

SYED AMMAL ENGINEERING COLLEGE

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Dr. E.M.Abdullah Campus, Ramanathapuram – 623 502.

Phone: 304001, 304002 (04567) Fax: 304123(04567)

Web: www.syedengg.ac.in E.mail:saec@syedengg.ac.in



DEPARTMENT OF MECHANICAL ENGINEERING

ME6701 – POWER PLANT ENGINEERING

(2 MARKS QUESTIONS)

UNIT I COAL BASED THERMAL POWER PLANTS

UNIT - 1: THERMAL POWER PLANTS

TWO MARKS

1. Name the four major circuits in steam power plant.

- Coal and ash circuit
- Air and flue gas circuit
- Feed water and steam circuit
- Cooling water circuit

2. What consists of air and flue gas circuit?

Air and flue gas circuit consists of forced draught fan, air-pre-heater, boiler, furnace, super heater, economiser, dust collector, induced draught fan and chimney.

3. What consists of feed water and steam flow circuit in steam power?

The feed water and steam flow circuit consists of feed pump, economiser boiler drum super heater, turbine and condenser.

4. What consists of cooling water circuit and coal & ash circuit in steam power plant?

The cooling water circuit consists of a pump, condenser and cooling tower. The coal and ash circuit consists of coal delivery, preparation of coal, handling of coal to the boiler furnace, ash handling and ash storage.

5. What is the main purpose of high-pressure boilers?

The high-pressure boilers are used to increase the efficiency of the plant and to reduce the cost of electricity production.

6. State important advantages of high-pressure boilers?

- The amount of scale formation is less, since the velocity of water through pipes are more.
- All parts of the system are heated uniformly, so there is no danger of overheating.

7. Name important high pressure boilers?

1. La Mont boiler
2. Benson boiler
3. Loeffler boiler
4. Velox boiler.

8. Write about La Mont boiler? What is the major disadvantage of La Mont boiler?

La Mont boiler is a forced circulation high pressure water tube boiler.

The major disadvantage is the formation of bubbles, salt and sediment on the inner surfaces of the heating surfaces. This reduces the heat flow and steam generation.

9. Write about Benson boiler? State some important advantages of Benson boiler?

Benson boiler is the high pressure, vertical fire tube boiler. This boiler has no drum and is ~designed to operate at critical pressure of 225 bar. Benson boiler has no drum. So the total weight of the Benson boiler is reduced by-20%, when compared to other boilers.

- o The erection of Benson boiler is easier and quicker.

10. Write about Loeffler boiler?

The major disadvantage in La Mont boiler is the deposition of salt and sediment on the inner surface of the water tubes. It reduces the heat transfer and ultimately the steam generating capacity.

In Loeffler boiler, this problem is solved by preventing water from flowing through the boiler tubes. The steam is generated outside the tubes.

11. Explain Reheat cycle?

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 reheat cycle, the expansion of steam takes place in one (or) more-turbines. Steam is expanded in the HP turbine first, and then it is reheated. The reheated steam is again expanded in the LP turbine.

12. Write about waste heat boilers?

The waste heat boilers use the waste heat in gases coming out of diesel engines and gas turbines at high temperature (or) use the waste as a fuel in the incineration.

Some boilers use the industrial dirty gases for power generation.

13. Write about fluidised bed boilers?

When the high velocity gas is passed through a packed bed of finely divided solid particles, the particles become suspended in the gas stream and the packed bed becomes a fluidised bed. When the gas velocity is very high, the fluidised bed become turbulent and rapid mixing of particles occurs. Ultimately, the, behaviour of mixture solid particles and -gas become a

fluid. Burning of a fuel in such a state is known as Fluidised Bed Combustion. The boiler plant using this fluidised bed combustion is known as fluidised bed boilers.

14. State some advantages of fluidised bed boilers?

- Any type of fuel - solid, liquid (or) gaseous fuel (or) domestic and industrial waste can be used in FBC system. Any type- of combustible matter can be burned by adjusting the factors as size, air velocity and rate of feed.
- High heat transfer rate is possible to the surfaces immersed in the bed, because solid mixing is extremely possible.
- High combustion efficiency.
- The solid fuel need not be pulverised in fluidised bed boilers.

15. Name the two types of coal handling?

- Out plant handling
- In-plant handling.

16. Write about out-plant handling?

Out plant handling includes the handling of coalmine to the thermal power plant. These handlings are outside the plant in the following ways.

- Transportation by sea (or) river
- Transportation by rail
- Transportation by road
- Transportation of coal by pipeline.

17. Write about inplant handling of-coal?

In order to handle large quantity of coal inside the plant, some mechanical handling systems are provided for smooth, easy and better controlled operation. The inplant coal handling is divided, into following categories.

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preparation

- Coal

transfer

- Coal

storage

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18. Why the preparation of coal is necessary?

The coal from coal mines cannot be directly fed into the furnace. Proper preparation of coal should be done before feeding the coal to the furnace. In the coal preparation, the coal passes through the different equipments like 1. Crushers 2. Sizers 3. Driers and Magnetic Separators.

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19. Name the different types of coal transforming equipments?

1. Belt conveyors 2. Screw conveyors 3. Bucket elevators 4. Grab bucket elevators 5. Skip hoists 6. Flight conveyors.

The coal transfer starts by carrying of coal from-unloading point to the storage site.

20. What is the use of belt conveyors?

Belt conveyors are mostly used for transporting coal over long distance with large quantity. An endless belt is made to run over a pair of end drums and pulleys and supported by series of roller at regular intervals.

21. Write about screw conveyor and bucket conveyors?

In screw conveyor, an endless helicoid screw is fitted to the shaft. On one end of the shaft, the driving mechanism is fitted and the other end of the shaft is supported on a ball bearing. While the screw is rotating, the coal is transferred from one end to the

Bucket conveyors are used as vertical lifts. The coal is loaded at the bottom and unloaded at the top in the bucket conveyors.

22. Define draught, what is the use of draught in thermal power plants?

Draught is defined as a small pressure difference required between the fuel bed (furnace) and outside air to maintain constant flow of air and to discharge the gases through chimney to the atmosphere. Draught can be obtained by chimney, fan, steam jet (or) -air jet (or) combination of these.

The uses are

- To supply required quantity of air to the furnace for combustion of fuel.
- To draw the combustion products through the system.
- To remove burnt products from the system

23. Write about classification of draught?

Draught is classified as

1. Natural draught
2. Artificial draught

The artificial draught is further classified as

- (a) Steam jet draught
- (b) Mechanical draught
- (c) Induced draught (d) Forced draught

24. Define the term Natural draught and what are the advantages of natural draught system?

The tall chimney creates the natural draught by the temperature difference between hot gases in the chimney and cold atmospheric air outside the chimney.

The advantages are

- No external power is required
- Air pollution is less since gases are discharged at high level.
- No maintenance cost
- Capital cost is less than artificial draught.

25. Write about artificial draught?

In modern power plants, the draught should be flexible to meet the fluctuating loads and it should be independent of atmospheric conditions. To achieve this, the aid of draft fans becomes must and by employing the draft fans, the height of the chimney would be reduced.

26. Write about forced draught system?

In this system, the blower (forced draft fan) is located at the base of the boiler near the grate. Air is forced to the furnace by forced fan and the flue gases are forced to chimney through economiser and air preheater.

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27. What are the advantages of forced draught system

- Since the fan handles cold air, the fan size and the power required are less.
- No need of water cooled bearings because the air being handled is cold air,
- Pressure throughout the system is above atmospheric pressure so the air leakage into the furnace is reduced.

28. How the induced draught is working?

In an induced draught system, a blower (induced draft fan) is placed near (or) at the base of the chimney. The fan sucks the flue gas from the furnace creating a partial vacuum inside the furnace. Thus atmospheric air is induced to flow through the furnace to aid the combustion of fuel. The flue gases drawn by the fan passes through chimney, to the atmosphere.

29. Why the balanced draught system is preferred than other system?

In the induced draught system, when the furnace is opened for firing, the cold air enters the furnace and dilate the combustion. In the forced draught system, when the furnace is opened for firing, the high pressure air will try to blow out suddenly and furnace may stop. Hence the furnace cannot be opened for firing (q) inspection in both, systems. Balanced draught, which is a combination of induced and forced draught, is used to overcome the above stated difficulties.

30. What is the difference between stocker firing and pulverised fuel firing?

The stocker firing method is used for firing solid coal whereas pulverised firing method is used for firing pulverised coal.

UNIT II DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS

1. What are the uses of air filter and superchargers in diesel engine power plant?

The purpose of air filter is to filter the air from dust and other suspended particles. The Purpose of super charger is to increase the pressure of the engine to increase power of the engine.

2. What is the use of draft tube?

The draft tube is used to regain the kinetic energy of water coming out of reaction turbine. It enables the reaction turbine to be placed over tailrace level.

3. What is the function-of cooling system in Diesel power plant?

The function of cooling system is to remove heat from the engine cylinder to keep the temperature of the cylinder in low range and extend engine life.

4. 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.

5. What is the purpose of intercooler in gas turbine power plant?

Since the power required to compress the air is less in isothermal process it is required to maintain the, temperature of air constant as far as possible. Hence the air leaving the L.P. compressor is cooled by intercooler and then passed to the H.P compressor.

6. Name two combined power cycles?

- Combined cycle of gas turbine and steam power plant.
- Combined cycle of gas turbine and diesel power plant.

7. 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.

8. What are the important advantages of Re-heating?

- Due to reheating, network done increases
- Heat supply increases
- Thermal efficiency increases
- Due to reheating, the turbine exit dryness fraction increases so moisture decreases - so blade erosion becomes minimum - so life of the turbine will be increased.

9. Name different methods of reheating?

- (a) Gas Reheating (b) Live - steam reheating
(c) Combined gas live steam reheater.

10. Define bleeding in steam power plant?

Assume 1 kg of steam is expanded in the turbine. Before complete amount of steam is expanded, some amount of steam (m kg) is extracted. Extracting the steam in the turbine before exhaust is called bleeding. This bled steam is used to heat the feed water.

11. Explain the term Regeneration?

Regeneration means heating the feed water by steam taken from the turbine. The steam is exhausted (bled) from the turbine at several locations before exhaust and is supplied to regenerator (feed water heater) to heat the feed water.

UNIT III NUCLEAR POWER PLANTS

1. Write about atomic number?

The nucleus contains protons and neutrons. The number of protons in a given atom is an atomic number (Z). The atomic number for H is 1 and He is 2.

2. Write about isotopes of an element?

Some elements have the same number of protons in the nucleus but different number of neutrons. As a result, these elements have the same atomic number but different mass number.

Such type of elements which have the same atomic number - same number of protons - the same chemical properties but different mass numbers due to different number of neutrons, are known as the isotopes of an element.

3. What are the requirements to sustain fission process?

- The bombarded neutrons must have sufficient energy to cause fission
- The number of neutrons produced must be able to create the rate of fission
- The fission process must generate energy
- The fission process must be controlled

4. Define multiplication factor of a fission process.

The effective neutron multiplication factor, k , is the average number of neutrons from one fission that cause another fission. The remaining neutrons either are absorbed in non-fission reactions or leave the system without being absorbed.

5. Define fertile materials and breeding in reactors

There are materials like U^{235} and Th^{232} which are not fissile but can be converted into fissile materials by the bombardment of neutrons. Such materials are known as fertile materials.

The process of converting more fertile material into fissile material in a reaction is known as breeding.

6. What are the desirable properties of a good moderator?

- It must be as light as possible It must slowdown the neutron as quick as possible
- It must have resistance to corrosion
- It must have good machinability
- It must have good conductivity and high melting point

7. What are the desirable properties of a coolant?

- It should not absorb neutron
- Have high chemical and radiation stability
- Non-corrosive
- Have high boiling point
- Non-toxic

8. Name few types of reactors.

Fast reactors, Thermal reactors, natural fuel reactors, Enriched Uranium reactors, water moderated reactors, heavy water moderated reactor, graphite moderated reactor, gas cooled reactors and Sodium cooled reactors.

9. What are the advantages using CO₂ as coolant?

- Gases do not react chemically with the structural materials
- Gas can attain any temperature for a particular pressure
- They do not absorb neutron
- The leakage of gas will not affect the reactivity
- The gas coolant provides best neutron economy

10. What are the advantages of breeder reactors?

- It gives high power density than any other reactor
- High breeding is possible
- High burn-up of fuel is achievable
- The operation of the reactor is not limited by Xe poisoning

11. What are the demerits of breeder reactor?

- Highly enriched fuel is required
- Control is difficult and expensive
- Safety must be provided against melt down
- Handling of sodium is a major problem

12. What are the advantages of Sodium in fast-breeder reactors?

- Sodium has very low absorption cross-sectional area
- It possesses good heat transfer properties at high temperature and low pressure
- It does not react with any of the structural materials used in primary circuits

13. Name the different types of MHD generators

- Open cycle MHD
- Closed cycle MHD

- Closed cycle MHD with liquid metal

14. What is the working principle of magneto hydrodynamic power plant?

The working principle of MHD is as like that of dynamo. Instead of solid conductor high temperature plasma is passed through the magnetic field at sonic speed. When the gas is passed through magnetic field, current is induced. Electrodes collect this induced current.

15. What is the purpose of control rods?

The control rods are used to start the chain reaction, maintain the chain reaction at required level and to shut down the reactor during emergency.

16. What are the different types of load acting on the chimney?

- Its own weight which is considered to act on a single vertical force acting through the centroid
- The wind pressure, which is considered to act on the horizontal force acting on the centroid of vertical projected area.

17. What is meant by Nuclear fission?

Uranium exists in different isotopes of U238, tP34 and U235. Out of these, EP35 is most unstable. When unstable heavy nucleus is bombarded with high-energy neutrons, it splits up roughly into two equal fragments and about 2.5 neutrons are released and a large amount of energy is produced. This process is called nuclear fission.

18. Name the different components of nuclear reactor?

1. Nuclear fuel
2. Moderator
3. Control rods
4. Reflectors
5. Reactor vessel
6. Biological shielding
7. Coolant

19.State some advantages of Pressurized Water reactor?

- The pressurized water reactor is compact
- In this type, water is used as coolant, moderator and reflector (available in plenty)
- It requires less number of control rods.

20. What are the advantages of gas cooled reactor nuclear power plant?

1. Fuel processing is simple
2. The use of CO₂ as coolant completely eliminates the possibility of explosion in reactor.
3. No corrosion problem

21. What is breeding in nuclear reactor?

The process of producing fissionable material from a fertile material such as uranium 238 (U238) and thorium 232 (Th 232) by neutron absorption is known as breeding.

22. Name the coolants commonly used for fast breeder reactors?

Liquid metal (Na (or) Na K) Helium (He) Carbon dioxide

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UNIT IV POWER FROM RENEWABLE ENERGY

1. Define Tide? The periodic rise and fall of the water level of sea which are carried by the action of sun and moon on water of the earth is called the tide.

2. In which system the power is Intermittently generated? In a single basin arrangement power can be generated only intermittently.

3. What are the consistencies 'Solar farm' and 'Solar tower'?

The solar farm consists of a whole field covered with parabolic trough concentrators and a 'solar tower' consists of a central receiver on a tower and a whole field of tracking.

4. Define Seebeck effect?

If two dissimilar materials are joined to form a loop and the two junctions maintained at different temperatures, an e.m.f. will be set up around the loop. This is called Seebeck effect.

5. What is working principle of thermionic?

A thermionic converter works because of the phenomenon of 'thermionic emission'.

6. What is Photo voltaic effect? 'Photo voltaic effect'

is defined as the generation of an electromotive force as a result of absorption of ionizing radiation.

7. Write a short notes on MHD – generator?

'MHD generator' is a device which converts heat energy of a fuel directly into electrical energy without a conventional electric generator.

8. Write a short notes on Fuel cell?

A 'fuel cell' is an electrochemical device in which the chemical energy of a conventional fuel is converted directly and efficiently into low voltage, direct current electrical energy.

9. List the non – conventional energy sources?

The various non-conventional energy sources are as follows: Solar energy Wind energy Energy from biomass and biogas Ocean thermal energy conversion Tidal energy Geothermal energy Hydrogen energy Fuel cells Magneto-hydrodynamics generator Thermionic converter Thermo-electric power.

10. Write the advantages of non – conventional Energy sources? Advantages of non-conventional energy sources:

The leading advantages of non-conventional energy sources are: 1. They do not pollute the atmosphere 2. They are available in large quantities. 3. They are well suited for decentralized use.

11. Write the characteristics of wind energy?

1. Wind-power systems do not pollute the atmosphere. 2. Fuel provision and transport are not required in wind-power systems. 3. Wind energy is a renewable source of energy. 4. Wind energy when produced on small scale is cheaper, but competitive with conventional power generating systems when produced on a large scale. Wind energy entails following short comings/problems: 1. It is fluctuating in nature. 2. Due to its irregularity it needs storage devices. 3. Wind power generating systems produce ample noise.

12. What are the types of wind mills?

1. Multiple blade type 2. Savonius type 3. Darrieus type

13. Write the types of wind machines?

1. Horizontal axis wind machines 2. Vertical axis wind machines

14. Write the classification of Tidal power plants?

1. Single Basin arrangement. 2. Double Basin arrangement.

15. What are the advantages and limitation of Tidal power generation?

Advantages: 1. Tidal power is completely independent of the precipitation (rain) and its uncertainty besides being inexhaustible. 2. Large area of valuable land is not required. 3. When a tidal power plant works in combination with thermal or hydro-electric system peak power demand can be effectively met with. 4. Tidal power generation is free from pollution.

Limitations: 1. Due to variation in tidal range the output is not uniform. 2. Since the turbines have to work on a wide range of head variation (due to variable tidal range) the plant efficiency is affected. 3. There is a fear of machinery being corroded due to corrosive sea water. 4. It is difficult to carry out construction in sea. 5. As compared to other sources of energy, the tidal power plant is costly. 6. Sedimentation and siltation of basins are the problems associated with tidal power plants. 7. The power transmission cost is high because the tidal power plants are located away from load centres. The first commercial tidal power station in the World was constructed in France in 1965 across the mouth of La Rance Estuary. It has a high capacity of 240 MW. The average tidal range at La Rance is 8.4 m and the dam built across the estuary encloses an area of 22 km².

16. Write the advantages of MHD systems?

1. More reliable since there are no moving parts. 2. In MHD system the efficiency can be about 50% (still higher expected) as compared to less than 40% for most efficient steam plants. 3. Power produced is free of pollution. 4. As soon as it is started it can reach the full power level. 5. The size of plant is considerably smaller than conventional fossil fuel plants. 6. Less overall operational cost. 7. The capital cost of MHD plants is comparable to those of conventional steam plants. 8. Better utilization of fuel. 9. Suitable for peak power generation and emergency service.

17. Write the advantages and disadvantages of fuel cell?

Advantages 1. Conversion efficiencies are very high. 2. Require little attention and less maintenance. 3. Can be installed near the use point, thus reducing electrical transmission requirements and accompanying losses. 4. Fuel cell does not make any noise. 5. A little time is needed to go into operation. 6. Space requirement considerably less in comparison to conventional power plants.

Disadvantages 1. High initial cost 2. Low service life.

18. Write the application of fuel cell?

The application of fuel cell relate to: 1. Domestic use. 2. Automotive vehicles 3. Central power stations. 4. Special applications.

19. Write the advantages of OTEC?

1. Ocean is an infinite heat reservoir which receives solar incidence throughout the year. 2. Energy is freely available

20. Write the disadvantages of OTEC? 1. Efficiency is very low, about 2.5%, as compared to 30 - 40% efficiency for conventional power plants. 2. Capital cost is very high

21. Define – Tidal power plant?

The tidal power plants are generally classified on the basis of the number of basins used for power generations. They are further subdivided as one-way or two-way system as per the cycle of operation for power generation.

22. Define – Renewable sources of energy?

Renewable sources of energy are continuously produced in nature, and they will not get exhausted eventually in future.

23. Define – Non-renewable source of energy?

Non-renewable sources of energy will get exhausted eventually in future. Example: Energy from fossil fuels.

24. Mention some conventional sources?

Fossil fuels, hydel energy and nuclear energy.

25. Mention some Non-conventional sources?

Solar energy, wind energy, tidal energy, ocean thermal energy, geothermal energy and biomass.

26. What are the 3 – major energy sources?

The energy sources available can also be classified into three major types based on the yield of net energy. They are: i) Primary energy sources, ii) Secondary energy sources, iii) Supplementary energy sources.

27. What are the five general categories of geothermal sources?

The following five general categories of geothermal sources have been identified.

1. Hydrothermal convective systems □ Vapour – dominated or dry steam fields. □ Liquid – dominated system or wet steam fields. □ Hot – water fields. 2. Geopressure resources. 3. Petrothermal or hot dry rocks (HDR) 4. Magma resources 5. Volcanoes.

28. Write the application of geothermal energy?

The following are the three main applications of the steam and hot water from the wet geothermal reservoirs: 1. Generation of electric power. 2. Space heating for buildings. 3. Industrial process heat. The major benefit of geothermal energy is its varied application and versatility.

29. What are the Advantages and disadvantages of Geothermal Energy over other Energy forms?

Advantages of geothermal process:

1. Geothermal energy is cheaper. 2. It is versatile in its use. 3. It is the least polluting as compared to other conventional energy sources. 4. It is amenable for multiple uses from single resources 5. Geothermal power plants have the highest annual load factors of 85 percent to 90 per cent compared to 45 per cent to 50 per cent for fossil fuel plants. 6. It delivers greater amount of net energy from its system as compared to other alternative or conventional systems. 7. Geothermal energy from the earth's interior is almost as inexhaustible as solar or wind energy, so long as its sources are actively sought and economically tapped.

Disadvantages:

1. Low overall power production efficiency (about 15% as compared to 35% to 40% for fossil fuel plants).
2. Drilling operation is noisy.
3. Large areas are needed for exploitation of geo-thermal energy.
4. The withdrawal of large amounts of steam or water from a hydro-thermal reservoir may result in surface subsidence or settlement.

UNIT V ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS

Define the following terms.

1. Connected Load

The connected load on any system, or part of a system, is the combined continuous rating of all the receiving apparatus on consumers' premises, which is connected to the system, or part of the system, under consideration.

2. Demand

The demand of an installation or system is the load that is drawn from the source of supply at the receiving terminals averaged over a suitable and specified interval of time. Demand is expressed in kilowatts (kW), kilovolt-amperes (kVA), amperes (A), or other suitable units.

3. Maximum Demand or Peak Load

The maximum demand of an installation or system is the greatest of all the demands that have occurred during a given period. It is determined by measurement, according to specifications, over a prescribed interval of time.

4. Demand Factor

The demand factor of any system, or part of a system, is the ratio of maximum demand of the system, a part of the system, to the total connected load of the system, or of the part of the system, under consideration. Expressing the definition mathematically,
Maximum demand Demand factor = Connected load

5. Load Factor

The load factor is the ratio of the average power to the maximum demand. In each case, the interval of maximum load and the period over which the average is taken should be definitely specified, such as a "half-hour monthly" load factor. The proper interval and period are usually dependent upon local conditions and upon the purpose for which the load factor is to be used. Expressing the definition mathematically,
Average load Load factor = Maximum demand

6. Diversity Factor

The diversity factor of any system, or part of a system, is the ratio of the maximum power demands of the subdivisions of the system, or part of a system, to the maximum demand of the whole system, or part of the system, under consideration, measured at the point of supply. Expressing the definition mathematically,
Sum of individual maximum demands Diversity factor = Maximum demand of entire group

7. Utilisation Factor

The utilisation factor is defined as the ratio of the maximum generator demand to the generator capacity.

8. Plant Capacity Factor

It is defined as the ratio of actual energy produced in kilowatt hours (kWh) to the maximum possible energy that could have been produced during the same period. Expressing the definition mathematically,

... (7.4) Plant capacity factor = $\frac{E}{C \cdot t} \times 100$

9. Load Curve

A load curve (or load graph) is a graphic record showing the power demands for every instant during a certain time interval. Such a record may cover 1 hour, in which case it would be an hourly load graph; 24 hours, in which case it would be a daily load graph; a month in

which case it would be a *monthly load graph*; or a year (7860 hours), in which case it would be a *yearly load graph*. The following points are worth noting :

- (i) The area under the load curve represents the energy generated in the period considered.
- (ii) The area under the curve divided by the total number of hours gives the average load on the power station.
- (iii) The peak load indicated by the load curve/graph represents the maximum demand of the power station.

10. Significance of Load Curves

- Load curves give full information about the incoming and help to decide the installed capacity of the power station and to decide the economical sizes of various generating units.
- These curves also help to estimate the generating cost and to decide the operating schedule of the power station, i.e. the sequence in which different units should be run. where, E = Energy produced (kWh) in a given period,
C = Capacity of the plant in kW, and
t = Total number of hours in the given period.

11. Plant Use Factor

It is defined as the ratio of energy produced in a given time to the maximum possible energy that could have been produced during the actual number of hours the plant was in operation. Expressing the definition mathematically,
Plant use factor = $\frac{E}{C \times t}$ □ □

12. Straight-line Depreciation

Straight-line depreciation is the simplest and most-often-used technique, in which the company estimates the salvage value of the asset at the end of the period during which it will be used to generate revenues (useful life) and will expense a portion of original cost in equal increments over that period. The salvage value is an estimate of the value of the asset at the time it will be sold or disposed of; it may be zero or even negative. Salvage value is also known as scrap value or residual value.

Cost of Fixed Asset Residual Value Annual Depreciation Expense = Useful Life of Asset (Years) □

13. Sinking Fund Method

The sinking fund technique of calculating depreciation sets the depreciation expense as a particular amount of an annuity. The depreciation is calculated so that at the end of the useful life of the annuity, the amount of the annuity equals the acquisition cost. The sinking fund method calculates more depreciation closer to the end of the useful life of the asset, and isn't used very often.

14. Declining Balance/Reducing Balance

This way of calculating depreciation falls under the accelerated depreciation category. This means that it sets depreciation expenses as higher earlier on, more realistically reflecting the current resale value of an asset.

The way that declining-balance depreciation is calculated is by taking the net book value from the previous year, and multiplying it by a factor (usually 2) which has been divided by the useful life of the asset.

15. Activity Depreciation

This way of calculating depreciation bases the depreciation expense on the activity of an asset, like a machine. Multiplying the rate by the actual activity level of the asset will give depreciation expense for the year.

16. Load Factor

In a *hydro-electric power station* with water available and a fixed staff for maximum output, the cost per unit generated at 100% *load factor* would be *half* the cost per unit at 50% load

factor. In a *steam power station* the difference would not be so pronounced since fuel cost constitutes the major item in operating costs and does not vary in the same proportion as load factor. The cost at 100% load factor in case of this station may, therefore, be about 2/3rd of the cost 50% load factor. For a *diesel station* the cost per unit generated at 100% load factor may be about 3/4th of the same cost at 50% load factor. From the above discussion it follows that :

- (a) Hydro-electric power station should be run at its maximum load continuously on all units.
- (b) Steam power station should be run in such a way that all its running units are economically loaded.
- (c) Diesel power station should be worked for fluctuating loads or as a stand by.

17. Demand Factor and Utilisation Factor

A higher efficient station, if worked at low utilisation factor, may produce power at high unit cost.

The time of maximum demand occurring in a system is also important. In an interconnected system, a study of the curves of all stations is necessary to plan most economical operations. The endeavour should be to load the most efficient and cheapest power producing stations to the greatest extent possible. Such stations, called “base load stations” carry full load over 24 hours, i.e. for three shifts of 8 hours.

- The stations in the medium range of efficiency are operated only during the two shifts of 8 hours during 16 hours of average load.
- The older or less efficient stations are used as peak or standby stations only, and are operated rarely or for short periods of time.

Presently there is a tendency to use units of large capacities to reduce space costs and to handle larger loads. However, *the maximum economical benefit of large sets occurs only when these are run continuously at near full load. Running of large sets for long periods at lower than maximum continuous rating increase cost of unit generated.*