1.10. TWO MARK QUESTIONS AND ANSWERS

1. ***What is a thermodynamic cycle?*** ***[Anna Univ. Oct' 97]***

   Thermodynamic cycle is defined as the series of processes performed on the system so that the system attains its original state.

2. ***Why is Carnot cycle not used in real applications?*** ***[Anna Univ. Dec'10]***

   (i) In a Carnot cycle, all four processes are reversible but in actual practice there is no process reversible.

   (ii) There are two processes to be carried out during compression and expansion. For isothermal process, the piston moves very slowly and the piston moves as fast as possible during adiabatic process. This speed variation during same stroke of the piston is not possible.

   (iii) It is not possible to avoid friction between moving parts completely.

3. ***A Carnot cycle works between temperatures 300 K and 700 K. Find the maximum work possible per kg of air.*** ***[Anna Univ. Nov'07]***

Given data:

$T_H = 700\ K$

$T_L = 300\ K$

☺ ***Solution:***

Maximum possible efficiency of Carnot cycle

$$\eta_{max} = \frac{T_H - T_L}{T_H} = \frac{700-300}{700} = 0.5714 = 57.14\ \%$$

We know that $\eta_{max} = \dfrac{W_1}{Q_S}$

Maximum possible work of Carnot cycle,

$$W_{max} = Q_S \times \eta_{max} = 1 \times 0.5714 = \mathbf{0.57\ kJ} \qquad \textbf{Ans.}$$

[∵ Assume that 1 kJ of heat is supplied]

4. *What is an air-standard cycle? Why such cycles are conceived?*

[Anna Univ. Oct' 96, Oct' 97, Nov'10, May'11, Dec'12 & May'14]

Cycle is defined as the series of operations or processes performed on a system so that the system attains its original state. The thermodynamic cycles which use air as the working fluids are known as *air standard cycles*.

Air standard cycles are conceived to simplify the analysis of IC engines.

5. *Name the various 'gas power cycles'.* ***[Anna Univ. Dec'16]***

1. Carnot cycle
2. Otto cycle
3. Diesel cycle
4. Brayton cycle
5. Duel combustion cycle
6. Atkinson cycle.

6. *Sketch Otto cycle on p-V diagram and name all processes.* ***[Anna Univ. Apr'04]***

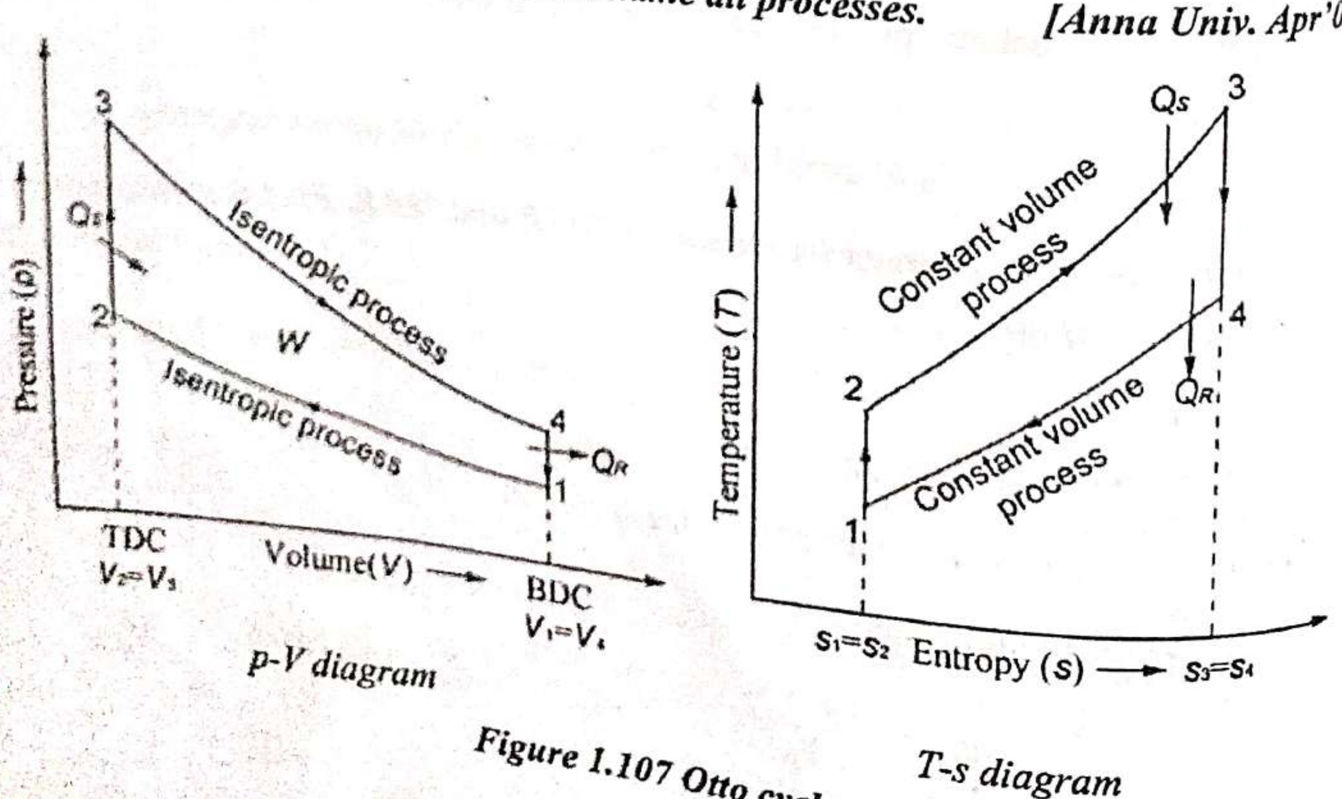


Figure 1.107 Otto cycle

1-2 ⇨ Isentropic compression

2-3 ⇨ Constant volume heat addition

3-4 ⇨ Isentropic expansion

4-1 ⇨ Constant volume heat rejection.

7. ***What are the assumptions made for air standard cycle analysis?***

[Anna Univ. Nov'02, May'03, Apr'05, June'09, May'11, May'13, May'15 & May'16]

1. The working medium is a perfect gas throughout i.e., It follows the law $pv = mRT$
2. The working medium does not undergo any chemical change throughout the cycle.
3. The compression and expansion processes are reversible adiabatic i.e., There are no loss or gain of entropy.
4. Kinetic and potential energies of the working fluid are neglected.
5. The operation of the engine is frictionless.
6. Heat is supplied and rejected in a reversible manner.

8. ***Mention the four thermodynamic processes involved in Diesel Cycle.***

[Anna Univ. Apr'08]

(i) One reversible adiabatic compression

(ii) One constant pressure processes

(iii) One reversible adiabatic expansion

(iv) One constant volume.

9. ***Mention the various processes of dual cycle.*** *[Anna Univ. Apr'96]*

1. Isentropic compression
2. Constant volume heat addition
3. Constant pressure heat addition
4. Isentropic expansion
5. Constant volume heat rejection.

10. ***Mention the various processes of the Brayton cycle.*** *[Anna Univ. Oct' 96]*

1. Isentropic compression
2. Constant pressure heat supplied
3. Isentropic expansion
4. Constant pressure heat rejection.

11. *In an engine working on an ideal Otto cycle, temperatures at the beginning at the end of compression are 27° C and 327° C respectively. Find the compression ratio and air standard efficiency of the engine.* ***[Anna Univ. Dec'11]***

Given data:

$T_1 = 27° \; C = 27+273 = 300 \; K$

$T_3 = 327° \; C = 327+273 = 600 \; K$

☺ ***Solution:***

$$\frac{V_1}{V_2} = \left(\frac{T_2}{T_1}\right)^{\frac{1}{\gamma-1}} = \left(\frac{600}{300}\right)^{\frac{1}{1.4-1}} = 5.66$$

Air standard efficiency, $\eta = 1 - \frac{1}{(r)^{\gamma-1}} = 1 - \frac{1}{(5.66)^{1.4-1}}$ = **50.01% Ans.**

12. *In an Otto cycle, the pressure ratio during compression is 11. Calculate the air standard efficiency.* ***[Anna Univ. June'09]***

Similar to **Question 11** in Page **1.228.**

[Ans:- 49.597%]

13. *Plot the Diesel cycle on p-V and T-s diagrams.* ***[Anna Univ. Oct'01 & Nov'04]***

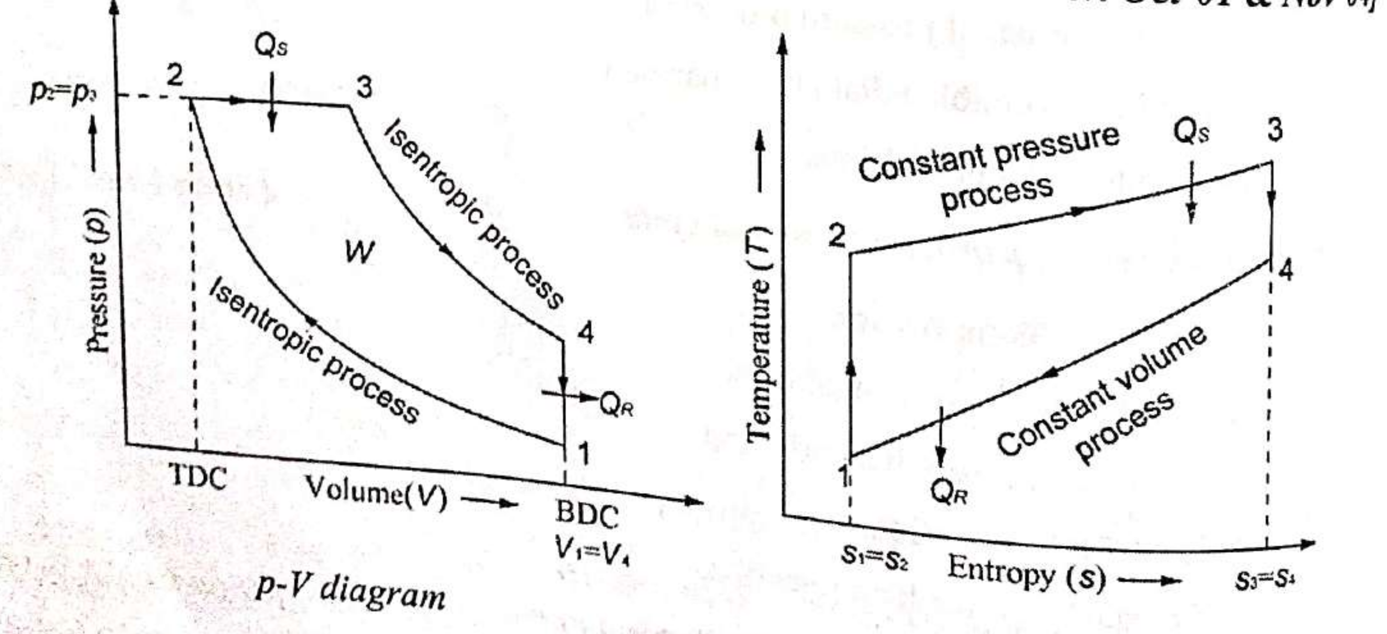


Figure 1.108 Diesel cycle

14. *Write down the air standard efficiency for Otto and diesel cycles.* ***[Anna Univ. Dec'08]***

Air standard efficiency is the ratio of work done during the process to the heat supplied during the process.

$$\text{Air standard efficiency, } \eta = \frac{\text{Work done}}{\text{Heat supplied}} = \frac{W}{Q_S}$$

where Work done = Heat supplied – Heat rejected

$$W = Q_S - Q_R$$

where Q_S = Heat supplied at constant volume process in Otto cycle

Q_S = Heat supplied at constant pressure process in Diesel cycle.

15. Sketch the dual cycle on p-V and T-s co-ordinates and name the various processes.

[Anna Univ. Apr'03, Dec'10, May'13 & May'17]

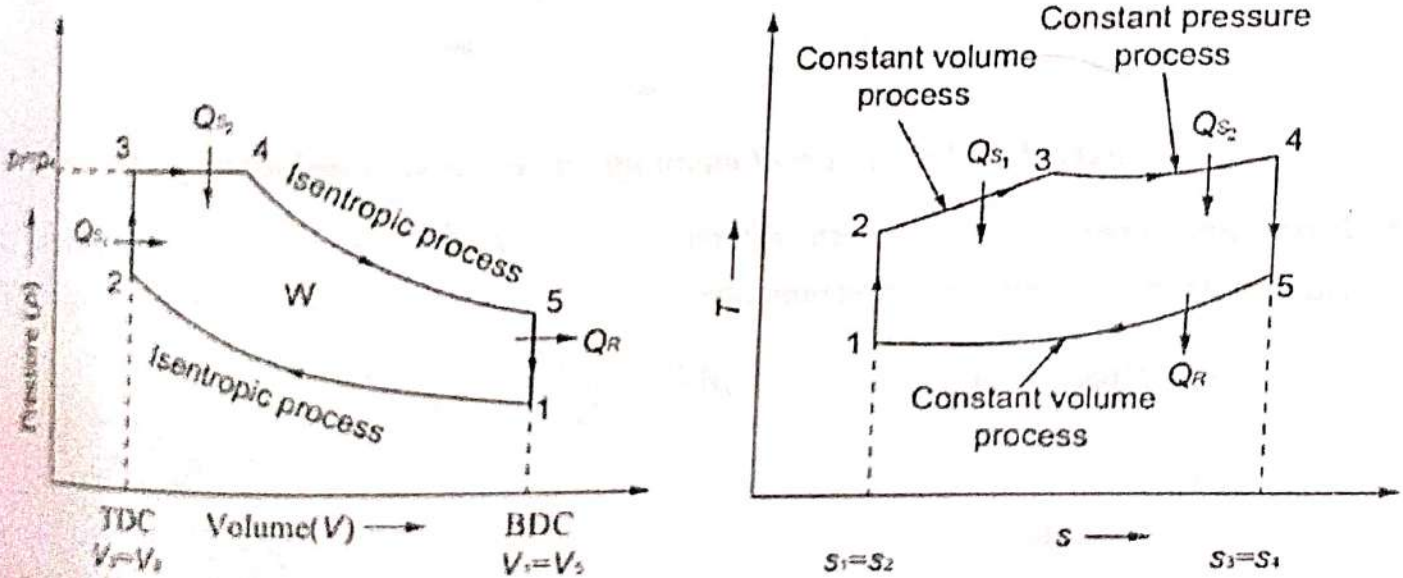
1-2 ⇨ Isentropic compression

2-3 ⇨ Constant volume heat addition

3-4 ⇨ Constant pressure heat addition

4-5 ⇨ Isentropic expansion

5-1 ⇨ Constant volume heat rejection.



p-V diagram *T-s diagram*

Figure 1.109 Dual cycle

16. Define mean effective pressure. What is its importance in reciprocating engines?

[Anna Univ. Apr' 95, Apr' 96, Apr'05, Nov'07, Dec'08, Nov'10, May'11, May'12, Dec'13, May'16 &Dec'17]

Mean effective pressure is defined as the constant pressure acting on the piston during working stroke. It is also defined as the ratio of work done to the stroke volume or piston displacement volume.

$k \Rightarrow$ Pressure ratio

$\gamma \Rightarrow$ Gas constant

$p_1 \Rightarrow$ Pressure at entry to the compressor.

29. *Write down the air standard efficiency for Otto and diesel cycles.[Anna Univ. Dec'17]*

Air standard efficiency of Otto cycle, $\eta_{Otto} = 1 - \frac{1}{(r)^{\gamma-1}}$

Air standard efficiency of Diesel cycle, $\eta_{Diesel} = 1 - \frac{1}{\gamma(r)^{\gamma-1}}\left(\frac{\rho^{\gamma}-1}{\rho-1}\right)$

where $\rho \Rightarrow$ Cut-off ratio

$\gamma \Rightarrow$ Gas constant

$r \Rightarrow$ Compression ratio.

30. *Define the terms actual thermal efficiency and relative efficiency.[Anna Univ. Dec'12]*

Actual efficiency is defined as the ratio of work output by the cycle to the heat input to the cycle.

Relative efficiency is defined as the ratio between actual efficiency and air standard efficiency.

$$\eta_{relative} = \frac{\eta_{actual}}{\eta_{air\ standard}}$$

31. *Differentiate any four differences between Otto and Diesel cycles.[Anna Univ. Nov'15]*

S. No.	***Otto cycle***	***Diesel cycle***
1.	Otto cycle consists of two isentropic and two constant volume processes.	It consists of two isentropic, one constant volume and one constant pressure process.
2.	Heat addition takes place at constant volume.	Heat addition takes place at constant pressure.
3.	Compression ratio is equal to expansion ratio.	Compression ratio is greater than expansion ratio.

4.	Efficiency is more than Diesel cycle for the same compression ratio and heat input.	Efficiency is less.

32. What are all modifications carried out in Brayton cycle? Why?

In Brayton cycles, the following devices can be incorporated to increase its thermal efficiency such as (i) regenerator, (ii) reheater and (iii) intercooler.

33. Is it always useful to have a regenerator in a gas turbine power cycle? Why?

It is not always useful to have a regenerator in a gas turbine cycle. The regenerator causes a pressure drop of 0.035 to 0.2*bar* in compressed air and about 0.035*bar* in exhaust gases. These pressure drops affect the gain in efficiency due to regeneration.

34. Sketch the schematic arrangement of open cycle gas turbine plant and name the components. *[Anna Univ. Apr'04]*

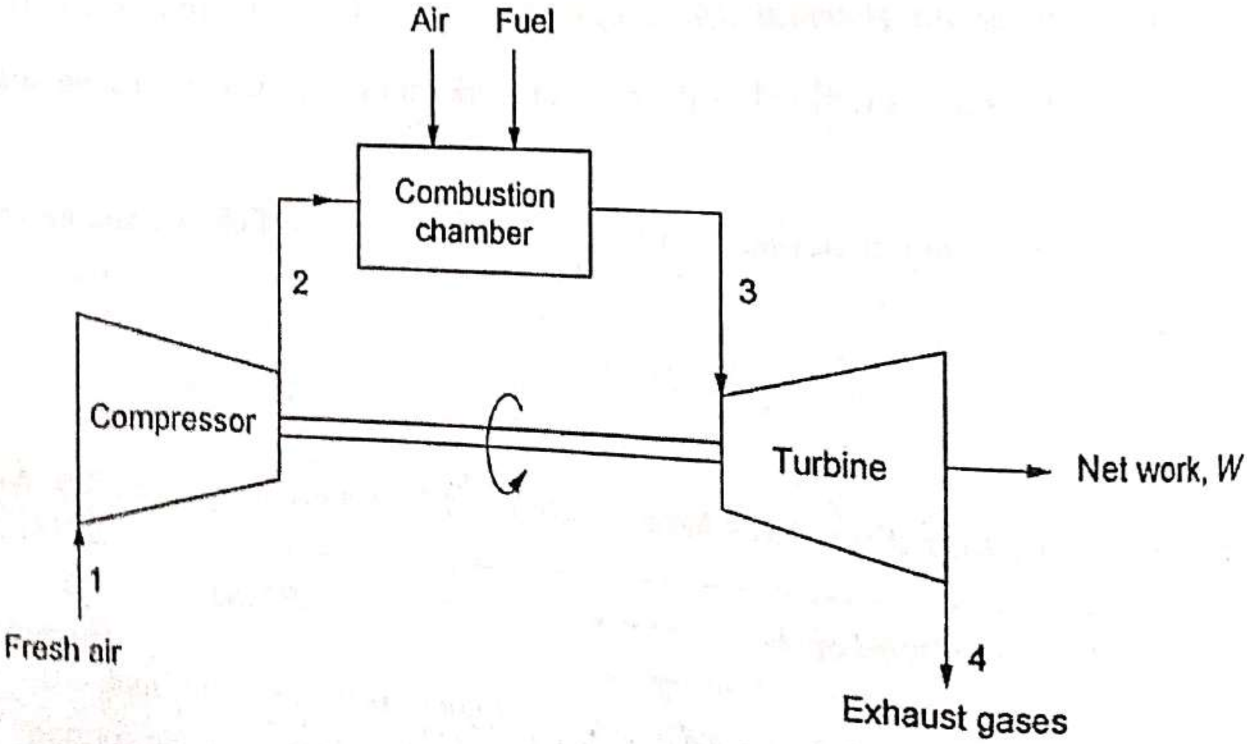
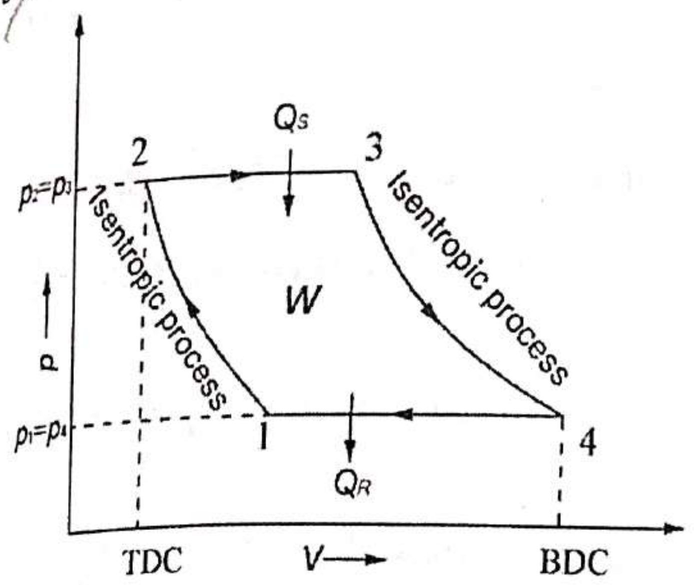


Figure 1.112 Open cycle gas turbine

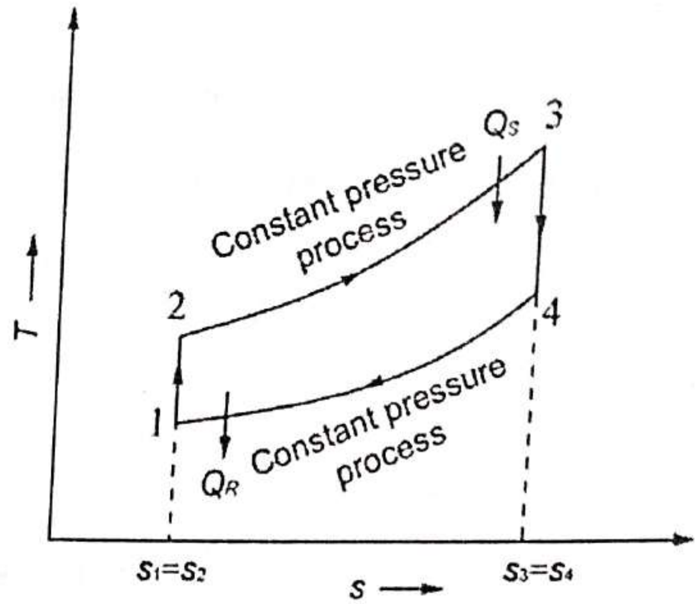
35. List down the various processes of the Brayton cycle. *[Anna Univ. May'17]*

1. Isentropic compression
2. Constant pressure heat supplied
3. Isentropic expansion, and
4. Constant pressure heat rejection.

36. ***Draw the p-V and T-s diagrams of Brayton cycle.*** ***[Anna Univ. Apr'05 & May'15]***



p-V diagram



T-s diagram

Figure 1.113 Brayton cycle

37. ***What is the expression for optimum pressure ratio for the maximum specific work output in Brayton cycle?***

$$\text{Optimum pressure ratio } R_p = \left(\frac{T_3}{T_1}\right)^{\frac{\gamma}{2(\gamma-1)}}$$

38. ***Why are generally gas turbine plants designed for optimum pressure ratio for maximum specific work output?***

It results the small plant and the efficiency curve is nearly flat in this region.

39. ***When will be the gas turbine cycle efficiency maximum?***

When pressure ratio, $R_p = 1$ and is equal to $\left(\frac{T_3 - T_1}{T_3}\right)$

40. ***Justify: Auxiliary power consumption of Brayton cycle is almost twice that of Rankine cycle despite the thermodynamic processes adopted are similar.*** ***[Anna Univ. Dec'17]***

More than 50% of the power is used to drive the compressors, motors and fans such as induced draft fans and forced draught fans. So, the remaining power generated by turbine is used to generate electrical power. Thus, auxiliary power consumption of Brayton cycle is almost twice that of Rankine cycle even the same thermodynamic processes are adopted.

2.20. TWO MARK QUESTIONS AND ANSWERS

1. *List out the applications of compressed air.* *[Anna Univ. May'11 & May'12]*

The compressed air is mostly used in pneumatic brakes, pneumatic drills, pneumatic jacks, pneumatic lifts, spray painting, shop cleaning, injecting fuel in diesel engines, supercharging internal combustion engines, refrigeration and air conditioning systems.

2. *Classify the various types of air compressors.* *[Anna Univ. Dec.03 & Nov'10]*

(a) According to the design and principle of operation

a) Reciprocating compressor

b) Rotary compressor.

(b) According to the action

a) Single acting compressor

b) Double acting compressor.

(c) According to the number of stages

a) Single stage compressor (for compression ratio up to 5)

b) Multistage compressor (for compression ratio more than 5).

(d) According to the pressure limit

a) Low pressure compressor (having maximum pressure up to 1 *bar*)

b) Medium pressure compressor (having maximum pressure from 1 *bar* to 8 *bar*)

c) High pressure compressor (having maximum pressure of 8 *bar* and more).

(e) According to the capacity

a) Low capacity compressor (Volume delivered 0.15 m^3/s or less)

b) Medium capacity compressor (Volume delivered 0.15 m^3/s to 5 m^3/s)

c) High capacity compressor (Volume delivered is above $5m^3/s$).

3. *Give the classification of compressor based on the movement of piston.*

[Anna Univ. Dec'13]

a) Single acting compressor

b) Double acting compressor.

4. *What is meant by single acting compressor?*

In a single acting compressor, the suction, compression and delivery of air take place on one side of the piston.

5. *What is meant by double acting compressor?*

In a double acting reciprocating compressor, the suction, compression and delivery of air take place on both sides of the piston.

6. *What is meant by single stage compressor?*

In a single stage compressor, the compression of air from the initial pressure to the final pressure is carried out in one cylinder only.

7. *Define the term isothermal compression efficiency.*

[Anna Univ. Nov'04, Dec'0, Apr'04, Apr'05, Nov'07 & May'18]

Isothermal efficiency is defined as the ratio between isothermal work to the actual work of the compressor.

$$\text{Isothermal efficiency, } \eta_{iso} = \frac{\text{Isothermal work}}{\text{Actual work}}$$

8. ***Define the mechanical efficiency of a reciprocating air compressor.***

[Anna Univ. Apr'05]

Mechanical efficiency of the reciprocating air compressor is defined as the ratio between theoretical or indicated power required to the driving power required or actual power supplied to the compressor.

$$\text{Mechanical efficiency, } \eta_{mech} = \frac{\text{Theoretical power or Indicated power}}{\text{Driving power required or actual power supplied}}$$

9. ***Define volumetric efficiency of an air compressor and write the expression for volumetric efficiency.***

[Anna Univ. Nov'04, Dec'03, Apr'04, May'06, May'07, Apr'08, Nov'10, May'13, May'15 & Nov'15]

Volumetric efficiency is defined as the ratio of volume of free air sucked into the compressor per cycle to the stroke volume of the cylinder.

$$\eta_{Vol} = \frac{\text{Volume of free air taken per cycle}}{\text{Stroke volume of the cylinder}}$$

10. ***State the conditions which lower the volumetric efficiency of an air compressor.***

[Anna Univ. Nov'15]

(i) Increase in clearance volume.

(ii) Increased pressure and temperature of suction.

11. ***Define clearance ratio.***

Clearance ratio is defined as the ratio of clearance volume (V_c) to swept volume (or) stroke volume (V_s).

$$C = \frac{V_c}{V_s}$$

12. ***Define isentropic efficiency.*** ***[Anna Univ. Nov'06 & May'18]***

Isentropic efficiency is the ratio of the isentropic power to the brake power required to drive the compressor.

$$\text{Isentropic efficiency} = \frac{\text{Isentropic power}}{\text{Actual brake power}}$$

13. ***Define mean effective pressure. How is it related to indicated power of an IC engine?***

Mean effective pressure is defined as hypothetical pressure which is considered to be acting on the piston throughout the stroke.

4. Pneumatic lifts
5. Spray painting
6. Injecting fuel in diesel engines
7. Supercharging internal combustion engines
8. Refrigeration and air conditioning systems.

26. Draw p-V diagram of a two stage reciprocating air compressor.

[Anna Univ. Apr'04 & May'14]

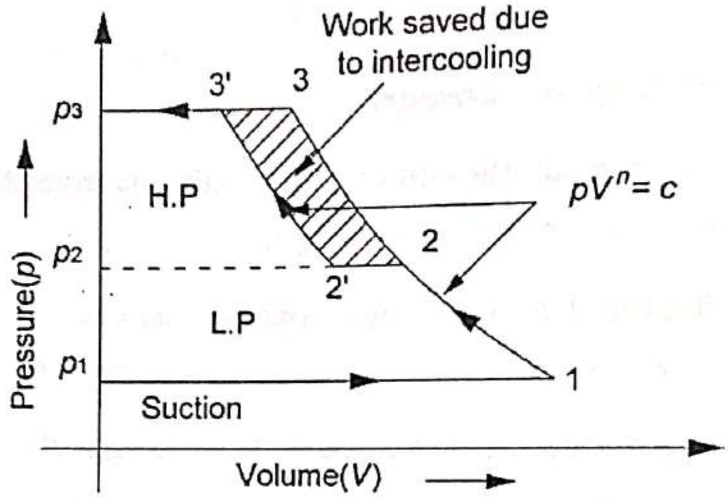


Figure 2.18 Two stage compression with intercooler

27. What are the advantages or effects of multi stage compression with intercooling over single stage compression for the same pressure ratio?

[Anna Univ. May'03, Nov'02, Apr'04, May'06, Nov'10, Dec'13, May'15 & May'18]

1. The work done per *kg* of air is reduced in multistage compression with intercooler as compared with single stage compression for the same delivery pressure.
2. It improves the volumetric efficiency for the given pressure ratio.
3. The size of the cylinders (i.e., high pressure and low pressure) may be adjusted to suit the volume and the pressure of the air.
4. It reduces the leakage loss considerably.
5. It gives more uniform torque and hence, a smaller size flywheel is required.
6. It provides effective lubrication because of lower operating temperature.
7. It reduces the cost of the compressor.

31. Give the expression for work done for a two-stage compressor with perfect intercooling. **[MU - April'98]**

$$W = \frac{2n}{n-1} p_1 V_1 \left[\left(\frac{p_3}{p_1} \right)^{\frac{n-1}{2n}} - 1 \right]$$

where

p_1 and $p_3 \Rightarrow$ Initial and final pressures

$V_1 \Rightarrow$ Initial volume

$n \Rightarrow$ Polytropic index.

32. Why clearance is necessary in reciprocating compressors? **[Anna Univ. Dec'08]**

The clearance is necessary in reciprocating compressors to trap the gas after each stroke.

33. What is the effect of clearance volume on the power required and work done in a reciprocating air compressor? **[Anna Univ. June'09 & Dec'17]**

Both power required and work done in a reciprocating compressor will decrease due to clearance volume.

34. Discuss the effect of clearance upon the performance of an air compressor.

[Anna Univ. May'03& Nov'01]

(i) The volumetric efficiency of air compressor increases with decrease in clearance of the compressor.

(ii) The free air delivered by the compressor is increased by reducing the clearance volume.

35. If C is the clearance ratio for a reciprocating air compressor, what will be the volumetric efficiency?

$$\eta_{vol} = 1 + C - C \left(\frac{p_2}{p_1} \right)^{\frac{1}{n}}$$

where $C \Rightarrow$ Clearance ratio

$p_2 \Rightarrow$ Delivery pressure

$p_1 \Rightarrow$ Suction pressure.

41. What is rotary compressor?

A rotary screw compressor is a type of gas compressor which uses a rotary type positive displacement mechanism. The mechanism for gas compression utilises either a single screw element or two counter rotating intermeshed helical screw elements housed within a specially shaped chamber.

42. Differentiate rotary and reciprocating compressors.

S. No.	*Rotary compressor*	*Reciprocating compressor*
1.	It is simple in construction.	Construction is complicated.
2.	Speed is high.	Speed is low.
3.	It is suitable for large rate of flow at low discharge pressure.	It is suitable for low rate of flow at very high discharge pressure.
4.	Maintenance cost is less.	Maintenance cost is high.
5.	There is no balancing problem.	Balancing is major problem.

43. Differentiate centrifugal compressor and axial flow compressor.

S. No.	*Centrifugal compressor*	*Axial compressor*
1.	Starting torque is low.	Starting torque is high.
2.	Isentropic efficiency is around 70%.	Isentropic efficiency is around 85%.
3.	It is not suitable for multistage compression.	It is suitable for multistage compression.
4.	More frontal area is required.	Less frontal area is required.
5.	Manufacturing cost is low.	Manufacturing cost is high.
6.	Running cost is low.	Running cost is high.

3.22. TWO MARK QUESTIONS AND ANSWERS

1. ***What is meant by IC engine?***

Internal Combustion engine (IC engine) is a heat engine which converts the chemical energy of a fuel into mechanical energy. Chemical energy of a fuel is first converted into thermal energy by means of products of combustion or oxidation with air inside the engine. This thermal energy is converted into useful work through the mechanical mechanism of the engine.

2. ***Discuss the relative advantages and disadvantages of internal combustion.***

Advantages of internal combustion engines:

1. It provides lower weight to power output ratio.
2. It is simple in design.
3. It needs less initial cost.
4. It produces high efficiency.

Disadvantages of internal combustion engines:

1. As much as rich fuel hydrocarbon based fuel should be used.
2. They need of some governing mechanisms to stabilize the output power throughout cycle.

3. ***What are the main components of I.C engine?*** ***[Anna Univ. Nov'16]***

(i) Cylinder block

(ii) Cylinder head

(iii) Crankcase

(iv) Oil sump or oil pan

(v) Cylinder liners

(vi) Piston

(vii) Connecting rod

(viii) Piston rings

(ix) Crank shaft

(x) Flywheel

(xi) Cam shaft

(xii) Spark plug and valves.

4. ***State the functions of push rod and rocker arm.*** *[Anna Univ. May'17]*

The push rod and rocker arm actuates valves according to the engine stroke by cams. They allow the pushrods to push up on the rocker arms and therefore, push down on the valves.

5. ***State the function of engine flywheel.*** *[Anna Univ. Nov'17]*

The flywheel is heavy and perfectly balanced wheel usually connected to the rear end of the crankshaft. Flywheel serves as an energy reservoir. It stores energy during power stroke and releases energy during other strokes. Thus, it gives a constant output torque.

6. ***State the functions ofconnecting rod, piston and crankshaft.*** *[Anna Univ. Nov'17 & May'18]*

Connecting rod:

It is used to connect the piston and crankshaft with the help of bearings. It is usually steel forging of circular, rectangular, I, T or H cross-sections. Its small end is connected to the piston by the piston pin and its big end is connected to the crank by the crank pin.

Piston:

It is a cylindrical shaped mass which reciprocates inside the cylinder. The piston serves the following purposes.

- It acts as a movable gas-tight seal to keep gases inside the cylinder.
- It transmits the force of explosion in the cylinder to the crankshaft through connecting rod.

Crankshaft:

The crankshaft is used to convert the reciprocating motion of the piston into rotary motion. The big end of the connecting rod is connected to the crankshaft. It can be a single crank type for single cylinder engines and a multiple crank type for multi-cylinder engine.

7. ***Draw the port timing diagram of a petrol engine.*** *[Anna Univ. Dec'08]*

IPO = Inlet Port Open

IPC = Inlet Port Close

IS = Ignition Start

EPO = Exhaust Port Open

TPO = Transfer Port Open

TPC = Transfer Port Close

EPC = Exhaust Port Close

TDC = Top Dead Center and BDC = Bottom Dead Center.

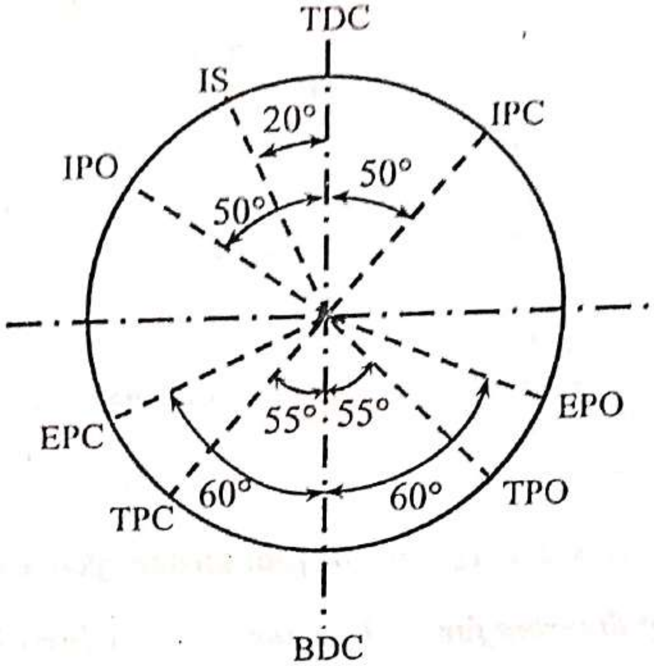


Figure 3.43 Port timing diagram for SI engine

8. ***Draw the actual p-V diagram of the four stroke petrol engine and indicate the salient points and ignition position.*** *[Anna Univ. Nov'10]*

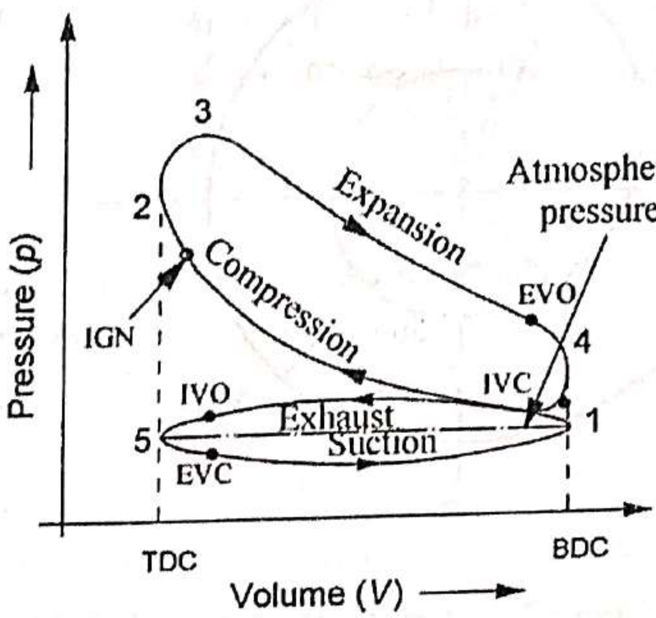


Figure 3.39 p-V diagram

9. ***Draw the actual p-V diagram of a four-stroke diesel engine and indicate all the processes.*** *[Anna Univ. Nov'17]*

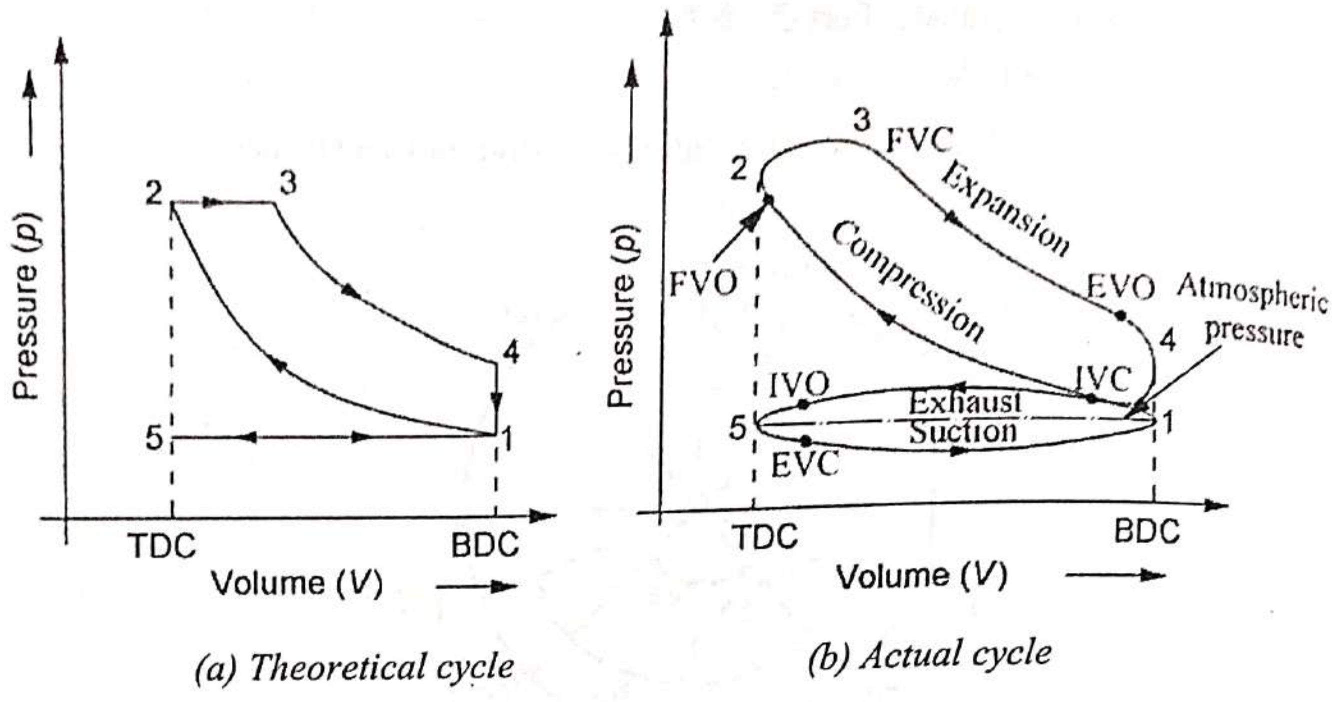


Figure 3.40 p-V diagrams for four stroke cycle CI engine

10. Draw the valve timing diagram for a CI engine. *[Anna Univ. Dec'10 & May'18]*

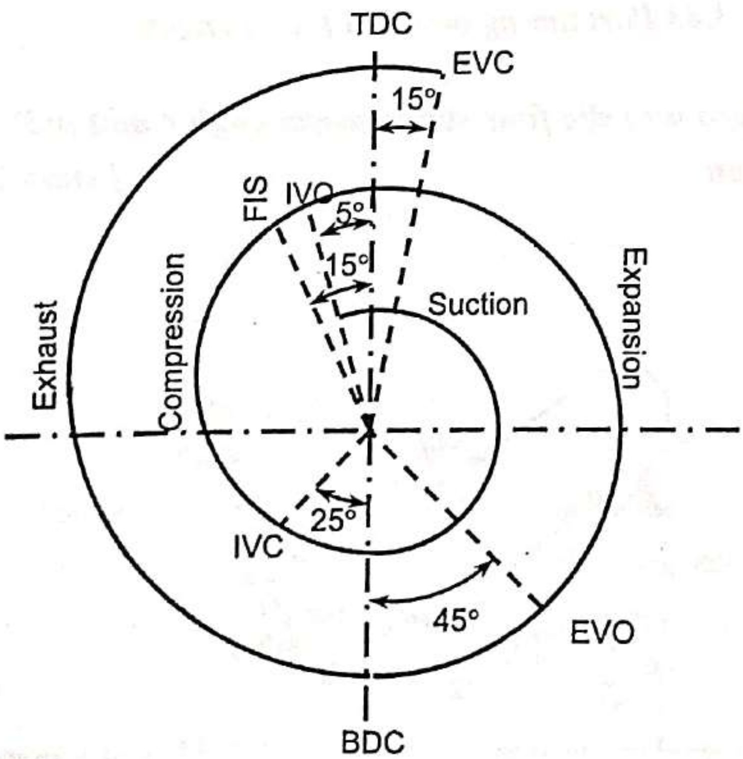


Figure 3.41 Actual valve timing diagram

IVO ⇒ Inlet Valve Open

IVC ⇒ Inlet Valve Close

FIS ⇒ Fuel Injection Start

EVO ⇒ Exhaust valve Open

EVC ⇒ Exhaust valve Close

TDC ⇒ Top Dead Center

BDC ⇒ Bottom Dead Center

11. Show the valve overlapping period of a typical 4-stroke petrol engine on valve timing diagram. ***[Anna Univ. May'16]***

IVO ⇒ Inlet Valve Open

IVC ⇒ Inlet Valve Close

EVO ⇒ Exhaust valve Open

EVC ⇒ Exhaust valve Close

TDC ⇒ Top Dead Center

BDC ⇒ Bottom Dead Center.

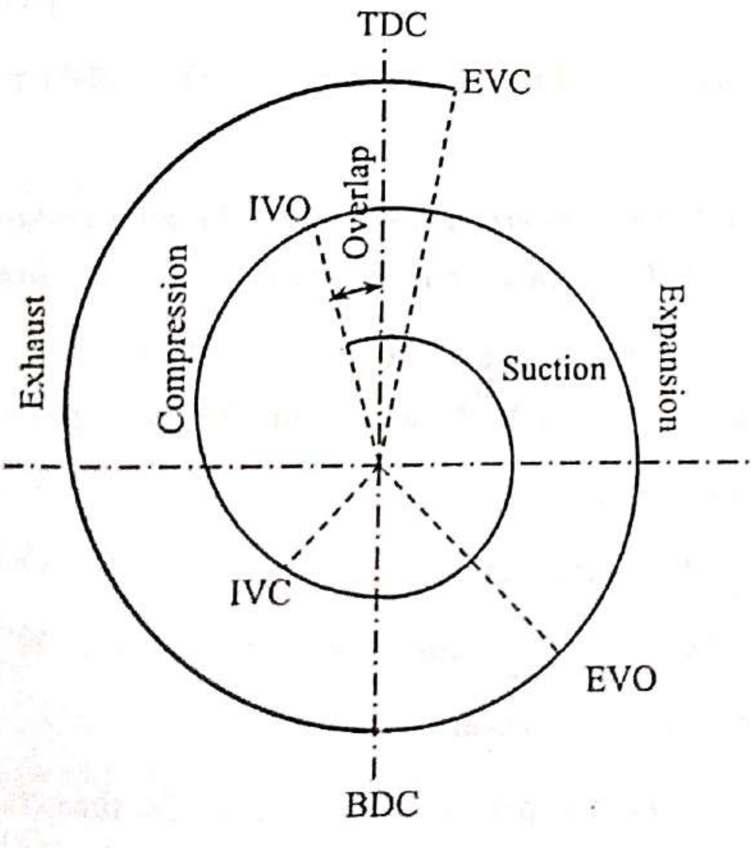


Figure 3.42 Overlap in valve timing diagram

During peak power operation, why does petrol engine require rich mixtures? ***[Anna Univ. June'09]***

During peak load, petrol engine needs to produce more power with smaller size of the engine. It is not possible with lean mixture of fuels. The use of rich mixture will replace the lean mixture during peak power operation in petrol engines.

4.11. TWO MARK QUESTIONS AND ANSWERS

1. ***Define the following terms: (a) Clearance volume and (b) Swept volume.***

(i) Clearance volume (V_c):

The volume of the cylinder when the piston is at TDC is known as *clearance volume.*

Bore, $d = 80$ mm

Stroke, $l = 110$ mm

Torque, $T = 23.5$ Nm

Solution:

$$\text{Power or work done, } P = \frac{2\pi NT}{60} = \frac{2\pi \times N \times 23.5}{60} = 2.4597\ N$$

$$P = \frac{p_m.l.a.n.k}{60} = \frac{p_m.l.a.(N/2).k}{60}$$

$$2.4597N = \frac{p_m \times 0.11 \times \frac{\pi}{4} \times (0.08)^2 \times (N/2) \times 1}{60}$$

$\therefore$ $p_m = 534.098\ kPa$ **Ans.**

10. *What are the advantages in MPFI system?* ***[Anna Univ. May'17]***

(i) It allows more time for mixing of air and petrol.

(ii) It allows a proper air fuel ratio to the engine by electrically injecting fuel in accordance with various driving condition.

(iii) More uniform air-fuel mixture is supplied to each cylinder. Hence, the difference in power developed in each cylinder is minimum.

(iv) The vibrations produced in MPFI engines is very less due to the life of the engine component increased.

(v) There is no need to crank the engine twice or thrice in case of cold starting as happen in the carburetor system.

(vi) It provides immediate response in case of sudden acceleration and deceleration.

(vii) The mileage of the vehicle is improved.

(viii) More accurate amount of air-fuel mixture will be supplied in these injection systems. It leads to effective utilization of fuel supplied and hence, it lowers emission level.

11. *What are the advantages and disadvantages of ECU?* ***[Anna Univ. Apr'05]***

Advantages:

1. A very high quality fuel distribution is obtained. Therefore, higher compression ratios can be adopted without any danger of detonation occurring.

2. Increased volumetric efficiency, power and torque.

Disadvantages:

1. Initials cost is very high. It is the greatest disadvantage.
2. It has more complicated mechanism because of electronic system injection nozzle and fuel injection pump.

Give short note on Unit Injector system. ***[Anna Univ. May'17]***

This system is also called *individual pump injection system*. The Unit Injector System (UIS) combines the injection nozzle and the high-pressure pump in a single assembly. One such unit injector is fitted in the head of each engine cylinder as shown in Figure 4.42. The high pressure is built up by the activation of the pump plunger of the unit injector by the engine camshaft via a tappet or rocker arm.

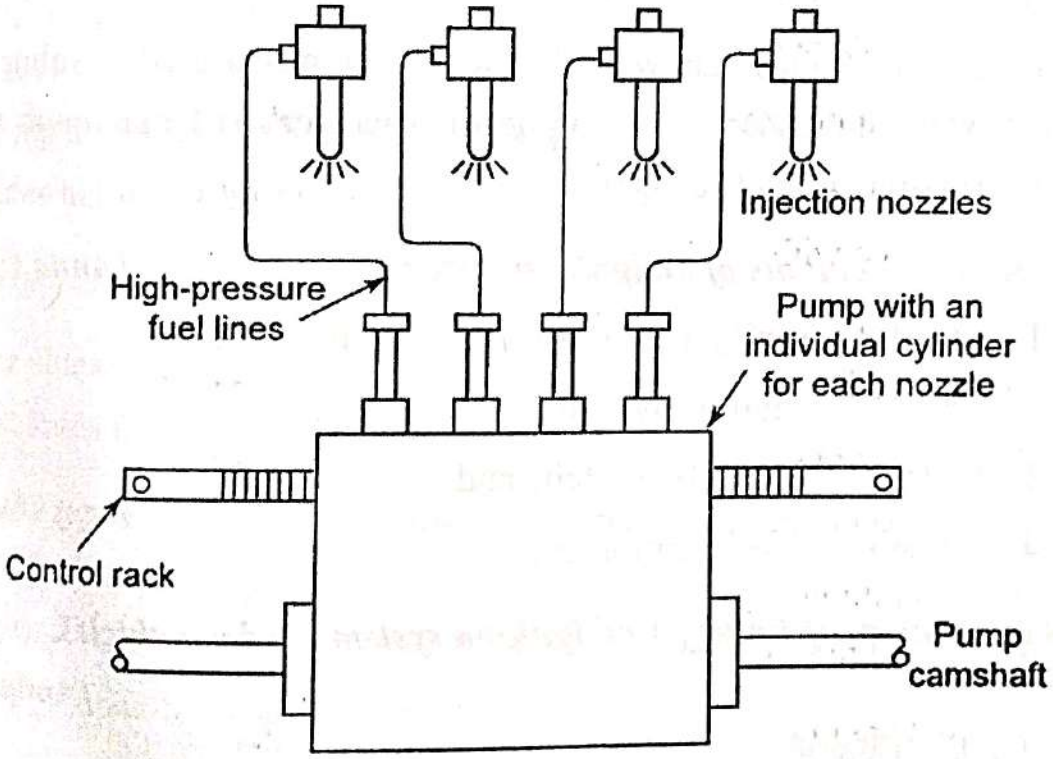


Figure 4.42 Unit injector system

What do you understand by monopoint and multipoint injection system?

[Anna Univ. Apr'05, Nov'05 & Apr'10]

In multipoint system, there is an injection valve for each engine cylinder. The main advantage of this system is, it allows more time for the mixing of air and petrol.

In monopoint system, an injection valve is positioned slightly above each throat of the throttle body. The injection valve sprays fuel into the air just before it passes through the throttle valve and it enters the intake manifold.

14. What is gasoline injection system? *[Anna Univ. May'15]*

If the fuel is injected directly into the combustion chamber instead of the intake port, the injection system is said to be *gasoline injection system*.

15. Define "Continuous Injection" of petrol engine. *[Anna Univ. May'16]*

The injection system which provides a continuous spray of fuel from each injector at a point before the intake valve is known as continuous injection system.

16. Define "Intermittent injection" of petrol engine. *[Anna Univ. Nov'16]*

The process of injecting petrol by an injector in spray form at regular intervals with a constant fuel discharge pressure and quantity of fuel which are controlled by the time period is known as *intermittent injection*.

17. Give the requirements of air fuel ratio in SI engine. *[Anna Univ. Apr'11]*

SI engine automobiles run with the help of a mixture of gasoline and air. The amount of mixture depends on (i) engine displacement (ii) maximum revolution per minute and (iii) volumetric efficiency.

18. What are the classifications of an ignition system? *[Anna Univ. May'12]*

1. Coil ignition system or battery ignition system.
2. Magneto ignition system.
3. Electronic ignition system, and
4. Transistorised ignition system.

19. Name the component of Battery Coil ignition system used in vehicles.

[Anna Univ. Dec'08]

(i) Distributor

(ii) Contact breaker

(iii) Primary winding

(iv) Secondary winding.

20. State the advantages and disadvantages of battery ignition system.

Advantages:

- It provides better sparks at low speed of the engine during starting and idling due to availability of maximum current throughout the engine speed range.
- The initial cost is low compared with magneto ignition system.

5.20. TWO MARK QUESTIONS AND ANSWERS

1. How gas turbine units are classified?

1. According to the cycle of operation
   - (a) Open cycle gas turbine
   - (b) Closed cycle gas turbine, and
   - (c) Semi closed cycle gas turbine.

2. According to the process
   (a) Constant pressure gas turbine, and
   (b) Constant volume gas turbine.
3. According to the use
   (a) Industrial gas turbine, and
   (b) Air craft gas turbine.
4. According to the application
   (a) Aircraft
   (b) Marine
   (c) Locomotive
   (d) Transport.
5. According to the type of fuel
   (a) Liquid
   (b) Gas
   (c) Solid.
6. According to the number of shafts
   (a) Single shaft
   (b) Multi-shaft.

2. ***What do you understand by a closed cycle gas turbine unit?*** ***[Anna Univ. May'11]***

In a closed cycle gas turbine, the air is isentropically compressed in air compressor to a required pressure and then it is passed through a combustion chamber where the fuel injects to the air and ignited. The high temperature air from combustion chamber expands through a gas turbine where the heat energy is converted into mechanical energy. Then, the exhaust gas from the gas turbine is passed through a pre-cooler where it is cooled at constant pressure with the help of circulating water to its original pressure. Then, the same air is passed through the compressor again and again.

3. ***What are the main units in a gas turbine power plant? [Anna Univ. Dec'13 & Dec'10]***

1. Compressor
2. Combustion chamber
3. Turbine.

4. *What is the difference between open cycle and closed cycle gas turbine plant?* **[Anna Univ. Apr'08 & Dec'11]**

S. No.	Open cycle gas turbine	Closed cycle gas turbine
1.	No pre-cooler is required because of burnt gas from gas turbine exhausted to atmosphere.	A separate pre-cooler arrangement is necessary.
2.	For the same power developed, the size and weight of the open cycle gas turbine unit are less.	The size and weight are more.
3.	Initial cost and maintenance cost of the plant are less.	Initial cost and maintenance cost are more.
4.	Combustion efficiency is more.	Combustion efficiency is less.
5.	Coolant is not required, therefore, it is used for moving vehicle such as air craft, jet propulsion etc.	Coolant is required for pre cooler, therefore, it is used for stationary applications such as power generation etc.
6.	The response to load variation is greater than a closed cycle gas turbine.	The response to load variation is less.

5. *Why is power generation by gas turbines attractive these days?* **[Anna Univ. May'11]**

Gas turbines are attractive because of their ability to quickly ramp up power production.

6. *List the various factors which influence the performance of gas turbine.* **[Anna Univ. Dec'10]**

1) Air temperature and site elevation
2) Humidity
3) Inlet and exhaust losses
4) Fuels
5) Fuel heating

6) Diluent injection

7) Air extraction.

7. Sketch the schematic arrangement of open cycle gas turbine plant and name the components. *[Anna Univ. Apr'04]*

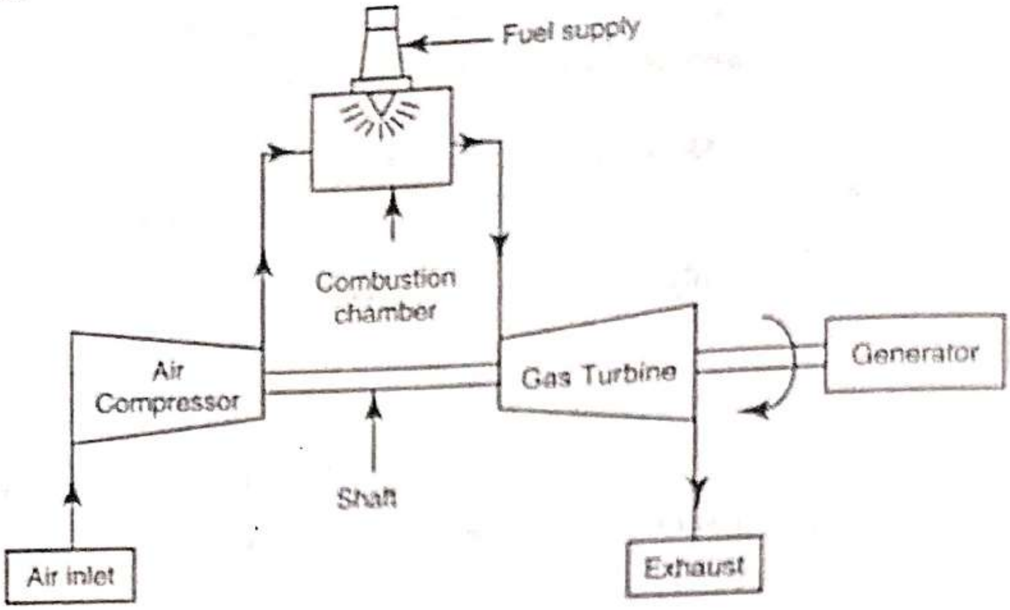


Figure 5.22 Open cycle gas turbine plant

8. What are all modifications carried out in Brayton cycle? Why?

In Brayton cycles, the following devices can be incorporated to increase its thermal efficiency such as (i) regenerator, (ii) reheater and (iii) intercooler.

9. What is the expression for optimum pressure ratio for the maximum specific work output in Brayton cycle?

$$\text{Optimum pressure ratio } R_p = \left(\frac{T_3}{T_1}\right)^{\frac{\gamma}{2(\gamma-1)}}$$

10. When will be the gas turbine cycle efficiency reaches maximum?

The gas turbine cycle efficiency reaches maximum when pressure ratio, $R_p = 1$ and is equal to $\left(\frac{T_3 - T_1}{T_3}\right)$.

11. What are the methods by which thermal efficiency of a gas turbine power plant be improved? *[Anna Univ. May'12 & Dec'12]*

1. Intercooling

2. Reheating