NUCLEAR FUELS AND REACTORS

What are nuclear fuels?

Nuclear fuel is any material that can be consumed to derive nuclear energy, by analogy to chemical fuel that is burned to derive energy. A modern nuclear power plant uses nuclear fission to produce heat and generate electricity (Fig. 17-1). One isotope of uranium, U-235, is the major fuel. When a U-235 nucleus is bombarded with a neutron, it breaks apart (the word fission means “splitting”). The initial reaction releases two or three neutrons. Each of these neutrons can trigger the fission of additional nuclei; hence, this type of nuclear reaction is called a branching chain reaction. Because this fission is initiated by neutron bombardment, it is not a spontaneous process and is different from natural radioactivity.

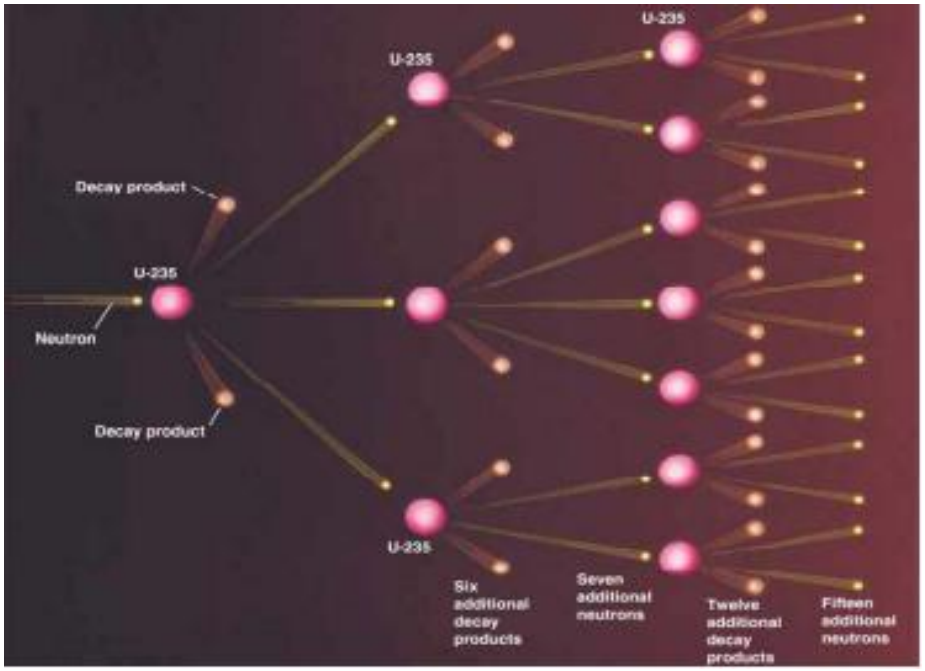

Figure 17-1. When a neutron strikes a uranium-235 nucleus, the nucleus splits into two roughly equal fragments and emits two or three neutrons. These neutrons can then initiate additional reactions, which produce more neutrons. A branching chain reaction accelerates rapidly through a sample of concentrated uranium-235.

To fuel a nuclear reactor, concentrated uranium is compressed into small pellets. Each pellet could easily fit into your hand but contains the energy equivalent of 1 ton of coal. A column of pellets is encased in a 2-meter-long pipe called a fuel rod (Fig. 17-2). A typical nuclear power plant contains about 50,000 fuel rods bundled into assemblies of 200 rods each. Control rods made of neutron-absorbing alloys are spaced among the fuel rods. The control rods fine-tune the reactor. If the reaction speeds up because too many neutrons are striking other uranium atoms, then the power plant operator lowers the control rods to absorb more neutrons and slow down the reaction. If fission slows down because too many neutrons are absorbed, the operator raises the control rods. If an accident occurs and all internal power systems fail, the control rods fall into the reactor core and quench the fission.

Figure 17-2. (a) Fuel pellets containing enriched uranium-235. Each pellet contains the energy equivalent of 1 ton of coal. (b) Fuel pellets are encased into narrow rods that are bundled together and lowered into the reactor core.

The reactor core produces tremendous amounts of heat. A fluid, usually water, is pumped through the reactor core to cool it. The cooling water (which is now radioactive from exposure to the core) is then passed through a radiator, where it heats another source of water to produce steam. The steam drives a turbine, which in turn generates electricity (Fig. 17-3).

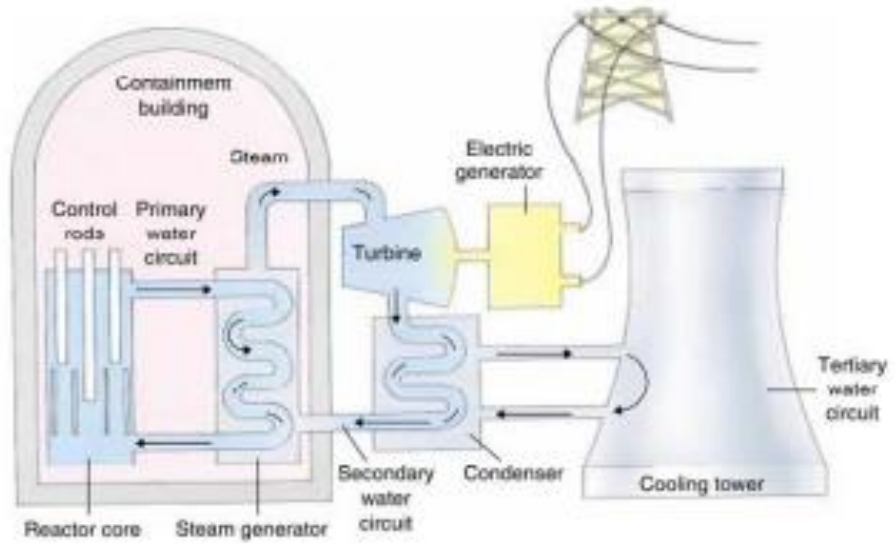

Figure 17-3. In a nuclear power plant, fission energy creates heat, which is used to produce steam. The steam drives a turbine, which generates electricity.

The nuclear power industry Every step in the mining, processing and use of nuclear fuel produces radioactive wastes. The mine waste discarded during mining is radioactive. Enrichment of the ore produces additional radioactive waste. When a U-235 nucleus undergoes fission in a reactor, it splits into two useless radioactive nuclei that must be discarded. Finally, after several months in a reactor, the U-235 concentration in the fuel rods drops until the fuel pellets are no longer useful. In some countries, these pellets are reprocessed to recover U-235, but in the United States this process is not economical and the pellets are discarded. In recent years, construction of new reactors has become so costly that electricity generated by nuclear power is more expensive than that generated by coal-fired power plants. Public concern about accidents and radioactive waste disposal has become acute. The demand for electricity has risen less than expected during the past two decades. As a result, growth of the nuclear power industry has halted. After 1974, many planned nuclear power plants were canceled, and after 1981, no new orders were placed for nuclear power plants in the United States. In 1994, 109 commercial reactors were operating in the United States. These generators produced 22 percent of the total electricity consumed that year. Those numbers will decline in the coming decade because no new plants have been started and old plants must be decommissioned.

-

- **EXERCISES :**

1- According to the passage, which of the following statements are "true" or "false ?

1. Electricity is produced by branching chain reaction.

2. Electricity generated by coal-fired power plants is more expensive than that generated by nuclear power.

3. By fission in a reactor, U-235 nucleus splits into two useful radioactive nuclei.

4. Neutron-absorbing alloys are used in control rods.

5. The energy of each fuel pellet is equal to energy of 1 ton of coal.

2- Choose a, b, c, or d which best completes each item.

1. What is used for cooling of a reactor?

a) water b) steam c) fuel rod d) coal

2. What is created by fission energy in a nuclear power plant?

a) Heat b) Steam c) Electricity d) Fuel rod

3. Which of the following items are used for bombardment of U-235?

a) fuel rod b) neutron c) control rod d) fission energy

3- Read these sophisticated words and search for the translation of each in French or Arabic :

1. nuclear fission ……..

2. branching chain reaction ……..

3. bombardment ……..

4. . radioactivity ……..

5. reactor ……..

6. fuel rod ……..

7. control rods ……..

8. power plant ……..

9. mining ……..

10. radioactive wastes ……..

4- Words with their synonyms and antonyms :

Word	Synonym	Antonym
modern	new and up-to-date fashion	old-fashioned
split	separate	join
trigger	start	finish
compress	compact	expand
discard	throw away	keep
recent	of late time	old
costly	expensive	cheap
halt	stop	start
decline	decrease	increase
tremendous	huge	small

I'll provide you with the link down below for a better understanding of the text !

https://www.youtube.com/watch?v=rcOFV4y5z8c