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ME8493 – Thermal Engineering I

Unit Wise Question Bank

ME 8493 THERMAL ENGINEERING - I - 2 MARKS – UNIT 1, 2, 3

UNIT – I GAS AND STEAM POWER CYCLES

1. **Define air standard efficiency cycle? (May -14, 17, Nov -18)**

It is defined as the ratio of work done by the cycle to the heat supplied to the cycle.

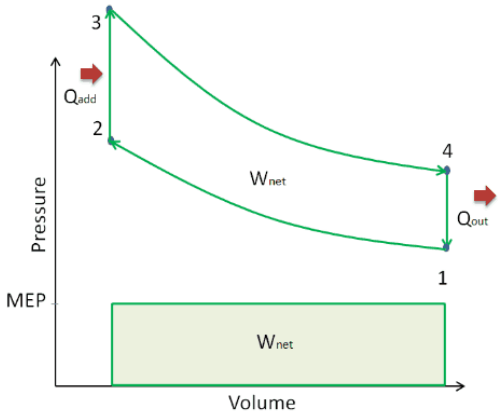
2. **What is cutoff ratio? (May -14, 16, Nov -18)**

It is defined as the ratio of volume after the heat addition to volume before the heat addition.

3. **Define Mean effective pressure. Show it on p-v diagram. (May – 16, Nov -13, 14, 17)**

It is hypothetical pressure which is acting on the piston during the power stroke.

Mean effective pressure = workdone /stroke volume.



4. **What are the assumptions made in air standard cycle? (May - 15, 16, Nov -16)**

- The work medium is a perfect gas throughout.
- The working medium does not undergo chemical change through the cycle.
- Kinetic and potential energies of the working fluid are neglected.
- The operation of the engine is frictionless

5. **Four major difference between Otto and diesel cycle. (Nov -16)**

S.No	Otto cycle	Diesel cycle
1	Efficiency is less due to low compression ratio	Efficiency is more due to low compression ratio
2	Fuel is admitted into the cylinder during suction stroke	Air alone is admitted in to the cylinder during suction stroke
3	Spark ignition system is used for ignition.	Compression ignition system is used for ignition.

6. **Air standard efficiency equation of diesel and otto cycle. (May - 16, 17, 18)**

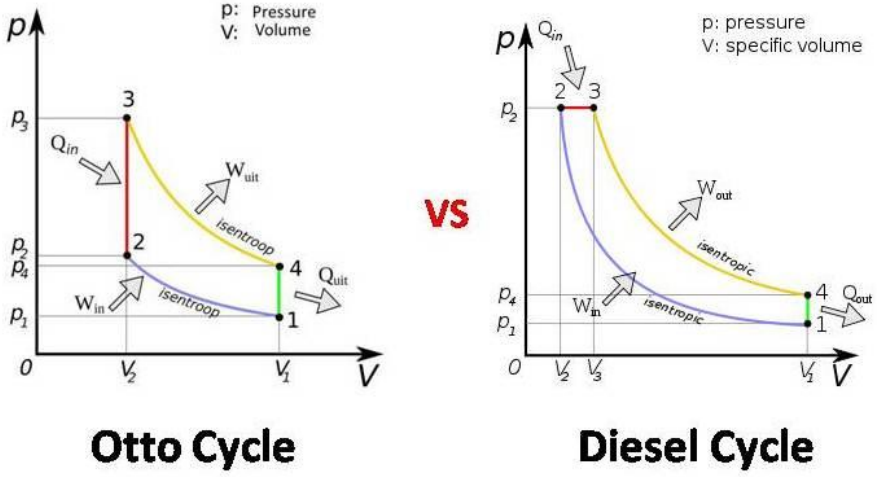
$$\eta_{Otto} = 1 - \frac{1}{(r)^{\gamma-1}}$$

$$\eta_{diesel} = 1 - \frac{1}{\gamma(r)^{\gamma-1}}\left[\frac{\rho^{\gamma}-1}{\rho-1}\right]$$

7. **Why does diesel cycle have high efficiency compared to Otto cycle? (May -19)**

The normal range of compression ratio for a diesel engine is 16 to 20 whereas for spark it is 6 to Due to higher compression ratios used in diesel engines, the efficiency of the diesel engine is more than that of a gasoline engine

8. **P-V diagram of diesel and otto cycle? (May -18)**



Otto Cycle **Diesel Cycle**

9. **What is the effect cut-off ratio on the efficiency of diesel cycle when the compression ratio is kept constant? (Nov -13, 15)**

When cut-off ratio of diesel cycle increases, the efficiency of cycle is decreased when compression ratio is kept constant and vice versa.

10. **What are the methods used to increase the efficiency of Rankine cycle.**

Rankine cycle efficiency can be improved by using the following three methods.

1. Reheating 2. Regeneration 3. Combined reheating and regeneration

UNIT II RECIPROCATING AIR COMPRESSOR

1. **Purpose of intercooler. (or) Advantages of intercooler? (Nov -14, 17, 15, 18)**

The cooler which is placed in between stages is called Intercooler. An intercooler is a simple heat exchanger.

- Reduced air temperature, volume and increased air density for next stage.So increased volumetric efficiency and compressor efficiency.
- Due to reduced temperature give better lubrication for cylinder and piston rings.

2. **Isothermal and isentropic efficiency of a reciprocating compresssor? (May -18, 19, Nov - 14)**

Isothermal efficiency is defined as the ratio between isothermal work done to the actual work done with polytropic compression.

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

3. **How is work saving possible in multi stage compressor? (or) Advantages of multi stage compressor? (May -15, 18, 19, Nov -16)**

- It improves the efficiency for the given pressure ratio.
- It reduces the leakage loss considerably.
- It gives the more uniform torque and hence, a smaller size of fly wheel is required.

4. **Effect of clearance volume on work of compression? (Nov -15, 17)**

If clearance volume is considered, actual volume of suction has decreased from the stroke volume. Thus the effect of clearance is to reduce the volume of air actually sucked in per working cycle.

5. **Free air delivered in a reciprocating air compressor. (May -15, 17)**

Free air delivery: The free air delivered is the actual volume delivered at this state pressure reduced to intake pressure and temperature and expressed in terms of m^3/min.

6. **State the conditions which lower the volumetric efficiency of an air compressor. (May – 13, 16)**

- Very high speed
- Leakage past the piston
- Too large a clearance volume
- Obstruction at inlet valve
- Inertia effects of air in suction pipe

7. **Define volumetric efficiency of a air compressor. (May - 15, 16)**

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.

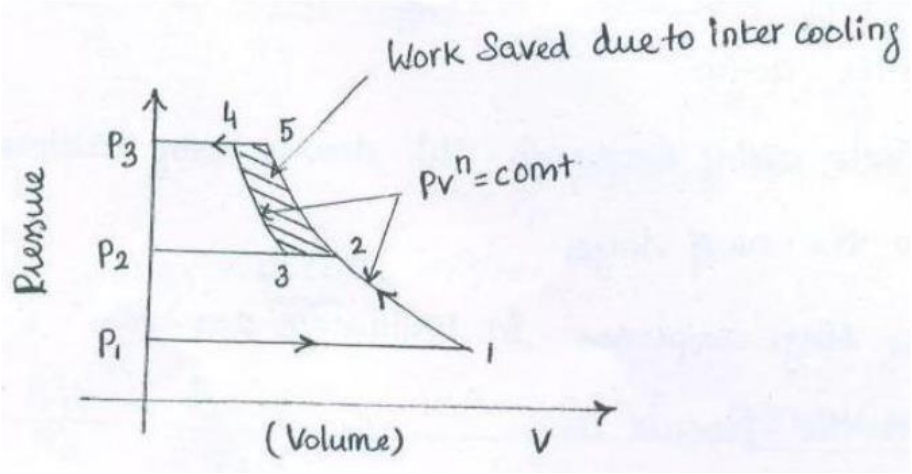
8. **Differentiate between centrifugal and axial compressors? (Nov -16)**

S.No	Centrifugal compressor	Axial compressor
1	Starting torque is low.	Starting torque is high
2	It is not suitable for multistage compression	It is suitable for multistage compression
3	Running cost is low	Running cost is high

9. **What is the effect of inter cooling in multi compressor? (Nov -14, 17)**

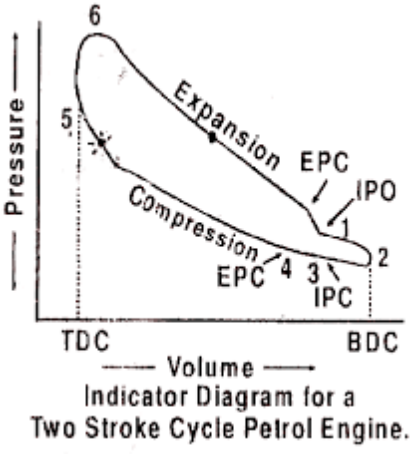
An inter cooler is a simple heat exchanger. It exchanges the heat of compressor air from the low pressure compressor to the circulating water before the air enters to the high pressure compressor. The purpose of inter cooling is to minimize the work compression.

10. **Draw the P-V diagram of a two stage reciprocating air compressor. (May - 14)**



UNIT III INTERNAL COMBUSTION ENGINES AND COMBUSTION

1. **Draw actual P-v diagram of two stroke engine. (Nov -14, 15)**



Indicator Diagram for a Two Stroke Cycle Petrol Engine.

2. **State the functions of flywheel, connecting rod, piston and crankshaft. (May -15, 18 Nov -17)**

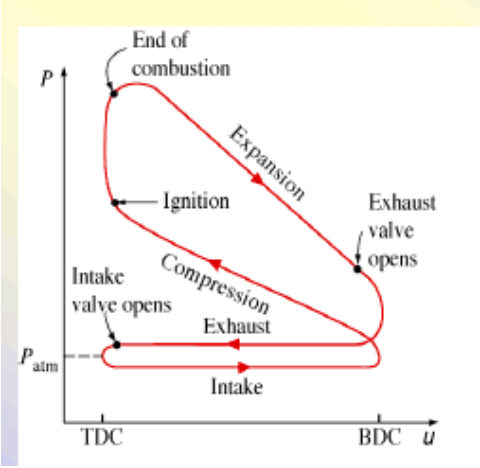
The function of **flywheel** is to store energy received during the power stroke and to return the energy during the other stroke when the power is not produced.

A **connecting rod** is an engine component that transfers motion from the piston to the crankshaft and functions as a lever arm. Connecting rods are commonly made from cast aluminum alloy and are designed to withstand dynamic stresses from combustion and piston movement.

A **piston** is basically a sliding shaft that fits inside the cylinder. Its purpose is to change the volume enclosed by the cylinder , to exert a force on a fluid inside the cylinder . In an engine, its purpose is to transfer force from expanding gas in the cylinder to the crankshaft via a piston rod or connecting rod.

The **crankshaft** is a moving part of the internal combustion engine (ICE). It's main function is to transform the linear motion of the piston into rotational motion. The pistons are connected to the crankshaft through the connecting rods. The crankshaft is mounted within the engine block.

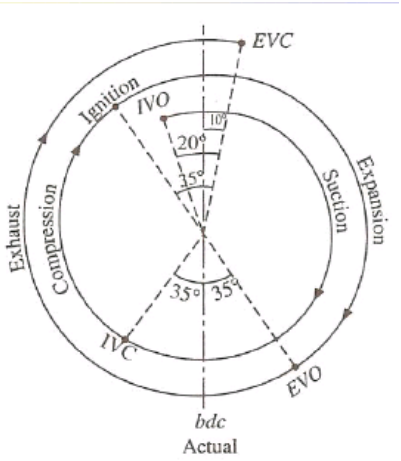
3. **Draw the actual valve timing of the four stroke diesel engine? (May -18, Nov -17)**



4. **What is octane number in I.C engines? (May -17)**

It indicates the ignition quality of gasoline. Higher this number, the less susceptible is the gas to 'knocking' when burnt in a standard spark-ignition engine. Octane number denotes the percentage (by volume) of iso-octane in a combustible mixture (containing iso-octane and normal-heptane) whose 'anti-knocking' characteristics match those of the gas being tested.

5. **Show the valve overlapping period of a typical 4-stroke petrol engine on the valve timing diagram. (May -16)**



6. Define the phenomenon of 'knocking' in spark ignited engines. (May -16, Nov -15)

If the temperature of the unburnt mixture exceeds the self ignition temperature of the fuel and remains at or above this temperature during the period of preflame reactions, spontaneous ignition occurs at various pin point locations. This phenomenon is called knocking.

7. Valve overlapping delay (Nov -14)

Valve overlap is the period during the valve timing where both the intake and exhaust valves are open. Occurring towards the end of the exhaust stroke, the intake valves are opened just before all the exhaust gases are released, providing more time for the intake air to enter the engine.

8. What is ignition delay (Nov -14, 15)

It is a time period between the starting of injection and combustion, during this period, the fuel is atomized, vapourized and mixed with air which is raised to itself ignition temperature.

9. How is cam shaft speed related to cam shaft speed? And why? (May -19)

In a two-stroke engine that uses a camshaft, each valve is opened once for every rotation of the crankshaft; in these engines, the camshaft rotates at the same speed as the crankshaft. Changing cam timing moves the overall power produced by the engine down or up the RPM scale.

The camshaft is either chain or gear driven from the crankshaft. Because the engine is a four stroke, the camshaft will rotate at half the speed of the crankshaft. (the valves and fuel pump will only operate once for every two revolutions of the crankshaft).

10. What are the effects of rich mixture in petrol engine? (May -19)

An engine runs especially rich when accelerating, when cold, or when under a load. If there is too much fuel and not enough air, the engine is said to be "running rich", or "has a rich mixture". It will have a gassy or rotten egg smell from the exhaust, give off a burning effect to the eyes and will make black smoke

ME 8493 THERMAL ENGINEERING – I - PART B & C– UNIT 1,2,3

UNIT – I GAS AND STEAM POWER CYCLES

1. A gas engine operating on the ideal Otto cycle has a compression ratio of 6:1. The Pressure and temperature of the commencement of compression are 1 bar and 300C. Heat added at the end of compression is 2650 kJ/kg k. Determine the peak pressure and temperature, work output per kg of air , Mean effective pressure and air standard efficiency. Assume Cp=1.004 kj/kg k and Cv =0.717 kJ/kg k, γ =1.4 for air. **(Concept: May – 18, 19, Nov – 14) (Nov - 17)**

2. An engine with 200mm cylinder diameter and 300 mm stroke works on theoretical diesel cycle. The initial pressure and temperature of air used are 1 bar and 27^0C. The cut - off is 8% of the stroke. Determine i) pressure and temperature at all salient points. ii) Theoretical air standard efficiency iii) Mean effective pressure iv) Power of the engine if working cycles per minute are 380. Assume compression ratio is 15. **(Concept: May - 17, 18, 19, Nov – 15) (May - 15)**

3. An oil engine works on the dual cycle, the heat liberated at constant pressure begin twice that liberated at constant volume. The compression ratio of the engine is 8 and the expansion ratio is 5.3. But the compression and expansion processes follow the law Pv1.3=C. the pressure and temperature at beginning of compression are 1 bar and 27 ^{0}C respectively. Assuming Cp=1.004 kJ/kg k and Cv =0.717 kJ/kg k for air, standard efficiency and the mean effective pressure. **(Concept: May - 16, 19, Nov – 16) (Nov - 17)**

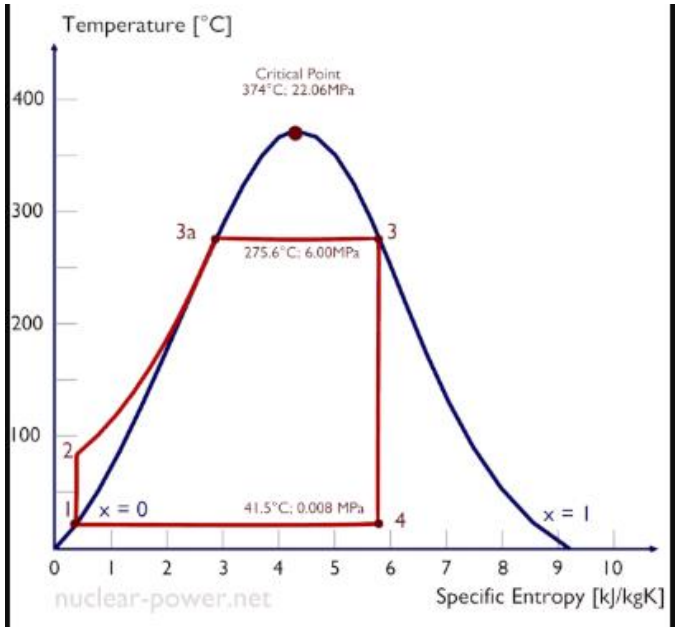
4. Derive an expression for the air standard efficiency and MEP of a Diesel cycle. **(May - 19, Nov – 15, 18)**

5. Derive an expression for the air standard efficiency and MEP of a Otto cycle. **(Concept: May - 17, Nov – 15)**

6. Let assume the Rankine cycle**,** which is the one of most common thermodynamic cycles in thermal power plants. In this case assume a simple cycle without reheat and without with condensing steam turbine running on saturated steam (dry steam). In this case the turbine operates at steady state with inlet conditions of 6 MPa, t = 275.6°C, x = 1 (point 3). Steam leaves this stage of turbine at a pressure of 0.008 MPa, 41.5°C and x =? (Point 4). Calculate:

1. The vapor quality of the outlet steam
2. The enthalpy difference between these two states (3 → 4), which corresponds to the work done by the steam, W_T.
3. The enthalpy difference between these two states (1 → 2), which corresponds to the work done by pumps, W_P.
4. The enthalpy difference between these two states (2 → 3), which corresponds to the net heat added in the steam generator

5. The thermodynamic efficiency of this cycle and compare this value with the Carnot's efficiency. **(Concept: May - 19)**



7. A reheat Rankine cycle using water as the working fluid operates between the pressure limits of 7.5 kPa and 17.0 MPa. Steam is superheated to 550 ^{o}C before it is expanded to the reheat pressure of 4.0 MPa. Steam is reheated to a final temperature of 550 ^{o}C. Determine: The cycle thermal efficiency, The steam rate (specific steam consumption).

8. Derive an expression for the air standard efficiency and MEP of a Dual Cycle.

UNIT II RECIPROCATING AIR COMPRESSOR

1. A single stage, single acting air compressor 30 cm bore and 40 cm stroke runs at 200 rpm. The suction pressure is 1 bar at 15_0C and the delivery pressure 5 bar. Determine ideal power required to run it, when : (i) Compression is isothermal (ii) Compression follows the law $pv^{1.25}$= c (iii) Compression is reversible adiabatic (γ=1.4) Determine the isothermal efficiency for ii, iii. Assume isentropic or reversible adiabatic index as γ=1.4 and R= 0.287 kJ/kgK . And also find adiabatic efficiency. **(Concept: May - 15, 17, 19, Nov – 15, 16, 18) (Nov - 17)**

2. A single stage double acting reciprocating air compressor delivers 0.6 kg of air per minute at 6 bar. The temperature and pressure at the end of suction stroke are 30C and 1 bar. The bore and stroke of the compressor are 100mm and 150mm respectively. The clearance is 3% of the swept volume. Assuming polytropic expansion and expansion with n=1.3. Find i)volumetric efficiency ii) power required if mechanical efficiency is 85% and iii) speed of the compressor. **(Concept: May – 16) (May - 15)**

3. A three stage air compressor with perfect intercooling takes 15 m^3 of air per minute at 95 Kpa and 27^oC and delivers the air at 3.5 Mpa. If the compression process is polytropic ($pv^{1.3}=c$) determine I. Power require if the mechanical efficiency is 90%. II. Heat rejected in the intercooler per minute. III. Isothermal efficiency. IV. Heat rejected through cylinder walls per minute. **(Concept: Nov – 17) (Nov - 15)**

4. What are the various Rotary compressors? Disucss briefly with neat sketch. **(Nov - 15)**

5. Derive an equation to explain the effect of clearance volume on compressor work. **(Nov - 14)**

6. Drive an expression for the work done by single stage single acting reciprocating air compressor. **(May - 17)**

7. Classify the Compressors and Explain in detail about various types of Reciprocating Compressors. **(May - 17, 19)**

8. Explain the Multistage compressor with suitable diagram and Compare it with single compressor. **(Nov – 18)**

UNIT III INTERNAL COMBUSTION ENGINES AND COMBUSTION

1. Draw and explain the valve timing diagram, port timing diagram of 4 stroke, 2stroke Diesel Engine. **(May – 15, 17)**

2. Explain the normal combustion and knocking in a diesel engine with pressure-crank angle diagram. **(May - 15)**

3. Analyse the effect of Octane and Cetane number on the I.C. Engine Cycle and performance. **(May - 17)**

4. What are the factors affecting he flame speed of the engine. **(Nov – 15)**

5. Explain the various types of Combustion Chamber. **(Nov – 15)**

6. Differentiate between 2 stroke and 4 stroke engine and draw the indicator diagram for CI engine. **(May - 19, Nov – 15)**

7. Explain the combustion phenomenon in SI Engines.

8. Explain four stages of combustion in CI engines.

ME 8493 THERMAL ENGINEERING - I - 2 MARKS – UNIT 4,5

UNIT IV INTERNAL COMBUSTION ENGINE PERFORMANCE AND SYSTEMS

1. **What are the advantages of MPFI diagram? (May -17)**
   (1) More uniform A/F mixture will be supplied to each cylinder, hence the difference in power developed in each cylinder is minimum.
   (2) No need to crank the engine twice or thrice in case of cold starting as happens in the carburetor system.
   (3) Immediate response, in case of sudden acceleration / deceleration.
   (4) Since the engine is controlled by ECM* (Engine Control Module), more accurate amount of A/F mixture will be supplied.

2. **Write the important requirements of fuel injection system (Nov 2015)**
   - The beginning as well as the end of injection should takes place sharply.
   - The injection of fuel should occur at the correct movement, correct rate and correct quantity as required by the varying engine load.
   - The fuel should be injected in a finely atomized condition and should be uniformly distributed inside the combustion chamber.

3. **State the purpose of thermostat in an engine cooling system (Nov 2015)**

   A thermostat is used in the water cooling system to regulate the circulation of water in system to maintain the normal working temperature of the engine parts during the different operating conditions.

4. **What is the effect of supercharging on the power output of the IC engine? (May 2013)**

   Supercharging increases the power output of the engine due to the increased induction of air.This makes more oxygen available for combustion.

5. **What is the antifreeze solutions used in the cooling systems (Nov -16)**
   - Water and ethylene glycol
   - Water and propylene glycol

6. **What is meant by motoring test? (Nov -16)**

   Motoring test determine the friction power at conditions very near to the actual operating temperatures at the test speed and load.

7. **Use of morse test? (May -19)**

   The purpose of Morse test is to obtain the approximate indicated power of a Multi cylinder engine. It consist of running the engine against the dynamo-meter at a particular speed, cutting out the firing of each cylinder in turn and noting the fall in BP each time while maintaining the speed constant.

8. **Functions of lubrication test? (May -19)**

   Lubricant testing and oil condition monitoring provides quality and condition assessment of lubricants and oils used in engines and other expensive machinery and systems. Lubricant quality control testing includes lubricant analysis programs for

large, high-value engines and drive-trains, turbines, ships, trains, generators, offshore platforms, and other highly valuable machinery. lubricant quality testing helps clients minimize costly down-time and repairs by alerting the customer to early, developing problems before they become big, expensive, and costly failures.

9. Define the term brake power. (May 2014)

The power developed at the output shaft (crank shaft) is called the brake power.

$B.P=2\pi NT$

N=speed in rpm

T=Torque in KN.m

10. Differentiate between the supercharging and turbo charging.

Supercharger and turbocharger both are used for increasing the volumetric efficiency of engine through increasing in density of intake air and this lead to increase power of engine that is power booster for engine. This is possible with the help of compressor. But,

In supercharger engine:

1. Compressor get drive from engine and this increase load on engine.
2. Wastage of engine power.
3. Same time supercharge engine are more prone to knocking this damage engine internal parts

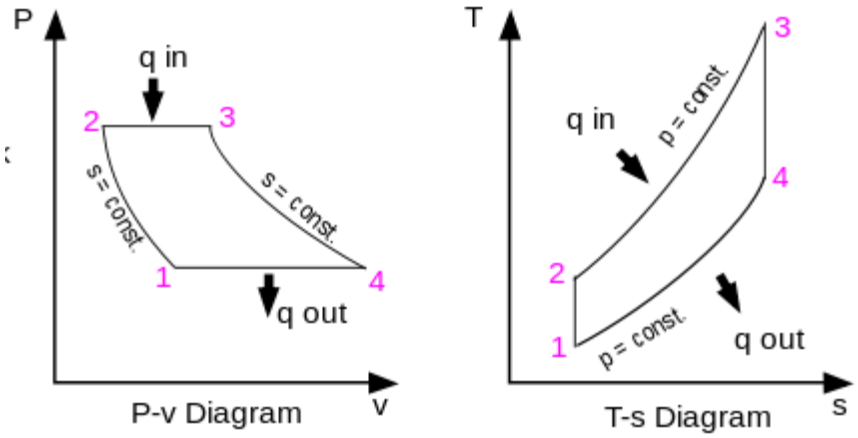
Where as

In turbocharger engine :

1. Compressor get drive from turbine and this turbine gets drive from exhaust gases so no extra load on engine.
2. No wastage of engine power
3. Same time turbocharger engine are less prone to knocking because inter cooler used with turbocharger which maintain intake air temperature.

UNIT V GAS TURBINES

1. **Draw brayton cycle in T-S and P-V planes. (May -15, 17, Nov -17)**



2. **What are the applications of gas turbine power plants? (A/M 18)**

   (a) Peak load plants: gas turbine power plants are used to supply peak loads in steam or hydro plants
   (b) Standby plants: They are used as Standby plants for hydro – electric plants
   (c) They are used in industries for driving compressors & electric generators
   (d) They are used in Jet planes, aircrafts & ships.

3. **What are the advantages of closed cycle gas turbine over open cycle gas turbine? (N/D 18)**

   Merits:
   (i) Efficiency is same throughout the cycle
   (ii)The turbine blades do not wear away since the combustion is external
   (iii)Starting of the plant is easy
   (iv) Low quality fuel can be used since the combustion is external.

   Demerits:
   (i) A separate pre cooler arrangement is necessary
   (ii)The size & weight are more
   (iii)Initial cost & maintenance cost are more
   (iv)Combustion efficiency is less.

4. **What is reheating and regeneration of gas turbine? (N/D 14, 16)**

   If the dryness fraction of steam leaving the turbine is less than 0.88, then, corrosion and erosion of turbine blades occur. To avoid this situation, reheat is used. In the simple open cycle system the heat of the turbine exhaust gases goes as waste. To make use of this heat a regenerator is provided. In the regenerator the heat of the hot exhaust gases from the turbine is used to preheat the air entering the combustion chamber.

5. **Why power generation by gas turbine is more attractive than other turbines? (N/D 15)**

Gas turbine power plant is attractive because of their ability to quickly ramp up power production

6. **What are the effects of introducing regeneration in the basic gas turbine cycle?**
   - The fuel economy is improved the quantity of the fuel required per unit mass of air is less.
   - The work output from the turbine, work required to the compressor will not change.
   - Pressure drop will occur during regeneration.
   - It increases the thermal efficiency when the low pressure ratio reduces.

7. **List down the various processes of the Brayton cycle. (A/M 17)**
   - Isentropic compression
   - Constant pressure heat addition
   - Isentropic expansion
   - Constant pressure heat rejection

8. **What fuel does a gas turbine use? (May -19)**

Gas turbines operate on natural gas, synthetic gas, landfill gas, and fuel oils. Plants typically operate on gaseous fuel with a stored liquid fuel for backup to obtain the less expensive, interruptible rate for natural gas

9. **Effect of reheat on the brayton efficiency cycle? And why? (May -19)**

Efficiency was improved with a Reheat Stage on the brayton cycle. To bring the average temperature at which we add heat to the cycle closer to the peak temperature, we can add a reheat stage to the cycle.

10. **What are the factors influencing ideal brayton cycle efficiency? (May -19)**

Key factors affecting the Brayton cycle efficiency includes the turbine inlet temperature, compressor and turbine adiabatic efficiencies, recuperator effectiveness and cycle fractional pressure loss.

ME 8493 THERMAL ENGINEERING – I - PART B & C– UNIT 4,5

UNIT IV INTERNAL COMBUSTION ENGINE PERFORMANCE AND SYSTEMS

1. A four cylinder four stroke oil engine 1o cm in dia and 15 cm in stroke develops a torque of 185 Nm at 2000 rpm. The oil consumption is 14.5 lit/hr. the specific gravity of oil is 0.82 and calorific value of oil is 42000 KJ/Kg. If the Imep taken from indicated diagram is 6.7 bar find I. Mechanical efficiency II. Break thermal efficiency III. Break mean effective pressure IV. Specific fuel consumption in litres on break power basis. **(Concept: May - 16, 17, 18, Nov – 14)** (**Nov – 15**)

2. A six cylinder four stroke engine of 340mm bore and 390 mm stroke was tested and the following information: Engine speed = 360 rpm; Brake power=180 kW;mf= 0.77 kg/min, calorific value= 45000kJ/kg; I.M.E.P = 3.8 bar.Flow of cooling water=6.4 kg/min with a temperature rise of 9C. Draw the heat balance for the engine. **(Nov - 15)**

3. Explain the 3 types of Ignition system. **(May - 18, Nov – 17, 18)**

4. Explain the lubrication system I.C Engine. **(May - 19, Nov – 16)**

5. Explain the function of a fuel injector with a simple sketch. **(May - 16, Nov – 14, 16, 17)**

6. Briefly discuss about MPFI. **(May - 18)**

7. Explain the functions of CRDI with neat sketch. **(May - 19)**

8. Explain the cooling system in I.C Engine.

UNIT V GAS TURBINES

1. Drive the expression for air standard efficiency of Brayton cycle in terms of pressure ratio. **(May - 19)**

2. Briefly discuss about the improvisation of Gas Turbine. **(May - 19)**

3. In a gas turbine plant working on the Brayton cycle the air at the inlet is at 27 ^{o}C, 0.1 MPa. The pressure ratio is 6.25 and the maximum temperature is 800^{0}C. the turbine and compressor efficiencies are each 80%.Find, (a) Compressor work per kg of air, (b) Turbine work per kg of air, (c) Heat supplied per kg of air, (d) Cycle efficiency, and (e) Turbine exhaust temperature. **(Concept: May - 15, 19, Nov – 14, 18) (Nov - 16)**

4. Air enters the compressor of a gas turbine plant operating on Brayton cycle at 1 bar, 270C. The pressure ratio in the cycle is 6. If WT = 2.5 WC. Calculate maximum temperature and cycle efficiency.(Apr - 15)

5. In a gas turbine plant working on the brayton cycle the air at the inlet is at 25 o C, 1 bar. The maximum pressure and temperature are limited to 3 bar and 6500C. Determine heat supplied and heat rejected per kg of air, Cycle efficiency and work output. (Nov - 14)

6. Explain the working principle of open and closed cycle Gas turbine.

7. A gas turbine draws in air from atmosphere at 1 bar and 10^{o}C and compresses it to 5 bar with an isentropic efficiency of 80%. The air is heated to 1200 K at constant pressure and then expanded through two stages in series back to 1 bar. The high pressure turbine is connected to the compressor and produces just enough power to drive it. The low pressure stage is connected to an external load and produces 80 kW of power. The isentropic efficiency is 85% for both stages. Calculate the mass flow of air, the inter-stage pressure of the turbines and the thermal efficiency of the cycle. $= 1.333.\gamma = 1.4$ and for the turbines γFor the compressor The gas constant R is 0.287 kJ/kg K for both. Neglect the increase in mass due to the addition of fuel for burning.

8. What are the materials used in Gas turbines? Discuss in detail.