SPECIAL REPORT

Soviets Announce Fusion Breakthrough

March 20 (IPS) — On March 10, Soviet Academicians E. Velikhov and B. Kadomtsev announced the results of a successful experiment in the T-10 Tokamak at the I.V. Kurchatov Institute of Atomic Energy. The following is the full translation of an article in the March 10 Pravda, the official Soviet Party Paper, entitled "Steps Toward Thermonuclear Energy" announcing that breakthrough:

In the summer of 1954 in Obninsk, the first atomic electric-power station in the world started up. It signalled that man had found a qualitatively new source of energy for peaceful economic activity — the nuclear energy of uranium. Nevertheless, the colossal practical significance of this new achievement of Soviet science and technology was not immediately picked up. The capacity of the first power station was quite modest, just 5,000 kilowatts, and the need to develop atomic energy was not obvious to everyone at that time. But years passed, and atomic power stations "joined" the energy system of the country. The power of just one block of the Leningrad Atomic Electric-power Station (AES) is one million kilowatts. These stations are reliable and easy to use. In the long term, only atomic energy is capable of sparing humanity from anxiety over the finiteness of fuel resources.

The Communist Party and Soviet state are constantly working to create all the conditions necessary for nuclear physicists in their fruitful scientific investigations and for the practical realization of the results of scientific research. This concern is reflected in the "Basic Directions of National Economic Development of the USSR" (10th Five year plan — trans.) adopted at the 25th Congress of the party, where the necessity is noted of developing theoretical and experimental research in the area of nuclear physics and plasma physics towards creating the scientific and technological basis for thermonuclear energy production. Soviet scientists and engineers are applying their efforts to making a worthy contribution to the solution of these important tasks.

Regular atomic stations, as is known, use the nuclear energy only of the heavy elements uranium and thorium. But there are significantly more reserves of energy in the lighter elements.

If nuclear energy is obtained from heavy elements, the reaction is one of nuclear fission; when it is obtained from the light ones, it is fusion. Reaching this latter goal — obtaining energy through fusion of light nuclei — is what the efforts of physicists working on controlled thermonuclear reactions are directed at. The solution of this problem would permit fuel utilization of lithium, which is transformed in the reactor itself into a heavy isotope of hydrogen, tritium, and regular water, which contains another heavy hydrogen isotope — deuterium.

Research on this has been in progress in our country for about 25 years. After a long stage of looking for optimal solutions, and struggle with many difficulties, the most promising lines of research have been "scouted out," and here the main efforts are concentrated. One of these is creating a thermonuclear reaction in the form of a steady burn, which was developed in recent years by the late Academician L.A. Artsimovich at the I.V. Kurchatov Institute of Atomic Energy. Experimental installations of this sort were christened tokamaks.' ... The successes achieved with the "tokamaks" attracted the attention of foreign scientists. Now installations of this type have been built and are being used for research in many countries and represent the most likely prospect for thermonuclear reactors.

Let us explain what is involved here. In order for thermonuclear reaction to take place with sufficient intensity and for the energy produced to compensate for that expended in heating the plasma, its temperature must be raised to 70 million degrees (for the lightest "inflammable" mixtures of deuterium and tritium heavy isotopes of hydrogen). Furthermore, the so-called characteristic heat-loss time of the plasma must be high enough on the order of several seconds for a steady 'burn.' Thus, heating in the 'tokamak' is relatively simple (the record temperature of 15 million degrees was achieved in French and American 'tokamaks', the way to increase the confinement time of the plasma energy and, consequently, to create a reactor is also known. As theory predicts and experiments shows, it is sufficient to increase the scale of the installation.

In order to test his conclusion, which is basic for further progress, and take the next step towards a reactor, the largest thermonuclear installation, the T-10, was built at the IAE (now a similar type of installation has been built at the lab in Princeton, USA): Designed by specialists at the D.V. Efremov Scientific Research Institute of Electrophysical Apparatus (NIIEFA) and built in factories in Leningrad and Kharkov, it was rapidly put to work, and a collective of physicists under the direction of doctor of mathematical physics V.S. Strelkov achieved several interesting results on it.

First of all, the basic conclusion of previous research was confirmed: increasing the scale actually increased the confinement time of the plasma energy five-fold compared to the previous installation, the T-4. Now it is about 0.1 seconds, which was predicted theoretically for research condition using half the power of the installation. A stable and sufficiently pure plasma was obtained and a stable thermonuclear reaction took place in it, with a number of neutrons per impulse 100 times greater that in the T-4. The temperature was still not very high, about 7 million degrees for ions, but it will be raised with the shift to the next calculated stage.

In this way, the experiments on the T-10 have confirmed the previous established principles and theoretical conceptions for this type of installation and are also useful in projecting the next steps. What are these steps?

Methods must be found to heat the plasma further, and experiments are already being carried out for this on smaller scale installations. In the future, these methods will be transferred to the T-10, with an appropriate modification of the T-

10 --trans. But beyond this, the level of understanding now achieved of the processes which go on in the 'tokamaks' plasma makes it possible to move to the next step, the creation of a so-called demonstration thermonuclear reactor. In this it will be possible to achieve a full-scale thermonuclear reaction in deuterium-tritium plasma, wherein the quantity of energy released in the course of the reaction will be approximately equal to that put into the plasma. The draft project for such a reactor has already been worked out at NIIEFA.

The demonstration reactor makes it possible not only to study all physical processes in the reacting deuterium-tritium plasma, but also to confront the engineering and technological difficulties, so as to study and then overcome them. It is a question of radiation damages of the materials, their interaction with the high-temperature plasma, the reproduction of tritium etc. Tests can also be done on systems of output and conversion of the energy of the thermonuclear reactions. More succinctly, this part of the research is close to the goals and tasks of the first atomic electric-power station.

Following the demonstration reactor, an experimental thermonuclear electric-power station or energy-yielding reactor could be planned. Of course, it is necessary to choose the optimal variant. In this connection the following should be considered: the energy of thermonuclear reactions is produced as a flux of high-energy neutrons. The question arises: can't this quality be utilized in a more sensible way that to simply turn the energy of the neutrons into heat? For example like this: surround the plasma with a layer of uranium, in which neutrons will produce nuclear fission and thus increase the energy output. Natural uranium could be used for this, or even lower-grade uranium than the isotope 235. A so-called hybrid is obtained, i.e. a mixed thermonuclear-atomic reactor, in which the energy is supplied by uranium, while the thermonuclear part serves only as a neutron source.

It turns out that in the hybrid variant, the demands on the paramenters of the plasma fall so much that even already-achieved parameters come right up to the necessary level. Furthermore, hybrid reactor electric-power stations become economically gainful with much lower power. Also, already existing technology of atomic reactors can be used in this. We add that in the hybrid reactor plutenium can be produced -- the fuel for ordinary reactors. Working together with ordinary atomic electric-power stations, hybrid stations will find their place in the economic optimization of atomic energy and serve as a good transitional stage to pure thermonuclear energy.

We have briefly reviewed here just the 'tokamak' line. But other lines have a firm place in research on controlled thermonuclear fusion, especially those using lasers and relativistic electron beams to ignite a reaction in small pellets. These lines can lead to entirely new technical advances for the conversion of thermonuclear energy.

The simplest method of initiating a small thermonuclear explosion is the rapid (100s of millionths of a second) of the surface layer of a small pellet, to a temperature of a million degrees, by stopping a powerful burst of accelerated electrons. The colossal pressure which arises accelerates the matter of the outer layer, which in turn compresses and heats the thermonuclear fuel.

In the days before the congress, a collective of scientists at the IAE under the leadership of Doctor of Mathematical Physicists L.I. Rudakov achieved a significant success in this pursuit. As a result of the thermonuclear reaction which took place in the deuterium fuel, over a million neutrons were obtained. This opens good prospects for development of an impulse thermonuclear reactor, similar to an internal combustion engine, in which energy is produced in the form of periodical short bursts.

Thus thermonuclear energy — like atomic energy — is a new quality in energy production of the future. To master it means to take an important step on the path of scientific and technological progress. Soviet scientists are actively bringing this future closer.