PROBLEM 6.60
The feed to a distillation column is a 45.0 mole% \( n \)-pentane – 55.0 mole% \( n \)-hexane liquid mixture. The vapor stream leaving the top of the column, which contains 98.0 mole% pentane and the balance hexane, goes to a total condenser (one in which all the vapor is condensed). Half of the liquid condensate is returned to the top of the column as reflux and the rest is withdrawn as overhead product (distillate) at a rate of 85.0 kmol/h. The distillate contains 95.0% of the pentane fed to the column. The liquid stream leaving the bottom of the column goes to a reboiler. Part of the stream is vaporized; the vapor is recycled to the bottom of the column as boilup, and the residual liquid is withdrawn as bottoms product.

(a) Calculate the molar flow rate of the feed stream and the molar flow rate and composition of the bottoms product stream.

Solution

\[
\begin{array}{|c|c|}
\hline
\text{UNKNOWNs AND INFORMATION} & \text{JUSTIFICATION/CONCLUSION} \\
\hline
+ ____ unknowns & _____ \\
- ____ balances & _____ \\
- 1 (95\% \text{ of A fed goes to distillate}) & \\
0 \text{ DOF} & \text{Problem is solvable} \\
\hline
\end{array}
\]

95\% of A fed goes to distillate

\[
\left(\frac{85.0}{\text{mol h}}\right) \left(0.980 \frac{\text{mol A}}{\text{mol}}\right) = 0.950(_______) \Rightarrow \dot{n}_0 = 195 \text{ kmol/h} \quad (6.60-2)
\]

Total mole balance

\[
\Rightarrow \dot{n}_1 = \text{__________} \text{ kmol/h} \quad (6.60-3)
\]

Pentane balance

\[
\Rightarrow x_1 = 0.0405 \frac{\text{mol A}}{\text{mol}} \quad (6.60-4)
\]