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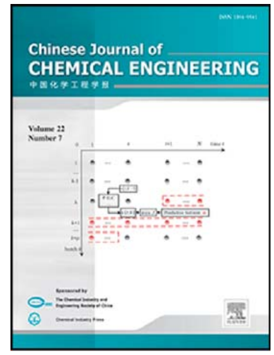

Hydrodynamic dispersion of reactive solute in a Hagen-Poiseuille flow of a layered liquid

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Hydrodynamic dispersion of reactive solute in a Hagen-Poiseuille flow of a layered liquid

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Abstract

An analysis of the solute dispersion in the liquid flowing through a pipe by means of Aris-Barton's 'method of moments', under the joint effect of some finite yield stress and irreversible absorption into the wall is presented in this paper. The liquid is considered as a three-layer liquid where the center region is Casson liquid surrounded by Newtonian liquid layer. A significant change from previous modelling exercises in the study of hydrodynamic dispersion, different molecular diffusivity has been considered for the different region yet to be constant. For all time period, finite difference implicit scheme has been adopted to solve the integral moment equation arising from the unsteady convective diffusion equation. The purpose of the study is to find the dependency of solute transport coefficients on absorption parameter, yield stress, viscosity ratio, peripheral layer variation and in addition with various diffusivity coefficient in different liquid layers. This kind of study may be useful for understanding the dispersion process in the blood flow analysis.

Keywords: Casson liquid, Yield stress, Axial-dispersion coefficient, Irreversible reaction, Diffusivity.

1. Introduction

Dispersion is the process which is utilized as an efficient means to accomplish the dilution or mixing. In recent days, the study on the longitudinal dispersion has gained attention due to its practical importance in the field of chemical engineering, physiological fluid dynamics, environmental sciences, biomedical engineering etc. for both corporeal and extra-corporeal. Specifically nutrients, metabolic items, drugs, etc. get transported through blood flow, as a consequence of diffusive and convective mechanisms. The pioneer researcher in this field was Taylor [1, 2] and a vital resulting commitment was tailored by Aris [3], who framed and partially solved equations for the integral moments of the cloud of contaminant. Sankarasubramanian and Gill [4] developed a derivative expansion method viz. 'generalized dispersion model', which holds true for large as well as small times. A numerical study was performed by Ananthakrishnan et al. [5] to solve the convective diffusion equation by a standard finite difference method which went on to show that the Taylor-Aris dispersion theory was pertinent only for adequately expansive estimation of the dimensionless time, i.e., $t > 0.8$. Barton [6] refined the Aris's model and extended the legitimacy to cover even small and moderate times.

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