عنوان مقاله:

Physical Overview of the Instability in Laminar Wall-Bounded Flows of Viscoplastic and Viscoelastic Fluids at Subcritical Reynolds Numbers

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نویسندگان:

Hamed Mirzaee - Faculty of Mechanical Engineering, Semnan University, Semnan, Iran

Goodarz Ahmadi - Department of Mechanical and Aerospace Engineering, Clarkson University, Potsdam, NY, USA

Roohollah Rafee - Faculty of Mechanical Engineering, Semnan University, Semnan, Iran

Farhad Talebi - Faculty of Mechanical Engineering, Semnan University, Semnan, Iran

خلاصه مقاله:

This paper reviews the latest findings on instability and subcritical transition to turbulence in wall-bounded flows (i.e., pipe Poiseuille flow, plane channel flow, and plane Couette flow). Among the non-Newtonian fluids, viscoelastic and viscoplastic fluids were investigated. The main focus was on the early stage of transitional flow and the appearance of coherent structures. The scaling of threshold disturbance amplitude for the onset of natural transition was discussed. In addition, the transition of Newtonian fluids was compared with that of non-Newtonian fluids. Accordingly, the scaling for the transition of viscoelastic (i.e., highly elastic) fluid can be shown as Ac=O(Wig), where Wi is the Weissenberg number, g≤-۱ is a scaling constant, and Ac is the critical perturbation amplitude. Moreover, the viscoelastic fluid flow at high Re numbers (i.e., Re>>۱) is more stable than the Newtonian fluid flow in terms of the critical disturbance magnitude. Interestingly, the scaling for instability of viscoplastic fluid can be read as Rec=O(Bib), where Bi is the Bingham number and b≤۱ is a constant. It was noted that exploration of perturbations like vortices, streaks, and traveling waves together with their amplitudes could clarify the instability and transition process. Hence, this paper focused on physical behavior and realizations of the transitional flow. Finally, a summary of consequential implications and some open issues for future works were presented and discussed.

کلمات کلیدی:

flow, instability, transition, Perturbation, amplitude, non-Newtonian fluids