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Columnar vortices induced by dielectrophoretic force in a stationary cylindrical annulus filled with a dielectric liquid. (English) Zbl 1461.76554

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Summary: The dynamics of flow of a dielectric fluid in a vertical cylindrical annulus with a fixed temperature difference and an increasing alternating electric tension has been investigated using a direct numerical simulation (DNS). The temperature difference imposed on the cylindrical surfaces induces a radial temperature gradient perpendicular to the ground gravity which generates a baroclinic flow ascending near the hot surface and descending near the cold one. The electric field coupled with the permittivity gradient generates a dielectrophoretic buoyancy force which is a source of vorticity. Above a critical value of the electric tension, the flow bifurcates to a pattern of stationary columnar vortices. These columnar vortices which characterize the thermoelectric convection are not axially invariant, in contrast with classical Taylor columns. They bifurcate to regular wave patterns and then to spatio-temporal chaotic patterns when the electric field intensity is increased. The flow and temperature fields, the kinetic energy and the enstrophy of thermoelectric convective regimes are computed for different values of the electric tension.

MSC:

76W05 Magnetohydrodynamics and electrohydrodynamics

76E20 Stability and instability of geophysical and astrophysical flows

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Keywords:

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