Perturbation enstrophy decay in Poiseuille and Couette flows according to Synge's method

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In this work we derive the conditions for no enstrophy growth for bidimensional perturbations in the plane Couette and Poiseuille flows. We follow the method of vorticity proposed by Synge in 1938 (see the Semi-Centennial Puplication of the Amer. Math. Soc., equation 12.13, and the more detailed version in the Proc. of the Fifth Inter. Congress of Applied Mechanics, pages 326-332), which is actually based on the analysis of the spatially averaged enstrophy. We find that the limit curve in the perturbation wavenumber-Reynolds number map differs from the limit for no energy growth (see e.g. Reddy 1993). In particular, the absolute stability region for the enstrophy is wider than that of the kinetic energy, and the maximum Reynolds number giving the monotonic enstrophy decay, at all wavenumbers, is 155 and 80 for the Poiseuille and Couette flows, respectively. It should be noted that in past literature the energy-based analysis was preferred to Synge's enstrophy analysis. This, possibly, for two reasons: the low diffusivity of the 1938 Vth ICAM proceedings and the objectively very complicated analytical treatment required. Nevertheless, the potentiality of this method seems high and therefore it is interesting nowadays to exploit it by means of the symbolic calculus.