A First Course on Kinetics and Reaction Engineering
Problem 1.5

Problem Purpose

This problem will help you determine whether you have mastered the learning objectives for this unit. In addition, this problem shows how to calculate concentrations in flow systems using the ideal gas law, molar flow rates, temperature and pressure.

Problem Statement

A graduate student was studying the gas phase decomposition of N_2O according to equation (1). The student ran several experiments involving this reaction using a steady-state flow reactor. The feed to the reactor always contained a mixture of helium and nitrous oxide (neither oxygen nor nitrogen was ever used in the feed). The inlet flow rates, the reactor temperature and the reactor pressure were held constant in each individual experiment. A gas chromatograph was used to measure the composition of the gas leaving the reactor. Using the data from the gas chromatograph, the student was easily able to calculate the mole fraction of oxygen leaving the reactor. Use the experimental data provided in the table below to calculate the outlet concentrations of N_2O, N_2 and O_2 for each of the student's experiments.

T K	P atm	$\dot{n}^0(N_2O)$ mol/s	$\dot{n}^0(He)$ mol/s	$y(O_2)$
785.15	1	4.73E-07	2.17E-05	0.00755
785.15	1	1.15E-06	2.08E-05	0.01824
785.15	1	1.13E-06	2.08E-05	0.01772
786.15	1	1.54E-06	2.02E-05	0.02426
787.15	1	1.98E-06	1.96E-05	0.03241
790.15	1	3.20E-06	1.78E-05	0.05686
760.15	1	8.61E-07	2.13E-05	0.00723
761.15	1	1.26E-06	2.08E-05	0.01088
761.15	1	2.19E-06	1.97E-05	0.02043
762.15	1	3.19E-06	1.83E-05	0.03574
736.15	1	1.97E-06	2.02E-05	0.00541
736.15	1	2.46E-06	1.97E-05	0.00670
736.15	1	4.08E-06	1.80E-05	0.01208
736.15	1	4.31E-06	1.77E-05	0.01406
737.15	1	5.35E-06	1.65E-05	0.01957

$$2\ N_2O \rightleftarrows 2\ N_2 + O_2 \qquad (1)$$