Back Pressure Ratio Behaviour for Critical Flow Venturis and the Effects of Diffuser Design on Performance

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Critical Flow Venturi (CFV) gas flow meters must establish a sonic velocity (or choked flow conditions) at the throat for reliable flow measurements. The ratio of maximum exit pressure to inlet pressure that ensures sonic velocity is referred to as the Maximum Back Pressure Ratio (MBPR). Being able to accurately predict the MBPR for a specific CFV as well as design a CFV to have a high MBPR allows diverse application and confidence in the flow measurement. Current standards provide MBPR equations for nozzles operated at throat Reynolds Numbers (*Re*) above 200,000. Previous research has provided a MBPR equation for specific diffuser geometries down to a *Re* of 3000 when flowing dry air. This previous research also showed that CFVs with long diffuser lengths displayed no Diffuser Performance Inversion, DPI, or what has previously been known as "premature unchoking".

This paper presents unchoking test results from CFVs tested with carbon dioxide, helium, and sulfur hexafluoride. Collected data will be combined with previous unchoking data and re-processed to reduce *Re* errors due to assumed throat diameters. New equations for predicting MBPR for broader application are presented that incorporate the necessary effects due to *Re*, diffuser length, diffuser area ratio, and isentropic exponent.

Multiple CFVs were tested with static wall pressure taps located in the diffuser. These data were compared to theoretical diffuser performance. Further explanation of the mechanisms behind diffuser performance inversion is presented.

An acoustic method of detecting CFV unchocking was tested . This method provides a quick check that the velocity is sonic in the throat of the CFV and is a tool to demonstrate the actual throat velocity during DPI events.