Effects of Pulsed Operation Conditions on Effective Thermo-physical Properties of Ceramic Breeder Pebble Beds

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Using ceramic breeder pebble beds inside the fusion blanket is a leading and promising concept in many fusion studies and blanket designs. The heat transfer parameters of the pebble beds, namely effective thermal conductivity and interface thermal conductance, control the bed's thermal performance. For a typical design of a ceramic breeding blanket, the temperature window of ceramic breeder was selected to range from 400°C to 900°C. Studying the thermo-physical properties of ceramic pebble beds under this high temperature range is a challenge to any experimental work. An advanced high temperature experiment was designed and built at UCLA to study the thermal performance of ceramic breeder pebble beds under pulsed operational conditions and the aforementioned high temperature window.

This work presents an experimental study of effective thermal conductivity, k_{eff}, of a ceramic breeder (Lithium Titanate) pebble bed and the interface heat conductance, h, between the ceramic pebbles and the surrounding structural wall. In addition these parameters (k_{eff} & h) were investigated under pulsed thermal loads in order to understand and quantify the effects of pulsed operation conditions on these parameters. The behavior of pebble beds may not show the same thermal behavior after loading with a specific number of thermal cycles. The objective is to determine how the cyclic thermal effects will degrade and/or change the thermal performance of the pebble bed. Also, finite element analysis (using ANSYS in 3D mode) was carried out to compare the thermal performance of the pebble bed with the experimental results.