

In the fusion power system, since energy has to be invested to maintain the reaction, there is no possibility of a runaway reaction as any change from the normal operation would tend to halt the process.

A very long term possibility is the use of advanced fuel cycles where the energy is created entirely in the form of charged particles with no resultant radioactivity, and with the potential of direct conversion to electricity with efficiencies of the order of 90 percent.

Several methods have been proposed for confining the reaction. The two most promising at present are magnetic confinement and inertial confinement. At the extreme temperatures required for fusion, the reactants exist in a charged particle state ("plasma"). Rather than neutral atoms, so that, in principle, confinement can be achieved by using shaped magnetic fields. Various types of magnetic confinement machines are currently being developed, but the largest research effort is being carried out on toroidal machines. Inertial confinement uses lasers, electron beams, or ion beams to deliver large amounts of energy in very short pulses, to fuel pellets. The required energy must be delivered in a sufficiently short time that the fusion reaction can occur before the pellet expands as a result of the large increase in temperature.

Deuterium is a stable material found in about one part in 7000 in ordinary hydrogen. Its oxide, D₂O, called heavy water, is being produced in tonnage quantities in Canada. Tritium is not found in nature. A fusion plant would manufacture its own supply of tritium by allowing the fusion neutrons to be captured in lithium. An atom of lithium is needed for each atom of tritium so that effectively the D-T fusion reaction needs a supply of lithium. This appears to be sufficiently plentiful to provide for possible world fuel requirements for several hundred years.

In the first fusion power plant the only fuels would be deuterium and lithium. Such plants would produce no fission products, the only radioactive material involved is tritium. While the structural materials in the plant would become radioactive, no particular problem is presented during normal operation. These power plants operate by absorbing the energy radiated by the reacting plasma in a "blanket" wrapped around the reaction region. The hot blanket is used to heat a working fluid which could drive a gas turbine which, in turn, drives an electrical generator.