Nuclear Reactor

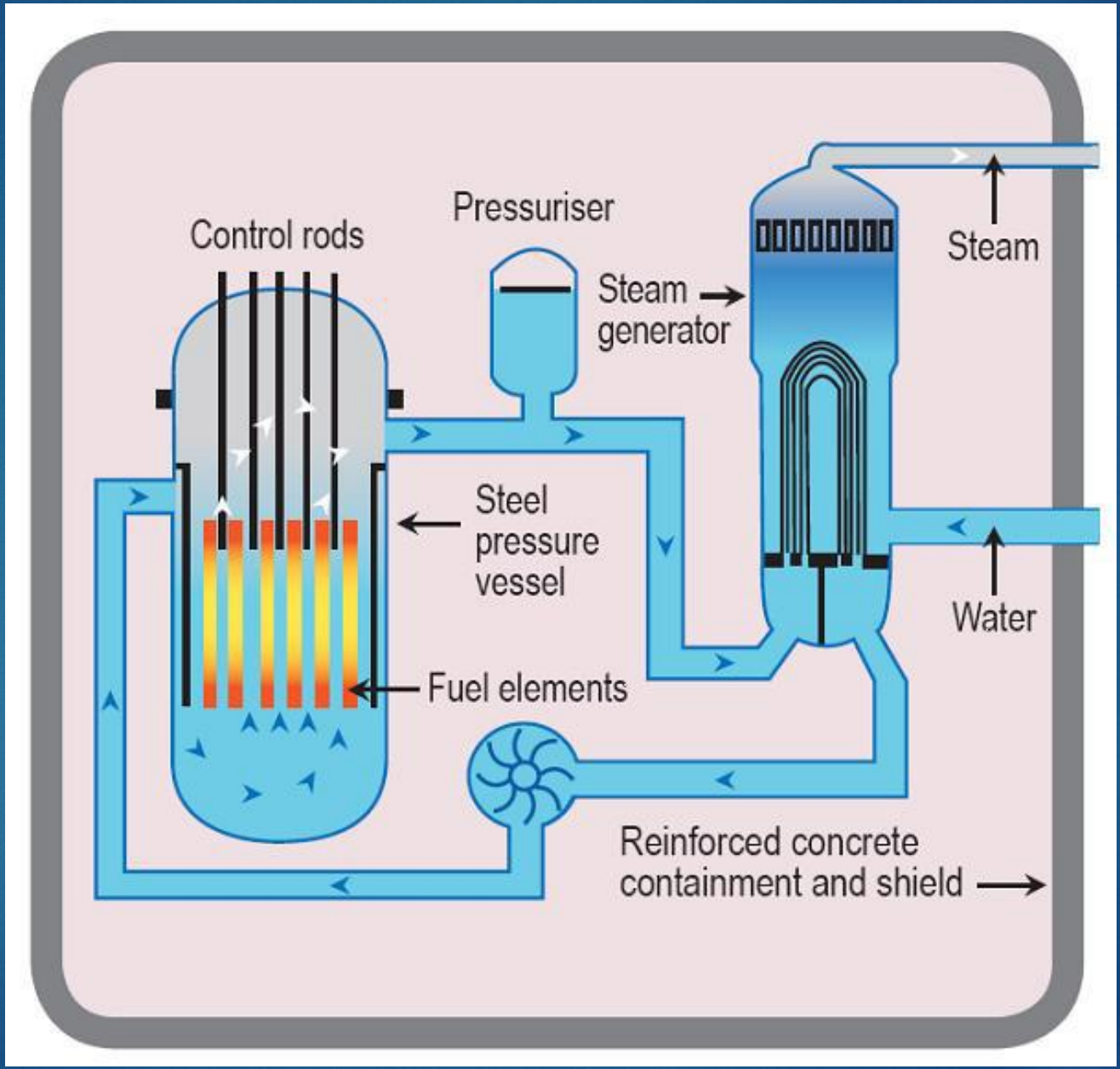
In the middle of the twentieth century, the attention of mankind was focused around the atom and scientists explaining the nuclear reaction, which they initially decided to use for military purposes, inventing the first nuclear bombs according to the Manhattan project. But in the 1950s, a nuclear reactor in the USSR was used for peaceful purposes. It is well known that on June 27, 1954, the world's first nuclear power plant with a capacity of 5,000 kW entered the service of humanity. Today, a nuclear reactor can generate electricity of 4,000 MW or more, that is, 800 times more than it was half a century ago.

What is a nuclear reactor: the basic definition and the main components of the unit

A nuclear reactor is a special unit by which energy is generated as a result of properly maintaining a controlled nuclear reaction. The use of the word "atomic" in combination with the word "reactor" is allowed. Many generally consider the concepts “nuclear” and “atomic” to be synonymous, since they do not find a fundamental difference between them. But representatives of science are leaning towards a more correct combination - “nuclear reactor”.

The following components are considered to be the main components in a nuclear reactor device:

- Moderator;
- Control rods;
- The rods, the content of the enriched mixture of uranium isotopes;
- Special protective elements against radiation;
- Heat carrier;
- Steam generator;
- Turbine;
  Generator;
- Capacitor;
- Nuclear fuel.


Control rods
Pressuriser
Steam
generator
Steam
Steel
pressure
vessel
Water
Fuel elements
Reinforced concrete
containment and shield

Fundamental principles of operation of a nuclear reactor

The fundamental principle of operation of a nuclear reactor is based on the characteristics of a nuclear reaction. At the time of the standard physical nuclear chain process, the interaction of the particle with the atomic nucleus takes place, and as a result, the nucleus is transformed into a new one with the release of secondary particles, which scientists call gamma quanta. A tremendous amount of heat is released during a nuclear chain reaction. The space in which the chain reaction takes place is called the active zone of the reactor.

To prevent the loss of neutrons, the reactor asset zone is surrounded by a special neutron reflector. Its primary task is to throw a large part of the emitted neutrons into the core. As a reflector, usually use the same substance that serves as a moderator.

Fundamental principles of operation of a nuclear reactor

The main control of a nuclear reactor is carried out with the help of special control rods. It is known that these rods are introduced into the reactor core and create all the conditions for the operation of the unit. Usually control rods are made of chemical compounds of boron and cadmium. (Boron or cadmium can effectively absorb thermal neutrons). And as soon as the launch is planned, according to the principle of operation of a nuclear reactor, control rods are introduced into the core. Their primary task is to absorb a significant portion of neutrons, thereby provoking the development of a chain reaction.

Fundamental principles of operation of a nuclear reactor

To reduce neutron leakage, the core of the reactor is surrounded by a reflector of neutrons, which throw a significant mass of emitted free neutrons inside the core. In the meaning of the reflector, usually the same substance is used as for the moderator.

According to the standard, the nucleus of atoms of the moderator substance has a relatively small mass, so that when colliding with a light nucleus, the neutron from the circuit loses more energy than when colliding with a heavy one. The most common moderators are plain water or graphite.

Fundamental principles of operation of a nuclear reactor

Neutrons in the process of nuclear reaction are characterized by extremely high speed of movement, therefore, a moderator is required, which pushes neutrons to lose some of their energy.

No other reactor in the world can function normally without the help of a coolant, since its purpose is to remove the energy that is produced in the heart of the reactor. Liquid or gases are necessarily used as heat carrier, since they are not capable of absorbing neutrons.

Used fuel for nuclear reactors

Uranium isotopes, also plutonium or thorium, can serve as the main fuel in the reactors.
Back in 1934, F. Joliot-Curie, having observed the process of fission of a uranium nucleus, noted that as a result of a chemical reaction, the nucleus of uranium is divided into nuclear fragments and two or three free neutrons. And this means that there appears a probability that free neutrons will stick to other uranium nuclei and will provoke the next division. And so, as the chain reaction predicts: six to nine neutrons will be released from the three uranium nuclei, and they will again join the newly formed nuclei. And so on to infinity.

The appearance of the first nuclear reactors

Back in 1919, physicists had already triumphed when Rutherford discovered and described the process of formation of moving protons as a result of the collision of alpha particles with the nuclei of nitrogen atoms. This discovery meant that the nucleus of the nitrogen isotope as a result of a collision with an alpha particle turned into the nucleus of an oxygen isotope.

The appearance of the first nuclear reactors

Before the first nuclear reactors appeared, the world learned several new laws of physics, interpreting all important aspects of nuclear reaction. So, in 1934, F. Zholio-Curie, H. Halban, L. Kowarski, for the first time, offered the society and a circle of world scientists a theoretical assumption and evidence base on the possibility of nuclear reactions. All experiments were associated with the observation of nuclear fission of uranium.

The appearance of the first nuclear reactors

In 1939, E. Fermi, I. Joliot-Curie, O. Gan, O. Frish tracked the fission reaction of uranium nuclei when they were bombarded with neutrons. In the course of research, scientists found that when a single accelerated neutron enters the uranium nucleus, the existing nucleus divides into two or three parts.

The appearance of the first nuclear reactors

Chain reaction was almost proven in the middle of the XX century. Scientists succeeded in proving in 1939 that when fissioning a single uranium nucleus, about 200 MeV of energy is released. But the kinetic energy of the nuclear fragments is allocated approximately 165 MeV, and the remainder carries away gamma rays. This discovery made a breakthrough in quantum physics.

The appearance of the first nuclear reactors

E. Fermi works and research continues for several more years and launches the first nuclear reactor in 1942 in the USA. The embodied project received the name - “Chicago woodpile” and was put on military rails. On September 5, 1945, Canada launched its nuclear reactor, ZEEP. The European continent did not lag behind, and at the same time the installation of the F-1 was being built. And for the Russians there is another memorable date - December 25, 1946 in Moscow under the leadership of I. Kurchatov the reactor is launched. These were not the most powerful nuclear reactors, but this was the beginning of human development of the atom.

The appearance of the first nuclear reactors

For peaceful purposes, a scientific nuclear reactor was created in 1954 in the USSR. The world's first peaceful nuclear-powered ship, the nuclear-powered icebreaker Lenin, was built in the Soviet Union in 1959. And one more achievement of our state is the nuclear icebreaker "Arktika". This surface ship for the first time in the world reached the North Pole. It happened in 1975.