Multiphase Flow Metering and Tomography Technology

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Abstract

Due to the difference from process, the challenges in multiphase flow metering are varying depending on specific process. The topic is still kept as one of emergent engineering problems in modern industries. This presentation takes one of multiphase flow problems in gas-oil production as a case study to address the unique feature and performance of multiphase flow measurement. It reviews the status of commercially available multiphase flow metering technologies and challenges in practical use and expresses advances of process tomography for multiphase flow visualisation and measurement, as well as addresses the opportunity and prospecting in future technology trends.

The performance of gas-oil-water three-phase pipeline flow meter is mainly specified by the field configuration (calibration process, phase densities, viscosity of fluids, salinity), daily production (flowrate) of each phase, uncertainty (on range-ability, repeatability and stability, flow regime dependency). Among them, the expected measurement uncertainty would be highly depended on application. The typical uncertainties are 5-10% for reservoir management (single well surveillance), 2-5% for production allocation, and approximately (at central station) 0.25 to 2% for fiscal metering (production). Flow meters in the Oil & Gas market have high capital costs and high profit margins, with most products selling for US$100,000 – US$500,000 plus up to 25% installation costs per unit. The life span of these systems is typically a maximum of 4 years. Current claims on measurement uncertainty are a relative error of less than 5 to 10% for phase flow rate and an absolute error less than 2% on water cut. Tomographic imaging has unique features at “seeing” through the optical opaque medium and “building” up a volumetric view of multiphase dynamics in process pipelines or reactors in a nonintrusive manner. The visualisation and measurement multiphase flow meter (VMMF) developed by the University of Leeds has utilised tomography and other sensing techniques for three-phase flows. It is a potential technology for single well installation due to its safe, low cost, nonintrusive and no mechanical motion in operation, particularly with an advantage on flow regime visualisation. A non-nuclear densidometer is reported, which has been applied as a replacement of gamma-ray based meter in dredging application. A recent progress on development of in-pipe rheology and mixing characterisation using electrical resistance tomography sensing method is also reported, which demonstrates its potential in industrial application.

Considering emergent challenges from multiphase, multicomponent flow measurement and characterisation in future manufacture, the technology trends multiple-science based sensing technologies, spatial and temporal domain analyses, and advanced data fusion method.