

## Taylor–Couette style flows with two parallel inner cylinders

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The flow in the gap between an inner rotating and an outer cylinder at rest presents a variety of regimes which are well documented, from 2D Couette flow to turbulent situations through Taylor-Couette eddies. In the present work we explore a more complex flow, with two parallel co-rotating inner cylinders inside a square container at rest. This configuration may be understood as somehow similar to the classical Taylor-Couette experiment, but with extra physical mechanisms caused by a saddle point in the base flow. The flow is visualised with reflecting flake shaped particles in suspension (Iridin 120 from Merck Company, made from a substratum of natural mica with range of size  $5\text{--}25\mu\text{m}$ ). Iridin is a very fine powder of flat particles which reflect or not light depending their orientation, thus providing flow visualisation. The apparatus is lit by a sheet of white light of width 3 mm. The camera axis is perpendicular to the lighting plane.

Six regimes are identified, see figure 1: (1) the two-dimensional base flow for  $Re < 50$ ; (2) steady rolls for  $50 < Re < 70$ ; (3) wavy rolls for  $70 < Re < 110$ ; (4) corkscrew rolls for  $110 < Re < 170$ ; (5) turbulent rolls for  $Re > 170$  and (6) a second type of steady rolls for a sudden start of cylinders and  $50 < Re < 60$ .

The mechanisms behind these regimes are similar the mechanisms behind Taylor-Couette flows, mainly rotative instability, but are made even more complex by the topology of the domain, which is here triply connected, and of the base flow, which presents a saddle point, allowing many topological configurations for vortex lines. The robustness of Taylor mechanism for formation of rolls is therefore strong. Going to unsteady regimes, the flow allows to explore instabilities in the saddle point region. A striking feature is that the fluid get re-stabilised in the converging zone of the base flow before being again unstable when going back to the saddle point region.

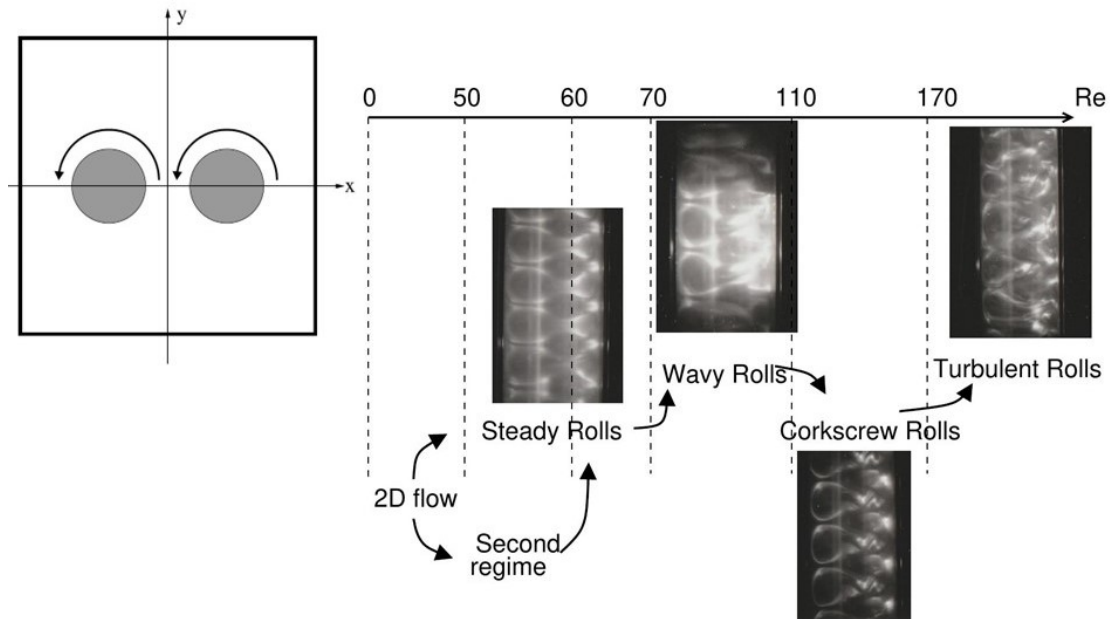


Figure 1: Plan view geometry of the apparatus and simplified map of regimes.

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