'The atom: an inexhaustible energy source' from Communauté européenne (April 1962)

Caption: In April 1962, the monthly publication Communauté européenne focuses on the thermonuclear applications of atomic fission and fusion in Europe.

Source: Communauté européenne. Bulletin mensuel d'information. dir. de publ. Fontaine, François ; RRéd. Chef Chastenet, Antoine. Avril 1962, n° 4; 6e année. Paris: Service d'Information des Communautés Européennes. "L'atome: source inépuisable d'énergie", p. 6.

URL:
http://www.cvce.eu/obj/the_atom_an_inexhaustible_energy_source_from_communaute_europeenne_april_1962-en-8730cbed-5a1e-47ae-807f-a0517be1f9ac.html

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The atom: an inexhaustible energy source

Contrary to a myth that has become too widespread, everybody is capable of understanding in general terms what happens inside a nuclear reactor or of learning the significance of the word ‘fission’. It is a matter of a few seconds’ attention, hardly the time taken to read a billboard praising the merits of a new refrigerator.

Unlike ‘chemical energy’, which leaves the heart of the atoms intact, ‘atomic energy’ involves directly action on the atomic nucleus in order to exploit its prodigious forces. To that end, scientists have perfected two methods: fission and fusion.

1. In the case of fission, large atomic nuclei, such as those of uranium, are exploded. This explosion, which splits the nucleus in half, creates energy. Brutal and instantaneous in an atomic bomb, fission is mastered and maintained in an atomic pile or a nuclear reactor. The nuclear fuels whose nuclei may be split in half are: uranium 233, uranium 235 and plutonium. Only uranium 235 exists in nature. It is found mixed with natural uranium in the proportion of 0.72 %. Plutonium is obtained from uranium 238 which is a component of natural uranium, and uranium 233 is obtained from thorium.

2. In the case of fusion, two small nuclei, such as deuterium, are fused together and their fusion into a heavier nucleus releases energy. This is what happens in the stars and in the H, or thermonuclear, bomb. The principal bodies whose nuclei can be fused, thereby creating energy, are deuterium, tritium, helium 3 and lithium 6.

An anonymous and silent concrete block

Now let us visit an atomic pile such as the one which serves the establishment in Ispra, the jewel in the crown of the Joint Research Centre set up by Euratom. We may well feel slightly disappointed when we go out through the air-tight double doors that lead into the hall that houses the pile. There, in front of us, is a simple, tall and anonymous concrete block which does nothing to arouse the imagination, all the less so because an atomic pile emits no sound when it is in operation.

However, at the heart of this block, in accordance with a complicated procedure, a mass of uranium in the form of elements is disintegrating. Safety rods, sometimes acting as an accelerator, sometimes as a horse’s bit, control the phenomenon. The energy released by the disintegration of the fuel is relatively weak because the atomic pile at Ispra is intended for research. This is not the same as in the case of a powerful reactor serving a powerful nuclear power station where everything is done to obtain maximum heat. That heat is directly captured in the reactor core by a coolant that, directly or indirectly, will involve a turbo generator giving electricity.

Surprising reactors

At the current state of the art, 1 kg of natural uranium, which contains 0.72 % of fissile uranium 235, can generate 20 000 kWh, which is 6 000 or 7 000 times more than can be generated from 1 kg of coal. These yields will be significantly improved over the next few years. But already, the atomic physicists are perfecting surprising reactors which, thanks to an ingenious device, create as much nuclear fuel as they consume.

It goes without saying that this procedure, if it could be transferred to motor vehicles, would be a cause of joy to drivers who would see the radiator water in their vehicle convert itself into petrol as the tank emptied, and in identical proportions. But, alas, such magic tricks remain exclusively in the domain of the nuclear universe.

Euratom’s role there is clear. It is a question of smoothly supplementing the knowledge and the achievements of the six Member States whose objective is to develop nuclear power stations generating electricity at competitive prices. This is a considerable task.

A fuel that comes from the sea

The peaceful applications of thermonuclear fusion are still at the stage of laboratory experiments. A thermonuclear power station does not exist even at the design stage, although, for several years now, nuclear power stations, working on the uranium fission principle, generate electricity. It is a pity because, once it has been tamed, thermonuclear fusion offers many advantages.

Firstly, it generates very significant quantities of energy. The fusion of 10 grams of deuterium releases as much energy as 28 tonnes of coal! Furthermore, thermonuclear fuel is abundant and is easy to obtain. This is, above all, the case of deuterium, which is a constituent element of water: one molecule in 5 000. Accordingly, in five litres of water there are 0.2 grams of deuterium, the fusion of which would supply as much energy as the combustion of 1 500 litres of petrol. Sea water therefore reveals itself to be an extraordinary reservoir of deuterium.

Of course, there is another side to the coin. It is very difficult to persuade deuterium nuclei to fuse. Positively charged, to use the jargon of the physicists, they repulse one another unceasingly. To overcome these forces of repulsion, a very large amount of energy has to be applied to them.

In an H-bomb, the energy ultimately required to bring about the fusion of the thermonuclear explosive is provided by an A-bomb. Acting as a match, the A-bomb gives off intense heat that dislocates the atoms that constitute the thermonuclear explosive. The electrons, gravitating around the nucleus like satellites, escape, and the repulsion forces disappear. The atomic nuclei can then fuse in chance encounters. This gas, where the atomic nuclei and the electrons are separated, is called plasma.

Plasma does not like mirrors

Instantaneous and brutal in the H-bomb, fusion has not hitherto been reproduced under laboratory conditions where it must be constantly controlled. Atomic physicists are still coming up against numerous obstacles, such as how to heat the plasma for a sufficient length of time and how to keep it inside non-material walls.

It is possible to produce very high temperatures (several million degrees), by using electric charges that reproduce – on a much vaster scale – the principle of a car's spark plug. It is a matter of producing an electric spark which creates through the gas a current sufficient for the gas to be heated to X million degrees. Generating the requisite hundreds of thousands of amps requires installations which consume enormous quantities of electricity.

But what containers would be capable of holding a gas or a plasma heated to 100 million degrees? It is useless to think of material walls. The transmission of heat to these walls would rapidly cool the plasma, while at the same time melting them like simple sticks of wax. The solution which seems to be the most promising consists of surrounding the plasma by non-material walls created by magnetic fields whose intensity is of the order of 100 000 gauss. (The intensity of the earth's magnetic field is around 1 gauss.)

Despite the ingeniousness of the research workers who multiply and reinforce the fields created by special coils and magnetic mirrors, the plasma has only one goal: to escape from the trap of the magnetic mirrors and to always find a fissure through which to escape after a few microseconds. Oh! If only it could behave itself for two seconds, then the deuterium nuclei would have plenty of time to meet and to fuse. Controlled thermonuclear fusion would then have been achieved. That would signal the end of the world's energy problems.

Euratom is strongly interested in controlled thermonuclear fusion. And by a system of association contracts, the European Community takes part in practically all the research carried out in this field in the Europe of the 'Six'.