

Study on Transducer Protrusion Effect of Ultrasonic Flowmeter Using Wind Tunnel and LDV

H. Hu¹, D. Zhu², L. Cui¹, C. Wang¹, T. Meng¹

¹National Institute of Metrology, No.18 Beisanhuan East Road, Beijing, China

²Tsinghua University, Beijing, China

E-mail (corresponding author): huhm@nim.ac.cn

Abstract: Transducer protrusion into the flow is one of the most important uncertainty sources of ultrasonic transit-time flowmeter. It introduces a symmetric error by local distortion of velocity profile along the acoustic path, and incomplete sampling of velocity along the path that arises from the transducer not being flush mounted in the conduit. Transducer protrusion effect depends on the protrusion ratio and the shape of the transducer mount. It should be estimated and corrected for flowmeters without being calibrated using flow standard facility. A stretchable model transducer made of plexiglass is mounted on a flat plate in wind tunnel. Local velocity distributions are observed along possible acoustic paths using Laser Doppler Velocimetry (LDV) technology. Three different positions of transducer protrusion are tested to analyse mechanism of protrusion effect and its correction method. Assume that the transducer protrusion only distorts path velocity profile in a certain distance and velocity profile out of this distortion distance stays the same, protrusion effect for different path lengths can be estimated using a three-zone (two distorted velocity zones at both ends and one undistorted zone in the middle) distance-weighted averaging method. Based on this quantitative analysis of protrusion effect, better measurement performance should be obtained for flowmeters with similar transducer design. Although the experiment is done in a wind tunnel, it also fits water flowmeter after a scale conversion under Reynolds law of similarity.

Key words: flowrate, ultrasonic transit-time, transducer Protrusion, wind tunnel, LDV

