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Name Hamza Ishaq (1)

Thermodynamics

Q 1(a)

i) The Ideal Gas Law:

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 $\left[\frac{0.821 \ L \cdot atm}{K \cdot mol}\right]$

$$PV = nRT$$

When using this equation you must have the following units.

- Pressure = atm
- Volume = Liters
- Temperature = K

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ii) <u>Dalton's Law of Partial Pressure:</u> states that the total pressure of a mixture of gases is the sum of the partial pressures of its components.

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

<u>Mathematically:</u>

$$P_T = P_A + P_B + P_C$$

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Q1 (b)

Solution.

$$P_1V_1 = P_2V_2$$

$$\frac{P_1V_1}{V_2} = \frac{P_2V_2}{V_2}$$

$P_1 = 4$ atm

$P_2 = ?$

$V_1 = 6$ litres

$V_2 = 2.50$

$$P_2 = \frac{P_1V_1}{V_2}$$

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

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

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Q 2 (a)

Answer:

Key factors of ideal refrigerator:

An ideal refrigerant should have the following properties.

1. Low viscosity
2. Low freezing point
3- Low boiling point
4- Low heat capacity
5- Low specific volume
6- Low saturation pressure
7- odorless
8- High latent heat of vaporization
9- Good thermal conductivity.
10- high COP
11- Non inflammable and non explosive.
12. High critical pressure and temp.

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Q 2(b)

Vapour Absorption Refrigeration:

Principle

Here the heat energy is utilized to achieve the refregeration. 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 b/w an evaporator and a condenser. One pump is connected b/w an absorber and a seperator. Water is filled in the absorber and it is connected to the evaporator. The evaporator is kept in the storage room. The seperator is connected to the condensor. Both the condenser and evaporator consists of pipes in coil form to provide more

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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 seperator. Tray may be positioned to collect the exit water near by the absorber and condenser. A reciever is connected in b/w condenser and the throttle value.

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. 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 reciever. The

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high pressure liquid ammonia is then passed through the throttle valve wher it is expanded with decreese in temperature and pressure. Later it enters the evaporator kept in the storage room.

Comparison b/w Vapour Compression and Vapour absurption refrigeration.

Vapour Compression	Vapour absurption
→ Works using mechanical energy	→ Works using heat energy
→ Refrigeration capacity is less then 1000 tons	→ Refrigeration capacity is greater then 1000 tons
→ COP is much higher	→ COP is less
→ Noisy due to compressor	→ Pump noises is less
→ chances of leakage of refrigerant are more	→ No leakage
→ Maintenance and operating cost are high	→ less
→ Smaller in size	→ larger
→ Wore and tear are more	→ wore and tear are less

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Q3

Difference b/w Fire tube and Water tube Boiler

Fire tube Boiler	Water tube Boiler
→ Hot flue gases flow inside the tube and the water	→ water flows inside the turbine and hot flue gases outside the tube
→ These boilers are generally internally fired	→ These boilers are generally extra really fired
→ The boiler pressure limited to 20 bar	→ The boiler pressure is limited up to 100 bar.
→ The fire-tube boiler has a lower rate of steam production	→ A higher rate of steam production.
→ This boiler is difficult to construct	→ Simple in construction.
→ It occupies large floor space for a given power	→ It occupies small floor space

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→ They are difficult to repair and cleaning as they are internally fired	→ They are easy to repair and clean as they are externally fired
→ They required a large shell diameter. Because the fire-tube situated inside the shell	→ They required a small shell diameter.

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Thermodynamics (10)

Q4

Answer.

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)

Cycle

It is a series of event that repeat themselves.

Four Stroke Engine

Four stroke cycle engine works on four stroke principle i.e there are four strokes in one cycle of such engine. Four-stroke engine is also called four cycle engine or "otto-cycle engine.

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The four strokes of otto-cycle engine are

1. Intake stroke
2. Compression stroke
3. Power stroke
4. Exhaust stroke

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 the intake valve.

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

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Thermodynamics (12)

the values 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. In modern engine it is compressed to one-eight or one-ninth of the original volume. The amount to which the air fuel mixture is compressed is called "the compression ratio".

If the mixture is compressed to one-eight of the original volume, the compression ratio is '8' to '1' (8:1)

Power stroke

During the compression stroke, the piston moves up when it gets near T.D.C a spark which ignite the compressed air fuel mixture. Due to which the temperature and the pressure of gas rises. The pressure

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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 crankshaft rotates this rotatory motion is carried through shaft and gears to the car wheels due to which wheel turns.

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 open for the second cycle.

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Compression Ratio:

The volume in which piston reciprocates i.e the volume from B.D.C to T.D.C is called swept volume (V_s)"

The volume in which fresh air-fuel mixture is compressed by the piston in the cylinder is called "[clearance volume]"

Thus the total volume of the cylinder is the sum of the swept volume and clearance volume

i.e $V_T = V_s + V_c$

And the compression ratio is the ratio of the total volume to the clearance volume.

i.e compression value ratio $= \frac{\text{Total volume}}{\text{Clearance volume}} = \frac{V_T}{V_c}$

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Thermodynamics (15)

Q5 (a)

Concept of Scavenging:

In an internal combustion engine scavenging is the process of replacing the exhaust gas in a cylinder with the fresh air/fuel mixture (or fresh air, in the case of direct-injection engines) for the next cycle. If scavenging is incomplete, the remaining exhaust gases can cause improper combustion for the next cycle, leading to reduced power output.

Scavenging is equally important for both two-stroke engines and four-stroke engines. Most modern four-stroke engines use crossflow cylinder heads and valve timing overlap to scavenge the cylinders. Modern two-stroke engine use either Schnuerle scavenging (also known as "loop scavenging") or uniflow scavenging.

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Thermodynamics (16)

Q 5 (b)

Answer

The rickshaw due to being equipped with 2-stroke engines, 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 two-stroke engines are Carbon Monoxide (CO), Nitrogen oxides (NO_x), 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 potention suffocating action. PM causes premature death, and illness. Its presence is accompanied by increased hospital admissions for asthma and other bronchial conditions such as bronchitis etc.

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None of the locally assembled rickshaw meets standards fixed by Pakistan standard quality Control Authority (PSQCA) for smoke emission. According to the PSQCA code, two-stroke exhaust contain 45 Per cent and old two-stroke has six Per cent carbon mono oxide.