

BITT POLYTECHNIC

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SUBJECT : POWER ENGINEERING

SEMESTER : 5TH

1-Marks Questions

1. The ratio of work done per cycle to the stroke volume of the compressor is

known as:-

- a) Compressor capacity
- b) Compressor ratio
- c) Compressor efficiency
- d) Mean effective pressure

Answer: Mean effective pressure

2. Aero plane employ following types compressor

- a) Radial flow
- b) Axial flow
- c) Centrifugal
- d) Combination of above

Answer: axial flow

3. The volume of air delivered by the compressor is called

- a) Free air delivery
- b) Compressor capacity
- c) Swept volume
- d) None of the above

Answer: Compressor capacity

4. The most efficient method of compressing air is to compress it.....

- a) Isothermal
- b) Adiabatically
- c) Isentropically
- d) None of these

Answer: Isothermal

5. Volumetric efficiency of air compressor is of the order of.....

- a) 20 to 30 %
- b) 40 to 50 %
- c) 60 to 70%
- d) 70 to 90%

Answer: 70 to 90%

5-MARKS QUESTTION

6. What is Air compressor?

Answer:

Compressor is a device which is used to increase the pressure of air from low pressure to high pressure by using some external energy.

7. What is the application of compressed air?

Answer:

The applications of compressed air are listed below:

- 1) It is used in gas turbines and propulsion units.
- 2) It is used in striking type pneumatic tools for concrete breaking, clay or rock drilling, chipping, caulking, riveting etc.
- 3) It is used in rotary type pneumatic tools for drilling, grinding, hammering etc.
- 4) Pneumatic lifts and elevators work by compressed air.
- 5) It is used for cleaning purposes.
- 6) It is used as an atomizer in paint spray and insecticides sprayguns.
- 7) Air-operated brakes are used in railways and heavy vehicles such as buses and Lorries.
- 8) Compressed air is used for starting I.C. engines and also super charging them.

8. Explain working principle of a compressor?

Answer:

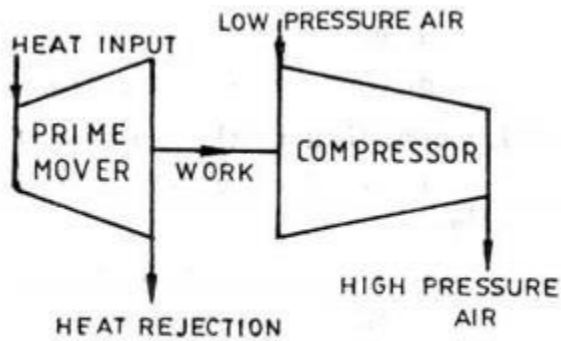


Fig:4.1 Air Compressor

A line diagram of a compressor unit is shown in fig: 4.1. The compression process requires work input. Hence a compressor is driven by a prime mover. Generally, an electric motor is used as prime mover. Air from atmosphere enters into the compressor. It is compressed to a high pressure. Then, this high pressure air is delivered to a storage vessel (reservoir). From the reservoir, it can be conveyed to the desired place through pipe lines. Some of the energy supplied by the prime

mover is absorbed in work done against friction. Some portion of energy is lost due to radiation and coolant. The rest of the energy is maintained within the high pressure air delivered.

9. What is classification of air compressor?

Answer:

Air compressors may be classified as follows:

According to design and principle of operation:

- (a) Reciprocating compressors in which a piston reciprocates inside the cylinder.
- (b) Rotary compressors in which a rotor is rotated.

According to number of stages:

- (a) Single stage compressors in which compression of air takes place in one cylinder only.
- (b) Multi stage compressors in which compression of air takes place in more than one cylinder.

According to pressure limit:

- (a) Low pressure compressors in which the final delivery pressure is less than 10 bars,
- (b) Medium pressure compressor in which the final delivery pressure is 10 bar to 80 bar and
- (c) High pressure compressors in which the final delivery pressure is 80 to 100 bar.

10. What is classification of air compressor according to capacity and method of cooling?

Answer:

According to capacity:

- (a) Low capacity compressor (delivers 0.15m³ /s of compressed air),
- (b) Medium capacity compressor (delivers 5m³ /s of compressed air) and
- (c) High capacity compressor (delivers more than 5m³ /s of compressed air).

According to method of cooling:

- (a) Air cooled compressor (Air is the cooling medium) and
- (b) Water cooled compressor (Water is the cooling medium).

11. What is classification of air compressor according to nature of installation?

Answer:

According to the nature of installation:

- (a) Portable compressors (can be moved from one place to another).
- (b) Semi-fixed compressors and
- (c) Fixed compressors (They are permanently installed in one place).

12. What is classification of air compressor according to application?

Answer:

According to applications:

- (a) Rock drill compressors (used for drilling rocks),
- (b) Quarrying compressors (used in quarries),
- (c) Sandblasting compressors (used for cleaning of cast iron) and
- (d) Spray painting compressors (used for spray painting).

13. What is reciprocating air compressor and its types?

Answer:

In a reciprocating compressor, a volume of air is drawn into a cylinder; it is trapped, and compressed by piston and then discharged into the discharge line. The cylinder valves control the flow of air through the cylinder; these valves act as check valves.

Types: a) single acting b) double acting c) multi staging

14. What is centrifugal compressor?

Answer:

In this compressor air enters axially and leaves radially. When the impeller rotates, air enters axially through the eye of the impeller with a low velocity. This air moves over the impeller vanes. Then, it flows radially outwards from the impeller. The velocity and pressure increases in the impeller. The air then enters the diverging passage known as diffuser. In the diffuser, kinetic energy is converted into pressure energy and the pressure of the air further increases. Finally, high pressure air is delivered to the receiver. Generally half of the total pressure rise takes place in the impeller and the other half in the diffuser.

15. What is the application of centrifugal compressor?

Answer:

Centrifugal compressors are used for low pressure units such as for

1. Refrigeration
2. Supercharging of internal combustion engines, etc.

16. List out component of centrifugal compressor.

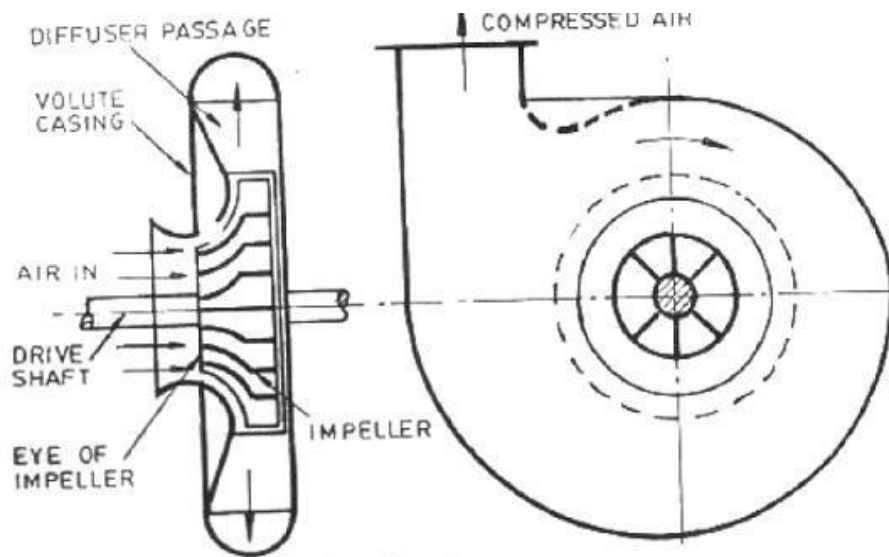
Answer:

It consists of an impeller, a casing and a diffuser. The impeller consists of a number of blades or vanes, is mounted on the compressor shaft inside the casing. The impeller is surrounded by the casing.

17. Explain working of centrifugal compressor?

Answer:

In this compressor air enters axially and leaves radially. When the impeller rotates, air enters axially through the eye of the impeller with a low velocity. This air moves over the impeller vanes. Then, it flows radially outwards from the impeller. The velocity and pressure increases in the impeller. The air then enters the diverging passage known as diffuser. In the diffuser, kinetic energy is converted into pressure energy and the pressure of the air further increases. Finally, high pressure air is delivered to the receiver. Generally half of the total pressure rise takes place in the impeller and the other half in the diffuser.



18. Explain working of root blower.

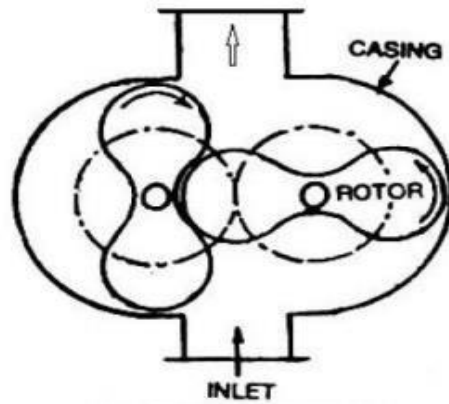
Answer:

When the rotor is driven by the gear, air is trapped between the lobes and the casing. The trapped air moves along the casing and discharged into the receiver. There is no increase in pressure since the flow area from entry to exit remains constant. But, when the outlet is opened, there is a back flow of high pressure air in the receiver. This creates the rise in pressure of the air delivered. These types of blowers are used in automobiles for supercharging.

19. Draw diagram of root blower and list out its components?

Answer:

A vane blower consists of (1) a rotor, (2) vanes mounted on the rotor, (3) inlet and outlet ports and (4) casing. The rotor is placed eccentrically in the outer casing. Concentric vanes (usually 6 to 8 nos.) are mounted on the rotor. The vanes are made of fiber or carbon. Inlet suction area is greater than outlet delivery area.



20. Explain working of vane blower?

Answer:

Working: When the rotor is rotated by the prime mover, air is entrapped between two consecutive vanes. This air is gradually compressed due to decreasing volume between the rotor and the outer casing. This air is delivered to the receiver. This partly compressed air is further increased in pressure due to the back flow of high pressure air from the receiver. Advantages: 1. Very simple and compact, 2. High efficiency 3. Higher speeds are possible.

10 MARKS QUESTION

1. Explain principle and working of single stage air compressor.

Answer:

In a single stage compressor, the compression of air (or gas) takes place in a single cylinder. A schematic diagram of a single stage, single acting compressor is shown in fig.

Construction:

It consists of a piston which reciprocates inside a cylinder. The piston is connected to the crankshaft by means of a connecting rod and a crank. Thus, the rotary movement of the crankshaft is converted into the reciprocating motion of the piston. Inlet and outlet valves (suction and delivery valves) are provided at the top of the cylinder.

Working: When the piston moves down, the pressure inside the cylinder is reduced. When the cylinder pressure is reduced below atmospheric pressure, the inlet valve opens. Atmospheric air is drawn into the cylinder till the piston reaches the bottom dead centre. The delivery valve remains closed during this period. When the piston moves up, the pressure inside the cylinder increases. The inlet valve is closed, since the pressure inside the cylinder is above atmospheric. The pressure of air inside the cylinder is increased steadily. The outlet valve is then opened and the high pressure air is delivered through the outlet valve in to the delivery pipe line. At the top dead centre of the piston, a small volume of high pressure air is left in the clearance space. When the piston moves down again, this air is expanded and pressure reduces, again the inlet valve opens and thus the cycle is repeated.

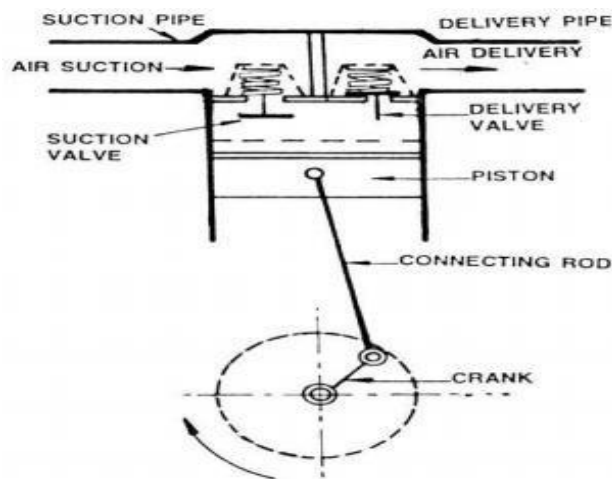


Fig :4.2 Single stage reciprocating Air Compressor

Disadvantages

1. Handling of high pressure air results in leakage through the piston.
2. Cooling of the gas is not effective.
3. Requires a stronger cylinder to withstand high delivery pressure.

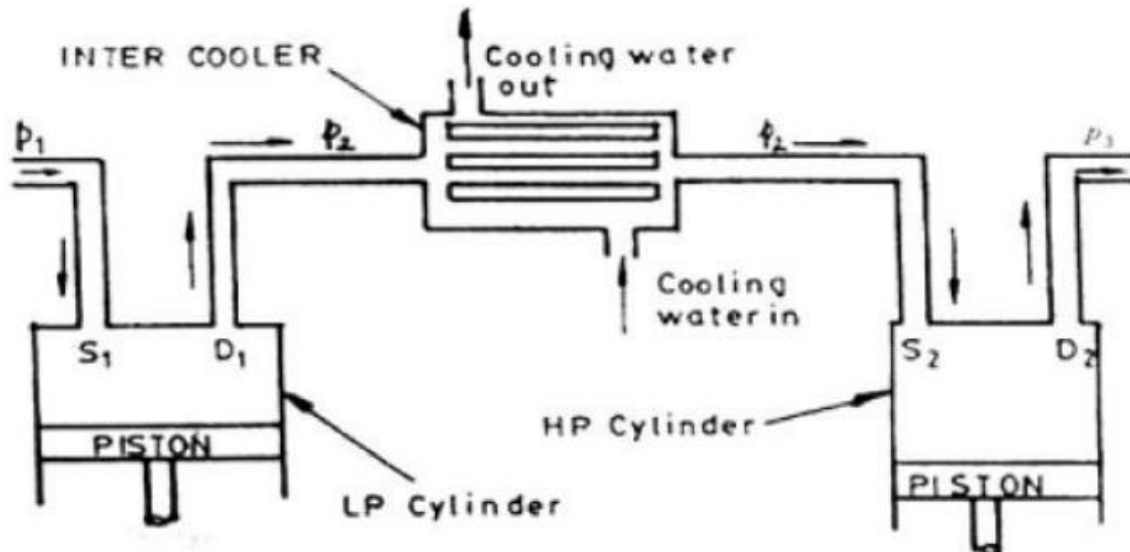
Applications: It is used in places where the required pressure ratio is small.

2. Explain construction and working of multistage air compressor.

Answer:

In a multi stage air compressor, compression of air takes place in more than one cylinder. Multi stage air compressor is used in places where high pressure air is required. Fig. shows the general arrangement of a two-stage air compressor. It consists of a low pressure (L.P) cylinder, an intercooler and a high pressure (H.P) cylinder. Both the pistons (in L.P and H.P cylinders) are driven by a single prime mover through a common shaft. Atmospheric air at pressure p_1 taken into the low pressure cylinder is compressed to a high pressure (p_2). This pressure is intermediate between intake pressure (p_1) and delivery pressure p_3 .

Hence this is known as intermediate pressure. The air from low pressure cylinder is then passed into an intercooler. In the intercooler, the air is cooled at constant pressure by circulating cold water. The cooled air from the intercooler is then taken into the high pressure cylinder. In the high pressure cylinder, air is further compressed to the final delivery pressure (p_3) and supplied to the air receiver tank.



3. Explain advantages and disadvantages of multistage air compressor.

Answer:

Advantages:

1. **Saving in work input:** The air is cooled in an intercooler before entering the high pressure cylinder. Hence less power is required to drive a multistage compressor as compared to a single stage compressor for delivering same quantity of air at the same delivery pressure.
2. **Better balancing:** When the air is sucked in one cylinder, there is compression in the other cylinder. This provides more uniform torque. Hence size of the flywheel is reduced.
3. **No leakage and better lubrication:** The pressure and temperature ranges are kept within desirable limits. This results in a) Minimum air leakage through the piston of the cylinder and b) effective lubrication due to lower temperature.
4. **More volumetric efficiency:** For small pressure range, effect of expansion of the remnant air (high pressure air in the clearance space) is less. Thus by increasing number of stages, volumetric efficiency is improved.
5. **High delivery pressure:** The delivery pressure of air is high with reasonable volumetric efficiency.
6. **Simple construction of LP cylinder:** The maximum pressure in the low pressure cylinder is less. Hence, low pressure cylinder can be made lighter in construction.

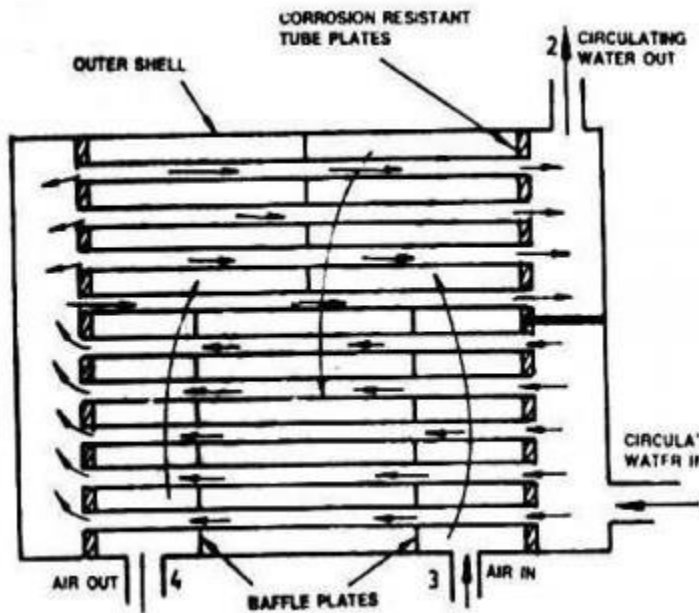
7. Cheaper materials: Lower operating temperature permits the use of cheaper materials for construction.

Disadvantages: 1. More than one cylinder is required. 2 An intercooler is required. This increases initial cost. Also space required is more. 3. Continuous flow of cooling water is required. 4. Complicated in construction.

4. Explain construction and working of intercooler.

Answer:

An intercooler is a simple heat exchanger. It exchanges the heat of compressed air from the LP compressor to the circulating water before the air enters the HP compressor. It consists of a number of special metal tubes connected to corrosion resistant plates at both ends. The entire nest of tubes is covered by an outer shell.



Working: Cold water enters the bottom of the intercooler through water inlet (1) and flows into the bottom tubes. Then they pass through the top tubes and leaves through the water outlet (2) at the top. Air from LP compressor enters through the air inlet (3) of the intercooler and passes over the tubes. While passing over the tubes, the air is cooled (by the cold water circulated through the tubes). This cold air leaves the intercooler through the air outlet (4). Baffle plates are provided in the intercooler to change the direction of air. This provides a better heat transfer from air to the circulating water.

5. Explain construction and working of axial flow compressor?

Answer:

In this air compressor, air enters and leaves axially.

Construction: It consists of two sets of blades: Rotor blades and stator blades. The blades are so arranged that the unit consists of adjacent rows of rotor blades and stator blades as shown in fig. The stator blades are fixed to the casing. The rotor blades are fixed on the rotating drum. The drum is rotated by a prime mover through a driving shaft. Single stage compressor consists of a row of rotor blades followed by a row of stator blades. Compression of air takes place in each pair of blades (one rotor blade and one stator blade). Hence there are many stages of compression in this type of compressor.

Working: When the switch is switched on, the prime mover rotates the drum. Air enters through the compressor inlet and passes through the rotor and stator blades.

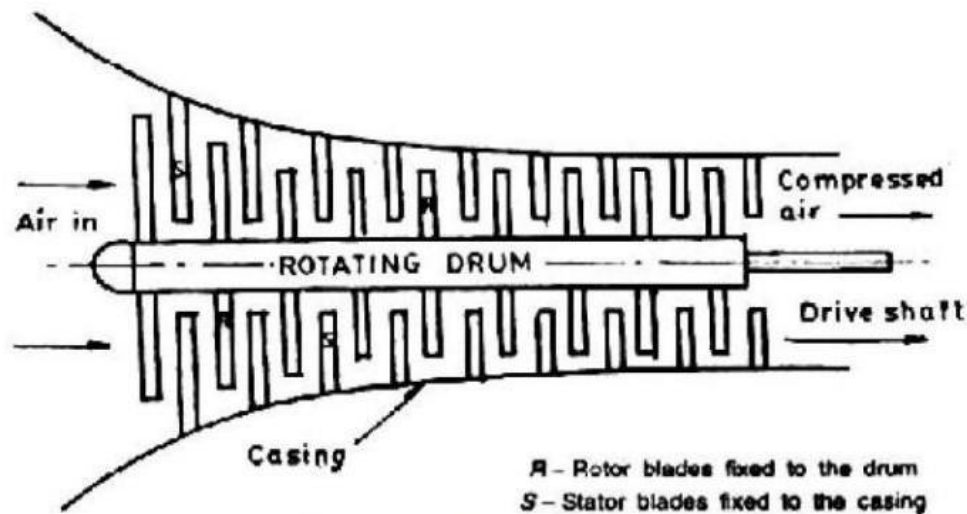


Fig:4.15 Axial flow compressor

Applications:

1. They are widely used in high pressure units such as industrial and marine gas turbine plants.
2. They are most suitable for aircraft work (Jet propulsion) since they require less frontal area.