Optimal Standoff Distance in Waterjet Cleaning

Last year Gu, et al.* presented a paper on the subject of optimal standoff distance in high pressure waterjet cleaning. Here are the highlights.

Experimental data of jet striking force with water jets of 0.97 to 3.57 mm in diameter striking at the target perpendicularly are shown in **Figure 1***. This plot indicates that the strike force of the jet reaches its maximum when the ratio of standoff distance L and nozzle diameter D_0 is 100. Calculations were done to offer explanations for this phenomenon.

The strike force of a continuous water jet can be calculated with this equation: $F = \rho_w Q v$

where ρ_w is water density, Q flow rate, and v speed of jet.

However, as the standoff increases, air will be mixed into the jet to turn it into a spray. The density of the air/water mixture ρ_w was related to the standoff distance and nozzle diameter with this equation:

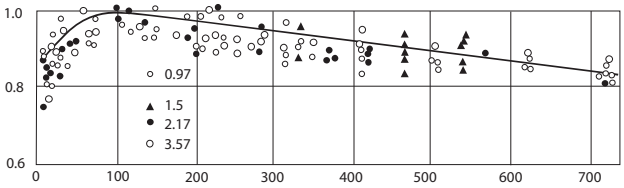
$$\frac{\rho_m}{\rho_w} = \frac{L/D_0}{(2.7/L/D_0) - 20} + \frac{8D_0}{L}$$

When the air content, expressed with the ratio a = $(\rho_w - \rho_m)/\rho_m$, exceeds 1/10–1/6, the water spray will transform into an air bubble spray. The strike pressure of the air bubble spray p_i can be calculated with Lord Rayleigh equation:

$$p_i = \frac{p_s}{6.35}\exp(\frac{2}{3\alpha})$$

where p_s is the strike pressure of a normal water spray.

The strike pressure of an air bubble spray is typically 8.6–12.4 times of a normal water spray. When the L/D_0 ratio is 100, the air content is 52 percent, and thus an air bubble spray is formed. Even though the density of the air/water mixture is decreasing as the standoff distance increases, the combination of air bubble bursting and spray striking actually enhances the strike pressure. But when the L/D_0 ratio is more than 100, the strike force attenuates.



Gu, Chun, Li, Angui, & Liu, Tingcheng (2006), "Optimal standoff distance of water spray cleaning," in Proceedings of the 8th Pacific Rim International Conference on Water Jet Technology, *Oct. 10–12, Qingdao, China, Paper 31.*

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