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An Innovative Technology for Coriolis Metering under Entrained Gas Condition

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Coriolis mass flowmeters are widely accepted in various industries as high reliability and accuracies can be offered for density and mass flow rate measurements. In practice, Coriolis flowmeters are usually used for single-phase fluids, i.e. either liquids or gases, since it has been known that their accuracies can be affected by the existence of entrained gas in a liquid flow. A number of research activities have been carried out in the past to understand the error mechanisms of Coriolis metering under two-phase conditions. It is now known that there are various error sources, among which the significantly increased compressibility due to the gas entrainment brings the most difficulty to field applications of Coriolis flowmeters. Based on the profound knowledge and experience in Endress+Hauser, the leading supplier of Coriolis flowmeters, the authors developed a new generation of Coriolis sensor together with an innovative technology, Multi Frequency Technology (MFT), which can compensate the measurement errors introduced by the elevated compressibility of an entrained gas flow. Differently from a conventional Coriolis flowmeter that performs the basic measurement at only one tube resonance mode, the new Endress+Hauser Coriolis sensor provides a novel hardware platform so that a higher natural mode of the measuring tube can be reliably excited, in addition to the basic working mode. Being driven at different frequencies, the same two phase fluid in the measuring tube can have different influences on the primary mode (i.e. the basic working mode) and the auxiliary mode (i.e. the higher tube mode). The innovative MFT enables the signal processing being simultaneously performed at two different signal frequencies. By analyzing the corresponding vibrational response of the two phase fluid at the two frequencies, the unique resonance property of this mixture can be obtained and the induced measurement errors can be compensated. In this paper, the theoretical background of Coriolis entrained gas metering is given, and the basic principle of the MFT is explained in detail. Measurement data obtained at an independent laboratory and during a field test are provided for the validation of this technology.