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Design Concept of K-DEMO for Near-Term Implementation

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Korean Fusion Energy Development Promotion Law (FEDPL) was enacted in 2007 to promote a long-term cooperative fusion research and development among participating industries, universities and research institutes. As a following step, a conceptual design study for a steady-state Korean fusion demonstration reactor (K-DEMO) has been initiated in 2012. The conceptual design activity will continue to the end of 2021 and the finish of the construction is planned to be completed by the end of 2037.
One special concept discussed of K-DEMO is a two-staged development plan. At first, K-DEMO is designed not only to demonstrate a net electricity generation (Q_eng > 1) and a self-sustained tritium cycle (Tritium breeding ratio, TBR > 1.05), but also to be used as a component test facility. Then, at its second stage, a major upgrade is carried out by replacing in-vessel components in order to show a net electric generation on the order of 500 MWe. After the thorough 0-D system analysis, the major radius and minor radius are chosen to be 6.8 m and 2.1 m, respectively, considering practical engineering feasibilities. In order to minimize the deflection of wave and maximize the efficiency, a top launch high frequency (> 200 GHz) electron cyclotron current drive (ECCD) system is the main candidate for the current profile control and off-axis current drive of K-DEMO. For matching the high frequency ECCD, a high magnetic field is required and it can be achieved by using high performance Nb3Sn-based superconducting conductor currently being used in accelerator magnet area and the peak magnetic field is approaching to 16 T with the magnetic field at the plasma center above 7 T. Pressurized water is the most prominent choice for the main coolant of K-DEMO when considering balance of plant development details. Considering the plasma performance and the peak heat flux in the divertor system, a double-null divertor system becomes the reference choice of K-DEMO. For a high availability operation, K-DEMO incorporates a vertical maintenance design.
A design concept and radial builds for K-DEMO considering a vertical maintenance scheme are presented together with preliminary design parameters.

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