UNSTEADY GENERALIZED COUETTE FLOW OF ON ALDROYD-B FLUID

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Le mouvement Couette généralisé d'un fluide Oldroyd-B incompressible entre deux plaques parallèles est recherché de point de vue analytique. Les solutions exactes pour le champ de vitesse sont obtenues par transformation de Fourier sine. Les tensions tangentielles adéquates sont aussi déterminées. Les solutions bien connues pour le fluide de Navier-Stokes, les solutions correspondant à un fluide de Maxwell et à un fluide de grade deux apparaissent comme un cas limite de nos solutions.

Key words: generalized Couette flow, Oldroyd-B fluid, velocity field; tangential tensions.

1. INTRODUCTION

The inadequacy of the classical Navier-Stokes theory to describe rheological complex fluids such as polymer solutions, paints, blood, certain oils and greases, etc., has led to the development of several theories of non-Newtonian fluids. Among the many models that have been used to describe the non-Newtonian behavior exhibited by these fluids, the rate-type fluid models have attracted much attention in the last few decades. For a recent review of these models we refer the reader to Rajagopal and Srinivasa [14].

Here, we shall consider the model due to Oldroyd [11], also called Jeffreys' model, in which the Cauchy stress **T** is given by [2, 11, 12, 14]:

$$\mathbf{T} = -p\mathbf{I} + \mathbf{S}, \qquad \mathbf{S} + \lambda \frac{\delta \mathbf{S}}{\delta t} = \mu\left(\mathbf{A} + \lambda_r \frac{\delta \mathbf{A}}{\delta t} \right), \tag{1}$$

where $-p\mathbf{I}$ denotes the indeterminate spherical stress, **S** is the extra-stress tensor, **A** is the first Rivlin-Ericksen tensor, λ and λ_r are relaxation and retardation times, μ is the dynamic viscosity (sometimes called shear viscosity) and $\delta / \delta t$ is a convective derivative. The most popular choice is the upper convected derivative:

$$\frac{\delta \mathbf{S}}{\delta t} = \dot{\mathbf{S}} - \mathbf{L}\mathbf{S} - \mathbf{S}\mathbf{L}^T, \tag{2}$$