ABSTRACT

Theoretical Study of Dispersion in Unsteady Casson Fluid Flow

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The study of longitudinal dispersion of solute in a tube/annulus with/without wall absorption has wide applications in the fields of chemical engineering, environmental dynamics, industrial engineering, biomedical engineering and physiological fluid dynamics. The basic principle involved in dispersion theory is the spreading of a solute in a flowing fluid due to the combined action of molecular diffusion and non-uniform velocity distribution. The study of dispersion in non-Newtonian fluids has attracted researchers due to its applications in biochemical and polymer processing engineering and in cardiovascular fluid flows. In particular, the study of dispersion phenomenon in Casson fluids has abundant applications in polymer industry and in cardiovascular flows. Casson fluid is an important non-Newtonian fluid which has finite yield value. With the objective to study the combined effects of non-Newtonian rheology (yield stress) and unsteady nature of the fluid on the dispersion process, we studied the following mathematical models, which have applications in industries, as well as understanding some of the clinically relevant aspects in cardiovascular flows:

• Dispersion of a solute in unsteady Casson fluid flow in a tube

• Effect of wall absorption on dispersion in unsteady Casson fluid flow in a tube

• Dispersion of a solute in unsteady Casson fluid flow in an annulus

• Effect of wall absorption on dispersion in unsteady Casson fluid flow in an annulus

• Dispersion in Casson fluid flow in an annulus with wall oscillation

We applied the generalized dispersion model to study the dispersion phenomenon in the above-mentioned models. The expressions for dispersion coefficient and mean concentration are obtained either analytically or numerically in each situation. The effects of various parameters that involved in the model on dispersion coefficient and mean concentration are analysed. Possible applications of these models in cardiovascular flows are discussed.

Keywords: Binil Thomas-Sebastian; Convection-Diffusion equation; Generalized dispersion model; Non-Newtonian fluid; Casson fluid; Oscillatory flow; Pulsatile flow; Blood rheology; Wall absorption; Wall oscillation; Catheterization.