

Chapter 01

Conventional Generation, Load Curves and Tariffs:

Lecture : 08

TOPIC:

1. Nuclear power station
2. Schematic arrangement of nuclear power station
3. Nuclear reactor

Chapter: 01

Conventional Generation, Load Curves and Tariffs:

- Generation scenario in India and Gujarat
- Steam power station, Schematic arrangement of steam power station, Equipment's of steam power station,
- Hydroelectric power station, Schematic arrangement of hydro-electric power station, Constituents of hydro-electric plants,
- Nuclear power station, Schematic arrangement of nuclear power station, Nuclear reactor,
- Gas turbine power plant, Schematic arrangement of gas turbine power plant,
- Comparison Of Various Power Plants.
- Load curves, Important terms and factors, Load duration curve, Examples. Tariff, Desirable characteristics of tariff, Types of tariff, Examples.

Nuclear power station

*A generating station in which nuclear energy is converted into electrical energy is known as a **nuclear power station**.*

In nuclear power station, heavy elements such as Uranium (U^{235}) or Thorium (Th^{232}) are subjected to nuclear fission* in a special apparatus known as a *reactor*. The heat energy thus released is utilised in raising steam at high temperature and pressure. The steam runs the steam turbine which converts steam energy into mechanical energy. The turbine drives the alternator which converts mechanical energy into electrical energy.

Nuclear power station

The most important feature of a nuclear power station is that huge amount of electrical energy can be produced from a relatively small amount of nuclear fuel as compared to other conventional types of power stations. It has been found that complete fission of 1 kg of Uranium (U^{235}) can produce as much energy as can be produced by the burning of 4,500 tons of high grade coal. Although the recovery of principal nuclear fuels (*i.e.*, Uranium and Thorium) is difficult and expensive, yet the total energy content of the estimated world reserves of these fuels are considerably higher than those of conventional fuels, *viz.*, coal, oil and gas. At present, energy crisis is gripping us and, therefore, nuclear energy can be successfully employed for producing low cost electrical energy on a large scale to meet the growing commercial and industrial demands.

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Advantages

- (i) The amount of fuel required is quite small. Therefore, there is a considerable saving in the cost of fuel transportation.
- (ii) A nuclear power plant requires less space as compared to any other type of the same size.
- (iii) It has low running charges as a small amount of fuel is used for producing bulk electrical energy.
- (iv) This type of plant is very economical for producing bulk electric power.
- (v) It can be located near the load centres because it does not require large quantities of water and need not be near coal mines. Therefore, the cost of primary distribution is reduced.
- (vi) There are large deposits of nuclear fuels available all over the world. Therefore, such plants can ensure continued supply of electrical energy for thousands of years.
- (vii) It ensures reliability of operation.

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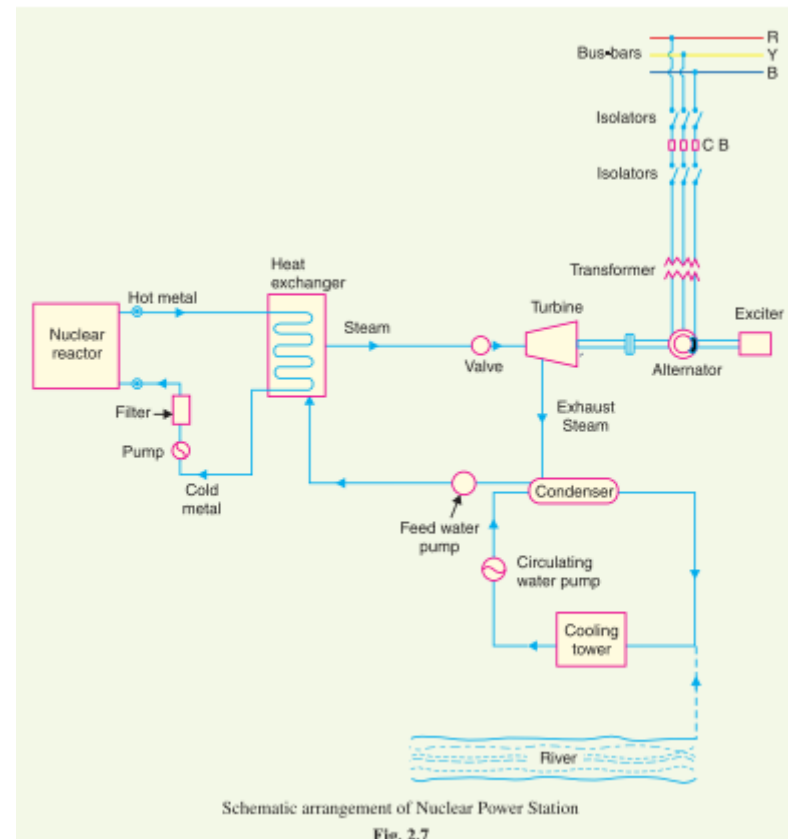
Disadvantages

- (i) The fuel used is expensive and is difficult to recover.
- (ii) The capital cost on a nuclear plant is very high as compared to other types of plants.
- (iii) The erection and commissioning of the plant requires greater technical know-how.
- (iv) The fission by-products are generally radioactive and may cause a dangerous amount of radioactive pollution.
- (v) Maintenance charges are high due to lack of standardisation. Moreover, high salaries of specially trained personnel employed to handle the plant further raise the cost.
- (vi) Nuclear power plants are not well suited for varying loads as the reactor does not respond to the load fluctuations efficiently.
- (vii) The disposal of the by-products, which are radioactive, is a big problem. They have either to be disposed off in a deep trench or in a sea away from sea-shore.

Schematic arrangement of nuclear power station

The schematic arrangement of a nuclear power station is shown in Fig. 2.7. The whole arrangement can be divided into the following main stages :

- (i) Nuclear reactor
- (ii) Heat exchanger
- (iii) Steam turbine
- (iv) Alternator.



Nuclear Reactor

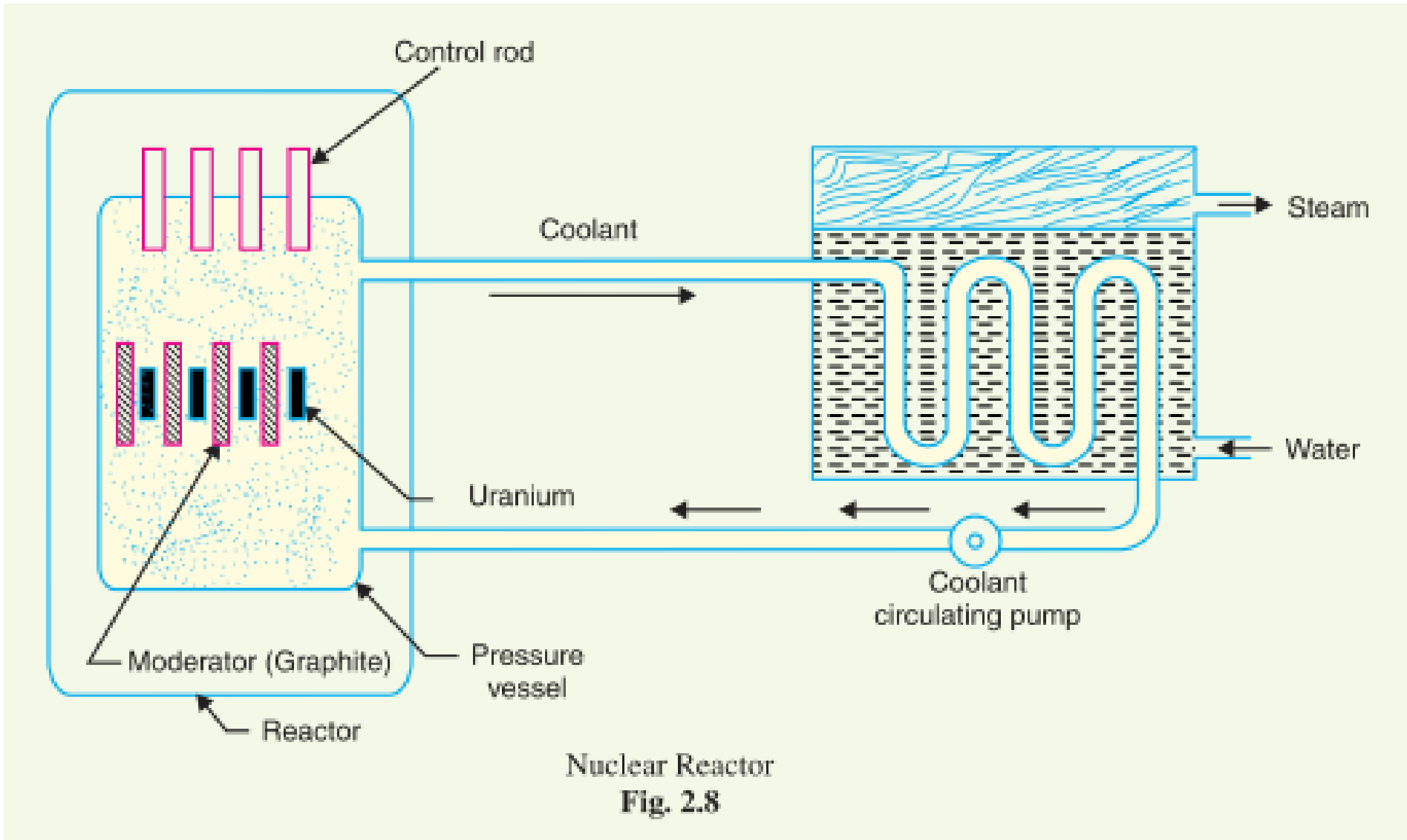
(i) **Nuclear reactor.** It is an apparatus in which nuclear fuel (U^{235}) is subjected to nuclear fission. It controls the *chain reaction** that starts once the fission is done. If the chain reaction is not controlled, the result will be an explosion due to the fast increase in the energy released.

A nuclear reactor is a cylindrical stout pressure vessel and houses fuel rods of Uranium, moderator and control rods (See Fig. 2.8). The fuel rods constitute the fission material and release huge amount of energy when bombarded with slow moving neutrons. The moderator consists of graphite rods which enclose the fuel rods. The moderator slows down the neutrons before they bombard the fuel rods. The control rods are of cadmium and are inserted into the reactor. Cadmium is strong neutron absorber and thus regulates the supply of neutrons for fission. When the control rods are pushed in deep enough, they absorb most

Nuclear Reactor

of fission neutrons and hence few are available for chain reaction which, therefore, stops. However, as they are being withdrawn, more and more of these fission neutrons cause fission and hence the *intensity* of chain reaction (or heat produced) is increased. Therefore, by pulling out the control rods, power of the nuclear reactor is increased, whereas by pushing them in, it is reduced. In actual practice, the lowering or raising of control rods is accomplished automatically according to the requirement of load. The heat produced in the reactor is removed by the coolant, generally a sodium metal. The coolant carries the heat to the heat exchanger.

Nuclear Reactor



- (ii) Heat exchanger.** The coolant gives up heat to the heat exchanger which is utilised in raising the steam. After giving up heat, the coolant is again fed to the reactor.
- (iii) Steam turbine.** The steam produced in the heat exchanger is led to the steam turbine through a valve. After doing a useful work in the turbine, the steam is exhausted to condenser. The condenser condenses the steam which is fed to the heat exchanger through feed water pump.
- (iv) Alternator.** The steam turbine drives the alternator which converts mechanical energy into electrical energy. The output from the alternator is delivered to the bus-bars through transformer, circuit breakers and isolators.

Precape

- Gas turbine power plant, Schematic arrangement of gas turbine power plant,
- Comparison Of Various Power Plants.

Thank You