國立雲林科技大學 113 學年度 碩士班招生考試試題

系所：化材系

科目：化工熱力學

1. (20%)

Air in the ideal-gas state (constant-volume heat capacity 12.471 J/mol-K) is compressed from 1 bar and 70°C to 1.7 bar and 150°C in a closed system which is placed inside a constant-temperature bath at 30°C.

(a) The compression process operates adiabatically in a mechanically reversible manner. Calculate the work required, enthalpy change and entropy change. (10%)

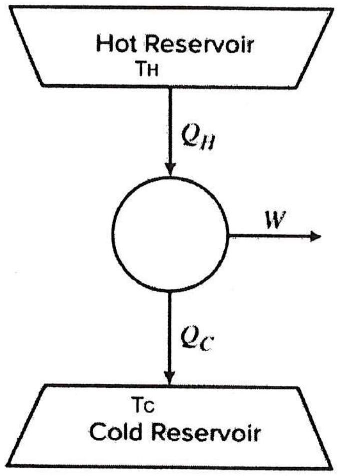
(b) The compression process has a work efficiency of 70% and accomplishes exactly the same changes of state. Calculate the work required, heat transferred and total entropy change. (10%)

2. (15%)

A central power plant operates with a heat engine by taking heat of 158000 kW from a hot reservoir at 350°C and discards heat to a cold reservoir at 30°C. It has a thermal efficiency equal to 55% of the maximum possible value.

(a) Calculate the thermal efficiency, work produced, and heat discarded. (10%)

(b) Show whether or not this plant operation is thermodynamically possible. (5%)



3. (15%)

Steam at 8600 kPa and 500°C (enthalpy H=3391.6 kJ/kg, entropy S=6.6858 kJ/kg-K) is fed at a rate of 59 kg/s into a steam turbine with rated capacity of 56400 kW. Exhaust from the turbine enters a condenser at 10 kPa (saturated vapor: S=8.1511 kJ/kg-K, H=2584.8 kJ/kg; saturated liquid: S=0.6493 kJ/kg-K, H=191.8 kJ/kg).

Calculate

(a) the maximum work output and correspondingly the quality of the steam at discharge. (10%)

(b) the turbine efficiency. (5%)

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4. (20%)

A device operates adiabatically and without moving parts, splitting a feed of compressed air into two streams: chilled and warm air. The feed air enters at 30°C and 7.5 bar, and the device produces chilled air at 10°C and 1.5 bar and warm air at 50°C and 1.5 bar. Assuming the device operates adiabatically and the air behaves as an ideal gas with $C_p=(7/2)R$, determine the ratio of the mass flow rate of the chilled air to warm air.

5. (10%)

Evaluate the spontaneity of a chemical reaction at both low and high temperatures for each possible combination of signs (positive or negative) for the enthalpy change (ΔH) and the entropy change (ΔS) of the system. Discuss your predictions in the context of the Gibbs free energy equation.

(a) ΔH negative, ΔS positive (5%)

(b) ΔH negative, ΔS negative (5%)

6. (20%)

A vessel is divided into two parts by a partition. One part contains 3 mol of nitrogen gas at 85°C and 25 bar, and the other contains 2 mol of argon gas at 120°C and 15 bar. If the partition is removed, allowing the gases to mix adiabatically and completely, determine:

(a) The final temperature and pressure in the vessel. (10%)

(b) The change in the entropy of the system. (10%)

Assume nitrogen to be an ideal gas with $C_v = (5/2)R$ and argon to be an ideal gas with $C_v = (3/2)R$.