FOSSEE, IIT Bombay
OpenFOAM Case Study Project
September 2025

Calculation of Reaction-Based Residence Time under Different Operating Conditions and Its Comparison with Flow-Based Residence Time

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Abstract

Residence time, a key factor in the study of reactive fluxes, controls the degree of conversion and the effectiveness of thermal and chemical systems. In this work, the calculation of reaction-based residence time under different operating conditions is investigated and contrasted with traditional flow-based residence time. While flow-based residence time was derived using hydrodynamic and thermal characteristics including reactor geometry and velocity profiles like flat and parabolic inlet, the axial concentration distribution of scalar was determined by solving the scalar transport equation with a first order reaction term. According to the comparison, there are notable variations when heat transfer and non-uniform velocity profiles occur, as reaction kinetics can lengthen or reduce the effective residence period. The results highlight how crucial reaction-based criteria are for accurate reactor and flow performance predictions.

Keywords: residence time, concentration, plug flow, parabolic inlet etc.