

NEUTRON MODERATION

In thermal reactors, the neutrons that cause fission are at a much lower energy than the energy level at which they were born from fission. In this type of reactor, specific materials must be included in the reactor design to reduce the energy level of the neutrons in an efficient manner.

Neutron Slowing Down and Thermalization

Fission neutrons are produced at an average energy level of 2 MeV and immediately begin to slow down as the result of numerous scattering reactions with a variety of target nuclei. After a number of collisions with nuclei, the speed of a neutron is reduced to such an extent that it has approximately the same average **kinetic energy** as the atoms (or molecules) of the medium in which the neutron is undergoing elastic scattering. This energy, which is only a small fraction of an electron volt at ordinary temperatures (0.025 eV at 20 °C), is frequently referred to as the thermal energy, since it depends upon the temperature.

Neutrons whose energies have been reduced to values in this region (< 1 eV) are designated thermal neutrons. The process of reducing the energy of a neutron to the thermal region by elastic scattering is referred to as *thermalization*, *slowing down*, or *moderation*.

The material used for the purpose of thermalizing **neutrons** is called a *moderator*. A good moderator reduces the speed of neutrons in a small number of collisions but does not absorb them to any great extent. Slowing the neutrons in as few collisions as possible is desirable in order to reduce the amount of neutron leakage from the core and also to reduce the number of **resonance** absorptions in non-fuel materials.

The ideal moderating material (moderator) should have the following nuclear properties:

- large scattering cross section,
- small absorption cross section,
- large energy loss per collision.

A convenient measure of energy loss per collision is the logarithmic energy decrement. The *average logarithmic energy decrement* is the average decrease per collision in the logarithm of the neutron energy. This quantity is represented by the symbol ξ .

$$\xi = \ln E_i - \ln E_f$$

Slowing Down Thermalization Of Neutron

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Slowing Down Thermalization Of Neutron:

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