INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Transport of a solute through a flowing solvent has several important applications in diverse fields, such as biology, chemistry, chromatography, environment fluid mechanics etc. Study of the transverse concentration distribution in steady or oscillatory flows has a great significance in estuaries and other coastal regions. Predictions of accurate pollutant distribution and peak pollutant concentration are of matter of concern. The influence of chemical reaction on solute transport has a great significance in blood flow through human arteries. This study also has importance regarding the shear-driven flows encountered in micro motors, micro channels and other micro fluidic systems.

The dissertation begins with an analytical study, which explores two-dimensional concentration distribution in an open channel flow with absorbing channel bed. This study explores mean and real concentration distributions after an initial time when transient behavior completely dies out. In this study, effects of bed absorption on solution dispersion as well as on transverse uniformity are discussed. Results reveal that transverse concentration of the solute should be preferred over the mean concentration to analyze the absorption effect more accurately.

The next study explores two-dimensional concentration distribution in an open channel flow with reversible phase exchange kinetics between the channel bed and fluid phase. This work explains the pattern of transverse real concentration distribution and uniformity over the cross-section of the channel. Effects of phase exchange parameters on solute dispersion are discussed. It is found that for slow phase exchange kinetics with small retentive channel bed, solute concentration distribution becomes uniform faster.

In the third work, an attempt is made to find analytical expressions for mean and transverse real concentrations by using a multi-scale homogenization technique and to explore the evolution of transverse concentration distribution for oscillatory Couette flows for inert boundary walls. The study also suggests a time scale that would be more appropriate to characterize the initial transition stage of the transport process to approach transverse uniformity.

In the forth endeavor, the solute is assumed to undergo reversible and irreversible reactions at the channel bed. Analytical expressions are derived for all the steady and oscillatory components of dispersion coefficients. It is seen that absorption induced dispersion coefficient can be negative unlike the leading order dispersion coefficients.

Finally, the dissertation deals with a problem that discusses the effects of non-linear chemical reaction on dispersion coefficients for an oscillatory Couette flow. This work reveals that increase in order of nonlinearity in mobile phase decay reduces the mass depletion in the flow and increase in order of nonlinearity in the immobile phase decay enhances the advection speed for large retention parameter.