Numerical investigation of electro-convection induced by strong induced unipolar injection between two rotating coaxial cylinders

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***Abstract* — In this study we examine the effect of a circular Couette shear on a radially Coulomb driven electroconvection in a two-dimensional annular fluid. Two-dimensional numerical simulations are carried out for electroconvective phenomena in a dielectric liquid confined between two rotating coaxial cylinders. In an unsheared state (absence of rotational motion from the cylinders) strong unipolar injection of ions either from the inner or outer cylinder leads to the development of electroconvective instability. The flow is then characterized by a subcritical bifurcation in the finite amplitude regime. A linear stability criterion Tc and a nonlinear one Tf that correspond to the onset and stop of the flow motion, respectively, are linked with a hysteresis loop [1]. When the cylinders are set into angular motion, this annular geometry and the Couette shear bring to mind the development of another instability: The Taylor-Couette instability. However the flow between concentric cylinders is only unstable for 3D geometry and 2D Couette flow is by itself stable [2]. In this geometry the shearing effect induced by the angular motion of the cylinders does not lead to the development of a second instability and thus no competition between electroconvective and Couette instabilities could be expected. However several interesting phenomena and stabilizing effect are observed when pure electroconvection is surimposed with a Couette shear flow. The most important effect of the Couette flow is in fact to suppress the onset of electroconvection [3]. The purpose of this article is to numerically investigate how and under which conditions the shear state interacts with the development of the electroconvective instability. In particular we shall determine how the linear and non-linear critical values Tc and Tf respectively are affected by the Reynolds number based on the difference of outer and inner cylinders and the angular velocity of the inner cylinder.**