Dynamics of a pair of spheres submerged in an oscillating flow

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When a system of spherical particles submerged in a viscous fluid is subjected to oscillations, the spheres align themselves in chains perpendicular to the oscillation direction at a constant spacing (Mazzuoli et al., 2016). The formation of this pattern is attributed to a non-zero residual also known as *steady streaming*. A single pair of particles, i.e. the building block of the particle chains, can be studied to better understand the underlying physical mechanisms. A key aspect is to determine the separation between the spheres as a function of the parameters of the problem as addressed by e.g. Klotsa et al. (2007). However, previous studies have been done using two distinct systems: a horizontally vibrating box and an oscillating flow over a fixed, flat bottom. These seemingly similar systems have in fact a crucial difference: the latter has the additional presence of a Stokes boundary layer near the bottom. Until now, its effect on the separation between the particles and their dynamics remains undetermined. We have performed numerical simulations of a fully resolved oscillating flow, in which the particle-fluid interactions are accounted for using the immersed boundary method (Breugem, 2012). For both systems, the simulations show that particles oscillate also perpendicular to the driving flow, such that the particles describe *figure 8* trajectories. This actually means that the separation is not constant. Furthermore, the systems show a clear difference in the dependence of both the mean and extrema of the particle separation as a function of the parameters of the problem. In fact, the parameter space for the oscillating flow over a fixed bottom has one additional non-dimensional parameter.

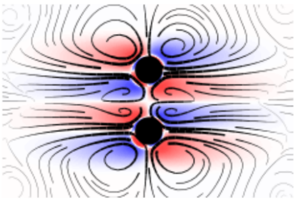

Figure 1: Average flow field in the horizontal plane going through the centers of a pair of particles with the vorticity in color and streamlines in black.

References

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