ECOLE DOCTORALE
ED 468
« Mécanique, Energétique, Génie Civil, Procédés »

Thesis proposal for a Doctoral position 2017-2020

Title	**Lateral migration of complex shapes particles flowing in micro-channels**
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Research project description :

It is now well known that the distribution of particles flowing in a micro-channel could become inhomogeneous even in very simple flow and geometrical configurations. For example, iso-dense spheres flowing in micro-channels under specific flow conditions migrate towards equilibrium positions located near the channel walls. Despite recent works [Di Carlo et al., Appl. Phys. Lett. 2011], the migration phenomenon is still unclear and insufficiently explored for other kinds of inert particle morphologies although most of the possible applications (microbial control in food industry, biological fluids analysis …) concern particles with complex shapes and more particularly micro-organisms. The aim of this project is thus to study the migration phenomena of inert non-spherical particles in micro-channels. It will lead to an improved knowledge of the physical mechanisms controlling the transport of complex shape micro-particles. This will permit to build a relevant tool to predict the response of such particles suspensions flowing in micro-channels. The fundamental aspects developed in this project will be helpful to improve the performances of existing separation processes and more importantly can yield new ideas for breakthrough technologies for the design of innovative micro-separators for biological applications.

This work takes place in a large project started in 2011 and associating several teams from different laboratories (ICA, LGC, LISBP, IMFT) collaborating in the research federation FERMAT located in Toulouse. Experimental set-ups based on classical microscopy have already been developed and used for spherical particles by Y.GAO PhD student working at ICA since September 2013 and supervised by P.Magaud and L.Baldas [Lafforgue-Baldas et al., J. Flow Chem 2013]. Spheres trajectories in similar conditions have been obtained by numerical simulations [Abbas et al., Phys. Fluids 2014] based on the Force Coupling Method. These studies have shown the role of the geometrical (channel shape, particle to channel size ratio …) and operating (Reynolds number) parameters on the migration mechanism. This approach will now be applied to inert particles with more complex shapes in similar flow conditions (laminar flow at low and moderate Reynolds numbers). The geometry of the first particles to be studied is close to yeast morphology (*Saccharomyces cerevisiae*). In a first phase, the PhD student will analyse the trajectories of single anisotropic particles and their orientation when flowing in rectangular or square micro-channels (of a few tens to a few hundreds of µm in width). Specific experimental methodologies will have to be developed for that, in particular 3D visualisation methods. In a second step, hydrodynamic interactions between particles will be studied in order to analyse collective effects. Finally, this work could lead to the design of the first prototype of an innovative micro-separator for biological applications.