



IAEA FEC 2014

Contribution ID: 675

Type: Poster

European DEMO Breeding Blanket Design and Development Strategy in a Roadmap to the Realisation of Fusion Energy

Friday, October 17, 2014 2:00 PM (4h 45m)

The EU Fusion Roadmap foresees the development and construction of a DEMO reactor that will deliver several 100s of MW of net electrical power starting from 2050. Although the EU breeding blanket programme has a long history of more than 30 years, this ambitious goal presents a significant challenge. The breeding blanket however will require a significant development R&D to cope with the challenges posed by the DEMO environment. Although DEMO will not be an optimised machine and will not reach performances expected for a first generation of fusion reactors, the gap between ITER and DEMO will be significant. The lifetime neutron fluence of high energy neutrons will be about two orders of magnitude larger. This calls for a class of structural materials not foreseen in ITER, in particular ferritic martensitic steels able to ensure an adequate life time of the blanket reducing the impact of replacement time and hence increasing the plant availability. In addition, this new class of materials should provide reduced activation characteristics to minimise drastically the total amount of high-activated long-life wastes. The need to ensure T self-sufficiency requires the integration in the blanket design of breeder and neutron multiplier materials, and to provide efficient systems to extract the T produced and confine it to prevent safety hazards of reactor personnel and population. The requirement of electricity production poses additional challenges to the blanket design and materials. Finally, safety and licensing requirements for a nuclear power plant will impact the selection of blanket design solutions, material choice and adopted technologies. In the present EU programme 4 breeding blanket concepts are under investigation for the possible use in an EU DEMO reactor according to the EU Fusion Roadmap. These blanket concepts are the two Helium cooled concepts tested in the European TBM Programme in ITER, a solid and a liquid breeder concepts, a water cooled PbLi concepts and a dual coolant He-PbLi concept. The adaptation of these blankets to the reference DEMO plant and the selection of the most suitable concept will be the work over the next 7 years in the framework of the new EUROfusion Consortium.

Paper Number

FIP/P8-4

Country or International Organisation

Germany

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Session Classification: Poster 8