A First Course on Kinetics and Reaction Engineering
Problem 13.1

Problem Purpose

This problem will help you determine whether you have mastered the learning objectives for this unit.

Problem Statement

Suppose you wish to test equation (1) to determine whether it is satisfactory as a rate expression for liquid phase reaction (2). To do so you used a 3 gal. reactor that had been tested and shown to behave as an ideal CSTR. You made 15 steady state experimental runs using the inlet flow rates and compositions shown in Table 1, and in each run you recorded the steady state conversion, also shown in Table 1. Determine whether equation (1) is an acceptable rate expression, and if it is, estimate the values and uncertainties for the two rate coefficients.

$$r_2 = k_f C_A^2 - k_r C_Y C_Z \qquad (1)$$

$$A \rightarrow Y + Z \qquad (2)$$

Table 1.

$\dot{V}^0$ (gal min^{-1})	C_A^0 (lbmol gal^{-1})	C_Y^0 (lbmol gal^{-1})	C_Z^0 (lbmol gal^{-1})	Fractional Conversion
0.5	8.35E-03	0.00E+00	0.00E+00	0.337
0.5	8.35E-03	1.67E-02	8.35E-03	0.088
0.5	8.35E-03	8.35E-03	1.67E-02	0.093
0.5	1.67E-02	4.17E-03	1.67E-03	0.406
0.5	3.34E-02	1.67E-03	4.17E-03	0.479
1	8.35E-03	0.00E+00	0.00E+00	0.226
1	8.35E-03	1.67E-02	8.35E-03	0.069
1	8.35E-03	8.35E-03	1.67E-02	0.071
1	1.67E-02	4.17E-03	1.67E-03	0.323
1	3.34E-02	1.67E-03	4.17E-03	0.407
2.5	8.35E-03	0.00E+00	0.00E+00	0.125
2.5	8.35E-03	1.67E-02	8.35E-03	0.042
2.5	8.35E-03	8.35E-03	1.67E-02	0.041
2.5	1.67E-02	4.17E-03	1.67E-03	0.197
2.5	3.34E-02	1.67E-03	4.17E-03	0.291