Possibility of Universal CFVN
-- Forced Boundary Layer Transition in CFVNs --

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CFVNs (Critical flow Venturi nozzles) are exclusively accurate devices to measure gas flow-rates, however, they have relatively large instabilities at the Reynolds number of about 10^6 owing to the boundary layer transitions, that makes the users of CFVNs be advised not to use them in the transition regimes. The transition causes a jump in the discharge coefficient by about 0.2% in the Reynolds number range from 1×10^6 to 2×10^6 when the CFVN is complying with ISO 9300 toroidal throat (R=2D, R is the inlet curvature and D is the throat diameter) and has a mirror finish on its surface. It is also widely considered that the magnitude of the jump depends on the surface quality of the CFVN which affects the transition location along the surface. It is shown in the paper that a rough surface artificially created on the inlet contraction of CFVNs lowers the transition Reynolds numbers with keeping the stability of their flow-rates in the same degree as those without the transition. The lowered transition Reynolds number results is the smaller jump of the discharge coefficient caused by the transition. An optimum rough surface in a R=1D toroidal throat CFVN resulted in a smooth transition of the discharge coefficient without any jump. Experimental results on the forced transitions in CFVNs of various R/D are shown in the paper and a possibility of the "Universal CFVN" that has a smooth curve of the discharge coefficient over the full range of the Reynolds number from the laminar to the turbulent boundary regimes are discussed.
