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Physics and Engineering Design Studies on Power Exhaust and Divertor for a 1.5 GW Fusion Power DEMO

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Handling of a large exhausted power to the SOL and divertor is the most important issue for DEMO reactor design. The plasma concept (Ip = 14 MA, R = 8.5 m, a = 2.5 m) with the reduced fusion power of 1.5 GW and central solenoid coils sufficient for inductive start was proposed. Plasma simulation of the power exhaust and engineering design of tungsten (W) plasma-facing-component and water-cooling concept are developed. The divertor designs with the leg length of 1.6 m and 2.0 m are investigated to produce the plasma detachment. The peak heat loading both at the inner and outer divertor targets is reduced to 5 MW/m^2 level, even in the shorter divertor at the high radiation fraction (f_rad = P_rad/P_out, where Pout is the exhausted power to the plasma edge) of 0.8 and relatively low midplane density (n_i^sep) of 2.3x10^19 /m^3, corresponding to the Greenwald density fraction (f_sep^GW = n_i^sep /n^GW) of 0.33. Conceptual engineering design of the heat sink and the arrangement in a divertor cassette is proposed. ITER technology of W-monoblock and Cu-ally cooling pipe is applicable to the high heat flux area near the divertor strike-point, where neutron flux is relatively low. Arrangements of two coolant routes for Cu-alloy pipe (200℃, 5MPa)and reduced activation ferritic/martensitic steel (RAFMS) pipe (290℃, 15MPa) and their flow velocities are determined to handle the peak target load of 10 MW/m^2 level. An integrated conceptual design of the DEMO divertor is presented.

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Japan

Primary author: Mr ASAKURA, Nobuyuki (Japan Atomic Energy Agency)

Co-authors: Mr KUDOU, Hironobu (JAEA); Dr UTOH, Hiroyasu (Japan Atomic Energy Agency); Dr SHIMIZU, Katsuhiro (JAEA); Dr HOSHINO, Kazuo (Japan Atomic Energy Agency); Dr TOBITA, Kenji (JAEA); Dr EZATO, Koichiro (JAEA); Prof. OHNO, Noriyasu (Graduate School of Engineering, Nagoya University); Dr HIWATARI, Ryoji (Central Research Institute of Electric Power Industry); Dr SUZUKI, Satoshi (JAEA); Dr TOKUNAGA, Shinsuke (JAEA); Dr SEKI, Yohji (Japan Atomic Energy Agency); Prof. UEDA, Yoshio (Osaka University); Dr SAKAMOTO, Yoshiteru (Japan Atomic Energy Agency); Dr SOMEYA, Youji (Japan Atomic Energy Agency)

Presenter: Mr ASAKURA, Nobuyuki (Japan Atomic Energy Agency)

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