The Leidenpump: A Non-Mechanical Means of Fluid Delivery

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The Leidenfrost effect, a phenomenon by which liquids on surfaces high above their boiling points form an insulating vapour layer, has itself caused significant challenges for engineers. This project entailed the development of a non-mechanical pump using only thermal energy and the Leidenfrost effect to propel liquid droplets. Inch-long, cylindrical brass modules were machined with a novel internal concentric circular ratchet pattern. The interaction between the vapour layer formed under the liquid droplet, in this case of distilled water, and the asymmetrical ratchets allowed droplet propulsion to be achieved. Modules were put end to end to form one continuous “leidenpump” inside a heated hose, and a precision system dispensed droplets of consistent mass. Average droplet speed was used to determine the ideal conditions for the pump, and droplet mass was measured upon entering and exiting the tube. Droplets of varying masses passed through the tube and they were able to climb slight inclines and move over a range of temperatures above the Leidenfrost point, but average speed decreased with increasing slope and inlet mass. Notably, momentum increased with increasing inlet mass. Surprisingly, droplets gained mass, a phenomenon that was tested and confirmed to be related to the condensation of hot water vapour in the tube on the relatively cool droplets. This technology could potentially be used in cooling nuclear reactors in a crisis by delivering essential coolant via arrays of pipes using reactor’s own excess thermal energy. The leidenpump presents an alternative means of pumping that can utilize waste heat.

Awards Won:

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