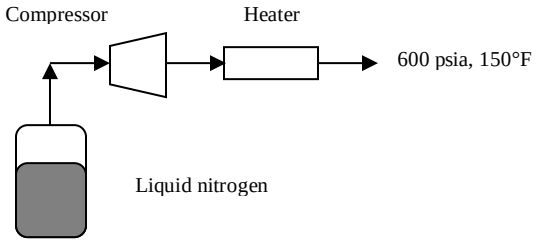
ABE – 201 Fall 2016

Homework 7
Due Friday 9/30 at beginning of class

1. (5 pts) As shown in the diagram below, plans call for supplying a processing facility from a tank of liquid nitrogen (specific gravity = 0.81) at its normal boiling point (-350°F) and 1 atm. Nitrogen vapor leaves the tank and is compressed and heated to obtain the desired conditions, 150°F and 600 psia. At the outlet the flow meter records a rate of 150 SCFM (standard cubic feet per minute).
    a. Using the ideal gas law, determine the actual volumetric flow rate of heated and compressed nitrogen.
    b. Using the generalized compressibility charts, determine the actual volumetric flow rate. Assuming this answer is the correct, what is the % error of the answer from part a)?



2. (10 pts) At steady state, oxygen flows into a fermenter at a mass flow rate of 1.05 kg/min. Ten percent of the O_2 is consumed by the bacteria as the gas passes through the fermenter. For each mole of O_2 consumed, 0.90 moles of CO_2 are generated. The remaining 0.10 moles of O_2 consumed is incorporated into new cell mass.
    a. If the temperature of the oxygen is 15°C and the gauge pressure is 25kPa at the inlet, what is the volumetric flow rate of the O_2 into the fermenter?
    b. The gas leaving the fermenter is 37°C and 0kPa gauge pressure. What is the volumetric flow rate of the gas leaving the fermenter (assume no water evaporates)?

3. (5 pts) A 500 L tank contains 525 moles of propane at 100°C. The critical point for propane is 369.9K and 42.0 atm. Calculate the tank pressure (absolute) using the Virial Equation (1^{st} order). Note: $\omega = 0.152$ for propane.