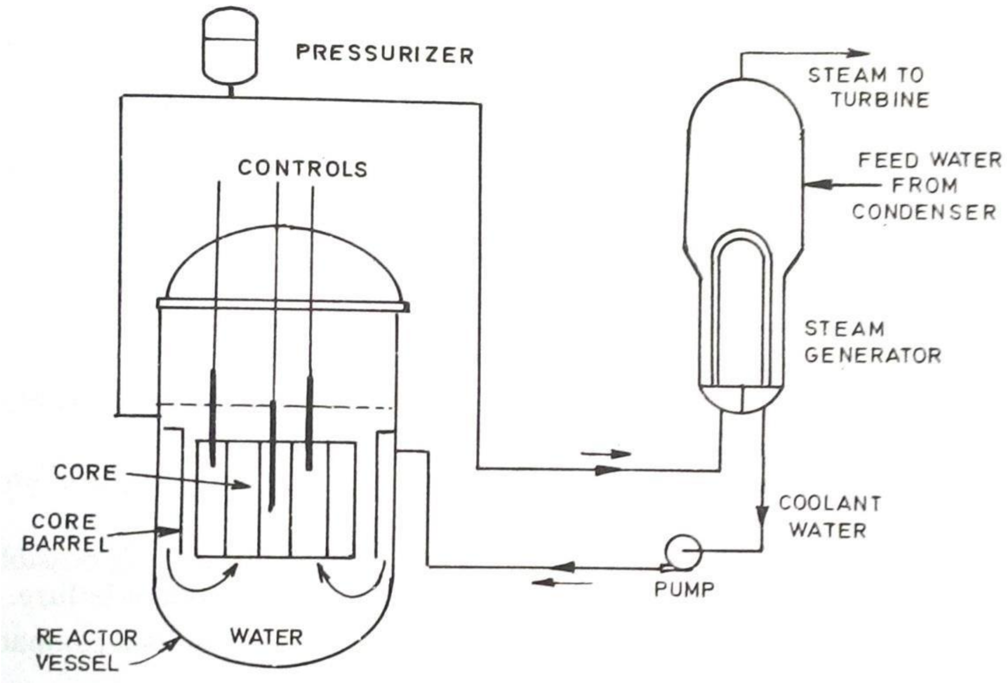
PRESSURIZED WATER REACTOR (PWR)



Pressurized-water reactor (PWR)

The PWR is a thermal reactor, generally using enriched fuel (uranium oxide) and depending on the type of moderator used clad with stainless steel or zirconium alloy and the pressure vessel is of steel. Light or heavy water may be used as the combined coolant cum moderator.

The pressure vessel and the heat exchanger are surrounded by a concrete shield. Heat exchanger is used to develop steam, the primary loop being formed by the coolant moderator.

The water under pressure is used as both the moderator and coolant. To prevent boiling of coolant in the core, it is maintained under pressure of 153 atm. (15.5MPa) (at this pressure water boils at 345˚ C).

As shown in Fig 3.5, a pump circulates water at high pressure round the core so that the water in the liquid state absorbs heat from the uranium and transfers it to the secondary loop, heat exchanger or boiler. After giving up some of its heat to boil water and produced steam in the steam generator, the high pressure water is pumped back into the reactor vessel.

It enters just above the core and flows down through the annular region called the down comer, between the core barrel and the pressure vessel wall. At the bottom of the core, the water reverses direction and flows upward through the core to remove the heat generated by fission.

The coolant steam pressure is maintained within a limited range by means of a pressurized connected between the reactor vessel and a steam generator. The pressurizer is a large cylindrical steel tank containing some 60% by volume of liquid water and 40% steam during steam operation.

A large PWR may have from two to four independent steam generators loops in parallel. Most steam generators consists of a large number of inverted U-shaped tubes enclosed in a casing called the shell. The high pressure, high temperature water from the reactor flows through the inside of the tubes, and heat is transferred to water at a lower pressure [75 atm (7.6MPa)] on the outside (shell side) of the tubes.

The water in the shell boils at the lower pressure and produced moist steam. Entrained moisture is separated in the upper part of the steam generator and steam at a temperature of about 290˚C proceeds to the turbine system. After passage through the steam generator tubes, the high pressure water is pumped back to the reactor vessel.

Coarse control of a PWR is achieved by the neutron poison (i.e. absorber) boron as boric acid, dissolved in the reactor water. The boron compensates for the extra fuel present initially, and this is used up during reactor operations, the basic acid concentration is decreased.

The controlled rods, referred to earlier, which can be moved in or out of the core, are used to start up the reactor and shut it down and for automatic fine adjustments during normal operation. Another used of the control rods is to make the heat (or power) distribution ad uniform as possible throughout the core. Completed insertion of the rods will always cause the reactor to shutdown.

Advantages

1. Steam supplied to the turbine is completely free from contamination
2. The reactor is compact in size as compared with some other type (such as gas cooled reactor GCR).
3. Light water is the cheapest coolant and moderator.
4. Cooling system is simple
5. Fission products remain contained in the reactor and are not circulated
6. High power density
7. Possibility of breeding plutonium by providing a blanket of U^{238}.

Limitations

1. High pressure requires a costly reactor vessel and leak proof primary coolant circuit.
2. High pressure and high temperature water at rapid flow rates increase corrosion an erosion problems.
3. Steam is produced at relatively low temperature and pressure and consequently needs super heating.