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Two phase gas-liquid stratified laminar flows in tubular reactors sustaining liquid phase reactions

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ABSTRACT

In this work, we develop a mathematical model for analyzing reactions with mass transfer in two phase gas-liquid stratified flow tubular reactors. The reaction occurs in the liquid phase and the flow is assumed laminar. The hydrodynamics, Residence Time Distribution (RTD) and mass transfer in stratified gas-liquid flows with different liquid holdups is analyzed using a semi-analytical approach. The bipolar cylindrical coordinate system is employed for an elegant description of the boundaries and the gas-liquid interface.

A novel contribution of this work is the model developed for analyzing the RTD of partially filled tubular reactors with different liquid holdups. Towards this, the velocity profile obtained is used to solve the diffusion-free species transport equation with a pulse tracer input and the evolution of the outlet concentration is obtained. The model developed is validated with RTD experiments carried out in a circular glass channel using 0.5N NaOH as the tracer. The model developed for RTD only describes mixing in an ideal laminar flow reactor. In order to model and predict conversion in realistic systems where radial diffusion is significant, the convection-diffusion-reaction equation is solved next. Two cases are studied where the (i) reactant is present only in the liquid phase and when (ii) the reactant is present in both the phases and it transfers from the gas phase to the liquid phase as it gets consumed. It is found that the product formation is enhanced in the latter case. By controlling

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