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Fusion Energy : Prospects to the Future

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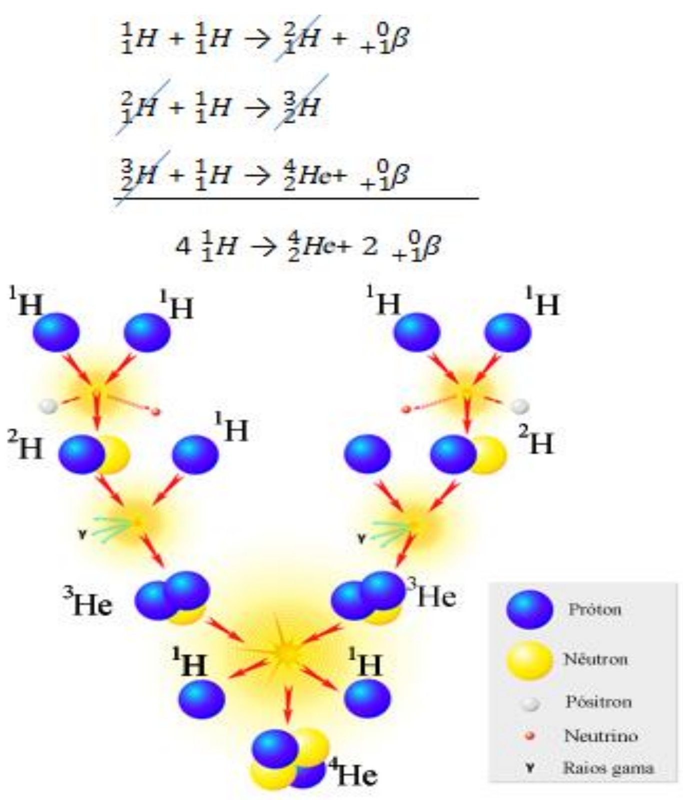
ABSTRACT AND INTRODUCTION

Fusion power is a proposed form of power generation that would generate electricity by using heat from nuclear fusion reactions. In a fusion process, two lighter atomic nuclei combine to form a heavier nucleus, while releasing energy. Devices designed to harness this energy is known as fusion reactors. Nowadays, Fusion has the potential to provide a safe, cost-efficient, and sustainable solution to global energy needs. Fusion energy has no difficult waste issues and is climate-friendly.



Nuclear fusion presents a number of significant technological challenges, which it must be solved before it can be made commercially available. A fusion reactor is a very complex device, and historical experimental systems have been chiefly physics experiments, designed for operational flexibility and, while experimental availability is a concern, the operating and maintenance regime required of a commercial power plant is very different from that of an experimental device.

BACKGROUND

Fusion materials have a twofold problem. The first is resisting radiation damage from fission neutrons to maintain their properties over the design lifetime—as well as exposure to high temperatures and high stresses. The second is the avoidance of elements, which form long-lived radionuclides under neutron radiation, giving rise to long-term radioactive waste—or even changing the nature and properties of an alloy through the production of transmutation elements. Additionally, the functional demands on materials vary widely: plasma-facing materials must be resistant against very high heat and particle loads, without sputtering; in-vessel structural materials must be dimensionally stable and remain ductile while installed; elements of the breeder blanket must multiply neutrons for tritium production—tritium itself is prone to permeating through materials and cannot be allowed to leach into the environment; diagnostic and heating systems may be directly exposed to radiation and sputtered dust, which will fog lenses and mirrors and affect the conductivity of electronics. It is difficult to conceive that a commercial reactor will be licensable by regulatory authorities without qualification of these materials in a nuclear environment, which implies that a high-energy neutron source is required for materials development.

CONSIDERATIONS

It is interesting to know that to be used to generate energy, it must be a controlled reaction and for that there are still some obstacles:

- For the fusion to be effective, high temperatures are necessary, as is the case with the Sun, which has regions with temperatures in the order of 100 million degrees Celsius. This large amount of energy is necessary to overcome the repulsion force resulting from the positive charges of the nuclei that will unite. Currently, this is achieved through the energy released in the controlled fission reaction of an atomic bomb, which serves as a fuse for the nuclear fusion reaction.
- Another problem that arises is to find how to work in a controlled manner with materials at thousands of degrees Celsius and it finds what materials could be used to build the reactor that would withstand such high temperatures.
- There is also a need for a quick flow of the energy released in the fusion reaction. Research in this area has led to a type of reactor called Tokamak, which is used today only for research. The most famous is the one in Princeton, United States, which works at a temperature of 100 million degrees Celsius. Below is the Tokamak COMPASS at the IPP presented in Prague, Czech Republic, during the Science and Technology Week organized by the Czech Academy of Sciences, on November 2, 2012: In these reactors an extremely strong magnetic field is produced. Deuterium and tritium gases are injected and heated to thousands of degrees Celsius to react. Since there is the passage of electric current and the generation of strong magnetic fields, a plasma is formed, which is in a tube inside the reactor, not coming into contact with its walls.

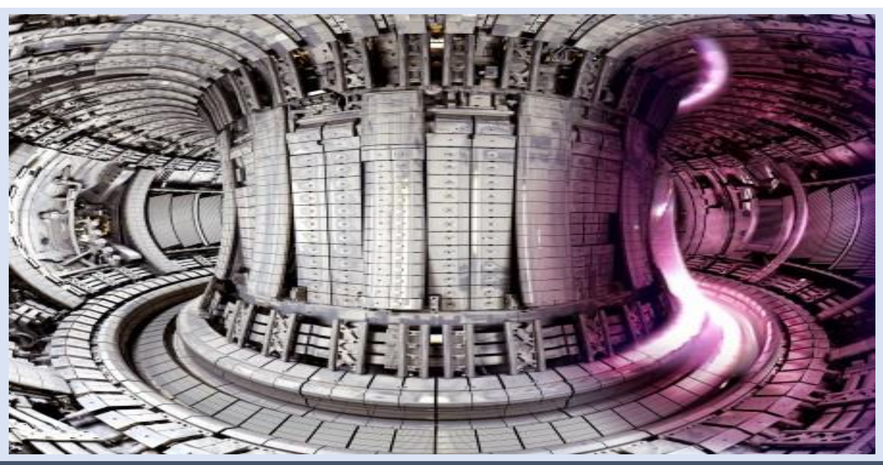
ADVANTAGES

- One of the most important aspect of this type of nuclear reaction is the amount of energy released. To give you an idea, the merger of just 2. 10 -9% of deuterium (hydrogen with a neutron and a proton in the nucleus) would provide an amount of energy that would be enough to sustain the world's energy demand for a year.

- That is why the dream of many scientists is to be able to harness the energy released in fusion reactions. The reactors currently used in nuclear power plants are nuclear fission, which is the process contrary to fusion and which produces a smaller amount of energy.

- Uncontrolled fusion was already used in the hydrogen or thermonuclear bomb in 1952, launched by the United States in a Pacific atoll. This bomb was nicknamed “Mike” and had a power 700 times greater than that of Hiroshima.

- In addition to the large amount of energy released, other advantages of using nuclear fusion to generate energy are that the materials used in these reactions are easily obtained, as deuterium is found in water molecules, tritium (isotope of hydrogen that has a proton and two neutrons in the nucleus) can be obtained through lithium, and lithium is a metal found in nature.



CONCLUSION

Progress in fusion energy research can be measured in the advance and basic understanding of high temperature plasmas, where scientists have developed new fields of physics - plasma physics - to devise methods that confine plasma to strong magnetic fields for, then, develop the skills to heat, stabilize, control turbulence and measure the properties of superheated plasma. And this analysis concludes that as more fusion reactors are built, carbon emissions are drastically reduced, as a larger fraction of global electricity production comes from fusion. In this future scenario, we will see that a new era of clean, safe and cheap energy has begun.