Unit 01:

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1.1 Classification of Power Plant:

Power Plant

A power plant is assembly of system or sub-system (machines or equipments) to generate electricity (and deliverers a flow of mechanical or electrical energy) e.g. Power with economy and Environment friendly to the society.

- Energy Efficient system (Increase the conversion efficiency)
- Thermal power plant (Steam PP, Diesel PP, Gas turbine PP, Nuclear PP, solar thermal PP etc): These convert heat into electrical energy.

Classification of Power Plant (PP):

Conventional:

- Steam PP
- Diesel PP
- Gas Turbine power plant
- Nuclear PP
- Solar thermal PP
- Hydro-electric PP

Non-Conventional:

- Photovoltaic solar cell PP
- Bio-gas & Bio-mass energy PP
- Geothermal Energy PP
- Wind energy PP
- Ocean thermal energy Conversion (OTEC)

1.2 Power and Energy

Energy: Ability to cause changes or the capacity for doing work, generating heat and emitting light.

Energy in Transition e.g. Heat and work (these only form of energy which can cross boundaries of a system)

Stored Energy e.g. Chemical energy, Potential energy or Gravitational energy etc.

- It is measured in joule(J) or kilo-joule(KJ)

Power: Rate of doing work which equals energy per unit time.

- It is measured in

joule/sec. or watts

1KW= 1000W

1 horse power(HP)= 746 W

Note: We need energy to run power plants to generate electricity & we need power to run our appliances and heat our homes.

1.3 Source of Energy: Refers Class notes

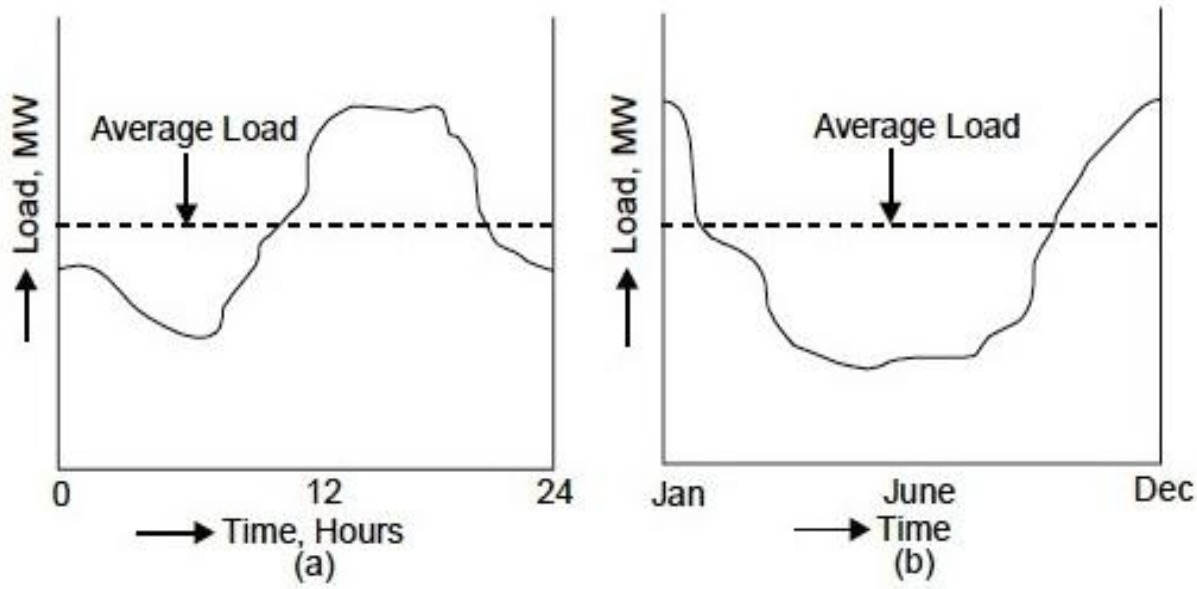
1.4 Review of thermodynamic cycles related to power plant: Refers class notes

Vapour power cycle : Carnot cycle, Rankine cycle, Regenerative cycle, Reheat cycle etc.

Gas Power cycle : otto, diesel, dual gas turbine cycle or brayton or joule cycle etc

1.5 Fuels and combustion calculations: Refers Class notes

1.6 Load Curves: (for more details refers class notes)



The load demand on a power system is governed by the consumers and for a system supplying industrial and domestic consumers, it varies within wide limits. This variation of load can be considered as daily, weekly, monthly or yearly. Typical load curves for a large power system are shown in Figure above; these curves are for a day and for a year and these show the load demanded by the consumers at any particular time.

- The load duration curve indicates for how many hours a certain load has been required in the course of the day (24hrs) or for one month (720hrs) or one year (8760hrs).
- Daily, monthly and yearly load duration curves aid better planning for economical utilization of power plants.
- The area under the annual load duration curve represents the total energy supplied (KWh) by the utility's generating system during the year or a day or a month. It is usually divided into three parts:

(a) Base load: The base load is the load below which the demand never falls and is supplied 100% of the time.

(b) Peak load: Peaking load occurs for about 15% of the time i.e for small fraction of time

(c) Intermediate Load: it represents the remaining load region in middle.

so a careful study of the load duration curve helps to decide the capacity of base load plant and also peak load plant.

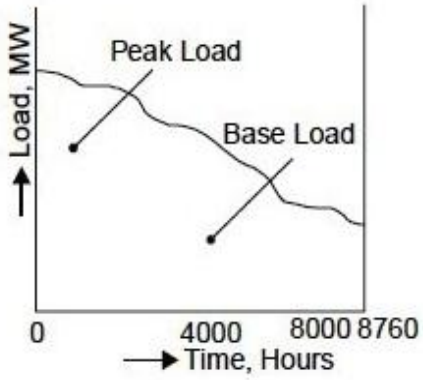


Fig: Load Duration Curve

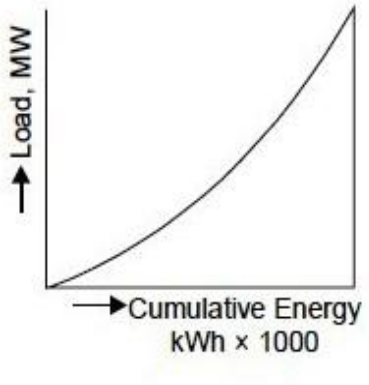


Fig: Energy Load Curve

The lower part of the curve consisting of the loads which are to be supplied for almost the whole number of hours in a year, represents the "Base Load", while the upper part, comprising loads which are required for relatively few hours per year, represents the "Peak Load".

1.6.1 Various terms and factors involved in power plant calculation: for detail refers class notes

- Load Factor
- Capacity factor
- Use Factor
- Reserve Factor
- Demand Factor
- Diversity Factor

Numerical problems: Refers Class notes

1.7 Power plant economics and selection

1.7.1 Effect of power plant type on cost

The cost of a power plant depends upon, when a new power plant is to set up or an existing plant is to be replaced or plant to be extended. The cost analysis includes

Fixed Cost: It includes Initial cost of the plant, Rate of interest, Depreciation cost, Taxes, and Insurance.

Operational Cost: It includes Fuel cost, Operating labour cost, Maintenance cost, Supplies, Supervision, Operating taxes.

Initial cost of a power station includes the following:

1. Land cost
2. Building cost
3. Equipment cost
4. Installation cost
5. Overhead charges, which will include the transportation cost, stores and storekeeping charges, interest during construction etc.

Rate of Interest:

All enterprises need investment of money and this money may be obtained as loan, through bonds and shares or from owners of personal funds. Interest is the difference between money borrowed and money returned. It may be charged at a simple rate expressed as % per annum or may be compounded, in which case the interest is reinvested and adds to the principal, thereby earning more interest in subsequent years.

Depreciation cost:

Depreciation accounts for the deterioration of the equipment and decrease in its value due to corrosion, weathering and wear and tear with use. It also covers the decrease in value of equipment due to obsolescence.

The elements that make up the operating expenditure of a power plant include the following

(1) Cost of fuels.
(2) Labour cost.
(3) Cost of maintenance and repairs
(4) Cost of stores (other than fuel).
(5) Supervision.
(6) Taxes

1.7.2 Effect of power plant type on rates

Rates are the different methods of charging the consumers for the consumption of electricity. It is desirable to charge the consumer according to his maximum demand (kW) and the energy consumed (kWh). The tariff chosen should recover the fixed cost, operating cost and profit etc.

Tariff should satisfy the following requirements:

(1) It should be easier to understand.
(2) It should provide low rates for high consumption.
(3) It should encourage the consumers having high load factors.
(4) It should take into account maximum demand charges and energy charges.
(5) It should provide less charge for power connections than for lighting.
(6) It should avoid the complication of separate wiring and metering connections.

1.7.3 Effect of power plant type on Fixed Element

Various types of fixed element are:

(i) Land

(ii) Building

(iii) Equipment

(iv) Installation of Machine

(v) Design and planning

The fixed element means which are not movable, and for any types of power plant, the fixed elements play a major role. Since each cost is added to the final cost of our product. So when a power plant is established, the first selection is fixed element. Effect of plant on land is as cost of land.

1.7.4 Effect of power plant type on Customer Element

The costs included in these charges depend upon the number of customers. The various costs to be considered are as follows:
(1) Capital cost of secondary distribution system and depreciation cost, taxes and interest on this capital cost.
(2) Cost of inspection and maintenance of distribution lines and the transformers.
(3) Cost of labour required for meter reading and office work.
(4) Cost of publicity.

1.7.5 Effect of power plant type on Investor's profit

- If the power plant is the public property, as is the case in India, then the customers will be the taxpayers to share the burden of the government. For this purpose, there is an item in the rates to cover taxes in place of the investor's profit. The consumers in the form of electric consumption bills will pay these taxes.

- The investor expects a satisfactory return on the capital investment. The rate of profit varies according to the business conditions prevailing in different localities.

1.7.6 Economics of Power Plant Selection

Economy is the main principle of design of a power plant. Power plant economics is important in controlling the total power costs to the consumer. Power should be supplied to the consumer at the lowest possible cost per kWh. The total cost of power generation is made up of fixed cost and operating cost.

The cost of power generation can be reduced by,

(i) Selecting equipment of longer life and proper capacities.
(ii) Running the power station at high load factor.
(iii) Increasing the efficiency of the power plant.
(iv) Carrying out proper maintenance of power plant equipment to avoid plant breakdowns.
(v) Keeping proper supervision as a good supervision is reflected in lesser breakdowns and extended plant life.
(vi) Using a plant of simple design that does not need highly skilled personnel.

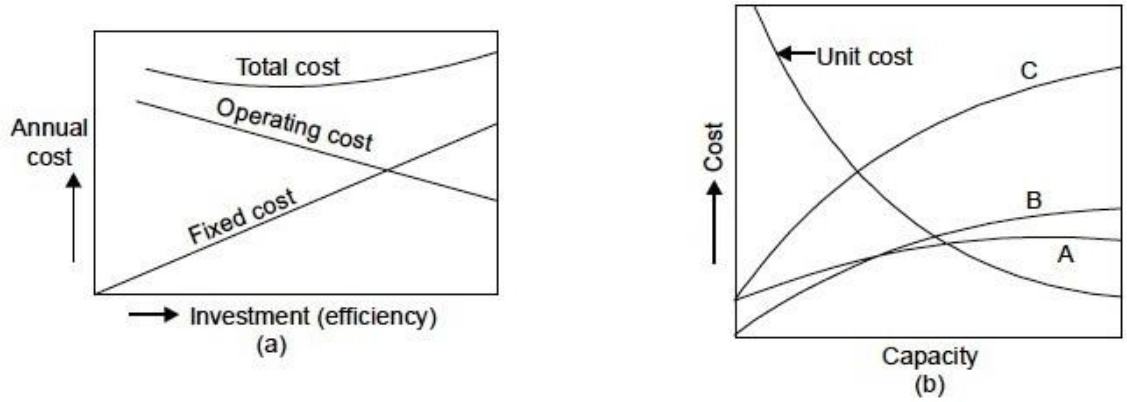


Fig (a) shows the variation of fixed cost and operation cost with investment Fig (b) shows the variation of various costs of power plant versus its capacity

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