Fusion Chain Reaction

In a more generalized sense, a nuclear fusion reaction can be considered a nuclear chain reaction: it occurs under extreme pressure and temperature conditions, which are maintained by the energy released in the fusion process.

Critical Mass Although two to three neutrons are produced for every fission, not all of these neutrons are available for continuing the fission reaction. If the conditions are such that the neutrons are lost at a faster rate than they are formed by fission, the chain reaction will not be self-sustaining. At the point where the chain reaction can become self-sustaining, this is referred to as critical mass.

In an atomic bomb, a mass of fissile material greater than the critical mass must be assembled instantaneously and held together for about a millionth of a second to permit the chain reaction to propagate before the bomb explodes

The amount of a fissionable material's critical mass depends on several factors; the shape of the material, its composition and density, and the level of purity. A sphere has the minimum possible surface area for a given mass, and hence minimizes the leakage of neutrons. By surrounding the fissionable material with a suitable neutron “reflector”, the loss of neutrons can be reduced and the critical mass can be reduced.

TYPES OF NUCLEAR MATERIALS

(a) Special Nuclear Material consists of uranium-233 or uranium-235, enriched uranium, or plutonium.

(b) Source Material is natural uranium or thorium or depleted uranium that is not suitable for use as reactor fuel. (c) Byproduct Material, in general, is nuclear material (other than special nuclear material) that is produced or made radioactive in a nuclear reactor. Byproduct material also includes the tailings and waste produced by extracting or concentrating uranium or thorium from an ore processed primarily for its source material content. Nuclear fission fuels are classified as fertile or fissile by the behaviour or their nuclei in fission reactions

Fissile Material

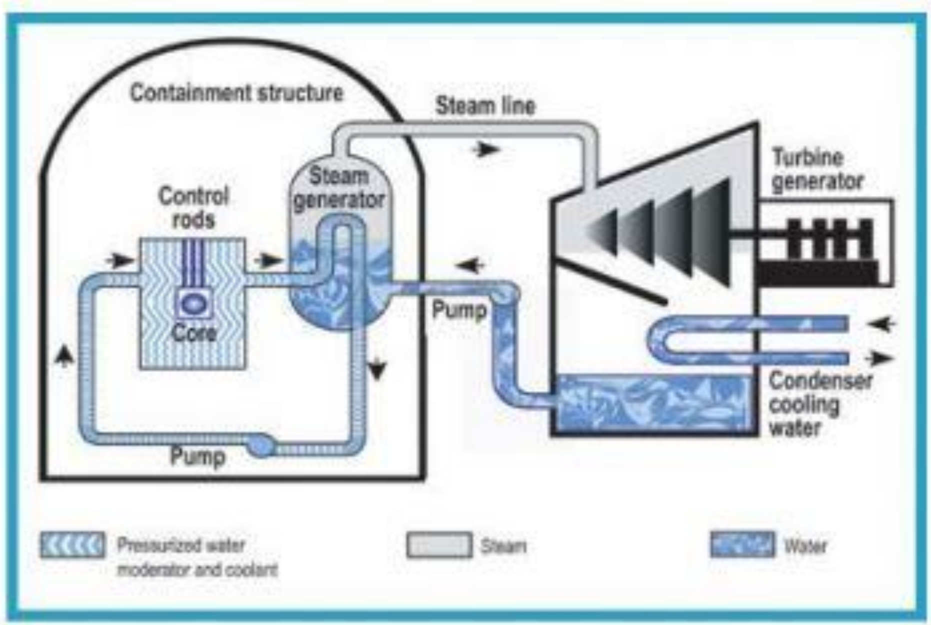
Fissile materials are composed of atoms that can be split by neutrons in a self-sustaining chain-reaction to release enormous amounts of energy. In nuclear reactors, the fission process is controlled and the energy is harnessed to produce electricity. In nuclear weapons, the fission energy is released all at once to produce a violent explosion. The most important fissile materials for nuclear energy and nuclear weapons are an isotope of plutonium, plutonium-239, and an isotope of uranium, uranium-235. Uranium-235 occurs in nature.

Fertile Material

A material, which is not itself fissile (fissionable by thermal neutrons), that can be converted into a fissile material by irradiation in a reactor. There are two basic fertile materials: uranium-238 and thorium-232. When these fertile materials capture neutrons, they are converted into fissile plutonium-239 and uranium-233, respectively.

NUCLEAR POWER REACTORS

A nuclear reactor produces and controls the release of energy from splitting the atoms of elements such as uranium and plutonium. In a nuclear power reactor, the energy released from continuous fission of the atoms in the fuel as heat is used to make steam. The steam is used to drive the turbines which produce electricity (as in most fossil fuel plants). There are several components common to most types of reactors:



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Fuel

Usually pellets of uranium oxide (UO_2) arranged in tubes to form fuel rods. The rods are arranged into fuel assemblies in the reactor core.

Moderator

This is material which slows down the neutrons released from fission so that they cause more fission. It is usually water, but may be heavy water or graphite.

Control Rods

These are made with neutron-absorbing material such as cadmium, hafnium or boron, and are inserted or withdrawn from the core to control the rate of reaction, or to halt it. (Secondary shutdown systems involve adding other neutron absorbers, usually in the primary cooling system.)

Coolant

A liquid or gas circulating through the core so as to transfer the heat from it. In light water reactors the moderator functions also as coolant.

Pressure Vessel or Pressure Tubes

Usually a robust steel vessel containing the reactor core and moderator/coolant, but it may be a series of tubes holding the fuel and conveying the coolant through the moderator.

Steam Generator

Part of the cooling system where the heat from the reactor is used to make steam for the turbine

Classification on the basis of different criteria :

On the Basis of Neutron Energy

(a) Fast Reactor: In these reactors, fission is effected by fast neutrons without any use of moderators.

(b) Thermal Reactors: In these reactors, fission is effected by fast neutrons are slowed down with the use of moderators. The slow neutrons are absorbed by the fissionable fuel and chain reaction is maintained.

On the Basis of Fuel Used

(a) Natural Fuel: In this reactor, natural Uranium is used as fuel and generally heavy water or graphite is used as moderator.

(b) Enriched Uranium: In this reactor, the Uranium used contains 5 to 10% U235 and ordinary water can be used as moderator.

On the Basis of Moderator Used

(a) Water moderated

(b) Heavy water moderated

(c) Graphite moderated

(d) Beryllium moderated.