Viscous Hydraulic Jumps

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We examine the form of the viscous hydraulic jump that arises when a descending vertical fluid jet impacts a rigid horizontal boundary. Fluid is expelled radially, and the layer generally thins until reaching a critical radius at which the layer depth increases abruptly. In our study, glycerol–water solutions with viscosities of 10–40 cS were pumped at flow rates of 40–100 cc/s through source nozzles with diameters of 4–10 mm. The fluid impacted the center of a circular glass plate of diameter 36 cm that formed the base of a reservoir. The fluid then proceeded through the jump, and over the edges of the reservoir, whose depth was controlled by an outer wall of height 2–10 mm.

Elegaard et al.\textsuperscript{1} first demonstrated that the axial symmetry of the viscous hydraulic jump may be broken, resulting in steady polygonal jumps (Fig. 1). Our investigation revealed a new class of steady asymmetric jumps that include cat’s eyes, three- and four-leaf clovers, and sunflowers (Figs. 2–5). The addition of a drop of surfactant has two effects that underscore the importance of surface tension on the jump structure: the jump expands in radius,\textsuperscript{2} and the circular symmetry is restored.