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International Thermonuclear Experimental Reactor (ITER)

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ITER ("The Way" in Latin) is one of the most ambitious energy projects in the world today.

In southern France, 35 nations are collaborating to build the world's largest tokamak, a magnetic fusion device that has been designed to prove the feasibility of fusion as a large-scale and carbon-free source of energy based on the same principle that powers our Sun and stars.

To continue the consideration of the ITER, it is necessary to understand what fusion is and what tokamak is like.

Fusion is the energy source of the Sun and stars. In the tremendous heat and gravity at the core of these stellar bodies, hydrogen nuclei collide, fuse into heavier helium atoms and release tremendous amounts of energy in the process.

Twentieth-century fusion science identified the most efficient fusion reaction in the laboratory setting to be the reaction between two hydrogen isotopes, deuterium (D) and tritium (T). The DT fusion reaction produces the highest energy gain at the "lowest" temperatures. Three conditions must be fulfilled to achieve fusion in a laboratory:

– very high temperature;

– sufficient plasma particle density;

– sufficient confinement time (to hold the plasma, which has a propensity to expand, within a defined volume).

The tokamak is an experimental machine designed to harness the energy of fusion. Inside a tokamak, the energy

produced through the fusion of atoms is absorbed as heat in the walls of the vessel.

The heart of a tokamak is its doughnut-shaped vacuum chamber. The charged particles of the plasma can be shaped and controlled by the massive magnetic coils placed around the vessel; physicists use this important property to confine the hot plasma away from the vessel walls. The term "tokamak" comes to us from a Russian acronym that stands for "toroidal chamber with magnetic coils."

The experimental campaign that will be carried out at ITER is crucial to advancing fusion science and preparing the way for the fusion power plants of tomorrow.

Thousands of engineers and scientists have contributed to the design of ITER since the idea for an inter-national joint experiment in fusion was first launched in 1985. The ITER Members – China, the European Union, India, Japan, Korea, Russia and the United States – are now engaged in a 35-year collaboration to build and operate the ITER experimental device, and together bring fusion to the point where a demonstration fusion reactor can be designed.

The amount of fusion energy a tokamak is capable of producing is a direct result of the number of fusion reactions taking place in its core. Scientists know that the larger the vessel, the larger the volume of the plasma and therefore the greater the potential for fusion energy [1].

With ten times the plasma volume of the largest machine operating today, the ITER Tokamak will be a unique experimental tool, capable of longer plasmas and better confinement. The machine has been designed specifically to:

1) Produce 500 MW of fusion power.

ITER will not capture the energy it produces as electricity, but – as first of all fusion experiments in history to produce net energy gain – it will prepare the way for the machine that can.

2) Demonstrate the integrated operation of technologies for a fusion power plant.

3) Achieve a deuterium-tritium plasma in which the reaction is sustained through internal heating.

Scientists are confident that the plasmas in ITER will not only produce much more fusion energy, but will remain stable for longer periods of time.

4) Test tritium breeding.

5) Demonstrate the safety characteristics of a fusion device.

One of the primary goals of ITER operation is to demonstrate the control of the plasma and the fusion reactions with negligible consequences to the environment. Taken together, the ITER Members represent three continents, over 40 languages, half of the world's population and 85 percent of global gross domestic product. In the offices of the ITER Organization (the Central Team) and those of the seven Domestic Agencies, in laboratories and in industry, literally thousands of people are working toward the success of ITER. ITER will be the first fusion device to produce net energy, the first fusion device to maintain fusion for long periods of time. And ITER will be the first fusion device to test the integrated technologies, materials, and physics regimes necessary for the commercial production of fusion-based electricity [2].

It’s time for a change and this change has name “fusion”.

Being the same energy that powers the Sun, fusion has advantages of not producing greenhouse gases, not generating long-lived radioactive waste and being intrinsically safe.

References:

1. Mode of access: https://www.iter.org/proj/inafewlines. – Date of access: 05.04.2017.
2. Mode of access: http://fusioned.gat.com/what_is_fusion.html. – Date of access: 05.04.2017.