

ABSTRACT

Thermal Instability of a Viscoelastic (Maxwell) Fluid Layer Heated From Below With Internal Heat Generation

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We consider the thermal stability of a thin (less than 0.1 cm thick) viscoelastic (Maxwell) fluid layer with internal heat generation. The fluid layer is bounded below by a plane surface and is heated below. Within the fluid there is an additional heat source in the form of internal heat generation. The fluid is also bounded above by a free deformable surface. The effect of the internal heat and the relaxation time is assessed to determine their effect on the thermal stability of the fluid.

We first found the critical Rayleigh number for the Newtonian fluid and the Maxwell fluid (with a relaxation time $L = 0.5$). Next we look at the stability curves for the Newtonian fluid as we vary the internal heat generation Q , and it was shown to always destabilize the fluid layer. Then we look at the Maxwell fluid with relaxation time $L = 0.5$ and we vary the internal heat generation. We found the critical Rayleigh number numerically, and saw that the internal heat generation also destabilizes the Maxwell fluid layer.

Next we found that by varying the relaxation time the fluid layer becomes unstable with and without the internal heat generation Q . Lastly, we look at how the Biot number affects the

stability of the fluid layer and found that with and without the internal heat generation the fluid layer is stable with increasing Biot number.

In general, we find that the internal heat generation destabilizes the viscoelastic (Maxwell) fluid and the relaxation time L , also destabilizes the fluid layer. The Biot number stabilizes the fluid layer in the absence of the internal heat generation and in the presence of internal heat generation.

Keywords: viscoelastic, internal heat generation, Benard-Maragoni, relaxation time, Maxwell fluid, overstability.