Numerical simulation of the sedimentation of an elliptic particle under external electric field using ISPH

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ABSTRACT

Motion of a rigid elliptic particle sedimenting in a quiescent background fluid is studied here. Both fluid and particle are assumed to be low-conductivity material with different properties. When subject to an external electric field, the difference between electrical properties of fluid and particle results in electrical forces and moments which affect the trajectory of the sedimenting particle. The electric field induced rotation in this case is of particular significance in particle orientation in sprays or electrorheological fluids used in microfluidic devices, to name a few. Electrohydrodynamics of multiphase flows [1] as well as the sedimentation of an elliptic particle [2] have been successfully investigated using incompressible smoothed hydrodynamics (ISPH) before.

Four different boundary conditions (A to D) as well as two sets of permittivity and conductivity ratios, $(10, 20)$ as S and $(20, 0.1)$ as U, are tested here. When particles with electrical properties of case S are released from rest, the major axis of the ellipse aligns with the electric field regardless of the boundary conditions. This causes the particle to descend faster than non-electrified sedimentation (refer to table 1). Figure 1 shows the trajectory and orientation of the particles with electrical properties of case U. In this case the behavior of the ellipse is highly dependent on the boundary conditions. Further details of the method and the results obtained will be discussed in the full paper.

Table 1: Terminal Reynolds numbers. When no electric field is applied $\text{Re}_t = 13.5$ [2].

Case	A	B	C	D
S	19.8	19.6	20.4	20.4
U	17.6	8.6	9.95	10.05

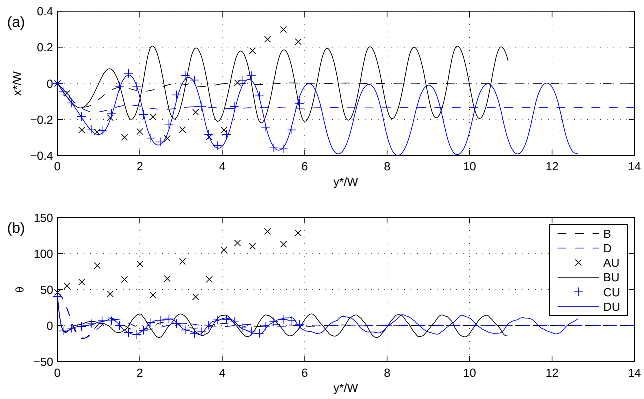

Figure 1: Horizontal position (a) and orientation (b) of the elliptic disc of case U while sedimenting in an external electric field.

REFERENCES

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