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Research Paper

Numerical Simulation of Non-Newtonian Inelastic Flows in Channel based on Artificial Compressibility Method

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Abstract. In this study, inelastic constitutive modelling is considered for the simulation of shear-thinning fluids through a circular channel. Numerical solutions are presented for power-law inelastic model, considering axisymmetric Poiseuille flow through a channel. The numerical simulation of such fluid is performed by using the Galerkin finite element approach based on artificial compression method (*AC*-method). Usually, the Naiver-Stoke partial differential equations are used to describe fluid activity. These models consist of two partial differential equations; a continuity equation (mass conservation) and time-dependent conservation of momentum, which are maintained in the cylindrical coordinate system (axisymmetric) flow in current study. The effects of many factors such as Reynolds number (Re) and artificial compressibility parameter (β_{ac}) are discussed in this study. In particular, this study confirms the effect of these parameters on the convergence level. To meet the method analysis, Poiseuille flow along a circular channel under an isothermal state is used as a simple test problem. This test is conducted by taking a circular section of the pipe. The Findings reveal that, there is a significant effect from the inelastic parameters upon the the velocity temporal convergence-rates of velocity, while for pressue, the change in convergence is modest. In addition, the rate of convergence is increased as the values of artificial compressibility parameter (β_{ac}) are decreased.

Keywords: Finite element method, Galerkin method, Naiver-Stoke, Non-Newtonian, Artificial compressibility method.

1. Introduction

There are many numerical studies of the Navier-Stokes equations by using finite element method that have been succeed and widely conducted based on artificial compressibility method (*AC*-method). Because of the *AC*-method can be used to deal with the difficulty of incompressibility condition by using the concept of the transformation of continuity equation, this method has been widely used for both of finite different and finite element method. The *AC*-method was originally introduced by Chorin (1967) with the objective of solving the steady state incompressible Navier-Stokes equations [1]. Moreover, it was also used to solve for unsteady case. For example, Peyret and Taylor [2] and Kao and Yang [3] were some of the first to extend the *AC*-method to the solution of the unsteady incompressible Navier-Stokes equations. The concept of this method is to transform the elliptic incompressible continuity equation to hyperbolic

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