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Non-circular hydraulic jump for impinging jet flow for high-viscosity liquids

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ABSTRACT

Non-axisymmetric hydraulic jumps were observed in experiments by Ellegaard et. al (1998) first when using high-viscosity liquids, and several different research groups investigated this new phenomenon from both experimental and theoretical aspects. They attempted a comparison of their experimental data with Watson's theory or a modified theory proposed by Bush et. al. (2003), which cannot capture the azimuthal dependence feature of the radius and are not accurate. Due to the clearly observed azimuthal velocity in the subcritical region, we propose a thin film flow approach that accommodates the azimuthal flow. Using a non-axisymmetric lubrication flow assumption and Laplace's equation derived from continuity equation, we can predict the velocity and height profile in the subcritical region. The balance of momentum and mass equations across the jump are taken in both the radial and azimuthal directions, which was not done previously. With this new proposed theory, the shape of the non-circular jump can be determined more accurately instead of just a mean radius, and the velocity and height profile of the jump are determined as well.

Word count: 174

REFERENCE

ELLEGAARD, C., HANSEN, A. E., HAANING, A., HANSEN, K., MARCUSSEN, A., BOHR, T., HANSEN, J. L. & WATANABE, S. 1998 Creating corners in kitchen sinks. Nature 392, 767–768.

WATSON, E. J. 1964 The radial spread of a liquid jet over a horizontal plane. J. Fluid Mech. 20, 481–499.

BUSH, J. W. M. & ARISTOFF, J. M. 2003 The influence of surface tension on the circular hydraulic jumps. J. Fluid Mech. 489, 229–238.