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Floquet stability analysis of viscoelastic flow over a cylinder. (English) Zbl 1359.76029

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Summary: A Floquet linear stability analysis has been performed on a viscoelastic cylinder wake. The FENE-P model is used to represent the non-Newtonian fluid, and the analysis is done using a modified version of an existing nonlinear code to compute the linearized initial value problem governing the growth of small perturbations in the wake. By measuring instability growth rates over a wide range of disturbance spanwise wavenumbers α, the effects of viscoelasticity were identified and compared directly to Newtonian results.

At a Reynolds number of 300, two unstable bands exist over the range $0 \leq \alpha \leq 10$ for Newtonian flow. For the low α band, associated with the "mode A" wake instability, a monotonic reduction in growth rates is found for increasing polymer extensibility L. For the high α band, associated with the "mode B" instability, first a rise, then a significant decrease to a stable state is found for the instability growth rates as L is increased from $L = 10$ to $L = 30$. The mechanism behind this stabilization of both mode A and mode B instabilities is due to the change of the base flow, rather than a direct effect of viscoelasticity on the perturbation.

MSC:

76A10 Viscoelastic fluids
76E17 Interfacial stability and instability in hydrodynamic stability

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viscoelastic simulation; Floquet stability analysis

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