

A First Course on Kinetics and Reaction Engineering

Activity 11.2c

The data in the table below were generated using the PFRStepResponse simulator. Prior to the stimulus, the volume percent of tracer in the reactor feed was equal to 0%, and after the step change it was equal to 0.99%. The reactor volume was 10 L, and after the stimulus the feed rate was 20.2 L min⁻¹.

<i>Time (min)</i>	<i>Outlet Tracer Volume Percent</i>
0	0
0.03	0.0247
0.12	0.0106
0.17	0.0162
0.2	-0.0119
0.25	-0.0147
0.28	-0.0146
0.3	0.0136
0.33	-0.0072
0.37	0.0009
0.38	-0.0199
0.4	-0.0037
0.43	-0.0166
0.45	-0.0078
0.47	-0.0033
0.48	-0.0005
0.5	0.9786
0.52	1.0006
0.53	1.0024
0.57	1.0071
0.62	0.9918
0.63	0.9991
0.65	0.9993
0.7	1.0029
0.72	0.9867
0.73	0.9758

As Example 11.5 points out, it isn't necessary to compute the age function when testing a reactor for its conformity to the ideal PFR model; the analysis is more easily performed using the response directly. The fluid entering a 10 L PFR and flowing at a rate of 20.2 L min⁻¹ will appear at the outlet from the PFR after 4.95 min. This is the average residence time, as calculated using equation (1), and according to the PFR model, all fluid elements have the exact same residence time..

$$\bar{t} = \frac{V}{\dot{V}} = \frac{10 \text{ L}}{20.2 \text{ L min}^{-1}} = 0.495 \text{ min} \quad (1)$$

Hence, in the present situation, if the reactor is an ideal PFR, then the volume percent of tracer should equal zero from time zero up until 0.495 min, and then it should jump to 0.99%. We could plot this expected behavior along with the actual response, but doing so really isn't necessary here. Instead, we can simply look at the experimental data. All of the data points recorded at times up to and including 0.48 min indicate (within experimental noise) no tracer is present. The next data point, at 0.5 min, and all that follow it indicate ca. 1% tracer as being present. Thus, to within the accuracy of the experimental measurements, the tested reactor does obey the assumptions of an ideal PFR.