CENG411: HOMEWORK 10

Please write down at the top of the page how many hours you spent on this homework.

1. (10 points) Show that the following process does not violate the laws of thermodynamics. An ideal gas of constant heat capacity \( c_p = 30 \text{ kJ/kgmol K} \) at 10 bar and 295K enters a device which is thermally and mechanically insulated from the surroundings. One half of the gas leaves the device at 355K and 1 bar, while the other leaves at 235K and 1 bar.

2. (10 points) The device described in Problem 1 exists and is known as a Ranque-Hilsch vortex tube. It contains no moving parts; compressed gas enters with a hot stream leaving one end of the tube and a cold stream leaving the other. No simple explanation of how this device works is actually available. Determine the maximum temperature difference obtainable when this device is fed with the same entering gas as in Problem 1.

3. (10 points) Consider a vapor-compression refrigeration (using throttling) cycle, with ammonia as the working fluid. The heat removal and rejection in the cycle is to be accomplished using heat exchangers (an irreversible process) i.e. water circulates around the units and leaves hotter or cooler than when it entered. A finite temperature difference is required for heat exchange, so the operating temperatures need to be between 10°F and 90°F. An irreversible compression stage with an adiabatic compression efficiency of 75% will be used. Calculate the coefficient of performance for this system. How does the reduction in efficiency due to irreversibility compare to that due to throttling the fluid?

4. (10 points) Problem 8.4 in Smith and Van Ness.

5. Summarize what you learnt from problems 1, 2, 3 and 4. (4 points)