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Heat Transfer Comparison of Varied Pebble Sizes and Packing Arrangements in a Pebble-Bed Reactor

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Pebble bed reactors are more cost efficient when heat transfer is optimized. In a pebble-bed reactor, optimizing heat transfer involves the analysis of complex flow. Therefore, computational fluid dynamics was used to simulate fluid movement in a structured cubic packing arrangement with a purpose in finding an optimal size of pebbles that will yield the fastest rate of heat transfer. The simple cubic pebble arrangement was used to determine if pebble size was key to optimizing heat transfer in the reactor. More complex arrangements of pebbles were used as comparison to the simple cubic packing in order to determine if changing pebble size in new arrangements were just as significant in its effects towards heat transfer characteristics. Furthermore, an additional purpose to this work was to observe the effect of pebble packing on the temperature, velocity, and pressure distribution around the pebble. To study only the effects from the arrangement of pebbles, the simulations consisted of the standard six-centimeter pebbles in different packing arrangements with a fixed inlet velocity and a fixed pebble surface temperature. To study the effects of pebble size, the standard six-centimeter pebble was reduced to three centimeters in diameter for each arrangement. The key packing structures in this study were simple cubic packing, body centered close packing, and hexagonal close packing.

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