GASEOUS CO2 FLOW METERING USING AVERAGING PITOT TUBE WITH FLOW CONDITIONING WING

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Abstract:

Carbon Capture and Storage (CCS) technology has been proposed as an abatement tool to combat and reduce the growing emissions of CO2. CCS facilities are intended to capture CO2 at power stations or other industrial plants, transport and store it in permanent storage sites such as saline formations and depleted oil and gas reservoirs. The measurement, accurate accounting and monitoring of CO2 across the entire CCS chain is vital to lift the strict regulations from legislative bodies off the full deployment of CCS and create a more positive public perception towards CCS. As a practical contribution to support this effort, one of the objectives of this research is to establish a CO2 flow measurement facility where various metering instruments can be tested or calibrated. The facility has an ultimate progressive goal to test gas, liquid and then two-phase mixtures of CO2. Flow meters based on Averaging Pitot Tubes (APTs) have been well researched in recent years, however, their performance in the metering of CO2 flow is largely unknown. This research attempts to evaluate the performance of one of the most advanced APTs in the field.

As a first step, the facility was developed to test the gas phase of CO2 using a weighing scale as the primary calibration reference. A Coriolis mass flow meter was calibrated in this facility and its performance was evaluated. Because its measurement results in comparison with its original factory calibration are well within the manufacturer's specifications, it gives us confidence to use the Coriolis flow meter as a secondary calibration reference. With these two references available in this facility, an Averaging Pitot Tube (APT) with Flow Conditioning Wing (FCW) geometrical shape as a cost-effective means to measure CO2 flow was experimentally assessed. A target accuracy of ±1% was set for both metering devices. A batch size of around 700g was tested across five different flow rates (4, 6, 8, 10 and 12g/s). Results from the experimental study indicate that the Coriolis meter and APT sensor performs well within the predefined error band. Additional analysis of the test results shows that measurement uncertainty in the case of both metering instruments is under ±3%.

Future work is set to focus on flow measurement for different velocities under an isobaric condition to further assess the APT-FCW as a viable and robust option for gaseous CO2 flow measurement.

Keywords: carbon capture and storage, carbon dioxide, flow measurement, averaging pitot tube, flow conditioning wing, coriolis mass flow meter

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