STABILITY ANALYSIS OF THE INTERFACES AT COMPRESSIBLE AND INCOMPRESSIBLE FLUIDS

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ABSTRACT

The theory of purely irrotational flows of a viscous fluid is an approximate theory which works well especially in gas-liquid flows of liquids of high viscosity, at low Reynolds numbers. The theory of purely irrotational flows of a viscous fluid can be seen as a very successful competitor to the theory of purely irrotational flows of an inviscid fluid. A free surface in viscous potential flow analysis takes into account viscous stresses through normal stress balance at the surface, but tangential stresses are not considered. The present research work is the study on **"STABILITY ANALYSIS OF THE INTERFACES AT COMPRESSIBLE AND INCOMPRESSIBLE**

FLUIDS" through viscous potential flow theory, normal mode technique and computer based MATLAB programming. The stability of the interface of viscous-viscoelastic incompressible, viscous-nanofluid, and viscous-compressible fluids has been investigated theoretically in the cylindrical geometry. The Newton-Raphson approach is used to solve the dispersion relation for the critical wave number and the various graphs are plotted to depict the behavior of flow variables on the perturbations growth rate and wave number.

Chapter 1 presents a brief introduction to the general stability theory, capillary instability, Kelvin-Helmholtz instability along with some definitions and basic equations related to stability analysis. Various related studies are described by various authors in this field and a summary of the thesis is provided.

The stability of the interface between a viscous and a viscoelastic fluid is theoretically investigated in **Chapter 2** when mass and heat transfer between phases is permitted. The viscoelastic liquid and the viscous fluid are contained by two rigid cylinders in an annular area. The research was carried out utilizing the Rivlin-Ericksen model-satisfying potential flow theory for viscoelastic liquid. The findings indicate that the impact of heat and mass transfer is observed to increase the stability of the interface.

Chapter 3 examines the stability of interface between the viscous incompressible fluid and Walter's B viscoelastic liquid. These liquids are contained in an annular space that is bounded by two rigidly defined cylinders. The interface obeys capillary instability because the surface tension effect is taken into account. It is found that, compared to the Newtonian fluid perturbations grow more slowly at the interface containing Walter's B viscoelastic fluid.

In **Chapter 4**, a region bounded by two rigid cylindrical surfaces is considered to investigate the stability properties of the viscous fluid-viscoelastic fluid interaction. The Walter's B viscoelastic fluid is taken for analysis and the fluid's phases are transferring mass-heat from one phase to another. The surface is unstable the surface forces produced by the surface tension are responsible for the breakup. It is found that as heat is transferred more efficiently, the interface's instability reduces.

The instability at the viscous fluid-viscoelastic fluid interface is studied in **Chapter 5**. The power-law viscoelastic is considered and the interface is transporting heat along with mass from one fluid phase to another. The irrotational flow theory of viscous-viscoelastic fluid is employed to work out the mathematical equations. The algebraic equation of the growth rate parameter is computed and analyzed numerically. The transport of heat is found to stabilize the interface by enlarging the stability range. The power-law index and consistency coefficient have stabilizing character while the density of power-law has an inverse effect.

The instability in a circular cavity occurring at the interface of viscous fluid and nanofluid is investigated in **Chapter 6**. The viscous fluid is considered inside the cavity while nanofluid lies outside the cavity and both the fluids form a circular interface. The dispersion relationship is quadratic in growth rate and it reduces to the case of plane interface for larger modes of perturbations. The viscosity of the nanofluid has a stabilizing effect. In comparison to smaller- sized nanoparticles, the nanofluid with greater radius nanoparticles forms a more unstable interface.

In **Chapter 7**, the Rayleigh instability has been examined at the interface of two compressible viscous fluids interface. In the cylindrical coordinate system, a viscous compressible fluid surrounds another viscous compressible fluid. The dispersion relationship is quadratic in terms of the growth rate achieved and plotted with the help of MATLAB software for various flow parameters. The interfacial stability increases with an increase in the non-dimensional viscosity ratio parameter of the compressible fluids and while the density ratio of compressible fluids interface has destabilizing character. It is found that inside fluid viscosity slows the growth of disturbance but an increase in outside fluid viscosity makes the interface unstable.

The **last Chapter** of the thesis is related to the conclusions and future scope of the work. In the present work, the stability results are achieved utilizing the linear theory of stability analysis. The nonlinear analysis of interfacial stability problems is very important because the governing equations describing these flows are nonlinear in nature. The same problems can be studied through the nonlinear analysis of stability theory.