

COMMISSARIAT A L'ENERGIE ATOMIQUE

CENTRE D'ETUDES NUCLEAIRES DE SACLAY

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F91191 GIF SUR YVETTE CEDEX

CEA-CONF - - 7894

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TRITIUM PROBLEMS IN A THERMONUCLEAR FUSION DEVICE

Work underway at CEA

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Communication présentée à : 2. National topical meeting on tritium technology
in fission, fusion and isotopic applications
Dayton, OH (USA) 30 Apr - 2 May 1985

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The tritium system of a thermonuclear fusion reactor starts from the machine with the chamber vacuum system, continues through the fuel clean-up system connected with the gaseous waste processing system. Then one finds the isotopic separation and pure deuterium and tritium are eventually stored, or reinjected into the plasma chamber. In addition if the reactor is equipped with a breeding blanket, a tritium extraction system is connected to the main loop. Atmosphere processing systems and tritium recovery from solid wastes are added to the whole.

In all these systems problems arise concerning components, or process or both. Since 1983, several studies are undertaken in CEA in the tritium system, specifically oriented on fusion problems.

Starting from the plasma chamber, available vacuum systems components to the required specifications do not exist. This is true for pumps as well as valves. Specifications concerning these materials and industrial inquiries are under way and the design of a facility to test this kind of material is now completed. Construction of this facility should start next year.

As far as the fuel clean-up process is concerned, a first review aiming to the selection of the best process has been made. Three processes have been studied : permeation through palladium-silver membranes, cryotrapping and metallic getters. Facing the lack of data concerning cryocondensation, the first conclusion was to recommend a process combining a metallic bed, on which tritiated impurities like water will be decomposed, with a palladium-silver membrane. Aerodynamics of this membrane will be studied next year and an experiment to test the process with tritium will be constructed afterwards. The problem with the palladium membranes is their SENSITIVITY to poisons.

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A facility is now being constructed to test this poisoning effect and to improve ways of regeneration. Experiment will start first with hydrogen during two years and then will be followed by experiment with tritium to explore effect of tritium reactions with impurities.

Tritium extracted from the breeding blanket will be separated from the helium purge gas as water. One of the most convenient way to decompose this water is to use electrolysis. But many problems arise at this level of radioactivity due to enhances corrosion by highly tritiated water and radiolysis of the latter. An experiment is being prepared and the facility is designed to test tritiated water electrolysis and electrolyser components with tritiated water at the maximum possible tritium concentrations.

It is foreseen to use an atmosphere clean-up system to maintain in the reactor building a low tritium concentration and to prevent large tritium releases into the environment. A mathematical model was developed to describe the reactor hall atmosphere clean-up and a computer code combining PERI and DIFFUSE codes is used. In addition a facility to test catalyst used in the clean-up process and to improve new catalysts is being built and should start on tritium before the end of 1984.

The last study undertaken in C.E.A. is the recovery of tritium from solid contaminated with this gas. Parts of the machine, such as first wall may contain large tritium inventory (hundreds of grams). Recovery of this tritium will be very important before conditioning and disposal of these elements. Studies to recover the gas by destructive and non destructive processes are underway.

Success in all these researches does not solve all tritium problems in a fusion device, but will provide a great part of the required knowledge in this area.