MECH 324 THERMAL SYSTEM DESIGN
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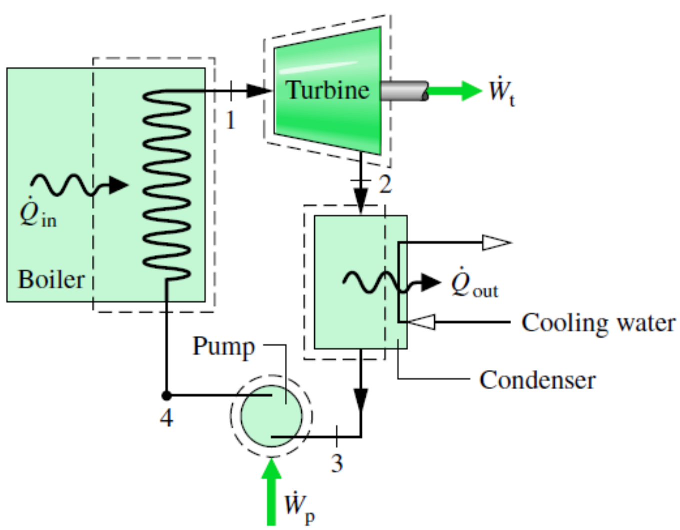
Week 1: Introduction to thermal system design
Introduction to thermodynamic basics
Week 2 Thermodynamic power systems
Thermodynamic refrigeration
Week 3: Flow systems & modelling
Week 4 Heat Transfer
Week 5 Heat exchangers
Week 6 Root finding, linear system of equations
Week 7 Curve fitting
Week 8 Economic evaluation
Week 9 Cost analysis
Week 10 sistem flow diagrams & preliminary system design
Week 11 Optimisation
Week 12 Optimisation
Week 13 Project presentations

Grading : 50% homework
50 % Thermal system design Project

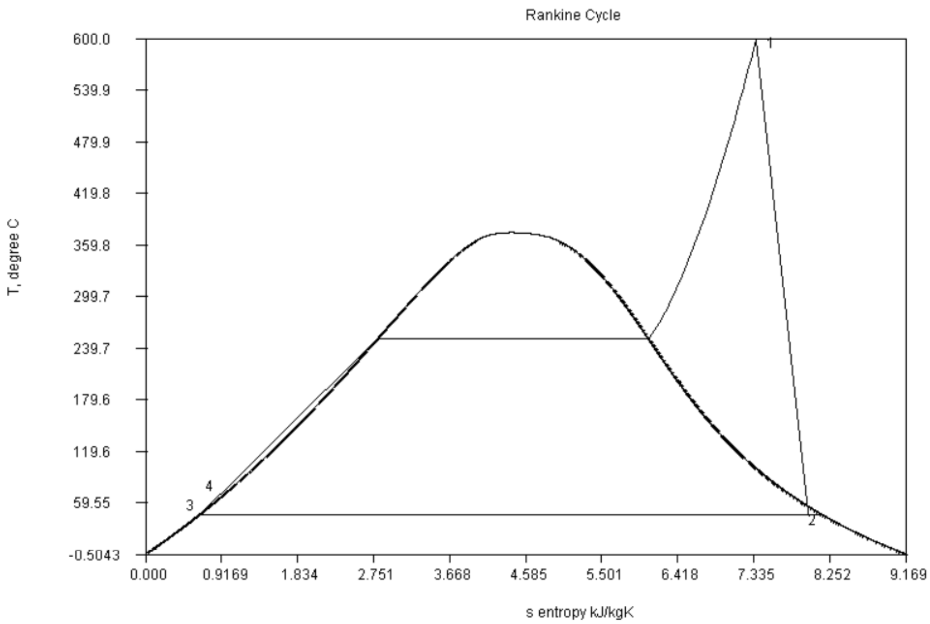
Week 2 Homework
PROBLEM 1
In a simple rankine cycle power plant operating fluid is water and water mass flow rate is m=10 kg/s. Turbine inlet temperature $T_1 = 600$ °C and $P_1 = 4000\ kPa$. Turbine exit pressure is $P_1 = 10\ kPa$. Turbine and pump isentropic efficiencies are 85 % respectively. Calculate

a) Power output
b) Cycle efficiency



$W_{pump} = m(h_4 - h_3)$ (3.3.1)

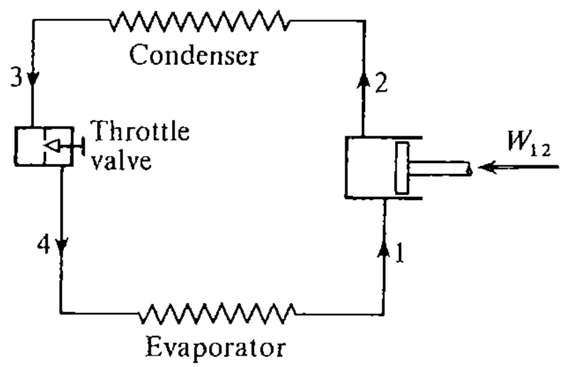
$$W_{isentropicpump} = m(h_{4s} - h_3) \qquad s_{4s} = s_3 \quad (3.3.2)$$
$$\eta_{isentropicpump} = \frac{W_{isentropicpump}}{W_{pump}} \quad (3.3.3)$$
$$Q_{boiler} = m(h_1 - h_4) \qquad (3.3.4)$$
$$W_{turbine} = m(h_1 - h_2) \qquad (3.3.5)$$
$$W_{isentropicturbine} = m(h_1 - h_{2s}) \qquad s_1 = s_{2s} \quad (3.3.6)$$
$$\eta_{isentropic\rightleftarrows turbine} = \frac{W_{turbine}}{W_{isentropicturbine}} \quad (3.3.7)$$



PROBLEM 2

In a standard refrigeration cycle, operating fluid is R134a and refrigerant mass flow rate is m=0.05 kg/s. Compressor exit pressure $P_2 = 400\ kPa$ and compressor inlet pressure is $P_1 = 140\ kPa$. pump isentropic efficiency is 85 %. In the evaporatör exit 5 K superheating is existed. In the condenser output 5 K overcooling (saturated liquid to liquid state) is existed. Calculate

a) Compressor power requirement
b) Evaporatör heat transfer
c) Condenser heat transfer
d) Refrigeration coefficient of performence
e) Heat pump coefficient of performance



$$W_{isentropiccompressor} = m(h_{2i} - h_1) \qquad s_{2i} = s_1$$

$$W_{compressor} = m(h_2 - h_1)$$

Isentropic efficiency of compressor: $\eta_{isentropic\_pump} = \frac{W_{isentropiccompressor}}{W_{compressor}}$

$$Q_{condenser} = m(h_2 - h_3)$$

Throttle valve: $h_3 = h_4$

$Q_{evaporator} = m(h_1 - h_4) = mT_1(s_1 - s_4)$

$W_{netin} = W_{compressor} = Q_{condenser} - Q_{evaporator}$ (

$Coefficient of Performance for evaporator = \frac{Q_{evaporator}}{W_{compressor}}$

$Coefficient of Performance for condenser = \frac{Q_{condenser}}{W_{compressor}}$