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P2.180 Discrete element code to simulate the heat transfer inside ceramic breeder pebble beds

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Tritium breeder pebble beds are multiphase materials where ceramic pebbles and purge gas coexist. Therefore, the heat transfer in the bed is influenced by both solid particles and helium gas. Furthermore, due to their discrete nature, pebble beds show a complex fully coupled thermo-mechanical behaviour. Simulations carried out with the Discrete Element Method (DEM) allow evaluating the thermo-mechanical behaviour of pebble beds as a result of the interactions among particles accounting for the influence of the filling gas.

In KIT a predictive in-house thermal-DEM code was developed to evaluate the heat transfer inside packed granular assemblies. A 3D thermal network model with was simulates the interconnected particles by thermal resistors. The Smoluchowski effect was implemented for the first time in a DEM code allowing simulating the effect of the gas pressure on the effective thermal conductivity.

In this work the code was used to investigate the heat transfer inside breeder pebble beds. An assembly of packed pebbles was simulated being consistent with the Helium Cooled Pebble Bed (HCPB) test blanket concept and pebbles parameters such as: bed thickness, relevant packing factor and representative size distribution of pebbles. Power density of neutron irradiation was applied to the particles, which were packed into a box with an upper and bottom wall at 500°C simulating the cooling plates of the HCPB test blanket module. Helium was modelled as stagnant purge gas filling the voids among particles. The temperature profile at different distances from the first wall was evaluated. Sensitivity studies were performed to investigate the influence of the gas pressure, gas type, solid material and pebble size. The influence of the cyclic compressive load was evaluated coupling the thermal with the mechanical KIT-DEM code.

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