

Conceptual Design Activities of FDS Series Fusion Power Plants in China

Y. Wu, H. Chen, S. Liu, S. Zheng, W. Wang, H. Wang, Y. Ke, Q. Huang, S. Wu, J. Li, and the FDS Team

Institute of Plasma Physics, Chinese Academy of Sciences
P.O. Box 1126, Hefei, Anhui, 230031, China
Phone/Fax: +86 551 5593326; E-mail: ycwu@ipp.ac.cn

A series of fusion power plants (named FDS series) have been designed and assessed for the examination of the safety, environmental and economical potential of fusion on the basis of design optimization with neutronics, thermalhydraulics, electro-magnetics, material and structural analyses in China. Up to now, four concepts have been developing, which are the fusion-driven subcritical system (named FDS-I), the fusion electrical generation reactor (named FDS-II), the fusion-based hydrogen production reactor (named FDS-III) and the spherical tokamak-based compact reactor (named FDS-ST). FDS-I, a fusion-fission hybrid reactor, is designated to transmute the long-lived nuclear wastes from fission power plants and to produce fissile nuclear fuel for feeding fission power plants as an intermediate step and early application towards final application of fusion energy on the basis of easily-achieved plasma physics and engineering technology, where the austenitic stainless steel-structured He-gas/liquid lithium-lead (LiPb) dual-cooled high level waste transmutation (DWT) blanket concept is adopted. FDS-II is designated to achieve economical application of electricity based on conservatively advanced plasma parameters, which can be limitedly extrapolated from the successful operation of ITER. Two optional concepts of liquid lithium-lead blankets including the RAFM steel-structured He-cooled LiPb tritium breeder (SLL) blanket and the RAFM steel-structured He-gas/liquid LiPb dual-cooled (DLL) blanket are adopted for FDS-II. FDS-III is designated to produce high temperature heat for efficient production of hydrogen with the SiCf/SiC composite-structured high temperature lithium-lead (HTLL) blanket. To demonstrate and validate the feasibility of the candidate blankets, the strategy for TBMs (test blanket modules) development has been proposed, which covers three-phases e.g. Out-of-pile experimental Mockup in liquid lithium-lead experimental loops, EAST-TBM (the Test Blanket Module for the Experimental Advanced Superconducting Tokamak EAST under construction) and ITER-TBM. The reference preliminary scenarios of three typical TBMs have been designing in wide collaboration with various institutions in China. In this contribution, a design overview of FDS series reactors, lithium-lead blankets and relevant TBMs are presented as well as a proposed roadmap of fusion energy development in China.