Coriolis Technology - Ambient Temperature Compensation

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Detecting and Correcting for Coriolis Meter Calculated Fluid Density Drift due to Ambient Temperature Variation

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Research Overview

TUV SUD NEL have researched ambient temperature effects on Coriolis flow meters as part of an engineering doctorate programme supported by Coventry University, with additional external supervision from Oxford University.

- Phase 1 of research tested multiple Coriolis meter designs [1]
- Results highlighted that the fluid density value output by the technology is prone to error, which can be directly correlated with variations in the surrounding ambient air temperature
- Vendor partnership formed for Phases 2 & 3. The objective - Development of a solution to this form of error, which can be implemented on existing meter designs and future products

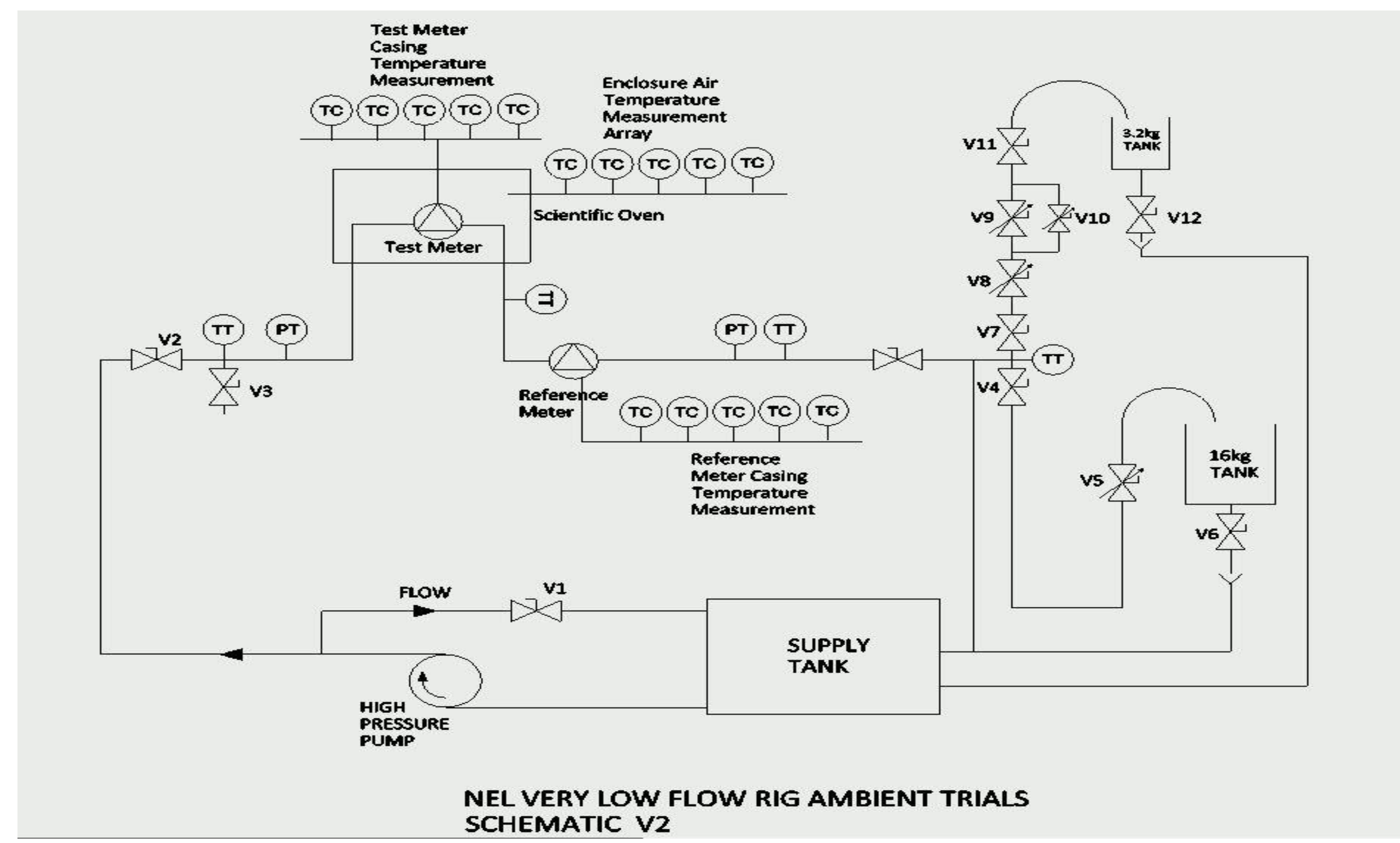

Fig. 1 - NEL's Very Low Flow Facility. Setup used in all research phases
Test section was modified to include a scientific oven for ambient air testing. Additional secondary instrumentation (temperature and pressure) added to monitor fluid properties at key locations. 'Test meter' installed in oven. 'Reference meter' installed directly downstream and open to room temperature (controlled to 20°C). Tests were repeated across 3 fluids of differing properties. [1], [2]

Error in Existing Temperature Compensation Methods

Fig. 2 shows a sample dataset from Phase 2, highlighting the performance of the temperature compensation methods currently used by the vendor. [2]

- There is a clear correlation between the test meter density value and the ambient air temperature changes
- The actual fluid properties were confirmed to be stable by both the secondary instrumentation and the downstream reference Coriolis meter
- Access to the patented algorithms, digital process parameters and meter internals allowed for the route cause of the errors to be targeted during analysis

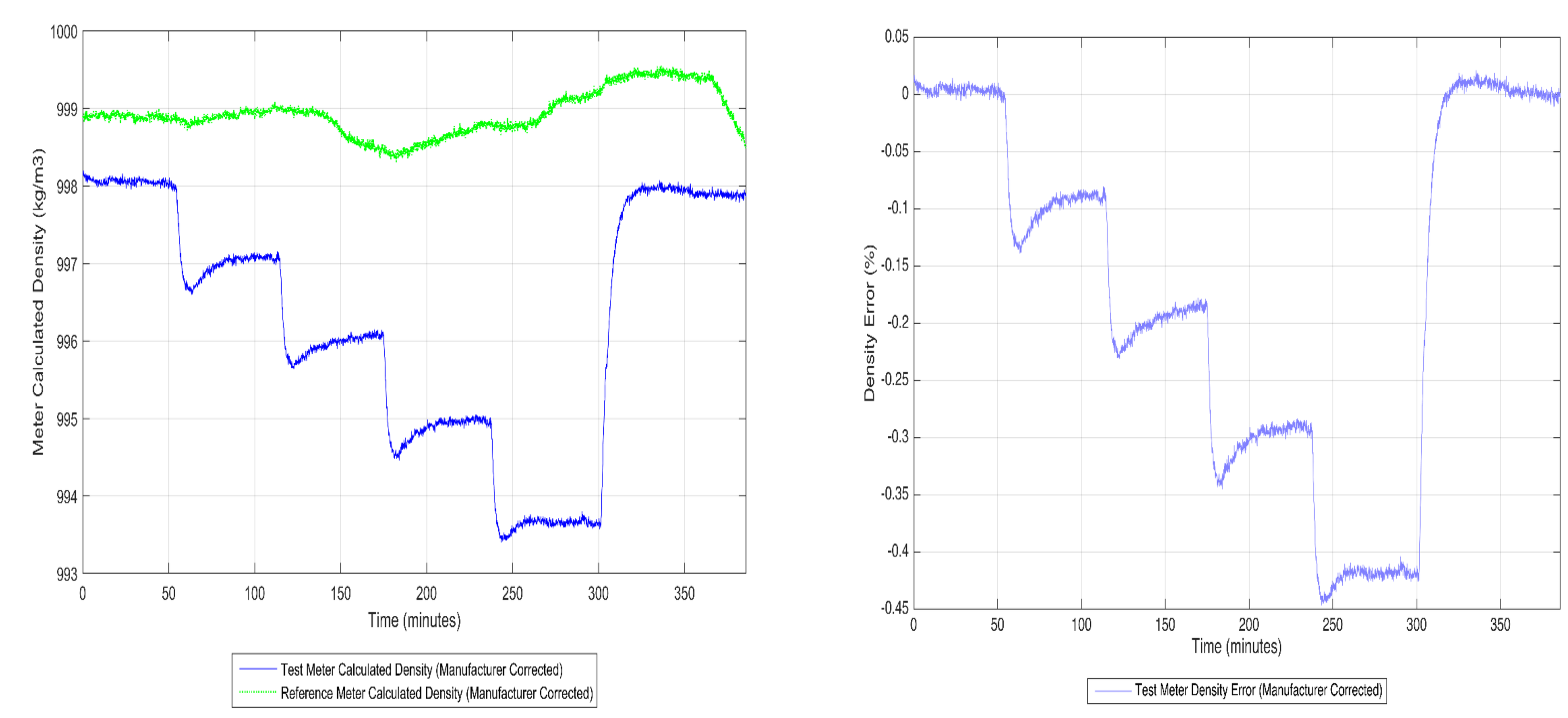

Fig. 2 - Effect of increasing ambient air by 10°C every 1hr (20°C – 60°C)
With water present in the system, the results show that at the maximum ambient temperature tested, the 'test meter' density output contained a **-0.42% error** with respect to the live calculated fluid properties. 'Reference meter' shows stable fluid properties (noting an initial 1kg/m3 offset between meters in baselines) [2]

New Density Correction Model

The results shown in Fig. 3 demonstrate the performance of a new temperature compensation model, which was developed using the Phase 2 research data. [2]

- The new model correctly detects the potential for an increase in error due to high temperature differentials in the system
- The model also makes a determination of the additional fluid property effects on the thermal stability of the system
- Resulting output is a density value which is consistently representative of the fluid present in the meter internals
- The observed lag in response of the new correction method is due to legacy sensor positioning on the meter body as well as the physical properties of mechanical components
- Phase 3 research has focussed on reducing this lag for the final form of the solution.

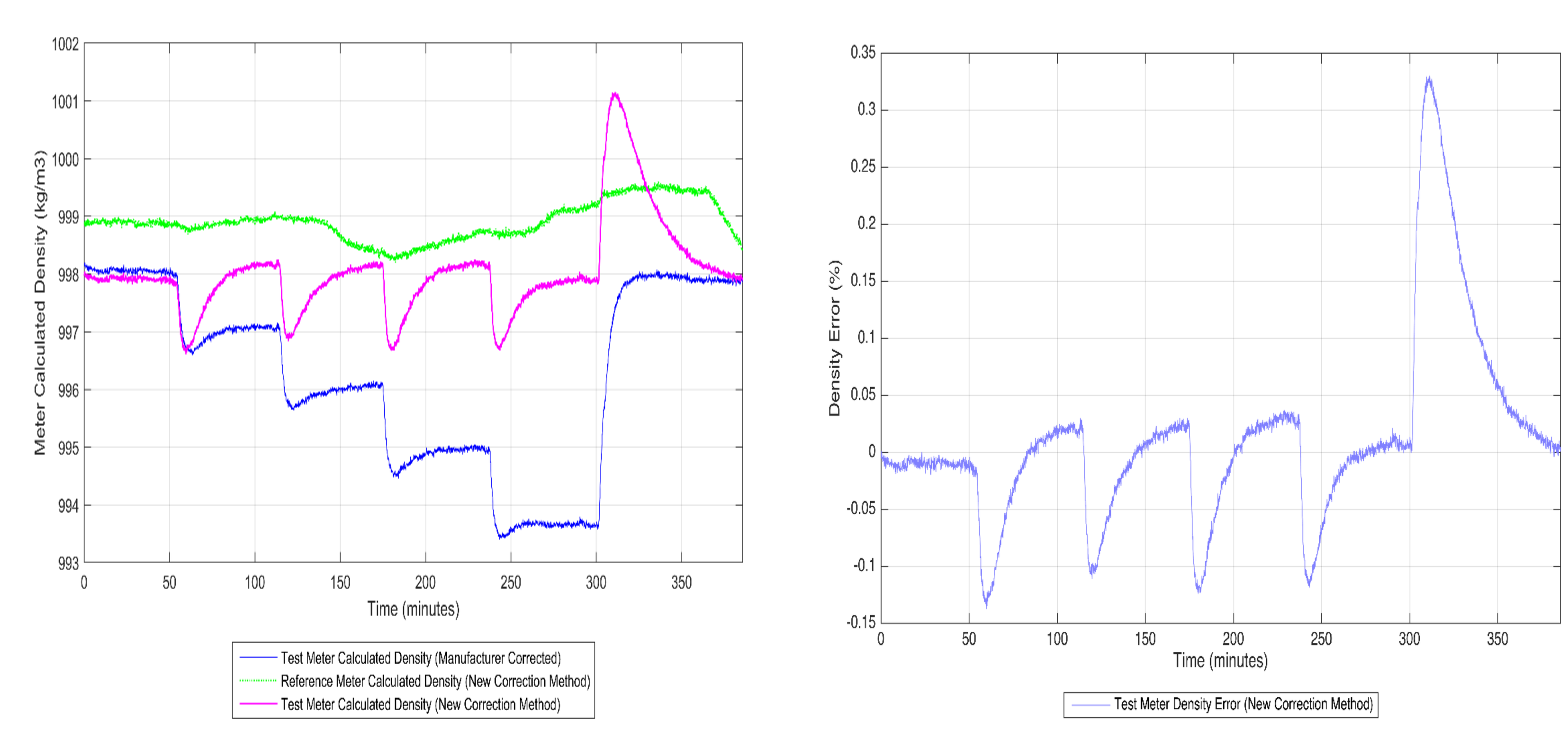

Fig. 3 - New Correction Model Results
The additional trendlines added to the data from Fig. 2. show that as a result of implementing the new model, the density error per 10°C air temperature increment is now limited to a temporary value of **-0.12%** and recovers to the expected value as determined by both the reference meter and live fluid property calculation. [2]

References:

1. LINDSAY, G., HAY, J., GLEN, N. and SHARIATIPOUR, S. Profiling and trending of Coriolis meter secondary process value drift due to ambient temperature fluctuations. In: Flow Measurement and Instrumentation, Vol 59, Pgs 225-232, March 2018.
2. LINDSAY, G., GLEN, N., SHARIATIPOUR, S., HENRY, M. and CHURCHILL, S. Detecting and Correcting for Coriolis Meter Calculated Fluid Density Drift due to Ambient Temperature Variation In: Proc. 36th Int. North Sea Flow Meas. Workshop, Aberdeen, 2018