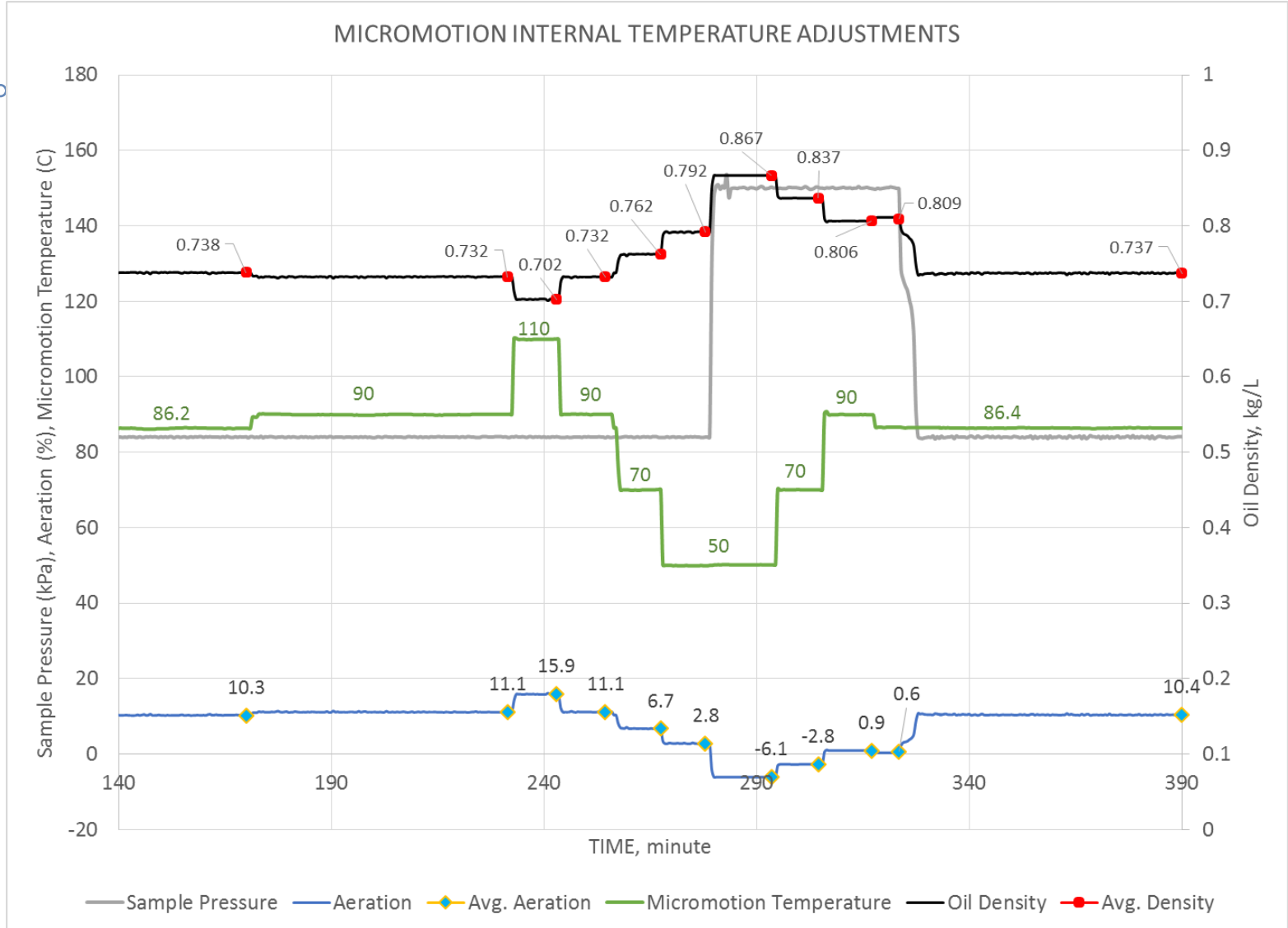


COAT MICROMOTION TEMPERATURE vs. DENSITY



DATA SET

MICROMOTION INTERNAL TEMPERATURE ADJUSTMENTS

Duration, min	Micromotion Temperature, C	Sample Pressure, kPa	Avg. Density, kg/L	Avg. Aeration, %	Density Change from Start	Aeration Change from Start
60	86.2	84	0.738	10.3	0.0%	0.0%
60	90	84	0.732	11.1	-0.8%	8.2%
10	110	84	0.702	15.9	-4.8%	54.6%
10	90	84	0.732	11.1	-0.8%	8.6%
10	70	84	0.762	6.7	3.3%	-34.2%
10	50	84	0.792	2.8	7.3%	-72.8%
10	50	150	0.867	-6.1	17.4%	-159.6%
10	70	150	0.837	-2.8	13.4%	-126.8%
10	90	150	0.806	0.9	9.2%	-91.0%
5	86.4	150	0.809	0.6	9.6%	-94.0%
60	86.4	84	0.737	10.4	-0.1%	1.3%

Each degree C offset adjusted density by 0.0015 kg/L.

Each degree C offset adjusted aeration by ~0.2%.

In this case, a 3.8C change in MM temperature made a 0.8% change in aeration.

Information From Emerson

May 11, 2016

- Micromotion adjusts for temperature of coriolis tube due to change in stiffness (modulus) of tube material.
- Tube material in new and old devices is the same.
- Tube dimensions in new and old devices are the same.
- Temperature is measured by RTD on exterior of tube.
- Micromotion software has linear correction available (Offset and Slope) to calibrate the RTD reading.
- Emerson does not calibrate the RTD.

Laboratory Findings

May 11, 2016

- The same sensor is used at all laboratories.
- At 90C controlled fluid temperature, all labs read ~86C on tube.
- Older 9 wire systems are effected by changes in tube temperature, new 4 wire systems are slightly, or not effected at all.
- Small changes in Micromotion temperature effect density linearly.
- Identical oils have measured different densities within the same lab, and between labs.

- Adjusting a newly calibrated older system to match fluid temperature helped it match a new system's results.

- The density difference noted when MM temperature matches fluid temperature could fail a reference or a candidate oil.

Questions for Emerson

May 11, 2016

- Why doesn't Emerson calibrate the RTD at higher temperatures?
- Does Emerson set the RTD temperature during its calibration? At what temperature?
- If sensors are identical and software allows for temperature calibration, why do old and new systems not react in the same manner? Do the new systems require additional authorization to respond to changes to slope and offset?
- Do new systems use the RTD temperature?
- Does the tube temperature measurement adjust only density, or also mass flow?