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Self-Similar Solution of Transport Equations in Rotating Cone-and-Plate Devices

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Transport equations describing laminar fluid flow, heat and mass transfer in a cone-and-plate device by means of self-similar transformations were reduced to a system of higher-order ordinary differential equations. The geometrical configuration consisted of a plate/disk and a cone, whose apex touched the plate/disk, with the disk-to-cone gap being of 1 to 5 degrees. Self-similar equations were solved numerically. Cases studied were rotating cone and stationary disk and vice versa, co-rotating, contra-rotating cone and disk, and stationary conical diffuser. The disk temperature followed a power-law radial distribution, whilst the cone was isothermal; boundary concentrations were constant. Prandtl and Schmidt numbers varied over the range from 0.1 to 800. Nusselt and Sherwood numbers and temperature/diffusion profiles across the gap revealed different regimes of heat/mass transfer, with the disk surface temperature distribution together with the Pr and Sc numbers playing a crucial role. Recommendations towards performance optimization of slowly rotating cone-and-plate devices used in bioengineering were developed.

[1] I.V. Shevchuk, *Convective Heat and Mass Transfer in Rotating Disk Systems*, Springer Verlag, Berlin, Heidelberg 2009.

[2] I.V. Shevchuk *High Temperature* **42**, 1 (2004), p. 95-100.