Title: ***Study of hydrodynamic instabilities in a Couette-Taylor-Poiseuille system with a rough inner cylinder surface using a Newtonian and non-Newtonian fluid***

The Couette-Taylor flow remains a benchmark case in the fluid dynamics history. It is often encountered in industrial energy systems, rotating systems (gear transmission bearings), chemical or biological reactors, separation and filtration operations, and in various other applications. Despite the simplicity of its geometry, this type of flow may have involved a variety of rather rich and complex vortex structures. Indeed, it is the first specimen, which foresees the appearance of hydrodynamic instabilities and describes the properties of the vortex structures such as the shape, the size, the energy intensity, the impact on the mass and heat transfers as well as the interaction between vortex structures of the fluid and the wall.

The study of Newtonian or non-Newtonian flows in such a configuration mainly depends on several geometric and physical parameters. The nature of the walls surfaces in contact with the fluid plays a key role in the advance or delay of hydrodynamic instabilities. That is why, in this research work, we propose to carry out detailed experimental and numerical investigations, to better understand the physical mechanisms governing these instabilities, taking into account of the nature of the smooth or rough wall surface and using a Newtonian fluid, then non-Newtonian fluid such as wet foams for example. This roughness, which can be in the form of micro-roughness (size from a few tens to a few hundreds of microns) or macro-roughness (such as wavy or grooved surfaces of the order of a few millimetres), could contribute very significantly in the heat and mass transfer phenomena (cooling of rotating electrical machines, for example). The experimental study will be conducted using various qualitative (use of kalliroscope particles, for example) or quantitative (PIV, polarography, etc.) techniques. The use of non-Newtonian fluids (wet foams, for example) turns out to be very original, where the study of the micro and macro roughness of surfaces, combined with investigations into the rheological behavior of the fluid would certainly lead to raising enormous scientific locks, which would be at the service of important technological locks to be lifted.

Keywords: Couette-Taylor flow, Heat and mass transfer, Newtonian flow, non-Newtonian flow, foam flow, instabilities, Taylor number, CFD simulation

Background of candidate: Expected PhD student candidate should have interesting knowledge on Fluid Mechanics, Basic skills to undertake CFD simulations using commercial codes and/or basics of programming.

Some references related to the topic:

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