Validation of Computational Fluid Dynamics Codes using Radiotracer Residence Time Distribution Analysis of Stirred vessels.

Introduction

• Radiotracer residence time distribution (RTD): an experimental tool study the performance of industrial process reactors.

• RTD is used for:
  ➢ Troubleshooting,
  ➢ Check the validity of design data.

• The main concern during RTD investigation:
  ➢ accurate formulation of the experimental distribution curve.
Objectives of study

• The final RTD results depends on the accuracy of the experimental RTD formulation.

• Hence the need to generated the RTD curve using CFD and compare simulation and experimental results.

• In other words, to validate CFD codes using results of experimental RTD formulation.
Methodology: Experimental RTD

• Experimental RTD was conducted in a gold leaching tank to determine the MRT

  Dagadu et al (2014)

• Radiotracer used: I-131 (mixed with Na$_2$S$_2$O$_3$)

• MRT Calculated from the method of moments

• MRTs:
  – Theoretical: 257 mins.
  – Experimental: 212 mins.
Description of Leaching Tanks
Tracer Injection and Monitoring

I-131
Methodology: CFD Simulation

- Flowfield in the leaching tank calculated to describe the flow structure and mixing.

- Models used:
  - Mixture model (recommended for slurry flows)
  - Standard $k-\epsilon$ model
  - MRF approach

Computational Model
RTD Simulation

• Lagrangian particle tracking method was used to calculate the trajectories of massless tracer particles through a calculated flowfield.

• Dispersion of tracers due to turbulent eddies was calculated with the discrete random walk model under the stochastic tracking technique.

• Particle were tracked from the inlet to the outlet of the tank at a step time of 2 minutes.
RTD Simulation (cont’d)

- No of particles tracked = 5760
  (required = 5000–10,000, Bai et al., 2008)

- Particle concentration versus time curve generated.
  - Histogram of particle concentration against recorded particle RT.

- The curve was then normalized to obtain the RTD curve.
Figure 1. Particle trajectories coloured by particle residence time [s]:
Simulation vs Experimental RTDs

Exp. MRT = 212 min.,
Sim. MRT=205 min
CONCLUSIONS

• The simulated RTD is in good agreement with experimental results.

• Particle tracking method also describes the flow structure in mixing vessels similar to plots of velocity vectors and contours of velocity as in previous works.
THANK YOU FOR YOUR ATTENTION!