

## ENERGY OF THE FUTURE – NUCLEAR FUSION SAFE AND SUFFICIENT SOURCE

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### ABSTRACT

*Renewable resources offer several advantages but they will never be able to completely replace fossil fuel. Thermo **nuclear fusion** remains a long term solution to the energy requirement. There is on earth a large supply of fuel which is practically **inexhaustible**. A cubic meter of water contains 34 grams of deuterium the energy equivalent of 300000 litres of oil. The oceans, the seas and lakes could supply enough deuterium for a 1000 reactors over a millions of years. This study's objective, analysing data from Max-Planck Institute in Greifswald, was to examine fusion power plant safety, advantages and influence on the environment. After a decay time of one to five hundred years the radiotoxic content is already comparable to the hazard potential of the entire coal ash from a power plant of equal power. This study's conclusions indicate that nuclear fusion could make a lasting contribution to **future energy supply**.*

**Keywords:** nuclear fusion 1, inexhaustible 2, future energy supply 3

### Introduction

Even though renewable resources will probably be able to meet a greater proportion of the World's energy requirements than they do at present, experts agree that they will not be able to satisfy the total demand. New energy options must therefore be developed - systems which are optimally safe, environment-friendly and economical. Controlled thermonuclear fusion is one of these rare options.

JET and ITER are fusion devices of the "tokamak" type. The JET Tokamak of the European Community, based in Abingdon (UK), is the largest and most powerful in the World.

Worldwide cooperation involving Europe, Japan, Russia, USA, China, South Korea and India have agreed to site ITER (International Thermonuclear Experimental Reactor) at Cadarache in France. The start of construction will be in 2007 with construction time of about 10 years. Around 600 scientists, engineers,

technicians and other personnel will work on the device for approximately twenty years.

Fusion devices of "stellarator" type: TJ-II is being operated at Madrid and Wendelstein 7-X is being built at Greiswald. Upon completion in 2012 the latter will be the world's largest experiment of the stellarator type.

The activity concentrations of  $^{226}\text{Ra}$  and of the natural radioactive series of  $^{232}\text{Th}$  are similar with the concentrations obtained in other studies.[5]

The relatively high concentrations of  $^{40}\text{K}$  which were obtained in this work are also similar with the concentrations obtained in other studies.[5-10]

The radionuclide  $^{137}\text{Cs}$  was identified in all soil samples, but obtained values are not high. This radionuclide originates from nuclear weapons test fall-out and after 1986, mostly from the accident of the nuclear power plant "Lenin" in Chernobyl.

## Nuclear fusion

The aim of fusion research is to utilize the energy source of the sun and stars here on earth: A fusion power plant is to derive energy from fusion of atomic nuclei. Under terrestrial conditions this can most rapidly be achieved with the two hydrogen isotopes, deuterium and tritium. These fuse to form helium, thus releasing neutrons and large quantities of energy:

One gram of fuel could yield in a power plant 90 000 kilowatt-hours of energy, i. e. the combustion heat derived from 11 tons of coal.

The basic substances needed for the fusion process, viz. deuterium and lithium, from which tritium is produced in the power plant, are available throughout the world in almost inexhaustible quantities. A cubic meter of water contains 34 grams of deuterium the energy equivalent of 300000 liters of oil. The oceans, the seas and lakes could supply enough deuterium for a 1000 reactors over a millions of years. With special conditions fusion needs an ignition temperature of 100 million degrees.

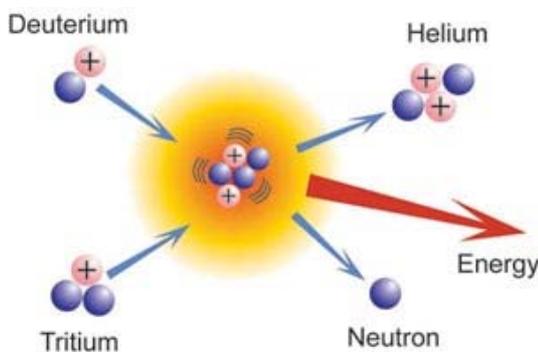


Fig. 1. Fusion reaction

## **Fusion advantages**

- The non - radioactive part of the fuel is abundant on a worldwide scale and practically inexhaustible.
- The radioactive part of the fuel (tritium) is generated in the reactor itself and is burned producing He and neutrons.
- The ash (He) is safe and non- radioactive.
- The quantities of the fuel and ash are very small (a few hundreds of kilograms per year and reactor.)
- The biological hazards presented by fusion waste are, after 10 years, one thousand times smaller than those associated with fission waste.

## **Safety and environmental properties**

- The reactor contains only a very small quantity of fuel (about 10 grams).
- An uncontrollable increase of the reactivity is impossible; any disturbance will immediately stop the reaction.
- The intensity and duration of the radioactivity of the reactor walls, which is produced by neutrons, can be minimized by the development of appropriate materials.
- Climatically harmful emission does not occur.
- The walls of the plasma vessel are left over as radioactive waste and have to be put into intermediate storage at the end of a service life. The activity of the waste rapidly decreases, after about a hundred years to ten – thousandth of the initial value.
- After a decay time of one to five hundred years the radiotoxic content is already comparable to the hazard potential of the entire coal ash from a power plant of equal power, which always contains radioactive materials.
- If appropriate recycling techniques are applied, there would no longer be any waste after a decay time of a hundred years. The entire material would then be cleared or approved for re- use in new power plants.



Fig. 2. Place for Wendelstein 7-X  
at Max-Planck Institute in

## Conclusion

A study on the development of the European energy market as of 2050 shows that fusion as a new and comparatively capital - intensive technology can penetrate the European market if the emission of CO<sub>2</sub> is to be appreciably reduced. In 2100 fusion could then cover about 20 to 30 per cent of Europe's power requirements.

The importance of the fusion option becomes obvious primarily in the global perspective, in view of the world's growing population: In countries with rapidly increasing economic activity such as India and China it is almost only coal - fired power plants that are being planned for the next few decades. Power plants and infrastructure are being designed for lifetimes of about forty years, by which time the DEMO fusion demonstration power plant is to start power production.

It is too early to give a precise assessment of the economic impact and viability of fusion energy. The investment costs will certainly be higher than for coal-fired or nuclear fission power stations, but fuel costs will be very low.

As a fusion power plant also promises a high degree of safety and properties favourable to the environment, nuclear fusion could make a lasting contribution to future energy supply.

## References

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