

Practice Set 3b

1. An air conditioning system cools air to 20°C from 35°C, when the barometric pressure is 103 kPa and the relative humidity is 90%. It delivers air at a flow rate of 12,500 L/h. Find the rate of moisture condensation (kg/h) and the volumetric flow rate of the air drawn from the outside. Ans: cond rate = 0.265 kg/h, air rate = 13500 L/h
2. A mixture containing 15.0 mol% hexane balance N₂ flows through a pipe at 6.53 kmol/h. The pressure is 2.00 atm (abs) and the temperature is 100°C. If I want to begin to condense the hexane, what temperature do I need cool to? If I want to condense 80% of the hexane, what temperature do I need to cool to? Ans: 34.8C and 2.5C
3. Methane is flowing in a pipeline at a target rate of 20.7 m³/min at 30°C and 250 kPa. To check the flow rate, He is introduced at 25°C and 300 kPa. How many cubic centimeters per minute of He must be added if the minimum detectable concentration of He downstream of the injection point is 10 ppm? Ans: 1.7 x 10⁻⁴ m³/min
4. A propane burning engine is being evaluated and the exhaust gas collected on a dry basis is 10.1% CO₂, 1.1% CO, 4.7% O₂ and 84.1% N₂. During the test, 0.50 kg of fuel is burned and 1.73 m³ of exhaust gas (again dry) was collected at 15°C and 108 kPa. However, after the test someone questions whether it was really propane that was burned. Using the data above, specify what hydrocarbon was burned. Ans: C₄H₁₀
5. Use P = 1 atm (abs) for this problem. For the reaction: C₂H₅OH → CH₃CHO + H₂ the following process is envisioned. Pure ethanol is mixed with a recycle stream that contains 95 mol% ethanol and 5.0 mol% acetaldehyde and the combined stream is heated and vaporized, and then enters a reactor at 280°C. Gases leave the reactor and are cooled to -40°C to condense the product acetaldehyde and residual ethanol. "Off-gas" from the condenser is vented. The condensate from the condenser, which contains 45 mol% ethanol, is sent to a distillation column and produces a distillate at a rate of 1000 kg/h, containing 97 mol% acetaldehyde and a bottoms product that is the recycle stream. Find the molar flow rates (kmol/h) of the entering ethanol and hydrogen in the off gas. What is the volumetric flow rate to the reactor in m³/h? What is the single pass conversion of ethanol and the molar flow rates of ethanol and acetaldehyde sent to the scrubber? Ans: 54%, 0.005 kmol/h and 0.76 kmol/h