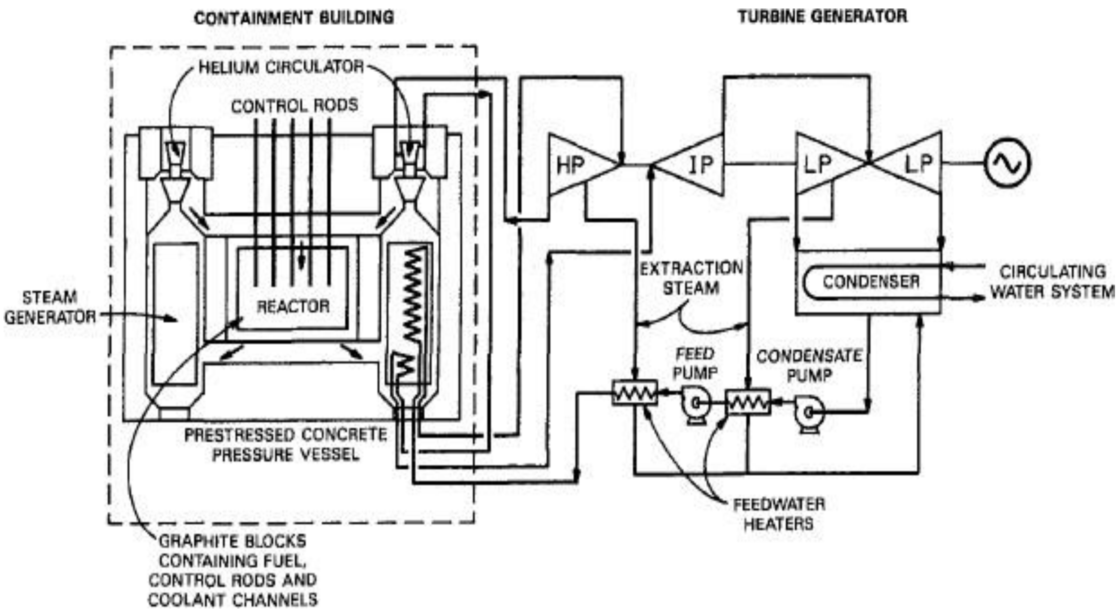
GAS COOLED REACTORS



Gas cooled reactor

The largest program involving commercial gas-cooled reactors (GCRs) was developed in England. The first series of GCRs used graphite as a moderator and carbon dioxide as the coolant. The reactor consisted of a large number of graphite blocks housed in a steel pressure vessel. Numerous channels ware drilled through the graphite blocks.

The channels either contained fuel elements or were used for control rod insertion. The fuel elements consisted of natural uranium metal clad with Magnox, an alloy of magnesium. Carbon dioxide passed through the fuel channels, removing the fission heat. The gas was then circulated to heat exchangers that produced steam, and then returned to the reactor.

The steam from the steam generators was expanded through a turbine generator, condensed, and returned to the steam generators. The Magnox series operated successfully but had low thermal efficiency and low fuel lifetime because of the low operating temperature (780˚F, 420˚C) and radiation damage limits due to the metallic uranium fuel. Later designs integrated the heat exchangers around the core inside the pressure vessel which consisted of a pre stressed concrete structure.

The advanced gas-cooled reactor (AGR) was developed to overcome the limitations of the Magnox except that the reactor fuel consisted of enriched uranium dioxide fuel pins clash with stainless steel and housed in fuel elements. Each fuel channel contained several fuel elements. Because of the high operating gas coolant temperature of 1,210˚F (654˚C) at the reactor outlet, superheat and reheat steam were produced.

High-temperature Gas-Cooled Reactors

The high-temperature gas-cooled reactor (HTGR) is an American design that produces a higher gas temperature, and thus, a higher steam temperature and higher thermal efficiencies than those of the LWR and HWR. Thermal efficiencies are similar to those for modern pulverized coal plants.

The HTGR, shown schematically in Fig 3.8, uses helium gas as the coolant and graphite as the neutron energy moderator. This reactor consists of hexagonal graphite blocks in which cylindrical fuel rods containing small spherical fuel particles of enriched uranium and thorium are housed within fuel holes interspersed with coolant holes for helium flow.

The graphite blocks are stacked vertically to form the reactor core. Helium flows through the graphite blocks, removing the fission hear, and then passes to one or more steam generators that produced superheated and reheated steam.

Superheated steam at 2400 psig(15.4Mpag), 950˚F(510˚C) is sent to a high-pressure turbine where the steam exhaust is then reheated in the steam generators at 550 psia (3.8MPa), 950˚F (510˚C) and sent back to the intermediate pressure turbine. The balance-of-plant systems (e.g., steam turbine generator, condensers, and feed water heaters) are very similar to those of a modern pulverized coal plant.

The graphite core, steam generators, and helium circulators are located in a pre stressed concrete pressure vessel. Control is provided by control rods of boron carbide, which enter from the top of the reactor core through channels in the graphite blocks.