PS 73

A vent stream consisting of methanol, air, and a negligible amount of moisture flows at 200 ft^3/min (measured at temperature of 77 °F and a pressure of 14.7 psi). The methanol is to be separated from the remaining vapors through saturation followed by condensation in a refrigeration condenser system. The inlet stream temperature is 85°F, and the inlet volume fraction of methanol is 0.385. The temperature necessary to condense the methanol is 17.3°F and the required removal efficiency is 90%. The coolant is ethylene glycol. The approach is 15°F, and the temperature rise of the coolant is 25°F. The heat capacity of the gaseous stream is 6.95 Btu/(lb.F). For methanol at 17.3F, the latent heat is 17230.6 Btu/lbmol. The emission stream is free of moisture and the ideal gas law applies. What is the total heat transferred from air/methanol mixture in the process?

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- Specific volume: $\frac{(359)(77+460)}{32+460} = 391.84 \frac{\text{ft}^3}{\text{lbmole}}$
- Molar feed rate: $\frac{200}{391.84} = 0.51 \frac{\text{lbmol}}{\text{min}}$
- Methanol loading: $0.385(0.51) = 0.19635 \frac{\text{lbmol}}{\text{min}}$
- Latent Heat= $0.19635(17230.6) = 3045$ Btu/min
- Sensible heat transfer
- $=0.51(6.95)(85 - 17.3) = 239.96 \frac{\text{Btu}}{\text{min}}$
- Total heat removal:
- 3045+239.96=3285 Btu/min or 197097 Btu/hr

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