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"A STUDY ON COMPARATIVE ANALYSIS ON NEWTONIAN FLOW AND POWER LAW MATERIAL"

Shalini Kumari [1]

[1] *Research Scholar, Department Of Mathematics , Jai Prakash University, Chapra Bihar .*

ABSTRACT

In recent years, material analysis of fluids has generated prodigious interest of researchers due to their effective role in interdisciplinary sciences. In view of its importance, the current correspondence is given to break down the progression of intensity law liquid speaking to the highlights of shear diminishing, shear thickening and Newtonian materials. Constitutive conditions communicated as tensorial portrayals portraying power law connection among thickness and shear rate. The new strategy embraces the indicator corrector conspires and recreates answers for the naturally visible conditions recovered from the cross-section Boltzmann condition through Chapman-Enskog extension investigation. The abbreviated power law model is melded into this methodology to locally change the physical consistency and the related loosening up boundary, which recovers the non - Newtonian practices. Differentiated and existing non-Newtonian cross-area Boltzmann models, the proposed strategy.

Key Words: *Non - Newtonian , Finite element method Power-law fluid Channel driven cavity Shear thinning and shear thickening, non-Newtonian power-law fluid flows.*

I. INTRODUCTION

Non-Newtonian fluid refers to a specific category of fluid which exhibits variable viscosity under the action of force. It certainly differs from the Newtonian fluid which follows Newton's law of viscosity and bears constant viscosity under stress. The physical viscosity in non-Newtonian fluids could be dependent on the magnitude of the shear stress (e.g., shear-thickening/dilatant fluids, shearthinning/pseudoplastic fluids, Bingham plastics, etc.) or even time-dependent (e.g., thixotropic liquids, rheopectic liquids, etc.). In fact, many practical fluids may present these nonNewtonian behaviors. Typical examples include blood, silicone oils, printer ink, polymers, etc. Numerical interpretation of the non-Newtonian behaviors thus becomes an important topic from both the academic and the application points of view. Explorations in this topic have been continuing for over a century; and many mathematical models have been constructed, which include the generalized Newtonian models, the linear or elementary nonlinear viscoelastic models, the models with memory-integral expansion, etc. Specifically, the generalized Newtonian fluid models maintain the general form of governing equations for Newtonian fluid while making the viscosity dependent on the shear rate [1]. The linear viscoelastic models, which were initially proposed by Maxwell [2], essentially establish a linear differential relationship between the stress tensor and the shear rate. Later, the elementary nonlinear viscoelastic model tracks the evolution of a particular fluid particle and thus consolidates the nonlinear convection effect into the constitutive relation, which makesthe model more "objective" [3, 4]. More recently, some models were proposed by the memory-integral expansion strategy [5, 6], which assumes that the stress in a fluid element is only dependent on its own kinetic history and can thus be achieved by integrations over time. Among these approaches of constructing non-Newtonian models, the generalized Newtonian fluid models seem to be the simplest and the most straightforward way due to the

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similarity to the Newtonian expressions. And the most commonly used one in this category might be the power-law model [7]. In this model, the local viscosity is assumed to follow an exponential relationship with the shear rate. By adjusting the power index, typical non-Newtonian behaviors like the shear thinning or the shear-thickening can be interpreted. One popular mathematical interpretation is the lattice Boltzmann equation (LBE) or the lattice Boltzmann method (LBM) which is a mesoscopic method developed on the kinetic theory. In LBM, the distribution function is the primitive variable that is directly evolved; and the conservative variables and fluxes at the macroscopic scale can be obtained by moments of the distribution functions in the velocity space. The LBM seems to be more attractive than conventional Navier-Stokes (N-S) solvers in some aspects like the kinetic nature, simplicity and explicitness. Being constructed at the mesoscopic scale, LBM is a more general model than the N-S equations in describing fluid behaviors. Its evolution of distribution functions is essentially accomplished in the velocity space rather than in the physical space; and the whole process is in a linear and explicit manner. The discretization of the nonlinear convection terms in the N-S equations are thus avoided, and the scheme can be conveniently parallelized. Efforts have been made in incorporating the non-Newtonian models into the LBM to recover and investigate this distinct physical phenomenon.

II. Literature Review

Aidun et al. [1991] pointed the direct relevancy of cavity flows to coaters, melting spinning processes, microcrystalline materials and so forth.[1]

Zumbrunnen et al. [1995] explained the application of eddies formation in drag reducing riblets and synthetization of fine polymer composites. [2]

Patnana et al. [2009] investigated uplift in drag coefficient against fixed magnitude of Reynold number and power law index in incompressible generalized Newtonian (power law) fluid across an unconfined circular cylinder. They measured drag coefficient variance against power law parameter and Reynold number.[3]

Chhabra et al. [2004] investigated steady and incompressible flow of power law fluid past a circular cylinder by implementing finite difference scheme for different magnitudes of Reynold number 1, 20 and 40.

Gabbanelli et al. [2005] recognized that the SRT model might be unstable at extreme values of the relaxation parameter and thus implemented a truncated power-law model which sets upper and lower limits to the fluid viscosity.[5]

Martıneza HY and Delgado VFM [2016] More literature about utilization of fractional derivatives is accessed through .But in current work we are considering partial derivative of integral order so we are capitalizing finite element scheme for the computation of numerical results.[6]

Gangawane KM et al [2017] In this regard an amendment is made by combining the flow in cavity and channel and termed as channel driven cavity. One of the most impressing features of channel driven cavity is that it covers various benchmark problems like flow in cavity and channel, forward and backward facing step processes, contraction and expansion phenomenon. So the development and fabrication of this configuration will serve as benchmark study for all type of problems and validate the previously computed results. During the last decades or so, there has been a growing recognition about utilized non-Newtonian materials in industrial sector like aqueous foams, mixture of immiscible materials, slurries for instance and polymers and solutions (man-made and natural.[7]

III. Conclusion

But in current work we are considering partial derivative of integral order so we are capitalizing finite element scheme for the computation of numerical results material analysis of fluids has generated prodigious interest of researchers due to their effective role in interdisciplinary sciences.

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