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AN IMPROVED LOW REYNOLDS NUMBER K- EPSILON MODEL FOR VISCOELASTIC FLUIDS

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An existing low Reynolds number model, developed by Cruz and Pinho (2003) for predicting drag reducing turbulent flows of elastic fluids, is here improved. In these turbulence models the rheology of the fluid is modelled by a constitutive equation of the Generalized Newtonian type containing a correction to mimic some effects of the extensional viscosity. This leads to a new stress in the momentum equation, accounting for the correlation between the fluctuating viscosity and the fluctuating rate of strain tensor, as well as an extra term in the transport equation for the turbulent kinetic energy. This new stress had been neglected previously but is now accounted for.
In this work a model is developed for the closure of this new stress term and its effect upon the performance of the turbulence model is assessed via an extensive series of simulations and comparisons with data from the literature for both purely viscous and elastic polymer solutions. The performance of the model has also been improved by a better choice of several parameters. The model is capable to predict well the behaviour of purely viscous power law fluids as well as the increased drag reduction due to fluid elasticity.
The novelty and advantage of this model is that it only needs input data on the rheology of the fluid and the bulk velocity of the flow, in contrast to existing models which require previous knowledge of the law of the wall for each fluid being investigated.

References

Cruz DOA and Pinho FT (2003) Turbulent pipe flow predictions with a low Reynolds number k- model for drag reducing fluids. Submitted to J. Non-Newt. Fluid Mech.

A GENERAL CRITERION FOR FLOW CLASSIFICATION

Thompson, R.L.; Souza Mendes, P.R.
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n 1979, Astarita proposed a local and objective criterion to classify flows. His criterion is not restricted to MWCSH, and is essentially an attempt to quantify the stress-relieving rotation experienced by the flowing material. In 1980, Huilgol analyzed Astarita's work and showed, through examples, some inconsistencies which rendered it useless as a general flow criterion. The present work revisits Huilgol's examples and discusses in detail the underlying physics that make Astarita's criterion to fail for certain flows. This analysis leads to a new criterion for flow classification involving the concept of persistence of straining. A key kinematic entity introduced in the proposed criterion is the pi-plane, a plane that is normal to the relative-rate-of-rotation vector. For a more comprehensive criterion, other parameters are needed in addition to a persistence-of-straining parameter. One of them is a measure of the deformation rate in the pi-plane. Although emphasis is given to isochoric motions, a compressibility parameter is also introduced to encompass non-isochoric flows. The proposed kinematic criterion is local, frame-indifferent and is not restricted to particular classes of flows. Its robustness is shown through detailed analyses of some representative flows.

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