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Design and analysis of robot for the maintenance of divertor in DEMO fusion reactor

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DEMO represents DEMOnstration Power station, which is a nuclear fusion power station and it is proposed to be built after ITER experimental nuclear fusion reactor. It is impossible to do any change or repair work during the nuclear operation by human directly due to the high radiation and extreme temperature in the fusion reactor. And the solution to solve these issues is adopt the remote handling robot.

Divertor is one part of the DEMO fusion reactor. In DEMO, there are 54 cassettes and each cassette is supported by stainless steel structure, the weight of each cassette is around 7 tones. The divertor is devoted to extract the ash and heat generated during fusion reaction, minimize plasma contamination and protect the surrounding walls in the extreme environment where thermal and neurotic loads are existed.

Concept of remote handling robot is designed, and main components of the robot such as bearings, wheels, rails and cylinders are selected. FEM analysis on critical point especially contact area is carried out. Mechanism of the robot and cassette removal and installation sequences are studied. Challenges here are space limitation and avoiding collision. The rail change system is one of the crucial part in this concept; four V shape wheels integrated with spherical roller bearing can rotate and roll along the toroidal rail. Clearance between blanket and the cassette is eliminated by the hydraulic jack installed on the top of the structure. The driven system of the structure movement along the toroidal rail is two telescopic cylinders, each cylinder controls one direction. Moreover, the merits and demerits are mentioned, in this concept, the structure is simple and have high stiffness, but the modification on the vacuum vessel should be taken into further consideration since the radiation may cause unexpected deformation on the rail.

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