MAE4380 Intermediate Thermodynamics
HW5

Problem 1

This is a repeat of problem one from home work 4.

A fogging system is being considered for the Brayton power cycle at the Mizzou power plant. The fogging system adds liquid water droplets at the inlet to the compressor which cool the inlet air through evaporation (it is an evaporative cooling system). On a day where the inlet air is 42°**C** with a relative humidity of 40% ($\phi = 0.4$) what is the lowest temperature that can be achieved with evaporative cooling?

Given that the turbine is using a simple Brayton power cycle, the volumetric flow rate is limited to 125$\mathbf{m^3/s}$, the turbine inlet temperature is always limited to 1800**K**, and the compressor pressure ratio is 16 what is the % gain in power that can be achieved by this fogging system when it cools the air to the lowest temperature possible? Remember to account for the changes in the working fluid properties (density and spec heats) due to the increased humidity.

What is the gain in thermal efficiency, in %, for the cycle?

How much water does this cycle consume (**kg/s**)?

Problem 2

An air conditioner is operating in a desert environment to cool air from 75°**F** with a relative humidity of 20% ($\phi_A = 0.2$) to 55°**F**. Assuming your refrigeration cycle has a COP_R of 3.5, what is the specific work required to do this? What is the percentage change in work required if the relative humidity at the inlet was increased to 80% ($\phi_B = 0.8$)?

Problem 3

Humid air at 40°**C** and a relative humidity of 80% is compressed in a two stage compressor from 100**kPa** to 2500**kPa**. Each compressor is isentropic and has the same pressure ratio and in between the fluid is cooled in an intercooler to the inlet temperature.

Will the water vapor condense in this device? Where?

What is the relative humidity at the exit of the second compressor?

Draw this process for the water on a T-s diagram.

Problem 4

Liquid methyl alcohol (the stuff you definitely don't want to drink) and a stoichiometric amount of dry air enter a combustion chamber where they completely react and release heat to leave at the same temperature (water leaves as a liquid). How much heat is released when 1**kmol** of methyl alcohol is burned?

Instead of dry air the methyl alcohol is now burned with a stoichiometric amount of pure oxygen, O_2. How much heat is released when 1**kmol** of methyl alcohol is burned in this way?

Problem 5

Ethyl alcohol (the stuff you drink while doing hw) and a stoichiometric amount of dry air enter a combustion chamber at 298**K** and 1**atm** where they completely react (assume the water remains in vapor form). What is the adiabatic flame temperature for this reaction? How much energy is released per **kg** of fuel burned?

You may assume constant specific heats evaluated at 300K or get exact solution with EES.