Partially confining the flow from an orifice with a short cylindrical chamber can produce a naturally-excited oscillating-jet flow. With a circular inlet, the diameter expansion ratio from orifice to chamber must exceed about five, $D/d_1 \gtrsim 5$, and the length ratio of the chamber must be in the range $2.6 \lesssim L/D \lesssim 2.8$, usually with a small circular lip attached at the chamber exit, $0.8 \lesssim d_2/D \lesssim 0.9$. A device with these geometric parameters is patented as the “fluidic-precessing-jet” (FPJ) nozzle.

Dimensional analysis suggests that Strouhal number of oscillation depends on parameters representing the chamber geometry and the inlet-orifice Reynolds number $Re_1$. Since $L/D$ of the FPJ nozzle is constrained within a narrow range, only variations in expansion ratio are likely to have a significant effect on Strouhal number; i.e. $St_1 = f(Re_1, D/d_1)$. A least-squared fit to published and new FPJ data produces

$$St_1 = \frac{f_p d_1}{U_1} = 7.6 \times 10^{-3} \left( \frac{D}{d_1} - 1 \right)^{-1}, \quad 4.3 \leq D/d_1 \leq 9.1 \quad (1)$$

with r.m.s. error of 7%. However, generating large-scale oscillation does not require the inlet orifice to be circular. With a triangular inlet, self-excited oscillation is obtained for expansion ratios much smaller than the FPJ’s lower limit of $D/d_1 \approx 5$.

The precession rate of oscillating-triangular-jet (OTJ) flow is rather different. A straight-line of best fit to the OTJ data gives

$$St_1 = 0.475 \times 10^{-3} \left( \frac{D}{d_{e1}} - 1 \right) + 0.129 \times 10^{-3}, \quad 2.1 \leq D/d_{e1} \leq 3.5 \quad (2)$$

with an r.m.s error of 2%. In Equation 2, $d_{e1}$ is the equivalent diameter of a circle with the same area as the triangular inlet. The lines of best fit for the OTJ oscillation rate (Equation 2) and for the FPJ oscillation rate (Equation 1) intersect at the minimum viable expansion ratio for the FPJ, $D/d_1 \approx 5$.

Power spectra obtained from FPJ flow have a broad peak at the precession frequency. A corresponding signal from the OTJ is aperiodic and the power spectrum has no peak. If we use the “maximum entropy method” of estimating (auto-regressive) power spectra, we find that poles of the spectra fall into three widely separated groups at low, middle and high frequencies. The middle group of poles ($0.002 \lesssim St_1 \lesssim 0.003$) are near the FPJ oscillation frequency given by Equation 1. The low-frequency poles are scattered around the observed OTJ Strouhal numbers (Equation 2). The high frequency poles are close to the cut-off frequency of a filter which was used for the data collection. For FPJ with $D/d_1 = 5.0$, the non-dimensional spectra become independent of Reynolds number as $Re_1$ exceeds 63,000. With the OTJ we can obtain spectra for smaller expansion ratios. However, as OTJ expansion ratio decreases, independence from $Re_1$ is lost. For $D/d_{e1} = 3.5$, the dependence on Reynolds number is weak; it takes the form of a vertical shift in the spectrum of about 30% over the Reynolds-number range $40,000 \leq Re_1 \leq 100,000$. At smaller expansion ratios ($2.1 \leq D/d_{e1} < 3.5$), the spectrum varies with Reynolds number in a more complex manner.

**Topic:** Turbulent Wall-Bounded Flows