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Thermonuclear Energy

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Humanity, in the process of its development, strives to improve the quality of its life. In order to achieve it, various gadgets and devices that simplify life were invented and created, such as smartphones, televisions, various smart appliances from vacuum cleaners to smart sockets. All these devices perform completely different functions, but they have something in common: they need energy to work. A hundred years ago, people only burned coal to produce electricity and were happy with everything, but now everything has changed. In the last few decades, people have been looking for new, alternative sources of energy because their needs have increased, their resources have decreased, and their environmental conditions have deteriorated. As a result of long research and development, many ways of generating energy have been invented and tested, such as solar energy, wind energy, water energy, geothermal energy, and so on. But one of the most promising, in my opinion, developments is the energy of thermonuclear fusion. Theoretically, a thermonuclear power plant can have high power, be environmentally friendly, and most importantly, the fuel for its operation is available in almost unlimited quantities [1].

Thermonuclear energy is a possible alternative to nuclear energy. Research in this area has been conducted since the 50s of the last century. In the process of thermonuclear fusion, the processes occurring inside stars, such as our sun, are reproduced. There is a connection of two atomic nuclei, accompanied by the release of energy. For energy production, the reaction of deuterium and tritium synthesis is best suited. As a result of international cooperation, the development of an international project for an experimental thermonuclear reactor began in the mid-80s. In 2006, the preparation and construction of the site in the south of France began, and in the summer of 2020, the full construction of the installation began. It is planned to launch the reactor in 2025. The goal of the project is to prove the possibility of using a thermonuclear reaction to generate energy. The successful launch of the reactor will open up a new industry in the energy sector. Currently, scientists are actively researching and developing two types of thermonuclear reactors: magnetic plasma confinement reactors and inertial plasma confinement reactors. In order for thermonuclear reactions to self-sustain and produce useful energy, the product of nr must be greater than Lawson's criterion, at a temperature of 10.0 keV (about 10^8K). Thus, the goal of thermonuclear research and development is to achieve a value of n, t, T about $2 - 10^{24}$s*eV/m^3. Thermonuclear devices called tokamaks are currently the closest to achieving these conditions. Proposed in the early 1950s by Soviet physicists A.D. Sakharov and I. E. Tamm, this installation got its name from the abbreviation of the words "Toroidal chamber with a magnetic Coil". The principles underlying the operation of this device are relatively simple. First, the plasma is produced in a vacuum chamber shaped like a torus or a doughnut. A system of electromagnets located outside the chamber creates a toroidal magnetic field directed along the axis of the torus. The field acts as a hose that maintains the pressure inside the plasma and prevents it from contacting the chamber walls. Another system of electromagnets located in the center of the torus induces an electric current in the plasma, which flows in the toroidal direction. This current heats the plasma to a temperature of about 1 keV. The plasma current creates its own magnetic field covering the toroid. This field prevents the plasma particles from drifting outside the main magnetic confinement region. Finally, the external conductc generate a vertical magnetic field that keeps the plasma cor from moving up and down, left and right inside the cha...ber [2].

Inertial plasma confinement and, accordingly, inertial fusion (ITS) was proposed in the USSR in the mid—60s of the last century. This direction, which is largely an alternative to the first one, is focused on creating such conditions (density) that the main part of the thermonuclear fuel "burns" before it explodes, without spending any effort on holding the plasma clots. At the same time, the difficulties that in the tokamak consist in holding the plasma were transformed into the task of heating it in a very short time. The time and parameters of this process are determined by the inertia of the fuel mixture, so heating should be carried out in a time of about 10^{-9} s. Currently, the creation of pulsed reactors is at the stage of physical research and justification of conceptual projects [3].

References:

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