USN | | | | | | | | | | |

Internal Assessment Test 3 – Nov. 2019

Sub:	Energy Engineering					Sub Code:	15ME71	Branch:	Mechanical
Date:	16/11/2019	Duration:	90 mins	Max Marks:	50	Sem / Sec:	7 A & B		OBE

Answer any five Questions

		MARKS	CO	RBT
1	Draw the schematic diagram of a Diesel power plant. Mention the function of each component of the plant.	[10]	CO1	L1
2	Explain the different methods of starting of diesel engine.	[10]	CO1	L1
3	Sketch and explain the working of floating gas holder type biogas plant used in India (KVIC plant).	[10]	CO4	L1
4	List the factors affecting biogas generation. Explain any four in brief.	[10]	CO4	L1
5	Write brief notes on (i) Photosynthesis and (ii) Energy Plantation.	[10]	CO4	L1
6	With a neat sketch, explain the working of double basin tidal power plant. What are the advantages?	[10]	CO4	L1

CI CCI HOD

USN | | | | | | | | | | |

Internal Assessment Test 3 – Nov. 2019

Sub:	Energy Engineering					Sub Code:	15ME71	Branch:	Mechanical
Date:	16/11/2019	Duration:	90 mins	Max Marks:	50	Sem / Sec:	7 A & B		OBE

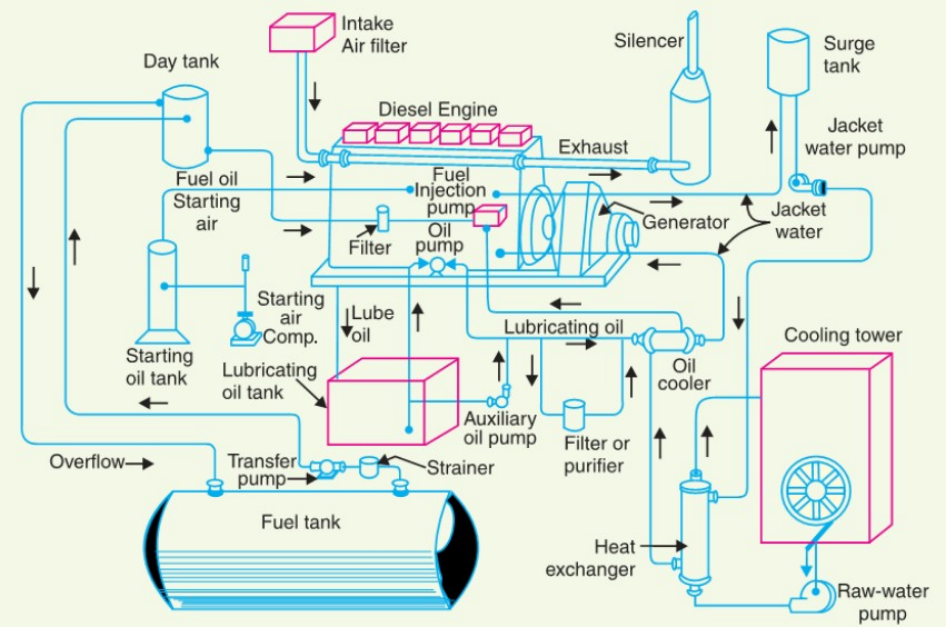
Answer any five Questions

		MARKS	CO	RBT
1	Draw the schematic diagram of a Diesel power plant. Mention the function of each component of the plant.	[10]	CO1	L1
2	Explain the different methods of starting of diesel engine.	[10]	CO1	L1
3	Sketch and explain the working of floating gas holder type biogas plant used in India (KVIC plant).	[10]	CO4	L1
4	List the factors affecting biogas generation. Explain any four in brief.	[10]	CO4	L1
5	Write brief notes on (i) Photosynthesis and (ii) Energy Plantation.	[10]	CO4	L1
6	With a neat sketch, explain the working of double basin tidal power plant. What are the advantages?	[10]	CO4	L1

CI CCI HOD

Q1) Draw the schematic diagram of a Diesel power plant. Mention the function of each component of the plant.

Answer: The essential components of diesel engine power plants are shown in the figure. It consists of the following components:



1) Engine: This is the main component of the plant which develops required power by burning fuel. The engine is directly coupled to the generator.

2) Air filters and super chargers: Air filters remove dust from the air which is taken by the engine. Super charger is used to increase the pressure of air supplied to the engine to increase the engine power. Generally a large diesel engine requires 0.076 to 0.114 m3 of air per min per kw of power developed. The fresh air is drawn through pipes or ducts or filters. The purpose of the filter is to catch any air borne dirt as it otherwise may cause the wear and tear of the engine.

3) Exhaust system: This includes the silencers, connecting ducts. The high temperature of exhaust gas may be utilized for heating oil or fuel supplied to the engine when the ambient temperature is low.

4) Fuel system: It includes the storage tank, fuel pump, fuel transfer pump, strainer and heaters. The fuel is supplied to the engine according to the engine load on the plant. The fuel is delivered to the plant by railroad tank car, by truck or by barge and tanker and stored in the bulk storage situated outdoors for the sake of safety. From this main fuel tank, the fuel oil is transferred to the daily consumption tank by a transfer pump through a filter.

5) Cooling system: It includes water circulating pumps, cooling towers, or spray ponds, water filters on plants. During combustion process the peak gas temperature in the cylinder of an internal combustion engine is of the order of 2500 K. Maximum metal temperature for the inside of the combustion chamber space are limited to much lower values than the gas temperature by a large number of considerations and thus cooling for the cylinder head, cylinder and piston must therefore be provided.

6) Lubrication system: It includes the oil pumps, oil tank filters, coolers and connecting pipes. Since frictional forces causes wear and tear of rubbing parts of the engine thereby reducing the life of the engine. So the rubbing part requires that some substance should be introduced between the rubbing surfaces in order to decrease the frictional force between them. Such substance is called lubricant. The lubricant forms a thin film between the rubbing surfaces. And lubricant prevents metal-to-metal contact.

7) Starting system: This includes compressed air tank. The function of this system is to start the engine from cold condition by supplying compressed air.

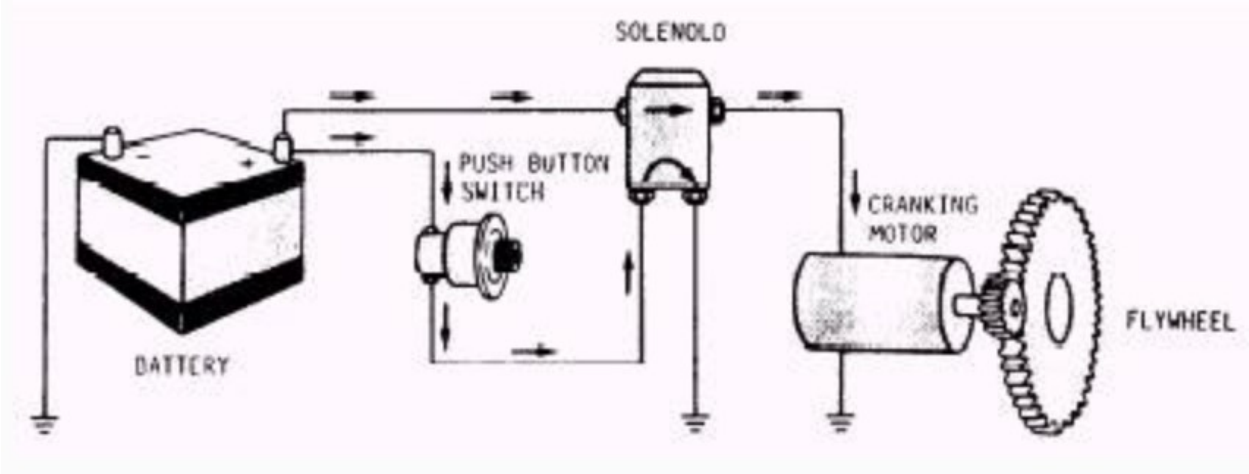
8) Governing system: The function of the governing system is to maintain the speed of the engine constant irrespective of load. This can be done by varying the fuel supply to the engine according to the load.

Q2) Explain the different methods of starting of diesel engine.

Answer: The various methods used for the starting of diesel engine are as follows:

Compressed Air System: Compressed air system is used to start large diesel engines. In this system compressed air at a pressure of about 20 kg per sq. cm is supplied from an air bottle to the engine an inlet valve through the distributor or through inlet manifold. In a multi-cylinder engine compressed air enters one cylinder and forces down the piston to turn the engine shaft. Meanwhile the suction stroke of some other cylinder takes place and the compressed air again pushes the piston of this cylinder and causes the engine crank shaft assembly to rotate. Gradually the engine gains momentum and by supplying fuel the engine will start running.

Electric Starting: Electric starting arrangement consists of an electric motor which drives pillion which engages a toothed rim on engine flywheel. Electric power supply for the motor is made available by a small electric generator. In case of small plants a storage battery of 12 to 36 volts is used to supply power to the electric motor. The electric motor disengages automatically after the engine has started. The advantages of electric starting are its simplicity and effectiveness.

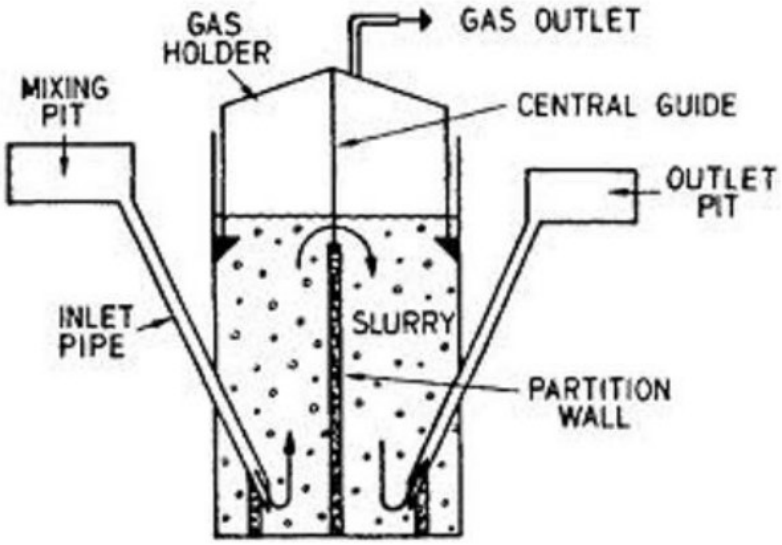


Starting by an Auxiliary Engine: In this method a small petrol engine is connected to the main engine through clutch and gear arrangement. Firstly, the clutch is disengaged and petrol engine is started by

hand. Then clutch is gradually engaged and the main engine is cranked for starting. Automatic disengagement of clutch takes place after the main engine has started.

Q3) Sketch and explain the working of floating gas holder type biogas plant used in India (KVIC plant).

Answer:



The KVIC type biogas plant has an inverted mild steel drum to work as gasholder. This is the most expensive component of the plant. The drum floats either directly on the fermented slurry or in a water jacket of its own. Most plants now have a pair of central guide pipes. The gasholder is free to rise or fall depending on the production and use of gas. It is also free to rotate on its axis. Gasholder rotation will also be useful as a device to break the scum in the digester. A flexible hosepipe is attached to the top of the gasholder for gas dispersion. The gas passes through a moisture trap before supplying to the utility/house.

The digester is a deep circular pit or a well, built of bricks, mortar and plaster, with a partition wall. The bifurcation of digestion chamber through partitioning wall provides optimum conditions for growth of acid former and methane former as the requirement of pH values for these bacteria are different. Therefore, this plant operates very well with good biogas yield. The underground structure helps minimize the heat loss from the plant and the cylindrical shape has better structural strength.

Advantages of Floating Drum type plant:

- It has less scum troubles because solids are constantly submerged.
- No separate pressure equalizing device needed when fresh waste is added to the tank or digested slurry is withdrawn.
- Higher gas production per cu m of the digester volume is achieved.
- Floating drum has welded braces, which help in breaking the scum (floating matter) by rotation.
- No problem of gas leakage.
- Constant gas pressure.

Disadvantages of Floating Drum type plant:

- It has higher cost, as cost is dependent on steel and cement.
- Heat is lost through the metal gas holder, hence it troubles in colder regions and periods.
- Gas holder requires painting once or twice a year, depending on the humidity of the location.
- Flexible pipe joining the gas holder to the main gas pipe requires maintenance, as it is damaged by ultraviolet rays in the sun. It may be twisted also, with the rotation of the drum for mixing or scum removal.

Q4) List the factors affecting biogas generation. Explain any four in brief.

Answer: The operation of biogas plant or digestion process is affected by a number of factors, which are to be optimized to obtain best results:

Temperature: Methane forming bacteria work best in temperature ranges 20−55˚C. Digestion at higher temperature proceeds more rapidly than at lower temperature, with gas yield rates doubling at about every 5˚C increase in temperature. In cold climate regions the digester has to be heated to about 35˚C, in most cases by using part of the biogas produced. Sometimes solar thermal collectors are used for heating. The gas production decreases sharply below 20˚C and almost stops at 10˚C. It is to be noted that raising the temperature accelerates the gas production; however its methane content gets relatively reduced.

Pressure A minimum pressure of 6-10 cm of water column, i.e. 1.2 bar (abs) is considered ideal for proper functioning of plant and it should never be allowed to exceed 40-50 cm of water column. Excess pressure inhibits release of gas from slurry. It also leads to leakage in masonry through micropores.

pH Value: In the initial acid forming stage of the digestion process pH value may be around 6 or less. However, during methane formation stage, pH value of 6.5 to 7.5 is maintained, as methane-forming bacteria are very sensitive to acidity. Too much and sudden deviation from this value is likely to cause imbalance in bacteria population affecting the production of gas.

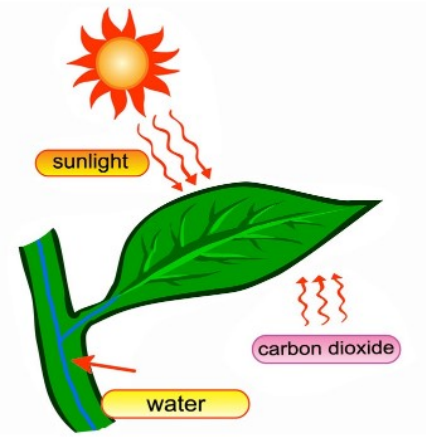
Feeding Rate: If the digester is fed with too much raw material at a time, acids will accumulate and the digestion process may stop. Also faster feeding rate will not help increase the gas production. At higher feeding rate the retention period will be less and undigested slurry may come out. Therefore, uniform feeding rate should be maintained.

Other factors which affect biogas production are:

- Solid to Moisture Ratio in the Biomoss
- Carbon to Nitrogen (C/N) Ratio and Other Nutrients in Biomass
- Seeding of Biomass with Bacteria
- Mixing or Stirring
- Retention Time
- Effect of Toxic Substances

Q5) Write brief notes on (i) Photosynthesis and (ii) Energy Plantation.

Answer: The most important chemical reaction on the earth is the reaction of sunlight and green plants. Radiant energy of sun is absorbed by the green pigment chlorophyll in the plant and is stored within the plant in the form of chemical bond energy. Photosynthesis in the plants is an example of biological conversion of solar energy into sugars and starches which are energy rich compounds.



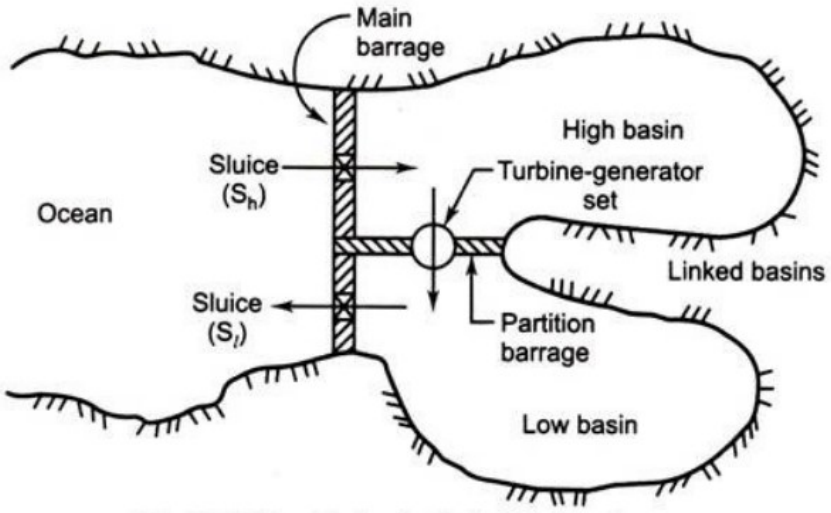
The process photo-synthesis is extremely complex and not yet completely understood by scientists. (In Greek photo means light and synthesis means combination). In this reaction, water and CO_2 molecules are broken down and a carbohydrate is formed with the release of pure oxygen. The process can be expressed as follows:

$$6CO_2 + 6H_2O + \text{light energy} \rightarrow 6O_2 + C_6H_{12}O_6$$

Energy Plantation means growing select species of trees and shrubs which are harvestable in a comparably shorter time and are specifically meant for fuel. The fuel wood may be used either directly in wood burning stoves and boilers or processed into methanol, ethanol and producer gas. These plantations help provide wood either for cooking in homes or for industrial use, so as to satisfy local energy needs in a decentralized manner. The energy plantations provide almost inexhaustible renewable sources (with total time constant of 3-8 years only for each cycle) of energy which are essentially local and independent of unreliable and finite sources of fuel. The attractive features of energy plantations are: (a) heat content of wood is similar to that of Indian coal, (b) wood is low in sulfur and not likely to pollute the atmosphere, (c) ash from burnt wood is a valuable fertilizer, (d) utilization of erosion prone land for raising these plantations helps to reduce wind and water erosion, thereby minimizing hazards from floods, siltation, and loss of nitrogen and minerals from soil and (e) help in rural employment generation - it is estimated that an hectare of energy plantation is estimated to provide employment for at least seven persons regularly. Selection of multipurpose species provides a number of by-products like oils, organic compounds, fruits, edible leaves, forage for livestock, etc .

Q6)With a neat sketch, explain the working of double basin tidal power plant. What are the advantages?

Answer:



It requires two separate but adjacent basins. In one basin called “upper basin” (or high pool), the water level is maintained above that in the other, the low basin (or low pool). Because there is always a head between upper and lower basins, electricity can be generated continuously, although at a variable rate.

In this system the turbines are located in between the two adjacent basins, while the sluice gates are as usual embodied in the dam across the mouths of the two estuaries. At the beginning of the flood tide, the turbines are shut down, the gates of upper basin are opened and those of the lower basin are closed. The upper basin is thus filled up while the lower basin remains empty. As soon as the rising water level in upper basin provides sufficient difference of head between the two basins, the turbines are started. The water flows from upper basin to lower basin through the turbines, generating power. The power generation thus continues simultaneously with the filling up the basin upper basin. At the end of the flood tide when upper basin is full and the water level in it is the maximum, its sluice gates are closed. When the ebb tide level gets lower than the water level in lower basin, its sluice gates are opened whereby the water level in lower basin, which was arising and reducing the operating head, starts falling with the ebb. This continues until the head and water level in upper basin is sufficient to run the turbines. With the next flood tide the cycle repeats itself.

The main advantage of this twin basin system is that a longer and more continuous period of generation per day is possible.