

MODULE -V
ENERGY SOURCES & STORAGE DEVICES

5.2 Nuclear Reactor (Or) Nuclear Pile

5.2.1 Breeder Reactor



5.2 Nuclear Reactor (Or) Nuclear Pile

Definition

Nuclear reactors are the heart of a nuclear power plant. They contain and control nuclear chain reactions that produce heat through a physical process called fission. That heat is used to make steam that spins a turbine to create electricity.

An equipment in which nuclear fission reaction takes place in a controlled manner is known as a nuclear reactor.

Light water Nuclear Power Plant (or) Light water nuclear Reactor

- It is a nuclear reactor in which the fuel rods are immersed in water.
- The water acts Coolant & Moderator
- It is used to produce electricity.

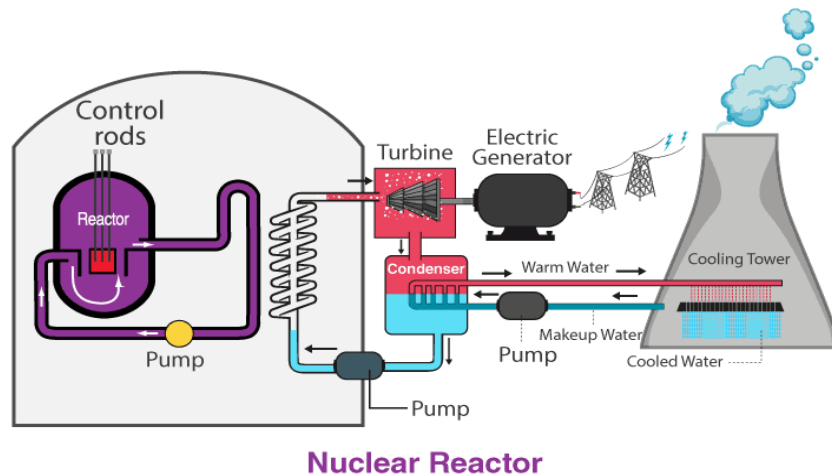


Fig:1-Nuclear reactor

Source: online sources

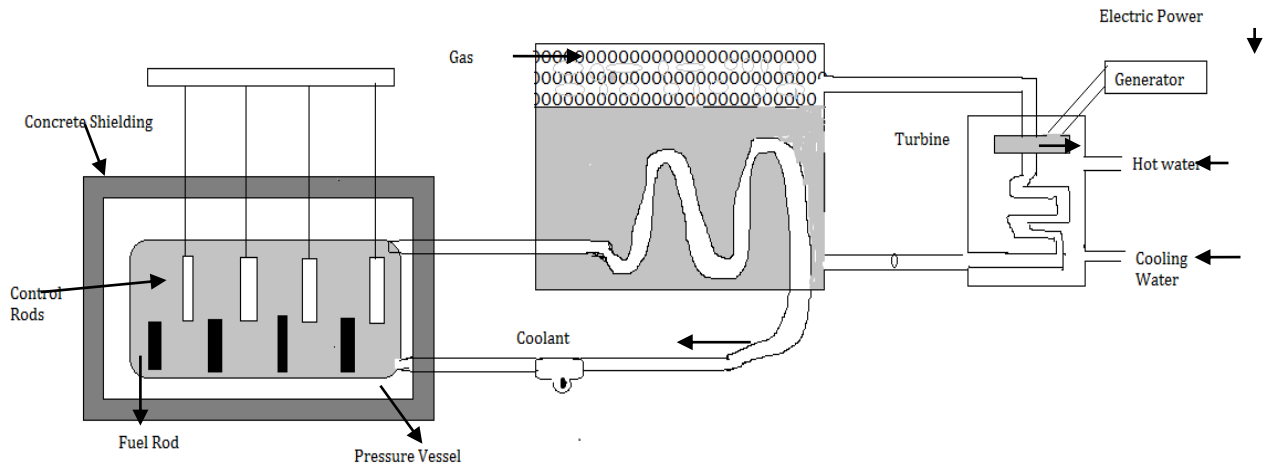


Fig:2-Nuclear reactor

Source: physical chemistry by Arun paul

Components of a Nuclear reactor

1. Fuel rods
2. Control rods
3. Moderator
4. Coolants
5. Pressure Vessel
6. Concrete Shield
7. Heat Exchanger
8. Turbine

Description

1) Fuel Rods

U^{235} rods are used as fuel, which maintains the fission chain reaction.

2) Controls Rods.

- Controls rods are used to control the fission reaction.
- Cadmium (or) Boron rods are used as control rods.
- Control rods absorb the neutrons and regulate the fission reaction.

3) Moderators

- Moderators are used to slow down the neutrons.
- In light water nuclear reactor ordinary water is used as moderator.
- Heavy water , Graphite , Berythium can also be used as moderator.

4) Coolant

- Coolant absorbs the heat energy from the reaction core.
- It enters through the base of the reactor and comes out through the top.
- Ordinary water is used as coolant in Light water nuclear reactor.
- Heavy water, liquid Na or K can also be used as coolants.

5) Pressure Vessel

- The reaction core is surrounded by the pressure vessel.
- It provides passage for coolant through the bottom and top.
- It can withstand a pressure of 200kg/cm².

6) Concrete Shield

- It protects the operating personnel and environment from the harmful radioactive radiations.

7) Heat Exchanger

- Heat exchanger contains water.
- The coolant transfers the heat to the water and produces steam.

8) Turbine

- The steam produced is sent to a turbine which drives a generator and produces electricity.

Working

- The fission reaction is started in the reaction core and controlled by using control rods.
- The heat released by the fission of U²³⁵ is absorbed by coolant (ordinary water)

- The heat from coolant is transferred to the heat exchanger containing water.
- Water is converted steam.
- Steam drives the turbine to generate electricity.

5.2.1 Breeder Reactor

- Reactor which converts fertile material into fissile material is known as Breeder reactor.

Fertile material (non fissionable) – (eg) U^{238} , Th^{232}

Fissile Material (fissionable) - (eg) U^{235} , Pu^{239}

- It produces more fissionable material than consumed.
- In a breeder reactor
 - ❖ The U^{238} $\xrightarrow{\text{converted to}}$ Pu^{239} +neutron + fission products 3 neutrons
(non –fissionable) by slow neutrons (fissionable)
 - ❖ Th^{232} $\xrightarrow{\text{converted to}}$ U^{235} +neutron + fission products 3 neutrons
(non –fissionable) by slow neutrons (fissionable)
- Here U^{238} , Th^{232} are Known as primary fuels
- Pu^{239} , U^{235} are known as secondary fuels.
- So in a breeder reactor, the secondary fuel product is greater than the primary fuel consumed.

Conversion factor = $\frac{\text{No.of 2}^{\circ} \text{ fuel atoms produced}}{\text{No.of 1}^{\circ} \text{ fuel atoms consumed}}$

- For a breeder reactor , the conversion factor is greater than one.