

The surface pressure p_s is therefore enormous by ordinary standards but is a small fraction of the total pressure P_o of the water jet.

The final equation of motion relates the decay of streamwise momentum flux ρu^2 to the shear stress τ on the cutting surface:

$$\frac{d}{ds} \int_0^d \rho u^2 dn = -\tau. \quad (9)$$

Strictly speaking, the integral should contain pressure terms as well, but equation (8) implies that the pressure p is of order $(d/R)\rho u^2$, which is negligible compared with ρu^2 under approximation (5). The neglect of pressure in the streamwise-momentum equation (9) is analogous to the boundary layer approximation in classical fluid dynamics.

Equation (9) can be transformed into a less familiar form, but one better suited to later calculations. Note first that the derivative d/ds with respect to arc-length can be written as $(-1/R) d/d\theta$ by virtue of equation (2). The momentum integral appearing in (9), moreover, is exactly the same as the integral in (8), regardless of how $u(s,n)$ may vary with n . The streamwise-momentum equation thus takes the form

$$\frac{d}{d\theta} [R(p_s - p_a)] = R\tau, \quad (10)$$

which will become a differential equation for $R(\theta)$ under appropriate assumptions about τ .