Bubble Point Method - Multicomponent Distillation Report:

1. Introduction This report analyzes a multicomponent, multistage distillation system using the Bubble Point Method. The goal is to compute the stage temperatures in a column separating methanol, ethanol, and n-propanol. The key objectives are:- Perform a manual hand calculation for one iteration.- Develop a Python program to compute the temperature profile iteratively.- Extend the code to optimize the feed tray location in a 10-stage column.

2. Methodology The distillation column is modeled using equilibrium-stage calculations. The Bubble Point Method is used to determine the temperature at each stage by solving: Ps = exp[C1 + C2/T + C3 ln(T) + C4 \* T^C5] Steps followed:

1. Compute vapor pressures for each component using the extended Clausius-Clapeyron equation.

2. Compute equilibrium constants (K-values) as K = Ps/P.

3. Solve for liquid compositions using a tridiagonal matrix (Thomas Algorithm).

4. Adjust stage temperatures iteratively to match equilibrium conditions.

5. Extend calculations to optimize feed tray location in a 10-stage system.

3. Code Implementation The Python code implements the following components:- `Distillation` class: Defines system parameters and equilibrium calculations.- `calculate\_Pij()`: Computes vapor pressures using Antoine coefficients.- `calculate\_Kij()`: Computes K-values based on system pressure.- `calculate\_Tj()`: Iteratively updates stage temperatures using the Bubble Point equation.- `thomas\_algorithm()`: Solves the tridiagonal system for liquid compositions.- Main script: Initializes the distillation column and runs the temperature convergence algorithm. The final output provides a temperature profile for each stage.

4. Results and Discussion The computed temperature profile indicates:- The highest temperature is at the reboiler, and the lowest at the middle.- The temperatures adjust dynamically based on component volatility.- Increasing the number of stages allows for better separation. Optimizing the feed tray location in a 10-stage system results in an improved separation efficiency.

5. Conclusion The Bubble Point Method effectively determines stage temperatures in a distillation column. The developed Python code iteratively solves for equilibrium conditions and computes optimal feed locations. This approach can be further extended to handle complex mixtures and additional operating conditions.

For problem 3(c) :

The feed flow should be at the 9 tray show that maximum separation of methanol could occur and at the distillate but also the tray 10 could not be answer as interference of reboiler could disturb the composition in vapour. We could determine what chemical deviation from ideal situation could happen in tray 10 but in tray 9 the vapor and liquid flow rate is only present so it would be better to work this way.