Our today's blog will deal with Nuclear technology. Nuclear technology is the technology which involves the reactions in the atomic nuclei of an atom. The changes in the nucleus of atoms are normally caused by either nuclear fusion or nuclear fission and the energy released is called nuclear energy. The power that holds the nucleus together is officially called the “strong force.” Nuclear energy can be used to create electricity, but it must first be released from the atom. In the process of nuclear fission, atoms are split to release that energy while in nuclear fusion, atoms combine and again release that energy.

History of Nuclear Technology

In early 1942 , **Enrico Fermi** led a group of scientists in initiating the first self-sustaining nuclear chain reaction at University of Chicago. By November 1942, they were ready for construction to begin on the world’s first nuclear reactor, which came to be known as Chicago Pile-1. When the rods were in the pile, there were fewer neutrons to fission uranium atoms. This slowed the chain reaction. When the rods were pulled out, more neutrons were available to split atoms. The chain reaction sped up. On the morning of **December 2, 1942,** the scientists were ready to begin a demonstration of Chicago Pile-1. Fermi ordered the control rods to be withdrawn a few inches at a time during the next several hours. Finally, the nuclear reaction became self- sustaining and Fermi and his team had successfully transformed scientific theory into technological reality. **The world had entered the nuclear age**.

Nuclear energy

Nuclear energy is the energy in the nucleus, or core, of an atom. Nuclear energy can be used to create electricity, but it must first be released from the atom. When the process is repeated over and over, it is called a chain reaction. In a nuclear power plant, uranium is the material used in the fission process.

What is nuclear fuel?

Nuclear fuel is the element that is used in nuclear power plants to produce heat to power the turbines. **Nuclear fuel** is material used in nuclear power stations to produce heat to power turbines. Heat is created when nuclear fuel undergoes nuclear fission. Most nuclear fuels contain heavy fissile actinide elements that are capable of undergoing and sustaining nuclear fission. The three most relevant fissile isotopes are uranium- 233, uranium-235 and plutonium-239. When the unstable nuclei of these atoms are hit by a slow-moving neutron, they split, creating two daughter nuclei and two or three more neutrons. These neutrons then go on to split more nuclei. This creates a self-sustaining chain reaction that is controlled in a nuclear reactor, or uncontrolled in a nuclear weapon.

Nuclear Power Plant:

A nuclear power plant is a station where all the nuclear reactions take place inside a nuclear reactor. In 1951, the first time that heat from a nuclear reactor was used to generate electricity. Nuclear power plants have a carbon footprint comparable to that of renewable energy such as solar farms and wind farms, and much lower than fossil fuels such as natural gas and brown coal. Despite some spectacular catastrophes, nuclear power plants are among the safest modes of electricity generation, comparable to solar and wind power plants.

Nuclear Reactions:

Nuclear reactions cause changes in the nucleus of atoms which in turn leads to changes in the atom itself. Nuclear reactions convert 1 element into a completely different element. Suppose if a nucleus interacts with any other particles then separates without altering the characteristics of other nuclei then the process is called nuclear scattering rather than specifying it as a nuclear reaction. This does not imply radioactive decay. One of the most evident nuclear reactions is nuclear fusion reaction that occurs in fissionable materials producing induced nuclear fission.

Nuclear Reactions – Types:

Inelastic scattering: This process takes place when a transfer of energy occurs. It occurs above threshold energy. $\mathbf{E_t = ((A + 1)/A) \times E_1}$, where E_t is called as the inelastic threshold energy and E_1 is the energy of the first excited state.

Elastic Scattering: It occurs when there is energy transfer between a particle and intended nuclei. It is the most vital process for slowing down neutrons. In the case of an elastic scattering total kinetic energy of any system is conserved.

Transfer Reactions: The absorption of a particle followed by discharge of 1 or 2 particles is referred to as transfer reactions.

Capture Reactions: When nuclei capture neutral or charged particles followed by discharge of α-rays, it is termed as capture reactions. Radioactive nuclides are produced by neutron capture reactions.

Advantages of Nuclear Energy Production:

1. Nuclear energy has the least impact on the environment, as it does not pollute air.
2. Nuclear plant does not require a very large area for setup.
3. Nuclear energy plants do not release greenhouse gases.
4. Once constructed and made it operative, its maintenance cost is much cheaper

Disadvantages of Nuclear Energy Production:

There are various disadvantages of Nuclear Energy Production:

1. It is very expensive to set up a nuclear plant.
2. Different types of approvals are required including government's approval.
3. Nuclear waste is very hazardous, as it remains radioactive for thousands of years.
4. Though it is rare, nuclear accidents are highly fatal. For example, the Chernobyl disaster (about 30 thousand people died).

Nuclear Power in India

India is one of the largest producers of electricity in the world. The various power plants we have here in India are mentioned below:

1. Rajasthan Atomic Power Station – 1973, Rajasthan
2. (Kalpakkam) Madras Atomic Power Station – 1984, Tamil Nadu
3. Tarapur Atomic Power Station – 1969, Maharashtra
4. Narora Atomic Power Station- 1991, Uttar Pradesh
5. Kakrapar Atomic Power Station – 1993, Gujarat
6. Kaiga Nuclear Power Plant -2000, Karnataka
7. Kudankulam Nuclear Power Plant – 2013, Tamil Nadu

IMPORTANT:- India started building nuclear power plants in 'fleet mode' from 2023. Under the fleet mode, a nuclear power plant is expected to be built over a period of five years from the first pour of concrete. It was for the first time that the government had approved building 10 nuclear power reactors in one go with an aim to reduce costs and speed up construction time.

Hope you liked learning interesting points about the nuclear technology. Stay connected for more.