## AFCoKaRE Practice Problem 1.7

Purpose: This problem allows you to practice solving the kinds of reaction progress problems for flow reactors that you will encounter later in the course where you will need to be able to solve them in order to perform kinetic data analysis or reaction engineering modeling.

Problem Statement: Suppose that a flow reactor operates isothermally at 800 K and 3 atm where ideal gas behavior can be assumed. A gas mixture at 800 K and 3 atm containing $90 \% \mathrm{~N}_{2}$, $8 \% \mathrm{O}_{2}$ and $2 \% \mathrm{NH}_{3}$ by volume flows into the reactor at a rate of $4 \mathrm{~L} \mathrm{~min}^{-1}$ and reacts according to reaction (1).
(a) If this reactor was being used to generate kinetics data, it might be necessary to write an expression for the outlet partial pressure of ammonia in terms of known constants and the outlet molar flow rate of ammonia in order to analyze the data. In doing so, it is important to recognize that the total outlet molar flow rate will change when the outlet molar flow rate of ammonia changes. Write the expression for the outlet partial pressure of ammonia in terms of known constants and the outlet molar flow rate of ammonia.
(b) Further suppose that in one kinetics experiment using this reactor, the outlet flow was found to contain $1.6 \%$ NO. During the analysis of the data, it might also be necessary to calculate the outlet molar flow rate of $\mathrm{NH}_{3}$ in this experiment. What is the outlet molar flow rate of ammonia in this experiment and what ammonia conversion does this correspond to?

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\begin{equation*}
4 \mathrm{NH}_{3}+5 \mathrm{O}_{2} \rightarrow 4 \mathrm{NO}+6 \mathrm{H}_{2} \mathrm{O} \tag{1}
\end{equation*}
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