

Department of Electrical Engineering

Final term exam

Date: 28/09/2020

Course Details

Course Title: Thermodynamics
Instructor: _____

Module: 02
Total Marks: 50

Student Details

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13172

Q1.	(a)	State the following along with their mathematical expressions: i. The ideal gas law ii. Dalton's law of partial pressure	Marks 04+06
	(b)		CLO 2
Q2.	(a)	You need to buy a refrigerator for your home. Outline the key factors that you will consider while buying the refrigerator. (b) Explain vapour absorption refrigeration system.	Marks 05+08
	(b)		CLO 3
Q3.		Distinguish between water tube & fire tube boilers.	Marks 06 CLO 3
Q4.		State the meaning of the word "stroke" & describe the working of a 04 stroke engine.	Marks 12 CLO 3
Q5.	(a)	Explain the concept of Scavenging. (b) Several provincial governments in Pakistan have banned the use of 02 stroke engines in auto rickshaws. Identify the causes behind this decision.	Marks 04+05
	(b)		CLO 3

Q # 01 (a)

(i) The ideal gas law:

The ideal gas law states that pressure, temperature, and volume of gas are related to each other.

The gas constant (R) is a mathematical combination of all the individual gas law constants (C_b, C_c, C_g, C_a).

$$\frac{PV}{nT} = R$$

The ideal gas law is more commonly written as:

$$PV = nRT$$

The value of R is $\left[\frac{.0821 \text{ L} \cdot \text{atm}}{\text{K} \cdot \text{mol}} \right]$

$PV = nRT$, when using this equation you must have the following units.

→ Pressure = atm

→ Volume = liters

→ Temperature = K .

(ii) Dalton's law of partial pressure:

This law states that the total pressure of mixture of gases is the sum of the partial pressure of its components.

The partial pressure of a gas in a mixture is the pressure that the gas would exert if alone.

$$P_T = P_A + P_B + P_C$$

where ,

P_T = Total pressure

P_A = Partial pressure of gas A.

P_B = Partial pressure of gas B.

P_C = Partial pressure of gas C.

Q # 1 (b):

Given data:
 $V_1 = 6$ liters
 $P_1 = 4$ atm
 $V_2 = 2.50$ liters
 $P_2 = ?$

Solution: $P_1 V_1 = P_2 V_2$

$$\frac{P_1 V_1}{V_2} = P_2$$

$$P_2 = \frac{(4 \text{ atm})(6 \text{ L})}{(2.50 \text{ L})}$$

$$P_2 = 9.6 \text{ atm}$$

final pressure.

$$7296 \text{ mmHg}$$

$$141.081 \text{ Psi}$$

Q # 2 (a):

The key factors that I will consider while buying a refrigerator.

- > Low viscosity.
- > Low freezing point.
- > Low boiling point
- > Low heat capacity
- > Low specific volume.
- > Low saturation pressure
- > Odorless
- > High latent heat of vaporization.
- > Good thermal conductivity.
- > High COP.
- > Non inflammable and non explosive
- > High critical pressure and temperature.

These all are the properties of good (ideal) refrigerator.

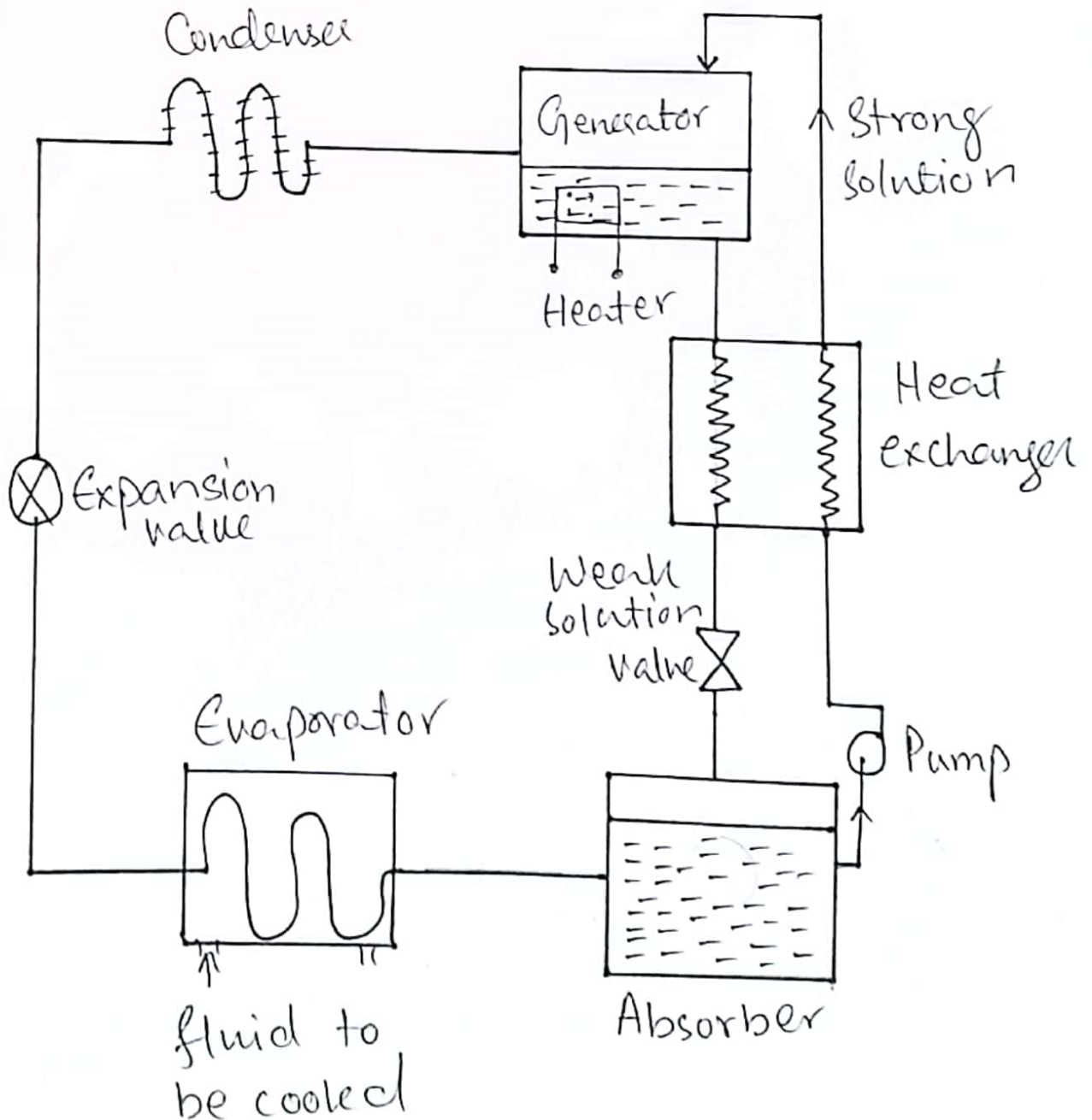
Q # 02 (b) :

Vapour absorption refrigeration :

Principle : Here the heat energy is utilized to achieve the refrigeration. An electric heater or steam is used to add the heat to the refrigerant for its evaporation. Also an absorber, a pump and a generator are used to complete the cycle.

Construction : Here a throttle valve is connected between an evaporator and a condenser. One pump is connected between an absorber and a separator. Water is filled in the absorber and it is connected to the evaporator. The evaporator is kept in storage room. The separator is connected to the condenser. Both the condenser and evaporator consists of pipes in coil form to provide more contact surface area for the refrigerant. Arguments are made to circulate the

Cold water around the condenser and in the absorber. An electric heater is housed in the separator. Trays may be positioned to collect the excess water near by the absorber and condenser. A receiver is connected in between the condenser and the throttle valve.



Working: Dry ammonia vapour from the evaporator enters the absorber containing water where it is absorbed by the water becomes a strong ammonia solution with an increase in temperature. The heat generated during this process is removed to some extent by circulating cold water through a pipe. Otherwise absorbing capacity reduces with hot water. The strong ammonia solution is now pumped by a pump to the generator where it is heated by an electric coil. As a result ammonia vaporizes and separates out from water. It is then driven out from the solution to the condenser where it is condensed and return to the liquid state. The liquid ammonia is then collected in the receiver. The high pressure liquid ammonia is then passed through the throttle valve where it is expanded with decrease in temperature and pressure. Later it enters the evaporator kept in the storage room.

Q # 3 :

Water tube boilers: These are the most efficient boilers. Water runs in the tubes and the hot gases surround it, hence the heat transfer area is low value.

Fire tube boilers: These types of boilers consists of a nest of tubes through which the hot gases flow. The tubes being surrounded by water. Since, the contact area between the water and hot gases is greater than in the case of shell tube types, hence it has the ability to generate larger quantities of steam. It has efficiency definitely greater than shell tube type. The marine boilers and locomotive boilers are its example. Velox boiler is a modern fire tube boiler.

Q # 4 :

Stroke: A stroke is movement of the piston from top dead centre (T.D.C) to bottom dead centre (B.D.C) or from (B.D.C) to (T.D.C).

Working of 4-stroke engine :

Four stroke cycle engine works on four stroke principle.

There are four strokes in one cycle of such engine. Four stroke engine is also called four-cycle engine or Otto cycle engine.

The four strokes of Otto cycle engine are :

- (i) Intake Stroke: On the intake stroke, the piston is moving down due to which a partial vacuum is produced inside the cylinder. The

intake valve is open, therefore, atmospheric pressure pushes the fresh air fuel mixture in the cylinder through intake valve.

(ii) Compression stroke: When the piston reaches the B.D.C on the intake stroke, the intake valve closes. Then the piston moves up on the compression stroke. During this stroke, both the valves are closed, therefore no air-fuel mixture can enter or goes out of the cylinder. Therefore, when the piston moves up the mixture inside the cylinder is compressed.

(iii) Power stroke: During the compression stroke, the piston moves up when it gets near (T.D.C), the spark plug produces a spark which ignites the compressed air-fuel mixture.

Due to which the temperature and the pressure of gas rises. The pressure becomes about 600 psi which push the piston down. As during this stroke, we obtain power therefore it is called power stroke.

The piston transmit this power through the connecting rod to the crank due to which the crank shaft rotates. This rotary motion is carried through shafts and gears to the car wheels due to which turns and car moves.

(iv) Exhaust stroke: During the power stroke as the piston reaches B.D.C, the exhaust valve opens. Then the piston moves up on exhaust stroke. When the piston moves up, it pushes out the burnt gases from the cylinder through exhaust valve. When the piston reaches T.D.C, the exhaust valve closes and intake valve opens for the second cycle.

Q # 05 (a) :

Scavenging : The process of explosion of burnt gases and the entering of fresh air-fuel mixture is known as scavenging.

The scavenging in two stroke engine is different than that of four cycle engine. The stroke of two engine stroke is slightly different, it is somewhat pear shaped. It do not contain camshaft, push rod, rocker arm and valves. Instead of these it have three ports i-e Exhaust port, Intake port and transfer port.

→ The cycle of two stroke is completed in one revolution of crankshaft while in four stroke engine cycle is completed in two revolutions of crankshaft. So it means that two stroke engines provide more power as compared to four stroke engines.

- > As two stroke engine produce more power as compare to four stroke engine, so its weight to power ratio is less while its power to weight ratio is more.
- > As there are less moving parts in two stroke engines, so it is easy to maintain it. i.e it has less maintainance
- > It may accelerate rapidly i.e It have more pop (pick).
- > In two stroke engine, the turning moment of crankshaft is uniform that's why we need to light fly wheel.
- > The work required to overcome the function of the exhaust and suction stroke is saved.
- > The scavenging is more complete in low-speed engines as it does not leave the clearance volume full of burnt gases as in the four stroke engine.

Q #05 (b):

The cause behind this decision is that the two-stroke engines rickshaws, are the most inefficient vehicles in complete burning of fuel and thus contribute most to emission of air pollutants in the environment. The major pollutants from 2-stroke engines are Carbon monoxide (CO), Nitrogen oxides (NOx), Hydrocarbons (HC) and particulate matter (PM). Their presence in the environment causes a number of respiratory diseases and other illnesses. For example CO and NOx are notorious irritants of respiratory system and have potential suffocating action. (PM) causes premature deaths and illness. Its presence is accompanied by increased hospital admissions for asthma and other bronchial conditions such as bronchitis etc.