COAT Micromotion Sensor Density Calibration Procedure

The goal of the procedure is to calibrate individual Micromotion (MM) sensors to match the ASTM D4052 density of a standard oil. The standard oil will be current COAT reference oils as outlined in the LTMS. ~~The standard oil will be COAT reference oils 832 or 833~~. The procedure uses linear regression to compare the D4052 densities to those measured with the sensor at similar temperatures. The slope ~~gain~~ and intercept from the linear regression are incorporated in the data acquisition system and recorded through LTMS at TMC.

1) Use a 2013 or newer CMF025M and paired transmitter that is shown to be in good working order by Emerson Processing – Micro Motion Division.
2) Input all Emerson supplied meter calibration coefficient values into the Transmitter using a Hart Communicator, or other device. These coefficients may not be adjusted unless the sensor is recalibrated by Emerson.
3) Set the Micro Motion Density output range from 0 g/mL to 1 g/mL
4) Report the values of the slope and intercept.
    a. (Note: to be moved to a supplemental reference document) Example: ~~Some labs may read 4-20 mA for outputs, but you may convert to 1-5 Volt using 250 Ohm high accuracy resistors.~~ The density output signal can be in mA, or V. If the DAQ is reading voltage (1-5 V) from the MM output, then uncorrected slope and intercept will be 0.25 and -0.25 ~~0.5 and -0.5~~, respectively. If DAQ is reading milliamps (4-20 mA) from the MM output, then uncorrected slope and intercept will be 0.0625 and -0.25 ~~0.125 and -0.125~~, respectively. Labs may have different signal conditioning and hence may have different slopes and intercepts.
5) Initial calibration of each device will require setting its MM Density DAQ coefficients slope and offset to mathematically uncorrected values. Only first-order corrections are allowed.
6) Per Section 10.2 through 10.2.5 *Aeration Pretest Procedure* run two flushes of reference oil to remove hang-up from previous fluids and use a CAT 1R-1808 fresh filter with the first charge.
7) On the third and final charge, use a new approved batch controlled oil filter. Run the engine for 5 minutes at idle to flow the newest oil through the aeration measurement circuit (lines, sensor, and pump). After 5 minutes, stop the engine and leave it off until the all the next calibration steps are complete. This will add an extra 5 minutes of warmup time to a reference test.
8) Obtain D4052 density data from your laboratory at the intervals outlined in the COAT procedure and verify that the linear R^2 is greater than 0.9999. These data will be used to set the DAQ's new slope and intercept.
9) Set the sensor enclosure temperature controls to target the average of sensor in and sensor out temperature to 50°C (preferably within 2°C of target). The enclosure and measured oil temperatures must be stable ±0.75°C for at least 30 minutes. Record data at 1Hz for 120 seconds and average it. Note: This target setting and stabilization period can take up to 3 hours.
10) Repeat step 9 and target 60, 70, 80, and 90°C (or highest attainable temperature).

11) Using linear regression calculate the DAQ's New Slope and Offset using the calculated voltage or current readings and the D4052 Density values. These new coefficients will be added to the LTMS file for future reference.
    a. (Note: to be moved to a supplemental reference document) An example of the new slope and offset for voltage applications may be 0.523 and -0.492, respectively, for a 1-5V output signal.

    Alternatively, the DAQ channel can be corrected using a linear regression analysis of the density readings of the DAQ during calibration versus the D4052 density, and this slope and offset will be included in the LTMS file.
12) A calibration must occur during each Reference Test, but only a change in measured density of 1.0% or more at the 70°C (or highest measured temperature) will require change of the DAQ's slope and intercept. The Slope and Intercept will be included in the LTMS for each Reference event. An alarm will be set and repair required if the density measured is more than 2% different from the D4052 value.
    a. (Note: to be moved to a supplemental reference document) For example, oil **832** has D4052 value of .8392 at 70°C. If the new calibration coefficients produce a shift of more than .0084 g/mL, the new coefficients must be changed in the LTMS. If the shift is more than .0168 for oil 832 at 70°C, the sensor and transmitter must be evaluated by Emerson Process - Micro Motion Division.
13) All COAT candidate oil tests must use the slope and intercept calculated during a valid Reference test per step 12.