# SNS COLLEGE OF TECHNOLOGY
## DEPARTMENT OF AGRICULTURE ENGINEERING

## 19AGT301 HEAT POWER ENGINEERING
**Two Mark Questions**

## GAS TURBINES

**1) What are the applications of Gas Turbines?**

**Ans.:-**1. Supercharging 2. Turbo jet and turbo-propeller engines
1. Marine field 4. Railways
5. Road transport 6. Electric power generation
7. Industry.

**2) What are the limitations of gas turbines?**

**Ans.:-**The gas turbines have the following limitations: i) They are not self starting; (ii) low efficiencies at part loads; (iii) non-reversibility; (iv) higher rotor speeds and (v) overall efficiency of the plant low.

**3) Classify gas turbines**

**Ans.:-**The gas turbines are mainly divided into two groups:
1. Constant pressure combustion gas turbine
(a) Open cycle constant pressure gas turbine
(b) Closed cycle constant pressure gas turbine.
2. Constant volume combustion gas turbine.

**4)List the merits of Gas Turbines over I.C. engines?**

**Ans.:-** Merits of Gas Turbines over I.C. engines:
1. The mechanical efficiency of a gas turbine (95%) is quite high as compared with I.C. engine (85%) .
2. A gas turbine does not require a flywheel as the torque on the shaft is continuous and uniform.
3. The weight of gas turbine per H.P. developed is less than that of an I.C. engine.
4. The gas turbine can be driven at very high speeds (40,000 r.p.m.) whereas this is not possible with I.C. engines.
5. The work developed by a gas turbine per kg of air is more as compared to an I .C. engine
6. The components of the gas turbine can be made lighter since the pressures used in it are very low, say 5 bar compared with I.C. engine, say 60 bar.
7. In the gas turbine the ignition and lubrication systems are much simpler as compared with I.C. Engines.

8. Cheaper fuels such as paraffine type, residue oils or powdered coal can be used whereas special grade fuels are employed in petrol engine to check knocking or pinking.
9. The exhaust from gas turbine is less polluting comparatively since excess air is used for combustion.
10. Because of low specific weight the gas turbines are particularly suitable for use in aircrafts.

**5)List the demerits of Gas Turbines over I.C. engines?**

**Ans.:**-Demerits of Gas Turbines over I.C. engines:-

1. The thermal efficiency of a simple turbine cycle is low (15 to 20%) as compared with I.C. engines (25 to 30%).
2. With wide operating speeds the fuel control is comparatively difficult.
3. Due to higher operating speeds of the turbine, it is imperative to have a speed reduction device.
4. It is difficult to start a gas turbine as compared to an I.C. engine.
5. The gas turbine blades need a special cooling system.
6. One of the main demerits of a gas turbine is its very poor thermal efficiency at part loads.
7. Owing to the use of nickel-chromium alloy, the manufacture of the blades is difficult and costly.
8. For the same output the gas turbine produces five times exhaust gases than LC. engine.
9. Because of prevalence of high temperature (1000 K for blades and 2500 K for combustion chamber) and centrifugal force the life of the combustion chamber and blades is short/small.

**6)List the advantages of Gas Turbines over steam turbines?**

**Ans.:**-The gas turbine entails the following advantages over steam turbines:

1. Capital and running cost less.
2. For the same output the space required is far less.
3. Starting is more easy and quick.
4. Weight per H.P. is far less.
5. Can be installed anywhere.
6. Control of gas turbine is much easier.
7. Boiler along with accessories not required.

**7)Draw typical open cycle and closed cycle gas turbine plants?**

**Ans.:-**

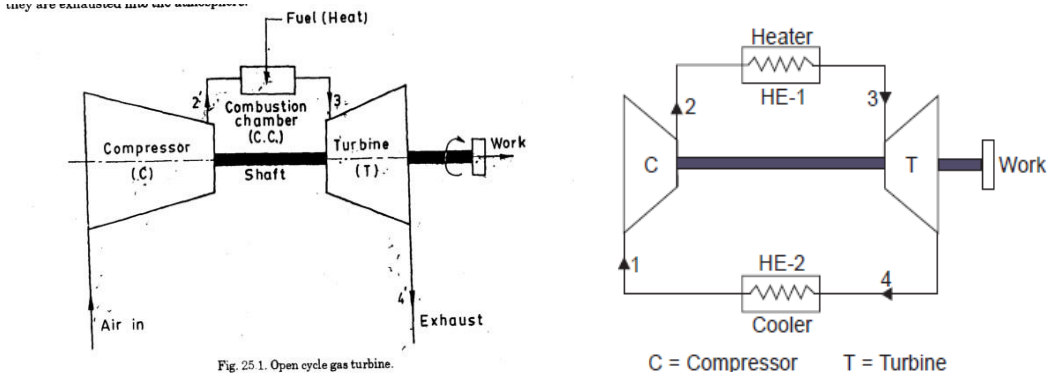


Fig. 25.1. Open cycle gas turbine.

**8) What are the methods for Improvement of Thermal Efficiency of Open Cycle Gas Turbine Plant?**

**Ans.:**-The following methods are employed to increase the specific output and thermal efficiency of the plant:

1. Inter-cooling 2. Reheating 3. Regeneration.

**9) Define Thermal efficiency, Compressor isentropic efficiency and Turbine isentropic efficiency?**

**Ans.:-**

$$\therefore \text{ Net work output} = \text{work output} - \text{work input}$$
$$= c_p (T_3 - T_4') - c_p(T_2' - T_1)$$

and
$$\eta_{Thermal} = \frac{\text{net work output}}{\text{heat supplied}}$$
$$= \frac{c_p (T_3 - T_4') - c_p(T_2' - T_1)}{c_p(T_3 - T_2')}$$

**Compressor isentropic efficiency, $\eta_{comp}$**
$$= \frac{\text{work input required in isentropic compression}}{\text{actual work required}}$$
$$= \frac{c_p(T_2 - T_1)}{c_p(T_2' - T_1)} = \frac{T_2 - T_1}{T_2' - T_1}$$

**Turbine isentropic efficiency, $\eta_{turbine}$**
$$= \frac{\text{actual work output}}{\text{isentropic work output}}$$
$$= \frac{c_p(T_3 - T_4')}{c_p(T_3 - T_4)} = \frac{T_3 - T_4'}{T_3 - T_4}$$

**10) Define work ratio and Effectiveness of the heat exchanger?**

**Ans.:-**

$$\text{work ratio} = \frac{\text{net work output}}{\text{gross work output}} = \frac{\text{work of expansion} - \text{work of compression}}{\text{work of expansion}}$$

$$\text{Effectiveness, } \varepsilon = \frac{\text{increase in enthalpy per kg of air}}{\text{available increase in enthalpy per kg of air}}$$

**11)What are the Operating Variables Effect Thermal Efficiency**

**Ans.:**-The thermal efficiency of actual open cycle depends on the following thermodynamic Operating Variables

(i) Pressure ratio

(ii) Turbine inlet temperature

(iii) Compressor inlet temperature

(iv) Efficiency of the turbine

(v) Efficiency of the compressor

**12) List the merits and demerits of Closed Cycle Gas Turbine over Open Cycle Gas Turbine?**

**Ans.:-Merits of closed cycle:**

1. Higher thermal efficiency 2. Reduced size

3. No contamination 4. Improved heat transmission

5. Improved part load efficiency 6. Lesser fluid friction

7. No loss of working medium 8. Greater output 9. Inexpensive fuel.

**Demerits of closed cycle:**

1. Complexity

2. Large amount of cooling water is required. This limits its use to stationary installation or marine use where water is available in abundance.3. Dependent system.4. The weight of the system per H.P. developed is high comparatively, therefore not economical for moving vehicles.5. Requires the use of a very large air heater.

**13)Draw a typical constant volume combustion turbine plant?**

**Ans.:-** Constant volume combustion turbine

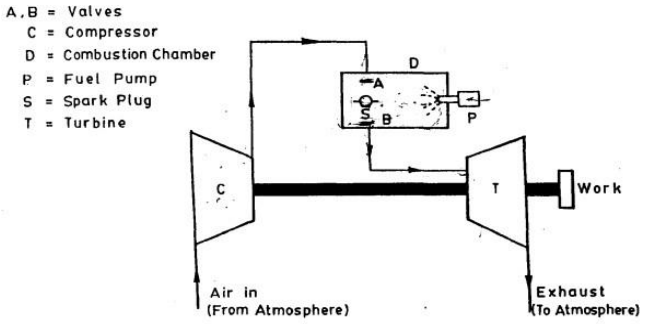


Fig. 25.18. Constant volume combustion gas turbine.

**14) Write a short note on fuels used for gas turbines.**

**Ans.:-**

1. **Gaseous Fuels:** Natural gas is the ideal fuel for gas turbines, but this is not available everywhere.
Blast furnace and producer gases may also be used for gas turbine power plants.

2. **Liquid Fuels:** Liquid fuels of petroleum origin such as distillate oils or residual oils are most commonly used for gas turbine plant. The essential qualities of these fuels include proper volatility, viscosity and calorific volume. Minerals like sodium, vanadium and calcium prove very harmful for the turbine binding as these build deposits or corrode the blades. In cold conditions residual oils need to be preheated.

3) **Solid Fuels:** The use of solid fuels such as coal in pulverised form in gas turbines presents several difficulties most of which have been only partially overcome yet. Finely crushed coal is used instead of pulverized fuel

**15) Define jet propulsion?**

**Ans.:-**The principle of jet propulsion involves imparting momentum to a mass of fluid in such a manner that the reaction of imparted momentum provides a propulsive force.

**16) Classify propulsion system?**

**Ans.:-**The propulsion system may be classified as follows:

1. Air stream jet engine., (Air-breathing engines)

(a) Steady combustion systems ; continuous air flow

(i) Turbo jet (ii) Turbo prop

(iii) Rain jet

(b) Intermittent combustion system ; intermittent flow

(i) Pulse jet or flying bomb.

2. Self contained rocket engines (Non-air breathing engines)
(i) Liquid propellent (ii) Solid propellent

**17)What are athodyds?**

**Ans.:-**Athodyds are aero-thermodynamic ducts which are straight duct type of jet engines having no compressor and turbine wheels. Example: ram jet and pulse jet

**18) What is the difference between jet propulsion and rocket propulsion?**

**Ans.:-**The main difference is that in case of jet propulsion the oxygen required for combustion is taken from the atmosphere and fuel is stored whereas for rocket engine, the fuel and oxidiser both are contained in a propelling body and as such it can function in vacuum.

**19) Define Thrust, Thrust power, Propulsive power, Propulsive efficiency, Thermal efficiency, overall efficiency and jet efficiency?**

**Ans.:-Thrust** is the force produced due to change of momentum

**Thrust power (T. P.):**It is defined as the rate at which work must be developed by the engine if the air craft is to be kept moving at a constant velocity Ca against friction force or drag.

Thrust power = forward thrust x speed of air craft

$$\text{T.P.} = \left[\left(1 + \frac{m_f}{m_a}\right)(C_j - C_a)\right] C_a \text{ W/kg of air}$$

**Propulsive power (P.P.):**

The energy required to change the momentum of the mass flow of gas represents the propulsive power. It is expressed as the difference between the rate of kinetic energies of the entering air and exit gases.

$$\text{P.P.} = \Delta\text{K.E.} = \frac{\left(1 + \frac{m_f}{m_a}\right) C_j^2}{2} - \frac{C_a^2}{2} \text{ W/kg}$$

**Propulsive efficiency :**

The ratio of thrust power to propulsive power is called the Propulsive efficiency of the propulsive unit.

$$\eta_{prop.} = \frac{\text{thrust power}}{\text{propulsive power}} = \frac{\left[\left(1 + \frac{m_f}{m_a}\right)(C_j - C_a)\right] C_a}{\left[\frac{\left(1 + \frac{m_f}{m_a}\right) C_j^2}{2} - \frac{C_a^2}{2}\right]} = \frac{2\left[\left(1 + \frac{m_f}{m_a}\right)(C_j - C_a)\right] C_a}{\left[\left(1 + \frac{m_f}{m_a}\right) C_j^2 - C_a^2\right]} \quad \ldots(25.17)$$

**Thermal efficiency, ($\eta_{th}$) :**

It is defined as the *ratio of propulsive work and the energy released by the combustion of fuel.*

$$\eta_{th} = \frac{\text{propulsive work}}{\text{heat released by the combustion of fuel}} = \frac{\text{increase in kinetic energy of the gases}}{\text{heat released by the combustion of fuel}}$$

*Overall efficiency* ($\eta_0$) is given by :

$$\eta_0 = \eta_{th} \times \eta_{prop.} = \frac{(C_j^2 - C_a^2)}{2 \times \left(\frac{m_f}{m_a}\right) \times \text{calorific value}} \times \frac{2\,C_a}{C_j + C_a}$$

For *maximum overall efficiency the air-craft velocity* $C_a$ *is one half of the jet velocity* $C_j$.

The jet *efficiency* ($\eta_{jet}$) is defined as :

$$\eta_{jet} = \frac{\text{final kinetic energy in the jet}}{\text{isentropic heat drop in the jet pipe + carry over from the turbine}}$$

**20) Define Rocket propulsion?**

**Ans.:-**The thrust required for rocket propulsion is produced by the high velocity jet of gases passing through the nozzle. But the main difference is that in case of jet propulsion the oxygen required for combustion is taken from the atmosphere and fuel is stored whereas for rocket engine, the fuel and oxidiser both are contained in a propelling body and as such it can function in vacuum.

**21) Classify Rocket Engines?**

**Ans.:-**The rockets may be classified as follows;
1. According to the type of propellent:
(i) Solid propellent rocket
(ii) Liquid propellent rocket.
2. According to the number of motors:
(i) Single-stage rocket (consists of one rocket motor)
(ii) Multistage rocket (consists of more than one rocket motor).

**22) What are the Requirements of an ideal rocket propellent**

An ideal rocket propellent should have the following characteristics/properties:
1. High heat value

2. Reliable smooth ignition
3. Stability and ease of handling and storing
4. Low toxicity and corrosiveness
5. Highest possible density so that it occupies less space.

**23) What are the applications of rockets?**

The fields of application of rockets are as follows:

1. Long range artillery 2. Lethal weapons 3. Signaling and firework display 4. Jet assisted take-off
5. For satellites 6. For space ships7. Research.