottom of the gap. Different flow regimes (Re ranging from 400 to 20000), different bubble sizes (d_b/d from 0.05 to 0.12), corresponding to very small void fraction ($\alpha \leq 0.14\%$), are investigated. Bubbles tracking by video recording and measurements of the inner cylinder's viscous torque are performed. The eulerian distributions of void fraction and gas phase averaged velocities are obtained in a meridian plane. Trapped bubbles lead to an increase in the viscous torque. When buoyancy induced bubble motion, by comparison to the coherent motion of the liquid is increased, a decrease in the viscous torque is suspected. These results must be considered as early indication of bubble interactions with the coherent motion and the viscous drag in Taylor Couette flow for the transitional and turbulent Taylor Vortex flow regimes.