55 Fission – The Reactor

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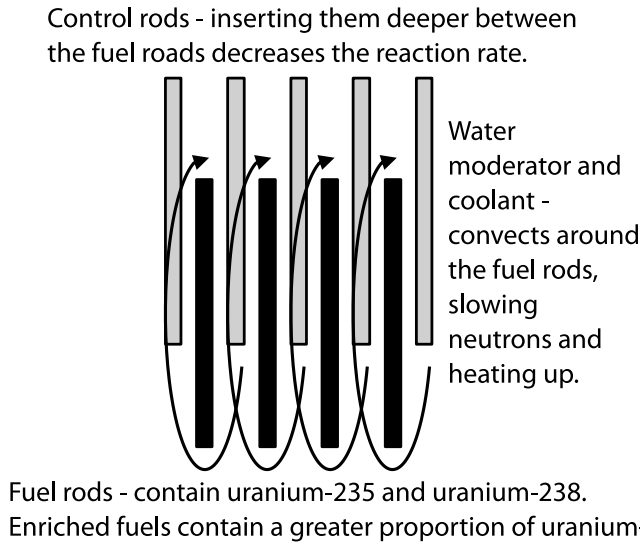
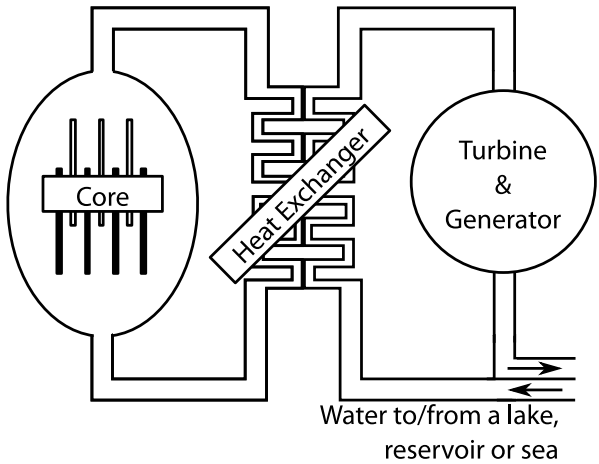
Nuclear fission reactors convert nuclear energy to thermal energy. The nuclear energy is locked away in the nuclei of atoms with large atomic masses. The most common nuclear fuel is uranium−235. When the nucleus of a uranium−235 atom fissions, it becomes two smaller nuclei plus two or three free neutrons.



The neutrons that are released from a fission reaction are too fast to be absorbed by other uranium−235 nuclei. A moderator, such as water or graphite, is used. This slows the neutrons (reducing their kinetic energy). The moderator is warmed and a coolant carries the thermal energy away. If water is used as a moderator, the water itself can be the coolant.

If one spare neutron from each fission reaction is slowed down enough and absorbed by another uranium−235 nucleus, the reaction is a self-sustaining chain reaction. If too many neutrons are absorbed, the reaction rate can exponentially grow - this is what happens when a nuclear fission bomb is detonated. To prevent the reaction rate increasing, control rods made from boron or cadmium are included in the reactor to absorb spare free neutrons.

The nuclear fuel rods, moderator, coolant and control rods are all in the nuclear reactor core, which is contained in a concrete domed building. Heat exchangers carry the energy out of the core.



55.1 What is the function of
(a) the nuclear fuel?
(b) the control rods?
(c) the moderator?
(d) the coolant?
(e) the concrete containment structure?
(f) the heat exchanger?

55.2 Explain why is it necessary to slow down the free neutrons that are emitted from a fission reaction.

55.3 Describe what steps must be taken to ensure the chain reaction is self-sustaining.

55.4 Explain why the temperature within the reactor core must be closely monitored.

55.5 What safety mechanisms are in place in case the reaction rate starts to increase exponentially?

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