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Hydromagnetic Linear Instability Analysis of Giesekus Fluids in Taylor-Couette Flow

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Abstract : In the present study, the effect of magnetic field on the hydrodynamic instability of Taylor-Couette flow between two concentric rotating cylinders has been numerically investigated. At the beginning the basic flow has been solved using continuity, Cauchy equations (with regards to Lorentz force) and the constitutive equations of a viscoelastic model called "Giesekus" model. Small perturbations, considered to be normal mode, have been superimposed to the basic flow and the unsteady perturbation equations have been derived consequently. Neglecting non-linear terms, the general eigenvalue problem obtained has been solved using pseudo spectral method (combination of Chebyshev polynomials). The objective of the calculations is to study the effect of magnetic fields on the onset of first mode of instability (axisymmetric mode) for different dimensionless parameters of the flow. The results show that the stability picture is highly influenced by the magnetic field. When magnetic field increases, it first has a destabilization effect which changes to stabilization effect due to more increase of magnetic fields. Therefor there is a critical magnetic number (Hartmann number) for instability of Taylor-Couette flow. Also, the effect of magnetic field is more dominant in large gaps. Also based on the results obtained, magnetic field shows a more considerable effect on the stability at higher Weissenberg numbers (at higher elasticity), while the "mobility factor" changes show no dominant role on the intense of suction and injection effect on the flow's instability.

Keywords : magnetic field, Taylor-Couette flow, Giesekus model, pseudo spectral method, Chebyshev polynomials, Hartmann number, Weissenberg number, mobility factor
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