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Design and Analysis of "Filling-Evacuating" High-Pressure Helium-Cooled Loop

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The breeder blanket and divertor are crucial plasma facing components (PFC) in a fusion reactor. The helium cooled blanket and divertor concepts have exhibited the best potential to come up to the highest safety requirements and therefore been chosen for the development object. As a result of high heat flux radiated from the plasma in the fusion reactor and high power density nuclear heat deposited by high-energy neutrons, the cooling of the First Wall (FW) and the discharge of nuclear heat have become one of the major technical challenges. To demonstrate and verify the helium-cooled technology and tools of China Test Blanket Module (TBM), and explore the feasibility and key technology of thermal hydraulics process of helium-cooled divertor, we have creatively adopted the "filling-evacuating"approach to design and fabricate the High-Pressure Helium-Cooled Loop (HPHCL), in which a mock-up of reduced-scale helium-cooled blanket module is designed and manufactured as a test section. Based on different experimental cases, the operating pressures of helium at mock-up range from 3 to 10 MPa and the maximum mass flow rate can reach up to 0.21Kg/s. In this paper, the design scheme of the HPHCL is presented, and the key issues of engineering manufacture and the test cases are calculated and analyzed. The helium gas flow and the heat transfer are calculated according to the test working conditions of the referenced ITER TBM's FW surface heat flux, using ANSYS fluid dynamics software FLUENT. The results will provide support for the follow-up fabrication of test system and implementation of the tests.

Eligible for student paper award?

Yes

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