

Instability of Plane Couette Flow

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Abstract

The energy gradient theory has been proposed with the aim of better understanding the mechanism of flow transition from laminar flow to turbulent flow. In this theory, it is suggested that the transition to turbulence depends on the relative magnitudes of the energy gradient amplifying the disturbance and the viscous friction damping that disturbance. For a given flow geometry and fluid properties, when the maximum of K (the ratio of the energy gradient in the transverse direction to that in the streamwise direction) in the flow field is larger than a certain critical value, it is expected that instability would occur for some initial disturbances. In this paper, using the energy analysis, the equation for calculating K for plane Couette flow is derived. It is demonstrated that the critical value of K at subcritical transition is about 370 for plane Couette flow. This value is about the same as for plane Poiseuille flow and pipe Poiseuille flow (385-389). Therefore, it is concluded that the critical value of K at subcritical transition is about 370-389 for wall bounded parallel shear flows which include both pressure and shear driven flows.