Explanation Chapter 4

4.1 Energy can neither be created nor destroyed but can be converted from one form to other is inferred from:
a) zeroth law of thermodynamic
b) first law of thermodynamics
c) second law to thermodynamics
d) third law of thermodynamics
e) basic law of thermodynamics
Ans: B. The first law states that energy is always conserved. The increase of entropy principle is stated in the second law of thermodynamics. The zeroth law states that if two systems are both in equilibrium with a third system, they are in thermal equilibrium with each other. The statement, the entropy of a pure crystalline substance at absolute zero temperature is zero, is known as the third law of thermodynamics. The basic law of thermodynamics is nonsense.

4.2 What is stated in the first law of Thermodynamics?
a) Conservation of mass
b) The increase of entropy principle
c) Conservation of momentum
d) Conservation of entropy
e) Conservation of energy
Ans: E. The first law states that energy is always conserved. The increase of entropy principle is stated in the second law of thermodynamics. Conservation of mass and momentum are also true, but these are not known as the first law of thermodynamics. Conservation of entropy is not true.

4.3 Use the first law of thermodynamics to determine the amount of heat change, Q, for a closed system, and whether it was added to or removed from the system, given that W = 225 J and ΔE=600 J.
a) Q = +825J
b) Q = +375J
c) Q = -375 J
d) Q = 0 J
e) Q = -600J
Ans: A. Using $Q-W=\Delta E$, positive sign means heat added to the system.

4.4 What is a steady-flow process?
a) A process in which the fluid does not flow (velocity is zero)
b) A process in which the fluid properties may change with the position within the device and with the time
c) A process in which the fluid properties may change with the position within the device but not with the time
d) A process in which the fluid properties may change with time but not with the position within the device
e) A process in which the fluid properties may not change with the time and not with the position within the device
Ans: C. A steady-flow process is defined as a process during which a fluid flows through a device (a control volume) steadily. That is, the fluid properties can change from point to point within the device (thus with position), but at any fixed point they remain the same during the entire process. Therefore, the volume, mass, and the total energy content of the control volume remains constant during a steady-flow process. The opposite of steady is unsteady or transient, that is in a transient flow the properties do change with time. They are more difficult to analyze, however steady-flow conditions can be closely approximated by devices that are intended for continuous operation like pumps, compressors, turbines, boilers and heat exchangers or power plants. These devices are called steady-flow devices (devices that operate for a long period under the same conditions).

4.5 What is the energy balance of Steady-State Flow Processes?
Ans: $q\_in+w\_in+(h+ke+pe)\_in = q\_out+w\_out+(h+ke+pe)\_out$
All properties of the Steady-state flow processes are independent of time.

4.6 When more than one fluid stream enters or leaves the control volume, which type of balance is taken? (Think about a mixing chamber)
a) mass balance
b) energy balance
c) mass balance and energy balance
d) none of the mentioned
Ans: C. Both energy and mass balance are considered here.

4.7 Air at 100kPa and 300K is compressed steadily by a 20kW motor to 300kPa. The air temperature is maintained constant at 300K dues to the heat transfer to the surrounding medium at 273K. What is the rate of heat loss of the air? (Hint: dh=cp*dT)

a) -20kW
b) 15kW
c) 20kW
d) -15kW
e) 0kW

Ans: C. Air is kept to the same temperature, so dh=cp*dT=0. From the conservation of energy, that means that Q_dot=-W_dot=-(W_out-W_in)=+W_in= 20kW.

4.8 What statement is correct?

a) In condenser enthalpy is converted into work
b) In steam boiler heat is converted into enthalpy
c) Pump use mechanical work input to increase the pressure of gases

Ans: B. A condenser converts enthalpy into heat output. A condenser doesn't produce any form of work. A boiler uses heat input to increase the energy of the working fluid. A pump is used only for liquids. The point of the condenser producing a saturated liquid is so the pump can work with it. For gases, a compressor is used.

4.9 How does the nozzle changes the energy states of a fluid?

a) decreases the velocity of a fluid at the cost of its pressure gain
b) increases the velocity of a fluid at the cost of its pressure drop
c) increases the velocity of a fluid and also its pressure
d) none of the mentioned.

Ans: B. A nozzle increases KE of fluid and reduces its pressure.

4.9 How does a diffuser changes the energy states of a fluid?

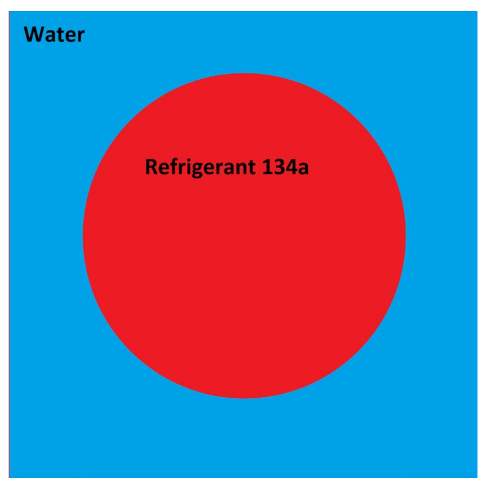
a) increases the pressure of the fluid at the expense of its KE
b) decreases the pressure of the fluid and also increases its KE
c) increases the pressure of the fluid and also its KE
d) decreases the pressure of the fluid and also its KE

Ans: A. A diffuser increases the pressure at the expense of its KE.

4.10 In a throttling device, what do we get from conservation of energy when changes in PE and KE are taken zero?
(a) dQ/dm≠0
(b) dW/dm≠0
(c) h1=h2
(d) none of the mentioned
(e) u1=u2
Ans: C. Enthalpy of the fluid before throttling is equal to the enthalpy of the fluid after throttling.

4.11 The inlet of a turbine is steam at P1=2MPa and T1=400℃ and the outlet has the properties P2=15kPa and x=0.9. Neglecting the potential and kinetic energy, calculate Δh:
a) 887.4
b) 922.01
c) 1009.21
d) 588.7
e) 684.41
Ans: A. h1=3248.4 from table A6 and h2=hf+x*hfg=2361.01 kj/kg. That means difference is around 887.4.

4.12 A circular tube with radius 15cm it's trapped inside a squared tube with length 50cm (section cut can be seen in the picture). Inside the circular tube, we find Refrigerant 134a that has to be cooled from 1MPa and 70℃ to 40℃. The cooling water inside the squared tube enters at 5MPa and 0℃ and leaves with a higher temperature. Knowing that the mass rates are proportional with the area in which the fluids flow, what is the exit temperature of the water?
a) 5.9℃
b) 3.1℃
c) 9.2℃
d) 15℃
e) 20℃



Ans: B.

$$Area_{refrigerant} = \pi r^2 = 706\ cm^2$$
$$Area_{water} = L^2 - \pi r^2 = 1793\ cm^2$$
$$Mdot_{r(h1-h2)} = Mdot_w * (h4 - h3)$$

From the table of the refrigerant h1=303.87 and h2=271.04. From the table for water at 5MPa h3=5.03 and h4 must be calculated.

$$h4 = h3 + (h1 - h2) * (Area_{refrigerant}/Area_{water}) = 18$$

This value must be interpolated, and final temperature of water will be 3.1 degree Celsius.