УДК 621.039.5=111

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Nuclear Power Stations

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A nuclear power station (or a nuclear power plant) is a thermal power station in which the heat source (or in other words the main part that produces and releases energy) is a nuclear reactor. As is typical of thermal power stations, heat from a reactor is used to turn water into steam that drives a steam turbine connected to a generator. The latter is used to transform mechanical energy into electrical one. As of 23 April 2014, the International Atomic Energy Agency (IAEA) reports that there are 449 nuclear power reactors in operation situated in 31 countries all over the world [1].

The history of a nuclear reactor began from the discovery of nuclear fission on December 17, 1938. In short, nuclear fission is a process in which the nucleus of an atom under external influence (for example: neutron bombardment) splits into several units, most likely two nuclei and 2-3 neutrons. This process is exothermic, and external energy is released in the form of kinetic energy of those particles. We talk about nuclear chain reaction provided that a neutron released by the one nuclear fission causes another nuclear fission.

The main problem of nuclear reaction is controlling. The nature of this process depends on the multiplication factor of a nuclear chain reaction. It is numerically equal to the number of subsequent reactions caused by a single reaction. To make a self-sustainable chain reaction that can be used in nuclear reactors multiplication factor must be equal to *1*, otherwise any variations are very critical.

Nowadays, there are few types of nuclear power stations that produce energy all over the world. They can be classified by several methods, but most commonly, by the type of a nuclear reactor:

1. Pressurized Water Reactor

A pressurized water reactor (also abbreviated as PWR) is the most popular one among modern active nuclear power plants, their number is 292 from total 448 reactors in the world, IAEA data, end of 2015 [1]. PWRs are one of three types of light water reactor (LWR), the other types being boiling water reactors (BWRs) and supercritical water reactors (SCWRs). In a PWR, the primary coolant (water) is pumped under high pressure to the reactor core where it is heated by the energy released by the fission of atoms. The heated water then flows to a steam generator where it transfers its thermal energy to a secondary system where steam is generated and flows to turbines which, in turn, spin an electric generator. In contrast to a BWR, pressure in the primary coolant loop prevents the water from boiling within the reactor. All LWRs use ordinary water as both coolant and neutron moderator [2]. The Biblis Nuclear Power Plant has two PWR power units, with a total capacity of 2,525 MW.

Biblis Nuclear Power Plant, Germany

2. Boiling Water Reactor

The boiling water reactor (BWR) is a type of light water reactor (LWR) used for the generation of electrical power. It is the second most common type of electricity-generating nuclear reactor after the PWR. The main difference between a BWR and PWR is that in a BWR, the reactor core heats water, which turns to steam and then drives a steam turbine. In a PWR, the reactor core heats water which doesn't boil. This hot water then exchanges heat with a lower pressure water system, which turns to steam and drives the turbine. The BWR was developed by the Idaho National Laboratory and General Electric (GE) in the mid-1950s. The main present manufacturer is GE Hitachi Nuclear Energy, which specializes in the design and construction of the reactor of this type. The Browns Ferry Nuclear Power Plant has four BWR power units, with a total capacity of 3,310 MW.

Browns Ferry Nuclear Power Plant, USA

3. Fast Neutron Reactor

A fast neutron reactor (a fast-breeder reactor or a breeder reactor) is a nuclear reactor that generates more fissile material than it consumes. These devices achieve this because their neutron economy is high enough to breed more fissile fuel than they use from fertile material, such as uranium-238 or thorium-232 [3]. Breeders were at first found attractive because their fuel economy was better than LWRs, but interest declined after the 1960s as more uranium reserves were found, and new methods of uranium enrichment reduced fuel costs. There are currently only two commercially operating fast neutron reactors, BN-600 and BN-800, both located in the Beloyarsk Nuclear Power Plant.

4th power unit of Beloyarsk Nuclear Power Plant, Russia

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