Leidenfrost Engine: Rotating disks on turbine-like surfaces

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Abstract: When a droplet is placed on a surface that is pre-heated to a temperature significantly higher than the droplet's boiling point, a vapor layer is produced instantly between the droplet and the surface. This vapor layer acts both as a cushion between the droplet and the surface allowing the droplet to levitate and as a thermal insulator slowing evaporation. This phenomenon is called the Leidenfrost effect. The presence of this vapor layer between the substrate and the droplet renders the substrate as a virtually frictionless surface on which the droplet can move. By introducing asymmetrical features in the substrate, the escaping vapor flow from the droplet can be rectified to achieve droplet translation. We have previously shown that these ideas can be combined with a turbine-like substrate to create a new concept of a Heat Engine based on rotating liquids and (sublimating) solids.
Here we investigate the rotation of droplets of water supporting surface tension coupled glass disks on heated turbine-like substrates (Figure 1). The transparency of the disks allows the liquid distribution over the substrate to be observed during rotation. The rotation of the disk is tracked over time to ascertain its angular acceleration and eventual steady-state angular speed. The experimental observations are further supported by an analytical model.

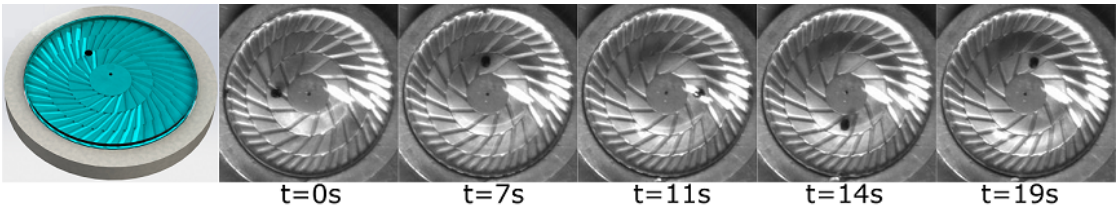

Figure 1: Time-lapse rotation of a glass disk supported on a liquid pool on a heated turbine-like surface.