UNIT II

Part-A

1. What consists of lubrication system in diesel engine power plant?

The lubrication system consists of oil pumps, oil tanks, filters, coolers and connecting pipes. The purpose of the lubrication is to reduce the friction of moving parts and also pipes to reduce the wear and tear of moving parts.

2. What is the essential component of diesel power plants? (Nov/Dec 2012)

Essential components of a diesel power plant are:

(i) Engine (ii)Air intake system

(iii)Exhaust system (iv)Fuel system

(v) Cooling system (vi) Lubrication system

(vii) Engine starting system (viii) Governing system.

3. List the various Liquid Cooling Systems?

In liquid cooling following methods are used for circulating the water around the cylinder and cylinder head:

(i) Thermo-system cooling
(ii) Forced or pump cooling
(iii) Cooling with thermostatic regulator
(iv) Pressurized cooling
(v) Evaporative cooling.

4. What is the purpose of super charging? (Nov/Dec 2008)

The purpose of supercharging is to raise the volumetric efficiency above that value which can be obtained by normal aspiration.

5. Define Flywheel?

It is a heavy wheel mounted on the crankshaft. It stores the excess energy delivered by the engine during power stroke and supplies the energy needed during other strokes. Thus it keeps the fluctuations in the crankshaft speed within desired limits.

6. Write the Disadvantages of over cooling of the Engine?

1) Engine starting is difficult,

2) Over-cooling reduces the overall efficiency of the system,

3) At low temperatures, corrosion assumes considerable magnitude that it may reduce the life of various components.

7. Write the function of Lubrication? (Nov/Dec 2007)

a. To reduce the wear and tear between the moving parts and thereby increasing the life of the engine.

b. The lubricating oil acts as a seal, i.e., it prevents the high pressure gases in the combustion chamber from entering the crankcase

c. To cool the surfaces.

8. What are the classifications of Lubrication system?

Classification of Lubrication System:

Some of the lubricating systems used for IC engines are:

i) Wet sump lubricating system,

ii) Mist lubricating system.

Wet sump lubricating system can be further classified as,

i) Splash type lubricating system,

ii) Pressure feed lubricating system.

9. Define – open cycle gas turbine? (Nov/Dec 2004)

In the open cycle gas turbine, air is drawn into the compressor from atmosphere and is compressed. The compressed air is heated by directly burning the fuel in the air at constant pressure in the combustion chamber. Then the high pressure hot gases expand in the turbine and mechanical power is developed.

10. Define – closed cycle gas turbine?

In this, the compressed air from the compressor is heated in a heat exchange (air heater) by some external source of heat (coal or oil) at constant pressure. Then the high pressure hot gases expand passing through the turbine and mechanical power is developed. The exhaust gas is then cooled to its original temperature in a cooler before passing into the compressor again.

11. Write the few fuels for Gas turbine and why these fuels are use for gas turbine?

Natural gas, last furnace gas, produce gas, coal gas and solid fuels distillate oils and residual oils paraffins used in gas turbine and methane, ethane, propane,

Important properties to be considered while selecting the fuel for gas turbine are as follows:

1) Volatility 2) Combustion products,

3) Energy contents, 4) Lubricating properties, 5) Availability.

12. Write the major field of application of gas turbines?

The major fields of application of gas turbines are:

i) Aviation
ii) Power generation
iii) Oil and gas industry
iv) Marine propulsion.

13. Define Gas turbine plant and write the working medium of this gas turbine?

A gas turbine plant may be defined as one "in which the principal prime-mover is of the turbine type and the working medium is a permanent gas".

14. What are the components of gas turbine plant? (Nov/Dec 2004)

A simple gas turbine plant consists of the following:

i) Turbine ii) Compressor iii) Combustor iv) Auxiliaries

.A modified plant may have in addition and intercooler, a regenerator, a repeater etc.

15. What are the methods to improving the thermal efficiency in open cycle gas turbine plant?

Methods for improvement of thermal efficiency of open cycle gas turbine plant are :

i) Inter cooling

ii) Reheating

iii) Regeneration

16. Define turbo charging in combined gas turbine and diesel cycles?

In the combined cycle, the exhaust gas from the diesel engine is expanded in the turbine, which is coupled with compressor which supplies pressurized air to the diesel engine. This increases diesel engine output. This arrangement is known as turbo charging.

PART – B

1. Explain the working of gas turbine cycle with regenerator. (Nov/Dec 2011)

In earlier discussion it is seen that for the maximization of specific work output the gas turbine exhaust temperature should be equal to compressor exhaust temperature. The turbine exhaust temperature is normally much above the ambient temperature.

Thus their exist potential for tapping the heat energy getting lost to surroundings with exhaust gases. Here it is devised to use this potential by means of a heat exchanger called regenerator, which shall preheat the air leaving compressor before entering the combustion chamber, thereby reducing the amount of fuel to be burnt inside combustion chamber (combustor).

Regenerative air standard gas turbine cycles shown ahead in figure (a) has a regenerator (counter flow heat exchanger) through which the hot turbine exhaust gas and comparatively cooler air coming from compressor flow in opposite directions.

Under ideal conditions, no frictional pressure drop occurs in either fluid stream while turbine exhaust gas gets cooled from 4 to 4‟ while compressed air is heated from 2 to 2‟. Assuming regenerator effectiveness as 100% the temperature rise from 2 – 2‟ and drop from 4 to 4‟ is shown on T-S diagram.

This shows an obvious improvement in cycle thermal efficiency as every thing else remains same. Network produced per unit mass flow is not altered by the use of regenerator.

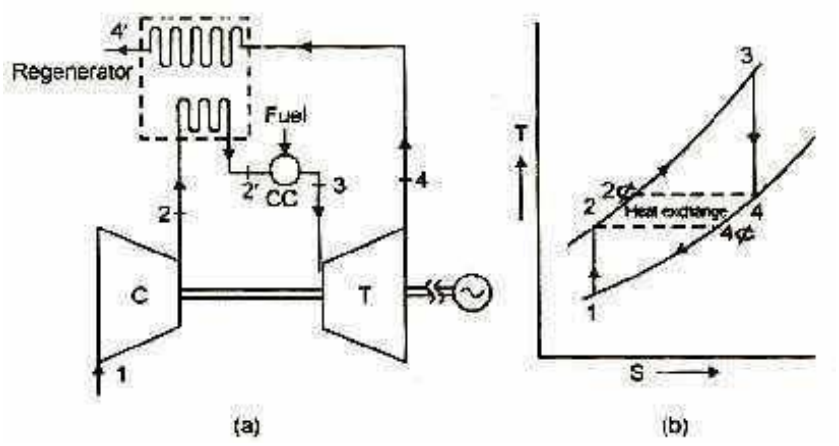


Figure: Regenerative air standard gas turbine cycle.

2. Explain the working of gas turbine cycle with inter cooling.

Net work output from gas turbine cycle can also be increased by reducing negative work i.e., compressor work. Multistage of compression process with intercooling in between is one of the approaches for reducing compression work. It is based on the fact that for a fixed compression ratio is higher is the inlet temperature higher shall be compression work requirement and vice-versa. Schematic for inter cooled gas turbine cycle is give in figure.

Thermodynamic processes involved in multistage inter cooled compression are shown in figure. First stage compression occurs in low pressure compressor (LPC) and compressed air leaving LPC at „2" is sent to intercooler where temperature of compressed air is lowered down to state 3 at constant pressure.

In case of perfect intercooling the temperature after intercooling is brought down to ambient temperature i.e., temperature at 3 and 1 are same. Intercooler is a kind of heat exchanger where heat is picked up from high temperature compressed air. The amount of compression work saved due to intercooling is obvious from p-V diagram and shown by area 2342". Area 2342" gives the amount of work saved due to intercooling between compressions.

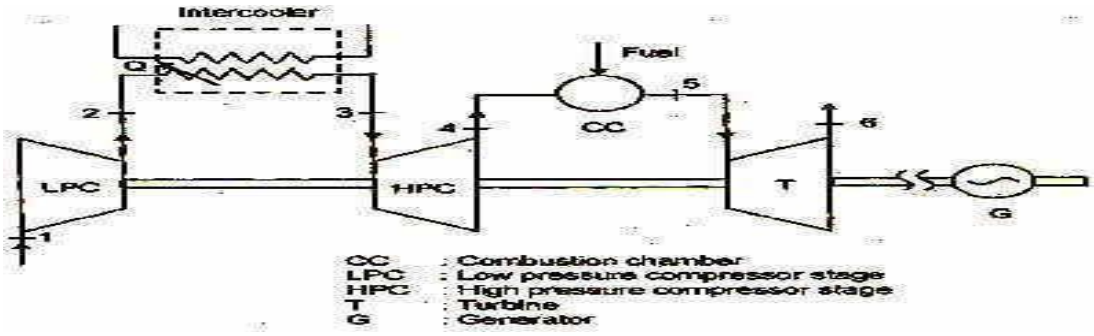


Figure: Gas turbine cycle with intercooling

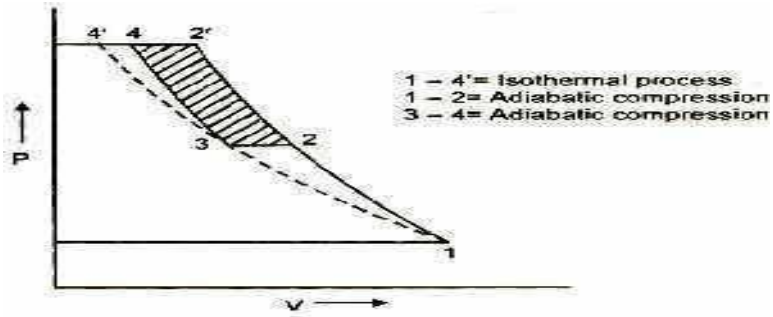


Figure : Intercooled compression

Some large compressors have several stages of compression with intercooling between stages. Use of multistage compression with intercooling in a gas turbine power plant increases the network produced because of reduction in compressor work. Inter cooled compression results in reduced temperature at the end of final compression.T-S diagram for gas turbine cycle with intercooling shows that in the absence of intercooling within same pressure limits the state at the end of compression would be 2‟ while with perfect intercooling this state is at 4 i.e., T2‟ > T4. The reduced temperature at compressor exits leads to additional heat requirement in combustion chamber i.e., more amount of fuel is to be burnt for attaining certain inlet temperature as compared to simple cycle without intercooling.

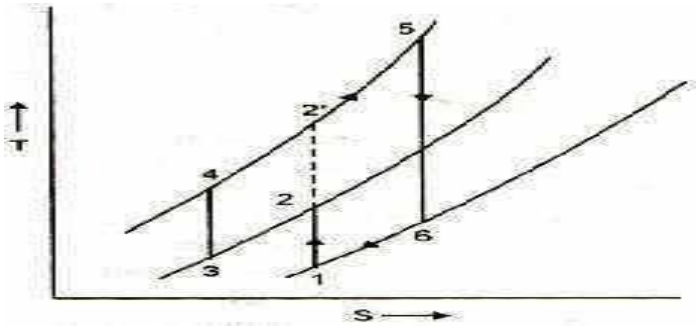


Figure: T-S diagram for gas turbine cycle with intercooling

Thus intercooled cycle thermal efficiency may not increase with intercooling because of simultaneous increase in heat addition requirement.

The lower temperature at compressor exit enhances the potential for regeneration so when intercooling is used in conjunction with regeneration an appreciable increase in thermal efficiency can result.

Net work output in gas turbine cycle with intercooling;

Wnet, intercool = m{(h5 – h6) – (h4 – h3) – (h2 – h1)}

Wnet, intercool = m cp {(T5 – T6) – (T4 – T3) – (T2 – T1)}

3. Draw and Explain the construction and working principle of Open cycle gas turbine power plant? (Apr 2011)

In the open cycle gas turbine, air is drawn into the compressor from atmosphere and is compressed. The compressed air is heated by directly burning the fuel in the air at constant pressure in the combustion chamber. Then the high pressure hot gases expand in the turbine and mechanical power is developed.

Part of the power developed by the turbine (about 66%) is used for driving the compressor. The remaining is available as useful output. The working fluid, air and fuel, must be replaced continuously as they are exhausted into the atmosphere. Thus the entire flow comes from the atmosphere and is returned to the atmosphere.

LAYOUT OF GAS TURBINE POWER PLANT

The gas turbine power plants which are used in electric power industry are classified into two groups as per the cycle of operation.

(1) Open cycle gas turbine. (2) Closed cycle gas turbine.

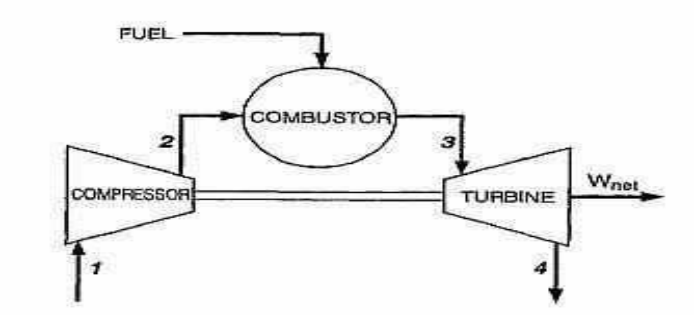
1. Open cycle gas turbine

1- Atmospheric Air

2- Compressed Atmospheric Air

3- Fuel air mixture after compression

4- Exhaust gases.



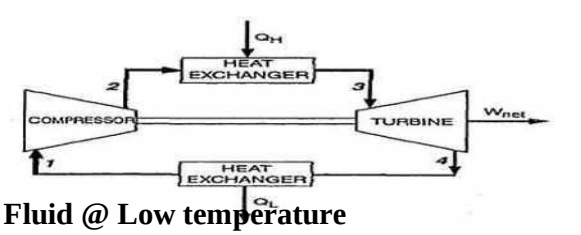
The heated gases coming out of combustion chamber are then passed to the turbine where it expands doing mechanical work. Part of the power developed by the turbine is utilized in driving the compressor and other accessories and remaining is used for power generation.Since ambient air enters into the compressor and gases coming out of turbine are exhausted into the atmosphere, the working medium must be replaced continuously. This type of cycle is known as open cycle gas turbine plant and is mainly used in majority of gas turbine power plants as it has many inherent advantages.

4. Draw and explain the construction and working principle of closed cycle gas turbine power plant? (Apr 2011)

In this, the compressed air from the compressor is heated in a heat exchanger (air heater) by some external source of heat (coal or oil) at constant pressure. Then the high pressure hot gases expand passing through the turbine and mechanical power is developed. The exhaust gas is then cooled to its original temperature in a cooler before passing into the compressor again.

The main difference between the open and closed cycles is that the working fluid is continuously replaced in open cycle whereas it is used again and again in a closed cycle. The open cycle plant is much lighter than the closed cycle. Hence it is widely used.

Closed cycle gas turbine



1 - **Low Pressure Working Fluid @ Low temperature**

2- High Pressure Working Fluid

3- Fuel + Working Fluid mixture @ High Pressure and Temperature

4- Low Pressure Working Fluid @ Temperature T4 < Temperature T3

In closed cycle gas turbine plant, the working fluid (air or any other suitable gas) coming out from compressor is heated in a heater by an external source at constant pressure.The high temperature and high-pressure air coming out from the external heater is passed through the gas turbine. The fluid coming out from the turbine is cooled to its original temperature in the cooler using external cooling source before passing to the compressor. The working fluid is continuously used in the system without its change of phase and the required heat is given to the working fluid in the heat exchanger

5. Draw and explain the construction and working principle of layout of diesel power plant: (May 2008)

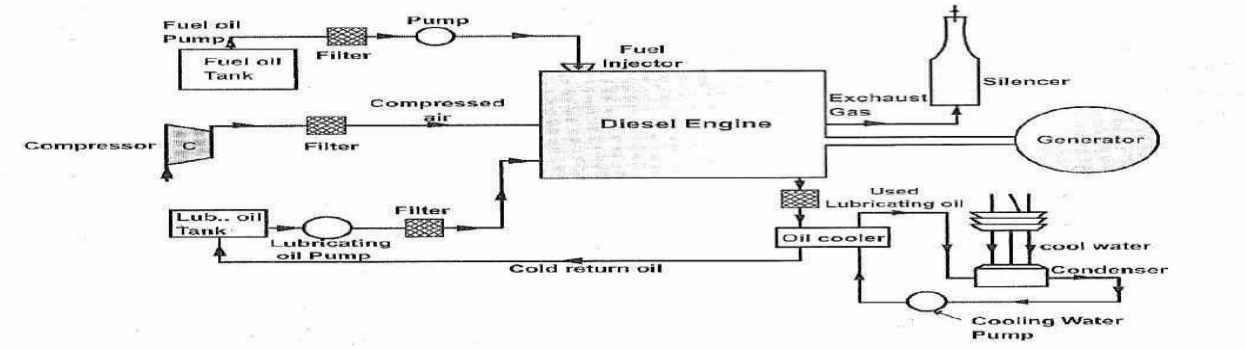


Figure shows the arrangements of the engine and its auxiliaries in a diesel power plant.

The major components of the diesel power plant are:

1) Engine

Engine is the heart of a diesel power plant. Engine is directly connected through a gear box to the generator. Generally two-stroke engines are used for power generation. Now a days, advanced super & turbo charged high speed engines are available for power production.

2) Air supply system

Air inlet is arranged outside the engine room. Air from the atmosphere is filtered by air filter and conveyed to the inlet manifold of engine. In large plants supercharger/turbocharger is used for increasing the pressure of input air which increases the power output.

3) Exhaust System

This includes the silencers and connecting ducts. The heat content of the exhaust gas is utilized in a turbine in a turbocharger to compress the air input to the engine.

4) Fuel System

Fuel is stored in a tank from where it flows to the fuel pump through a filter. Fuel is injected to the engine as per the load requirement.

5) Cooling system

This system includes water circulating pumps, cooling towers, water filter etc. Cooling water is circulated through the engine block to keep the temperature of the engine in the safe range.

6) Lubricating system

Lubrication system includes the air pumps, oil tanks, filters, coolers and pipe lines. Lubricant is given to reduce friction of moving parts and reduce the wear and tear of the engine parts.

7) Starting System

There are three commonly used starting systems, they are;

1) A petrol driven auxiliary engine
2) Use of electric motors.
   Use of compressed air from an air compressor at a pressure of 20 Kg/cm.