Recursos educativos
E. Nuclear.: Fisiò

Nuclear Power

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1.What is a nuclear power ?

A nuclear power station is an industrial installation built to generate electricity from nuclear energy.

The nuclear power stations are part of the family of the thermoelectric power stations, which implies that they use heat to generate electricity. This heat comes from the fission of material such as uranium and plutonium.

2. Operation of a nuclear power station

The operation of a nuclear power station is based on the exploitation of the heat in order to move a turbine by the action of the steam, which is connected to an electricity generator. In order to obtain steam the uranium or plutonium is used as fuel.

The process can be simplified into five stages

- Due to the fission of the uranium carried out in the nuclear reactor, a large amount of energy is freed up, heating up the water until it evaporates.
- This steam is transported to the turbine?generator group by means of a steam circuit.
- Once there the turbine vanes revolve given the action of the steam and move the generator which transforms the mechanical energy into electricity.
- Once the steam has gone through the turbine, it is sent to a condenser where it cools down and becomes liquid again.
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And the water is transported in order to generate steam again, thus closing the water circuit.

The waste generated by the fission of the uranium is stored within the power station, in special concrete pools for radioactive material.

5. Fission nuclear reactors

A fission nuclear reactor is an installation able to start, maintain and control the chain fission reactions, having the appropriate means to extract the generated heat.

The essential elements making up a nuclear reactor are the following:

- Fuel. Made up by fissionable material, it is generally made up of uranium where the fission reactions take place. It is, therefore, the heat generation source.
- Moderator. It decreases the speed of the fast neutrons generated in the fission, maintaining the reaction. It usually uses water, heavy water, helium, graphite or metal sodium.
- Control elements. They allow controlling the population of the neutrons and maintain the reactor stable at all times.
- Cooling agents. They extract the heat generated by the fuel. Liquid cooling agents are generally used, such as light and heavy water and such as carbon dioxide and helium.
- Shielding. Prevents the radiations and the neutrons from the reactor from escaping to the outside. Concrete, steel or lead are usually used.
- Safety elements. All the fission nuclear power stations have multiple accident prevention systems that may cause any seepage of radioactivity to the outside of the nuclear reactor.

Types of nuclear reactors

The thermal reactors can also be classified depending on the moderator used. Generally, each moderator has a type of fuel associated as well as a type of cooling agent. The essential differences between the reactors are the following:

Light water reactor

Within this group there are two types of reactors:

- Pressurized water reactor (PWR). They use water as moderator and cooling agent. The fuel used is slightly enriched uranium in the form of uranium dioxide.

This type of reactor has been mainly used in the United States, Russia, Germany, France and Japan.

- Boiling water reactor (BWR). In this type of reactor, a part of the water of the cooling (which at the same time acts as moderator) goes to the steam stage in the reactor itself. It is mainly used in the United States.

Heavy water reactor

The heavy water reactor uses natural uranium as fuel and the heavy water is used as a moderator and cooling agent.

This type of reactor is mainly used in Canada.

Natural uranium, gas and graphite reactor

This type of reactor uses natural uranium as fuel in a metallic way. They use graphite as moderator and carbon dioxide as a cooling agent.

These reactors are mainly used in France and in Great Britain.

Gas advanced reactor

The main differences are in the fuel. They use slightly enriched uranium oxide in stainless steel tubes.

Graphic and light water reactor

This exclusively soviet design uses slightly enriched uranium as fuel, graphite as a moderator and water as cooling agent, which becomes steam in the reactor itself.

6. Characteristics of a pressurised water nuclear power station (PWR)

The fuel used in the PWR nuclear power stations is enriched uranium dioxide and the process starts introducing it in the shape of pills in a series of tubes.

The fuel elements are cooled by means of a water circuit (called primary circuit) which at the same time is used as a moderator.

The water increases the temperature and is kept as liquid due to the high pressure of the system.

The cooling agent circulates along the steam generators, providing heat to a different completely independent water circuit, (secondary circuit) which transforms into steam, making the turbine vanes revolve, which is coupled to an electricity generator.

Once it has gone through the turbine the steam is condensed and returns to the steam generator.

The entire circuit is located inside the contention building, built of reinforced concrete with a thickness of between 50 and 100 cm and with an inside covering of steel making it completely hermetic. This contention building is kept below the atmospheric pressure in order to prevent possible seepage to the outside in the event of any accident.

To understand the operation of a pressurised water nuclear power station better you can access this game.

7. Characteristics of a boiling water nuclear power station (BWR)

The BWR power stations are different from the previous in that they do not have a secondary water circuit.

In addition, the primary circuit works at a lower pressure and the steam is produced in the reactor from where it is directly sent to the turbine to move the generator.

Both the PWR and the BWR power stations have a fuel building which is used to store the new fuel elements and to keep the fuel already used until it is transported to a final storage centre for used fuel.

The fuel and also the contention building are connected to each other so the fuel elements can be moved without leaving the controlled area of the power station and it is completely isolated from the rest of the power station installations.

In addition, the nuclear power stations have auxiliary buildings where the safety equipment and systems are located.

You can learn more about the operation of a boiling water nuclear power station in the following interactive game.

8. Environmental impacts of the nuclear power plant

We can highlight that the nuclear power stations do not emit carbon, sulphur, nitrogen oxide or any other element derived from the combustions, like the ashes, to the atmosphere. Therefore they do not contribute to global warming, which is responsible for the climate of the planet or acid rain.

However, caution should be taken in the generation of electricity by means of nuclear energy, both in the extraction, concentrating and enrichment of uranium and in the production of electricity also.

The production of electric energy in nuclear power stations generates long-lasting radioactive waste that has to be stored at the same power station and in special tanks for radioactive material.

The nuclear power stations have always been subject to a strict institutional regulatory control difficult to be matched by other industrial activities. This regulation takes into account all the stages making up the production cycle, also including the protection of the employees, the public in general and the dismantling of the power station at the end of its useful life.
