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An enhanced near-term HCPB configuration as driver blanket for the EU DEMO

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The Helium Cooled Pebble Bed (HCPB) breeding blanket is the reference blanket proposed for the EU-DEMO. A concept for the HCPB based on a cooling plate (CP) “sandwich” architecture built in Multi-Module Segments was developed for the EU-DEMO 2015 tokamak baseline. This architecture significantly improved the tritium breeding performance with respect to the former “beer-box”-like concept and keeps the circulating power at a moderate level (≈ 130 MW), improving also former figures (>200 MW). However, the still questionable technology readiness of a helium-cooled based Primary Heat Transfer System (PHTS) with such circulating power and the need for a simpler architecture to improve the blanket reliability still reveals critical deficiencies of the “sandwich” concept. This has led to a design revision towards establishing an enhanced, simpler, near-term configuration. Such configuration is based on a fission-like hexagonal arrangement of radial fuel-breeder pin assemblies built in Single Module Segments. This concept has been implemented in the latest EU DEMO 2017 baseline and features advanced ceramic breeder (mixed $\text{Li}_4\text{SiO}_4 + \text{Li}_2\text{TiO}_3$) for enhanced pebble bed thermo-mechanics and Be_{12}Ti neutron multiplier for improved safety, minimizing the tritium retention, swelling and reactivity issues when compared to pure Be. The paper reports a basic successful set of neutronic, thermo-hydraulic and thermo-mechanical performances, with a manufacturing and assembly strategy, highlighting the simplicity of this new configuration and its integration in the PHTS. This new HCPB architecture has indeed an especially key positive impact on the Balance of Plant, which it leads, together with other enhancements in the PHTS, to a remarkably low circulating power ($70\div 80$ MW), enabling the use of mature, state-of-the-art He turbomachinery and solving the question about the low technology readiness. The paper concludes with a discussion on the future development steps and about the revised set of requirements for the EU HCPB TBM and associated testing.

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