(1) An equimolar liquid mixture of benzene (B) and toluene (T) at $10°C$ is fed continuously to a vessel in which the mixture is heated to $50°C$. The liquid product is 40.0 mole% B, and the vapor product is 68.4 mole% B. How much heat must be transferred to the mixture per g-mole of feed? [30 pts]

$$C_{p,Benzene(l)}[kJ/mole·°C] = 126.5 \times 10^{-3} + 23.4 \times 10^{-5}T$$

$$C_{p,Benzene(v)}[kJ/mole·°C] = 74.06 \times 10^{-3} + 32.95 \times 10^{-5}T$$

$$C_{p,Toluene(l)}[kJ/mole·°C] = 148.8 \times 10^{-3} + 32.4 \times 10^{-5}T$$

$$C_{p,Toluene(v)}[kJ/mole·°C] = 94.18 \times 10^{-3} + 38.00 \times 10^{-5}T$$

$$(\Delta \hat{H}_v)_{Benzene}(80.10°C) = 30.765(kJ/mole), \quad (\Delta \hat{H}_v)_{Toluene}(110.62°C) = 33.47(kJ/mole)$$

(2) An inclined manometer is often used to measure small pressure differences. See Fig. 1.

 (a) The process fluid is a gas at low pressure, the angle of inclination is $20°$, $L = 10$ cm, and the manometer fluid is oil with a specific gravity of 0.8. What is the pressure differential (pascal) $p_1 - p_2$? [20 pts]

 (b) If the process fluid is oil (sp gr =0.8), the manometer fluid is water, and $L = 12$ in., what is the pressure drop in psi? [20 pts]
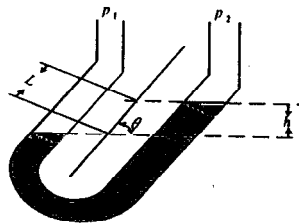

Fig. 1.

(3) Saturated steam at 1 atm is discharged from a turbine at a rate of 1150 kg/hr ($\hat{H} = 2676$ kJ/kg). Superheated steam at $300°C$ and 1 atm ($\hat{H} = 3074$ kJ/kg) is needed as a feed to a heat exchanger; to produce it, the turbine discharge stream is mixed with superheated steam available from a second source at $400°C$ and 1 atm ($\hat{H} = 3278$ kJ/kg). The mixing unit operates adiabatically. Calculate the amount of superheated steam at $300°C$ produced and the required volumetric flow rate of $400°C$ steam. (Note: the specific volume of steam at $400°C$ and 1 atm is 3.11 m³/kg) [30 pts]