UNIT-5

1 Define Economics of Power Generation

Ans: The art of determining the per unit (i.e., one kWh) cost of production of electrical energy is known as **economics of power generation.**

2. What is the importance of power plant Economics of Power Generation:

Ans: The function of a power station is to deliver power at the lowest possible cost per kilo watt hour. This total cost is made up of fixed charges consisting of interest on the capital, taxes, insurance, depreciation and salary of managerial staff, the operating expenses such as cost of fuels, water, oil, labor, repairs and maintenance etc. The cost of power generation can be minimized by:

1. Choosing equipment that is available for operation during the largest possible % of time in a year.

2. Reducing the amount of investment in the plant.

3. Operation through fewer men.

4. Having uniform design

5. Selecting the station as to reduce cost of fuel, labor, etc.

All the electrical energy generated in a power station must be consumed immediately as it cannot be stored. So the electrical energy generated in a power station must be regulated according to the demand. The demand of electrical energy or load will also vary with the time and a power station must be capable of meeting the maximum load at any time. Certain definitions related to power station practice are given below:

3 What is the Capital cost

Ans: The **capital cost** includes the **cost** of the **plant**, land acquisition (unless a rent is paid, in which case this is a running **cost**), grid connection (although in some European states, the utility bears the **cost**), and initial financing **costs** (not repayment **costs**).

4 What are the various costs of Electrical Energy? Explain them

Ans: The total cost of electrical energy generated can be divided into three parts, namely;
(i) Fixed cost; **(ii)** Semi-fixed cost; **(iii)** Running or operating cost.

(i) Fixed cost. It is the cost which is independent of maximum demand and units generated. The fixed cost is due to the annual cost of central organisation, interest on capital cost of land and salaries of high officials. The annual expenditure on the central organisation and salaries of high officials is fixed since it has to be met whether the plant has high or low maximum demand or it generates less or more units. Further, the capital investment on the land is fixed and hence the amount of interest is also fixed.

(ii) Semi-fixed cost. It is the cost which depends upon maximum demand but is independent of units generated. The semi-fixed cost is directly proportional to the maximum demand on power station and is on account of annual interest and depreciation on capital investment of building and

equipment, taxes, salaries of management and clerical staff. The maximum demand on the power station determines its size and cost of installation. The greater the maximum demand on a power station, the greater is its size and cost of installation. Further, the taxes and clerical staff depend upon the size of the plant and hence upon maximum demand.

(iii) Running cost. It is the cost which depends only upon the number of units generated.

The running cost is on account of annual cost of fuel, lubricating oil, maintenance, repairs and salaries of operating staff. Since these charges depend upon the energy output, the running cost is directly proportional to the number of units generated by the station. In other words, if the power station generates more units, it will have higher running cost and vice-versa.

5 Define Load curve, Load duration curve, Maximum demand, Average load, Peak load, Base load, connected load, Demand factor, Diversity factor, load factor, Station load factor, Plant factor, Capacity factor?

Ans: Load curve:

Load curve is plot of load in kilowatts versus time usually for a day or a year.

Load duration curve:

Load duration curve is the plot of load in kilowatts versus time duration for which it occurs.

Maximum demand:

Maximum demand is the greatest of all demands which have occurred during a given period of time.

Average load:

Average load is the average load on the power station in a given period (day/month or year)

Base load:

Base load is the minimum load over a given period of time.

Connected load:

Connected load of a system is the sum of the continuous ratings of the load consuming apparatus connected to the system.

Peak load:

Peak load is the maximum load consumed or produced by a unit or group of units in a stated period of time. It may be the maximum instantaneous load or the maximum average load over a designated interval of time.

Demand factor:

Demand factor is the ratio of maximum demand to the connected load of a consumer.

Diversity factor:

Diversity factor is the ratio of sum of individual maximum demands to the combined maximum demand on power stations

Load factor:

Load factor is the ratio of average load during a specified period to the maximum load occurring during the period. *Load factor = Average Load / Maximum demand*

Station load factor:

Station load factor is the ratio of net power generated to the net maximum demand on a power station.

Plant factor:

Plant factor is the ratio of the average load on the plant for the period of time considered, to the aggregate rating of the generating equipment installed in the plant.

Capacity factor:

Capacity factor is the ratio of the average load on the machine for a period of time considered, to the rating of the machine.

6 Explain the concept of Effluents from power plants and Impact of Environment:

Ans: Effluents of thermal power plants contain trace elements and heavy metals, needs remediation before discharging to the environment. Heavy metals tend to bio accumulate in a biological organism such as fish and thus enter the human food chain. Present study has been carried out to assess the contamination of water sources in Yellur and surrounding villages closer to a thermal power plant in Udupi district, Karnataka State, India. Water samples from 6 Km buffer zone were collected and analyzed for physico chemical parameters and the core zone (within 2km) samples were analyzed for heavy and trace metals (Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn) contamination. This study indicates that the well, stream and pond water within the core zone is contaminated with heavy metals and the levels were higher than the maximum acceptable limits of the stipulated drinking water guidelines. Physico chemical analysis showed DO, Turbidity, TDS, Chlorides, Sodium, Potassium and Hardness of samples of core zone were exceeding the maximum permissible limits of WHO drinking water guidelines.

IMPACT ON ENVIRONMENT:

Due to continuous & long lasting emission of Sox & NOx, which are the principal pollutants coal based plants, surrounding structures, buildings, monuments of historic importance & metallic structures too are affected very badly due to corrosive (Acid rain) reactions.

Impact on water

The water requirement for a coal-based power plant is about 0.005-0.18 m3/kwh. At STPS, the water requirement has been marginally reduced from about 0.18 m3/kWh to 0.15 m3/kwh after the installation of a treatment facility for the ash pond decant. Still the water requirement of 0.15 m3/kwh = 150 Liters per Unit of electricity is very high compared to the domestic requirement of water of a big city. Ash pond decant contains harmful heavy metals like B, As, Hg which have a tendency to leach out over a period of time.

Due to this the ground water gets polluted and becomes unsuitable for domestic use. At Ramagundam STPS leakage of the ash pond decants was noticed into a small natural channel. This is harmful to the fisheries and other aquatic biota in the water body. Similar findings were noted for Chandrapur. The exposure of employees to high noise levels is very high in the coal based thermal power plant. Moreover, the increased transportation activities due to the operation of the power plant leads to an increase in noise levels in the adjacent localities. 108

Impact on land

The land requirement per mega watt of installed capacity for coal, gas and hydroelectric power plants is 0.1-4.7 ha, 0.26 ha. and 6.6 ha respectively. In case of coal based power plants the land requirement is generally near the area to the coal mines. While in the case of gas-based it is any suitable land where the pipeline can be taken economically. Land requirement of hydroelectric power plants is generally hilly terrain and valleys. 321 ha., 2616 ha. and 74 ha. of land were used to dispose fly ash from the coal based plants at Ramagundam, Chandrapur and Gandhinagar respectively. Thus large area of land is required for coal based thermal power plant. Due to this, natural soil properties changes. It becomes more alkaline due to the alkaline nature of fly ash.

Biological & thermal impact

The effect on biological environment can be divided into two parts, viz. the effect on flora and the effect on fauna. Effect on flora is due to two main reasons, land acquisition and due to flue gas emissions. Land acquisition leads to loss of habitat of many species. The waste-water being at higher temperature (by 4-5oC) when discharged can harm the local aquatic biota. The primary effects of thermal pollution are direct thermal shocks, changes in dissolved oxygen, and the redistribution of organisms in the local community. Because water can absorb thermal energy with only small changes in temperature, most aquatic organisms have developed enzyme systems that operate in only narrow ranges of temperature. These stenothermic organisms can be killed by sudden temperature changes that are beyond the tolerance limits of their metabolic systems. Periodic heat treatments used to keep the cooling system clear of fouling organisms that clog the intake pipes can cause fish mortality. Socio-economic impact

8 What are the Pollutants and pollution standards?

Ans: Thermal pollution is the degradation of water quality by any process that changes ambient water temperature. A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers. When water used as a coolant is returned to the natural environment at a higher temperature, the change in temperature decreases oxygen supply and affects ecosystem composition. Fish and other organisms adapted to particular temperature range can be killed by an abrupt change in water temperature (either a rapid increase or decrease) known as "thermal shock." Burning Coal in a power plant produces a number of pollutants. Some of these pollutants are specific to the type of fuel or is part of the combustion process or related to the design and configuration of the plant. This article highlights the major pollutants discharged from the power plant.

Carbon Dioxide (CO_2)

CO_2 was thought of as a product of combustion and not as a pollutant. Kyoto protocol, effects of Green House gases and global warming issues have changed the way we look at CO 2. CO_2 has turned to be the major greenhouse gas. A fossil fuel power plant is the major contributor of CO_2. One MJ of heat input produces 0.1 kg of CO_2. The only way to eliminate CO_2 is to capture it before leaving to atmosphere. After capturing it has to be stored permanently or sequestered.

Commercially viable capture and sequestration systems are yet to be in place. Till such time the only way is to Improve the power plant efficiency so that the reduced coal consumption reduces CO2 per kwhr. Switch over from Fossil based energy sources to renewable sources like wind, solar or hydro power. Reduce Deforestation and increase Afforestation to absorb the excess CO2 produced.

Sulphur Dioxide (SO2)

This is a product of Combustion and depends on the amount of Sulfur in Coal.This is also referred to as SOx. Sulphur in Coal ranges for 0.1 % to 3.5% depending on type and rank. During combustion Sulfur combines with Oxygen to form SO2. Power plants are the largest emitters of SO2. In the presence of other gases SO2 forms Sulphuric acid and can precipitate down as acid rain leading to destruction of eco systems. Use of low Sulfur coals is the best ways to reduce the SO2 emissions. Desulphurization plants downstream of the boilers also reduce emissions. Fluidized bed combustion of coal is another effective method to reduce SO2 emissions.

Ash

Ash is the residue after the combustion. A 500 MW coal fired power plant burning Coal with around 20 % Ash, collects ash to the tune of Two Million Tons in Five years. Cement plants may utilize a small portion of the ash. Disposing bulk of it on a long term basis can raise major environmental issues.

Ash contains toxic elements that can percolate into the drinking water system.

The wind, breach of dykes or ash spills can carry away the ash particles to surrounding areas causing harm to humans and vegetation.

Considering the life of a power plant is 20 years, great foresight , planning and commitment is required to dispose the ash in an eco friendly way.

Particulate Matter

Power plants have elaborate arrangements to collect the ash. A small quantity still goes out through the stack and is categorized as Particulate Matter emission. The very tall stacks in power plants disperse this ash over a very wide area reducing the concentration levels to human acceptable levels at ground levels.

The particles of size less than 2.5 microns called PM 2.5 is of great concern since these are responsible for respiratory illness in humans.

Nitrogen Oxides (NOx)

Nitrogen in fuel and in the air reacts with Oxygen at high temperatures to form various oxides of Nitrogen collectively called NOX. Fossil fuel power plants are the second largest emitter of NOX. This is a hazardous pollutant creating visual and respiratory problems. Also NOX combines with water to form acid rain, smog, and ground ozone. Design changes in combustion technology have helped in reducing the NOX emissions. Methods like Selective Catalytic Reactors are used in power plants to meet the emission regulations.

The **Pollutant Standards Index**, or **PSI**, is a type of air quality index, which is a number used to indicate the level of pollutants in air. **PSI**	**DESCRIPTOR**	**GENERAL HEALTH ISSUES**
0-50	Good	None
51-100	Moderate	Few or none for the general population
100-200	Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects. To stay indoors
201-300	Very Unhealthy	Health warnings of emergency conditions. The entire population is more likely to be affected.
300+	Hazardous	Health alert: everyone may experience more serious health effects