Influence of Upstream Shape Factors on Discharge Coefficient of Critical Flow Venturi Nozzles

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In this publication, the influence of the shape and surface quality upstream of a throat of critical flow Venturi nozzles on the discharge coefficient in general and the transition of the character of boundary layer from laminar to turbulent in particular has been studied experimentally as well as numerically.

Several nozzles of 2 - 10 mm throat diameter with intake radius of curvature of 2 D^* and 1 D^* (D^* being the throat diameter) and intake pipe diameter 2.5 and 3 D^* have been first investigated experimentally in the high pressure natural gas facility pigsar in Dorsten, Germany, at pressures up to 50 bar, resulting in Reynolds numbers larger than 2 10^6 . Two of the nozzles were cut in two halfs axially in order to make the treatment with flat black paint and coating with shear sensitive liquid crystals easier. The purpose was the visualization of the transition from laminar to turbulent flow.

Subsequently, in some of the nozzles, the exact shape was determined at the PTB facility, and afterwards, the discharge coefficient in the transitional range of Reynold numbers of the nozzles was again determined at the PTB. Depending on the radius of curvature in the intake, the effect of the transition on the discharge coefficient was more or less pronounced.

In parallel effort, the same nozzles were studied using numerical flow simulatrion. Here, the highly accurate code ACHIEVE with nonlinear turbulence models k-ε and k-ω being applied. The bypass transition model of Abu Ghanam - Shaw was used to predict the location of the transition. The results were consistant with the experimental data.

The full paper will present the details of the above experimental and numerical work.

Keywords: flow metering, critical flow Venturi nozzle, numerical flow simulation, transitional flow, discharge coefficient