On-site calibration of LNG Flowrate Measurement with a cryogenic LDV standard

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A very promising alternative to the state-of-the-art static volume measurements for Liquid Natural Gas (LNG) custody transfer processes is the dynamic principle of flow metering. In the frame of the first (2010-2013) & second (2014-2017) Joint Project Research "METROLOGY for LNG", CESAME EXADEBIT explored a novel cryogenic flow metering technology using Laser Doppler Velocimetry (LDV).

The Physikalisch-Technische Bundesanstalt (PTB) performed by a similar approach the development of an optical-based primary standard for implementation in natural gas under high Pressures (up to 5.5 MPa). The CESAME EXADEBIT study focused on the technological challenges and solutions for extending the LDV method to cryogenic temperatures, and on the uncertainty estimation that can be realistically achieved with such equipment to measure the LNG flowrate.

Cryogenic flow meters are currently calibrated with water at ambient temperature over a small range of Reynolds number. Results extrapolation must be realized to fit the real Reynolds number conditions resulting with worst measurement accuracy and a larger uncertainty on the volumic mass flow rate. The cryogenic LDV standard can be a credible alternative to perform on-site calibration of ultrasonic and Coriolis flow metering with real conditions (fluid properties, Reynolds number, and velocity profile). Furthermore, the cryogenic LDV standard is traceable to SI units.

The paper presents the following results:

- Study of the technical solutions to perform LDV measurements in cryogenic conditions (optical windows, vacuum insulation, seeding…)

- Assessment of the volume flowrate measurement of cryogenic fluid with a simplified measurement package by means of experiments conducted with nitrogen in the National Institute of Standard and Technology in Boulder, Colorado.

- Uncertainty budget of the cryogenic LDV standard.