Bubble induced bifurcation in turbulent von Karman flow

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Bubbly flows are ubiquitous in nature and have been shown to control gas fluxes between the atmosphere and the ocean [1]. For this particular situation as for many others, there is a strong coupling between the large scale flow, the bubble size distribution and the gas transfer. For a given geometry and a given forcing, adding bubbles to an initially single-phase flow can have drastic impacts on energy fluxes within the flow [2] or fluid-structure interactions [3]. We present an experimental study of large scale flow bifurcation induced by bubble migration. A turbulent von Karman flow is generated by two counter-rotating disks fitted with blades. This flow has been investigated extensively as a model for turbulence because of its high shear rate in the middle plane, creating a strongly turbulent mixing zone. The torque Γ required to turn one disk at rotation rate Ω in single phase turbulent von Karman flow, follows the asymptotic behaviour in the high Re limit :

$$\Gamma = C(\theta)\rho R^2\Omega^2 \tag{1}$$

where R is the radius, ρ is the liquid density and θ is the ratio of the disks rotation rates [4]. In turbulent two-phase flows with given fluids, the function C also depends on void fraction α and Reynolds number. We show experimentally that bubble migration induce a bifurcation of the large scale flow and result in a drastic reduction of energy input in the system when void fraction exceed a certain threshold α_c. The nature of the bifurcation depends on θ and can lead to a reduction of energy input up to 30% compared with a single phase flow at the same effective density.

Références

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