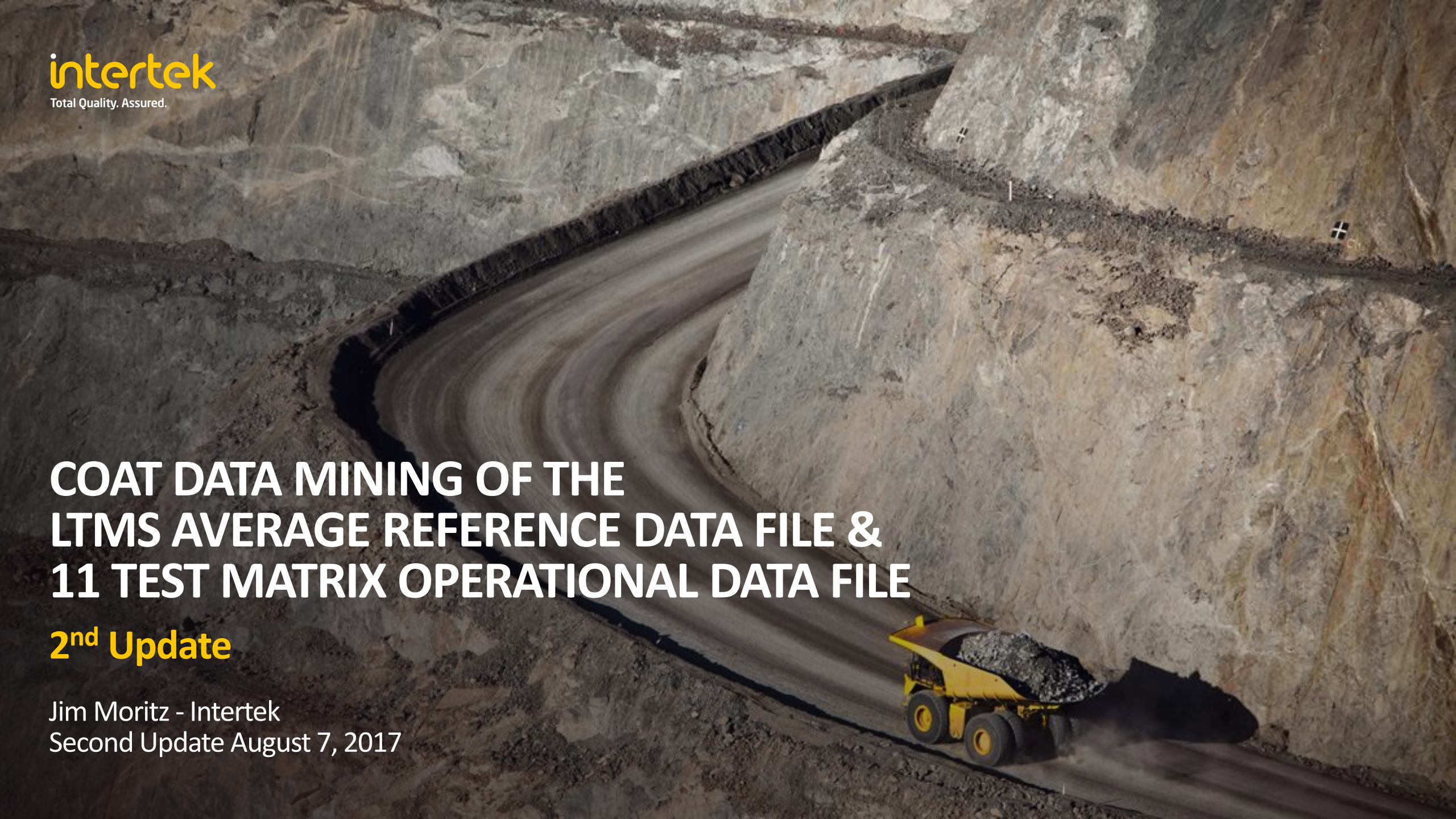


intertek
Total Quality. Assured.

COAT DATA MINING OF THE LTMS AVERAGE REFERENCE DATA FILE & 11 TEST MATRIX OPERATIONAL DATA FILE

2nd Update

Jim Moritz - Intertek
Second Update August 7, 2017

SECTIONS OF SLIDES

01 **Observations**

02 **LTMS Data File Relationships**

03 **Operational Data File Plots**

04 **Summary and Suggested Future Actions**

01

OBSERVATIONS

OBSERVATIONS FROM THE DATA

The data are telling us a lot.

All Chartable tests which date back to August 13, 2015 are used.

- Also used 3 tests on new filter/cal method that were later declared Non-Chartable.
  - There is useful information in those 3 tests.

The delta pressure between the 2 MM sample pressure values was calculated as a parameter.

- This seems useful.

There are still lab differences.

There are shifts in results that occurred before the MM calibration procedure.

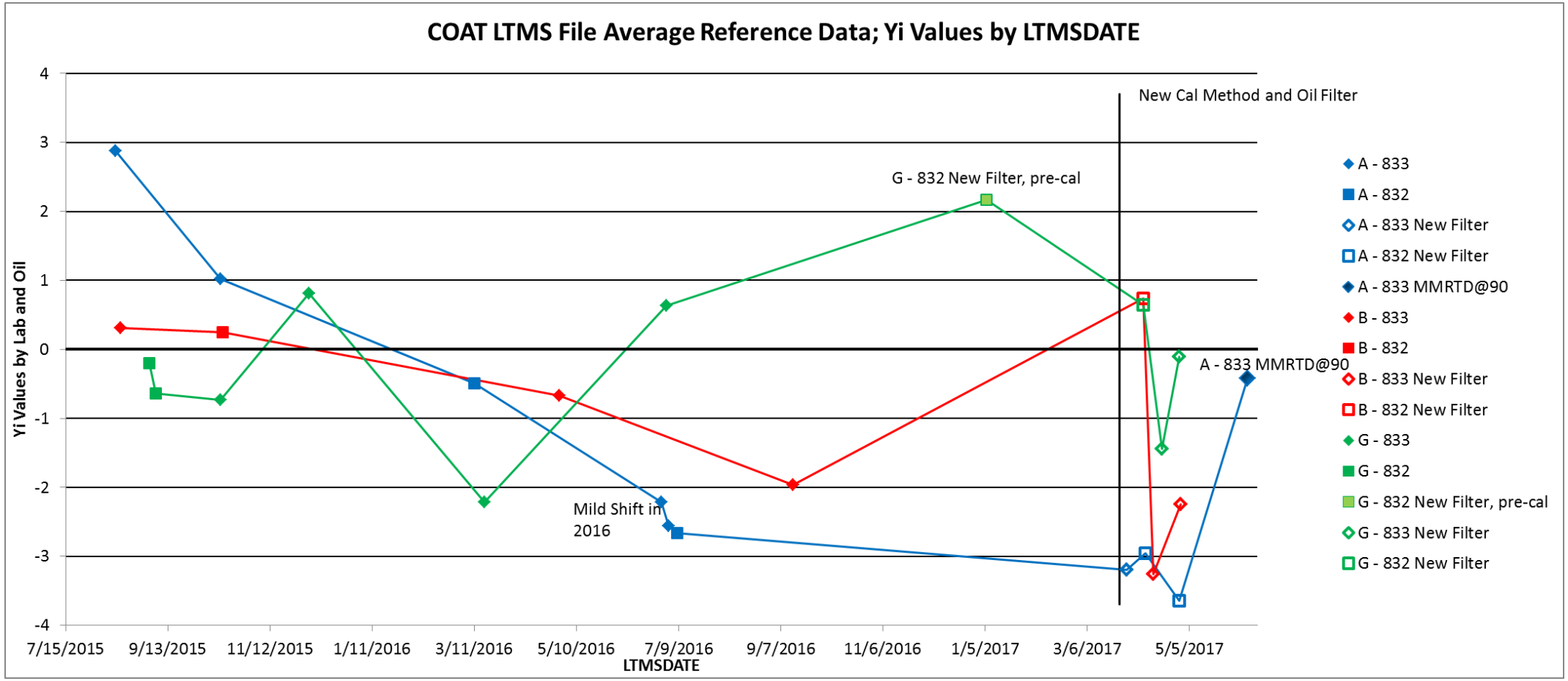
There are operational shifts that occurred at the time of the new calibration procedure.

02

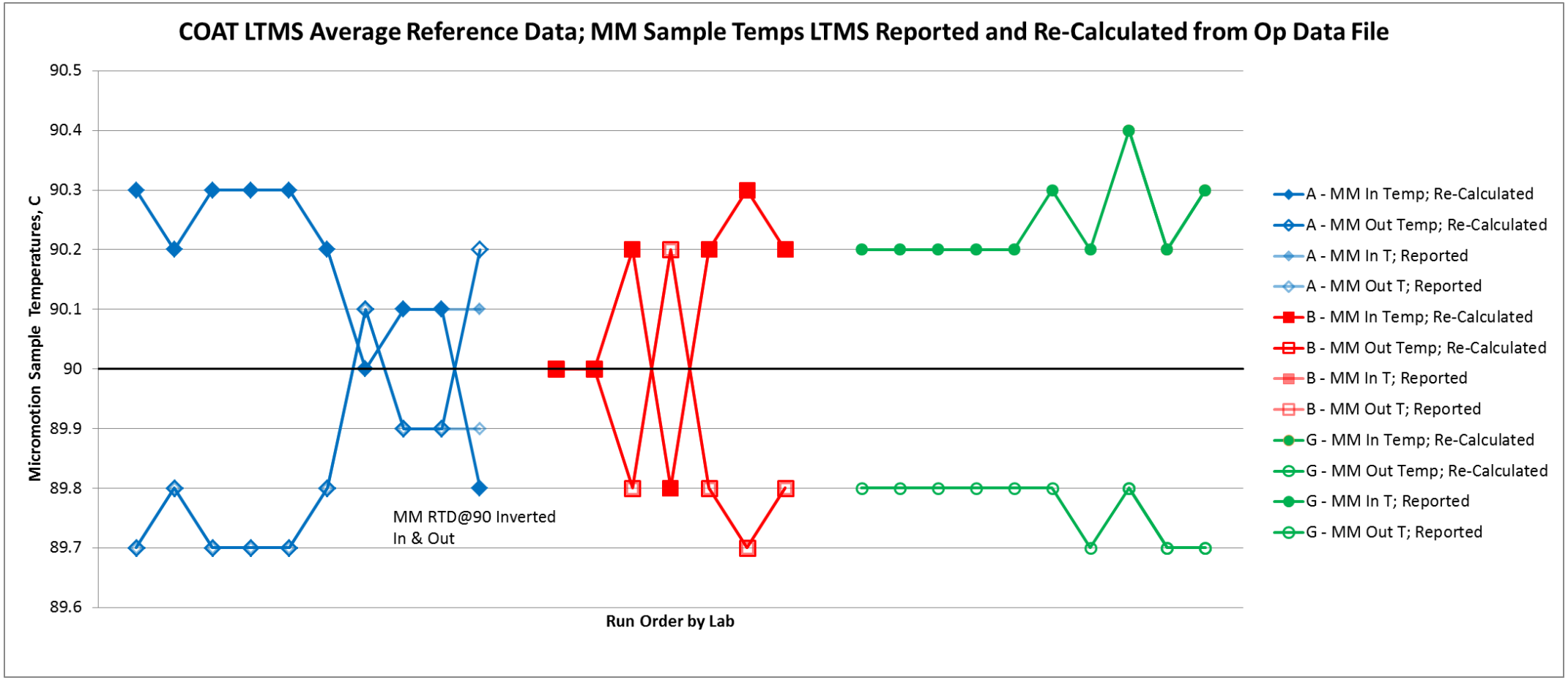
PLOTS FROM REFERENCE TEST REPORTED AVERAGES, (LTMS FILE)

Data Since August 2015

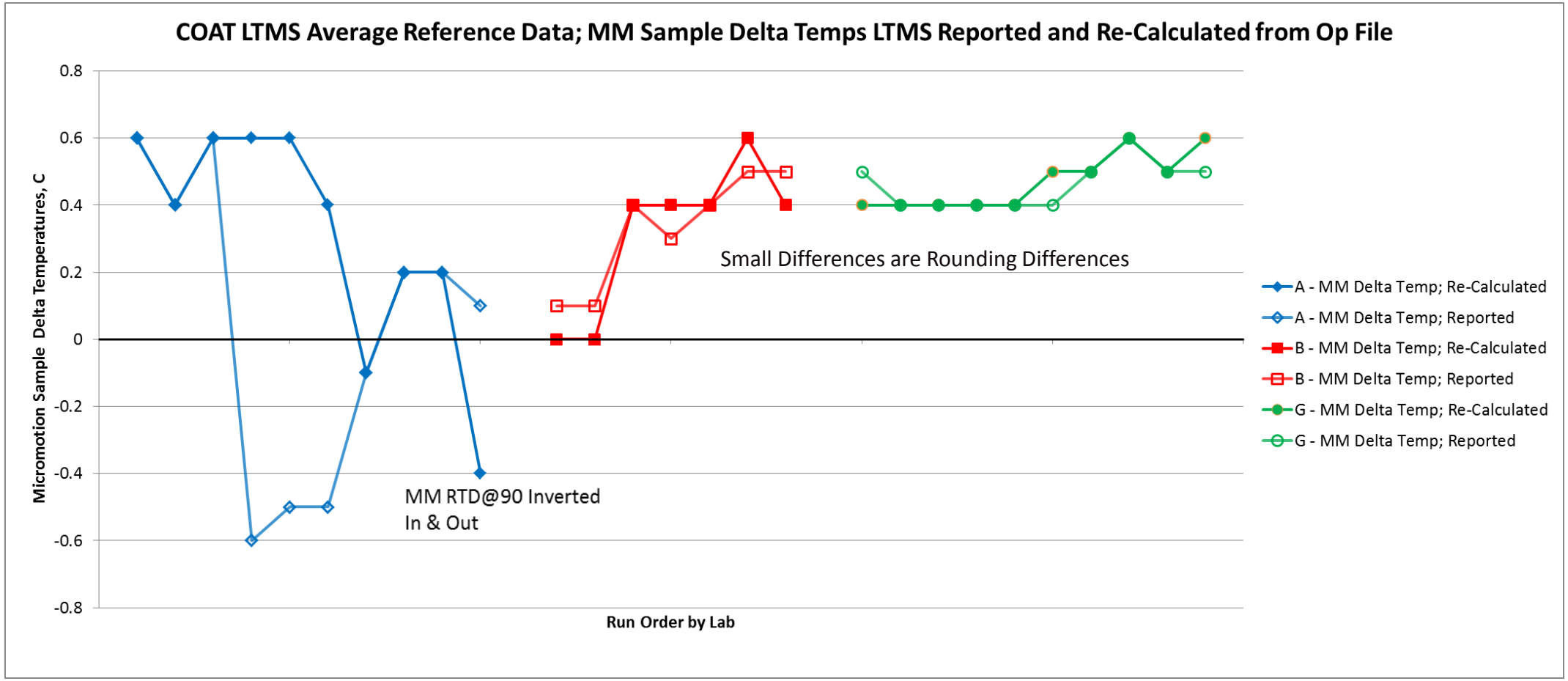
LAB YI RESULTS PLOTTED OVER TIME (LTMSDATE) PLOTTED BY LAB, OIL, NEW FILTER AND CAL METHOD



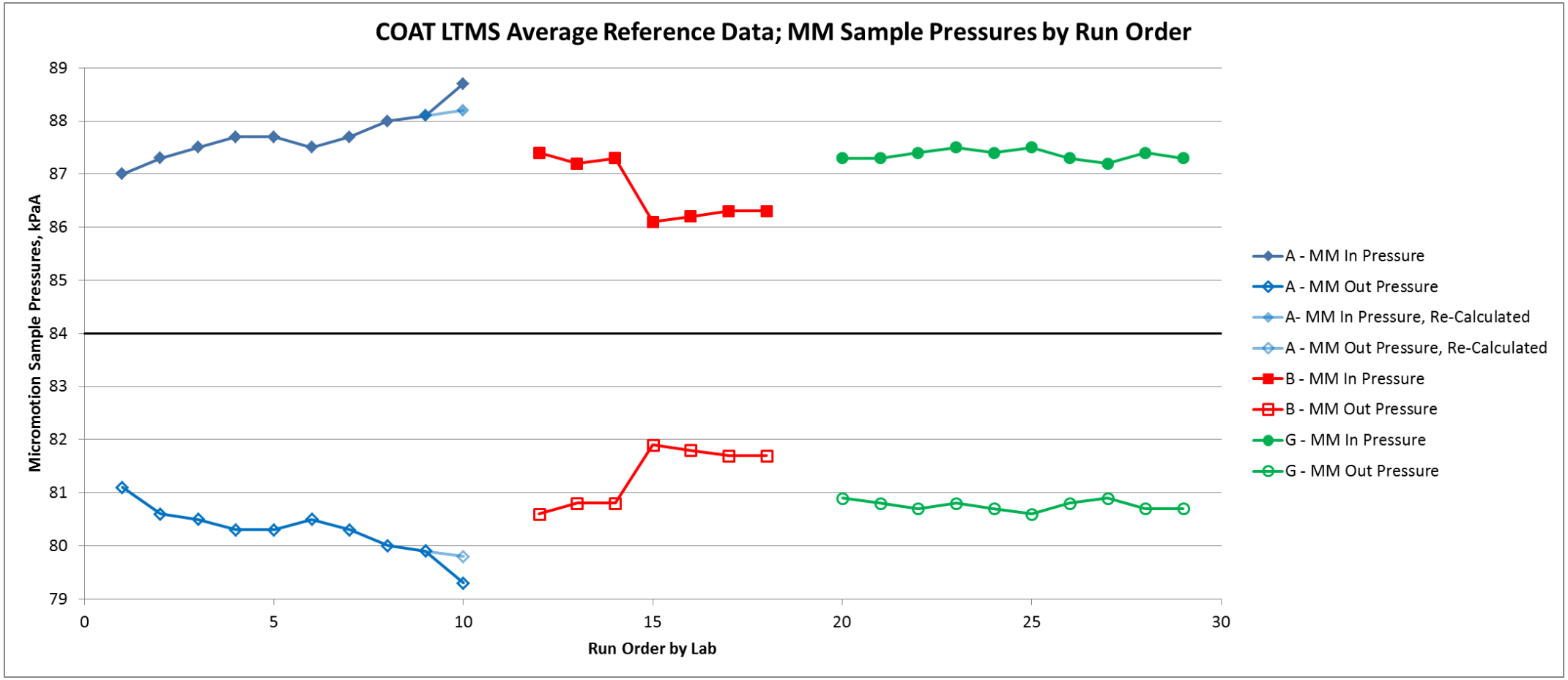
AVERAGE MICROMOTION OIL SAMPLE TEMPS (IN & OUT) OVER TIME



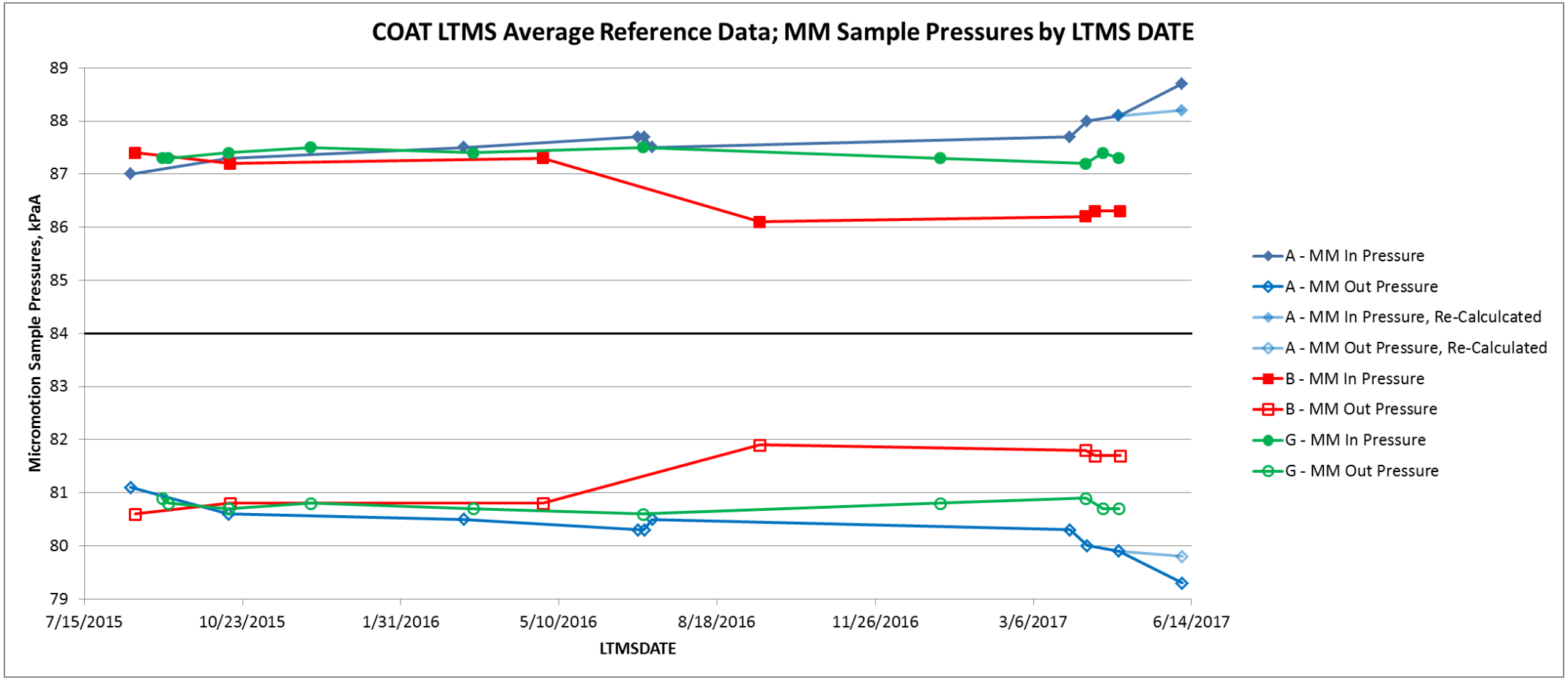
AVERAGE MICROMOTION OIL SAMPLE DELTA TEMPS (IN - OUT) OVER TIME (SOME VALUES SEEMED REVERSED; THEY HAVE BEEN CHANGED)



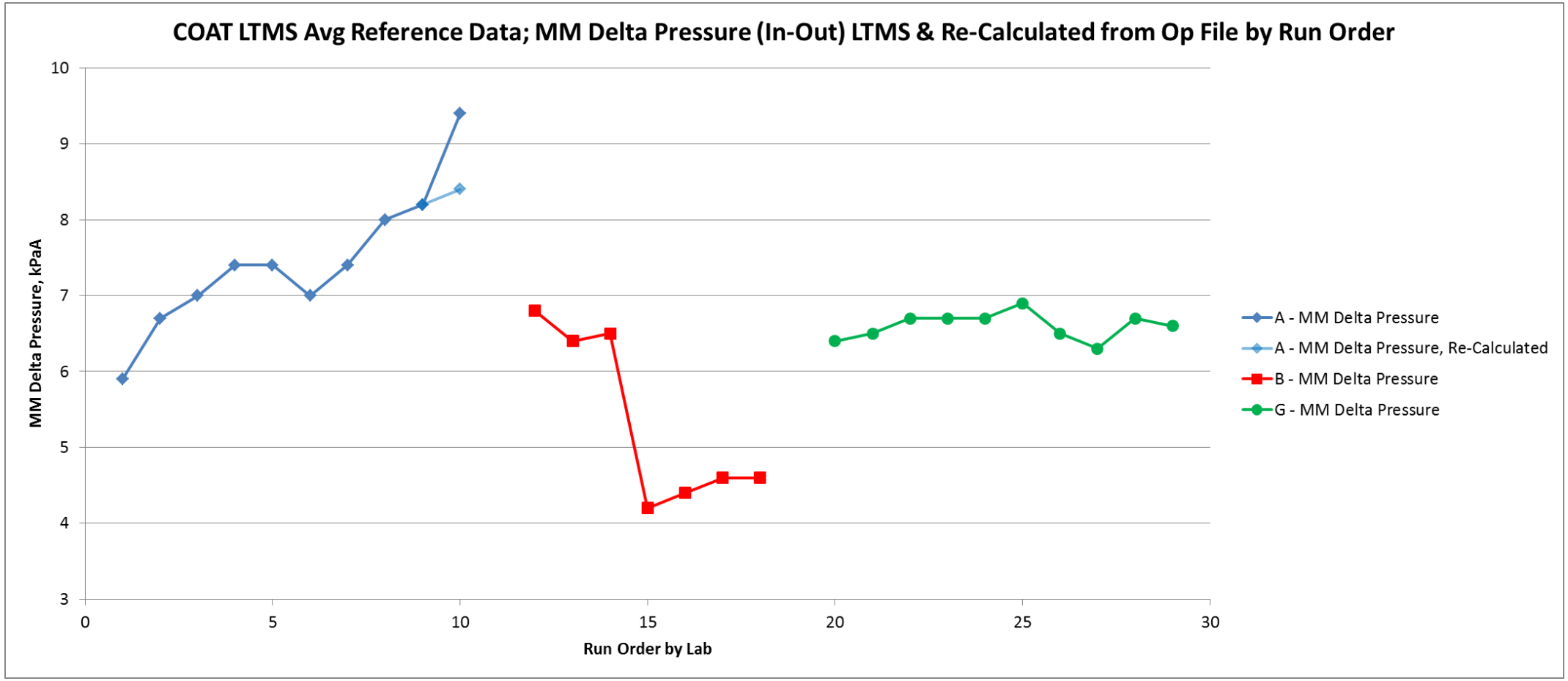
AVERAGE MICROMOTION OIL SAMPLE PRESSURES (IN & OUT) OVER TIME PLOTTED BY LAB IN RUN ORDER



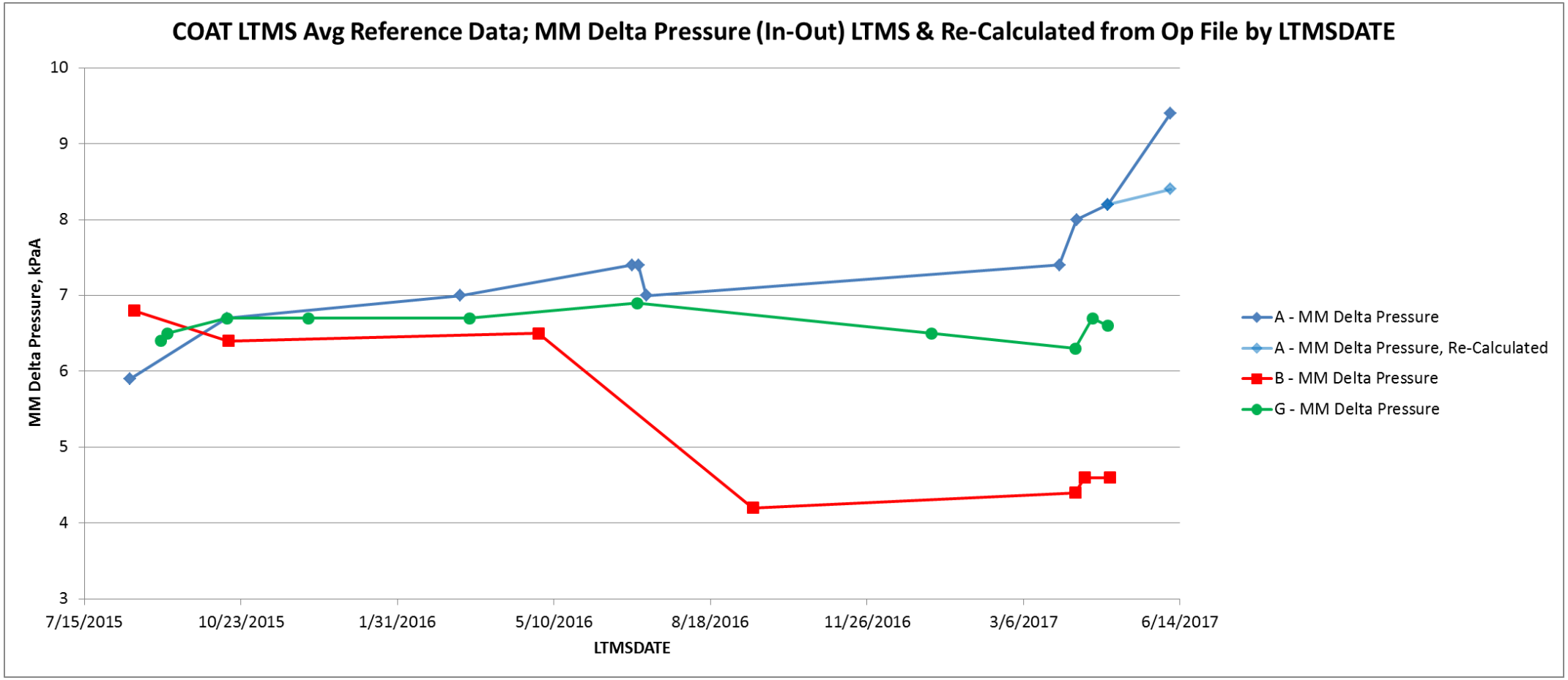
AVERAGE MICROMOTION OIL SAMPLE PRESSURES (IN & OUT) BY LTSMDATE



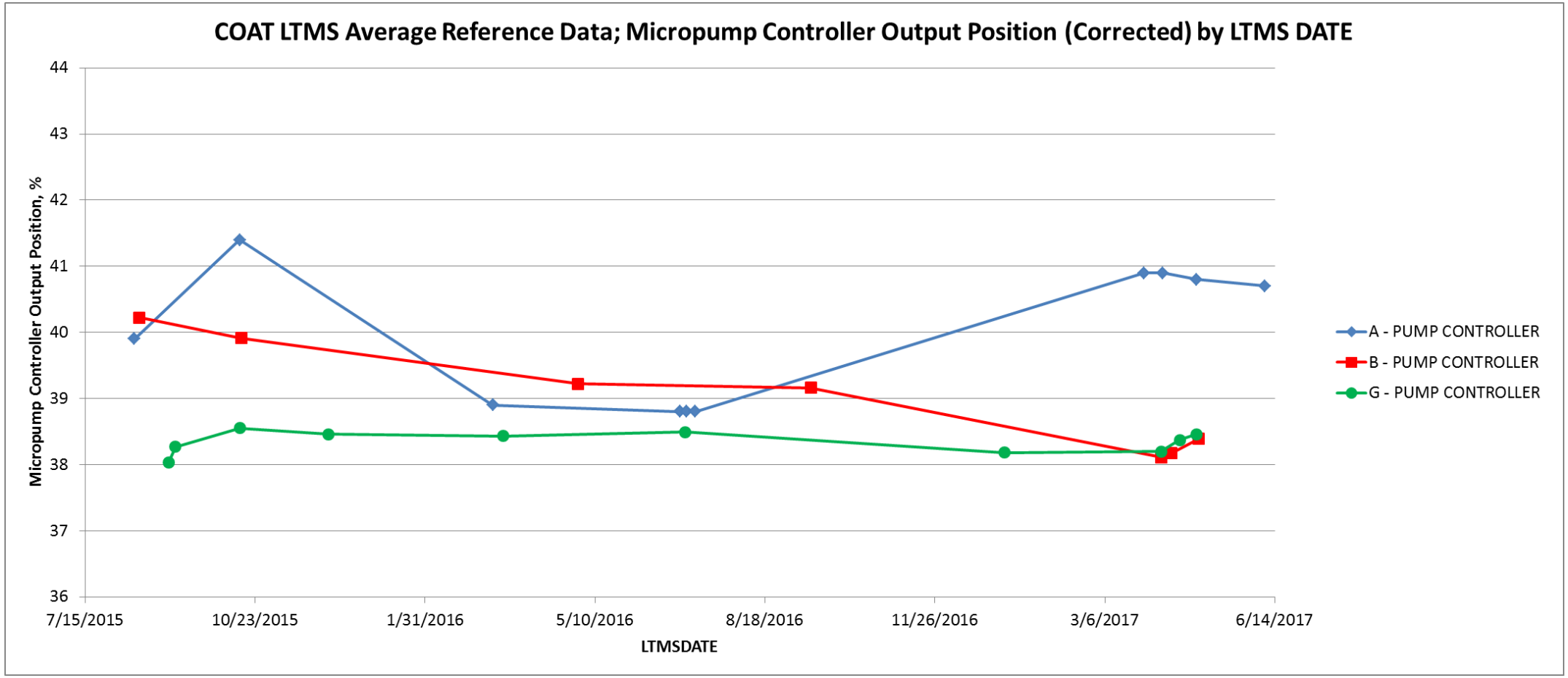
AVG MICROMOTION OIL SAMPLE DELTA PRESSURES (IN - OUT) OVER TIME PLOTTED BY LAB IN RUN ORDER



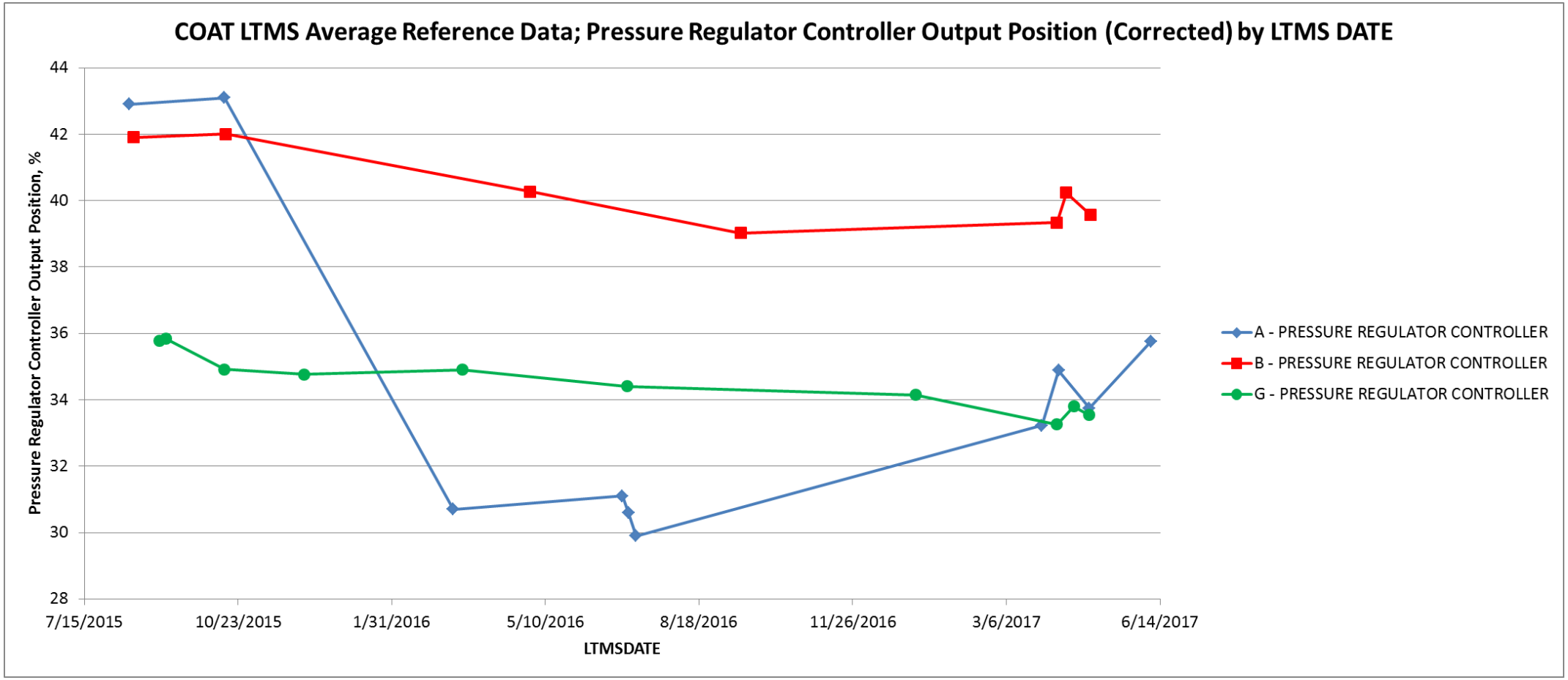
AVG MICROMOTION OIL SAMPLE DELTA PRESSURES (IN - OUT) BY LTMSDATE



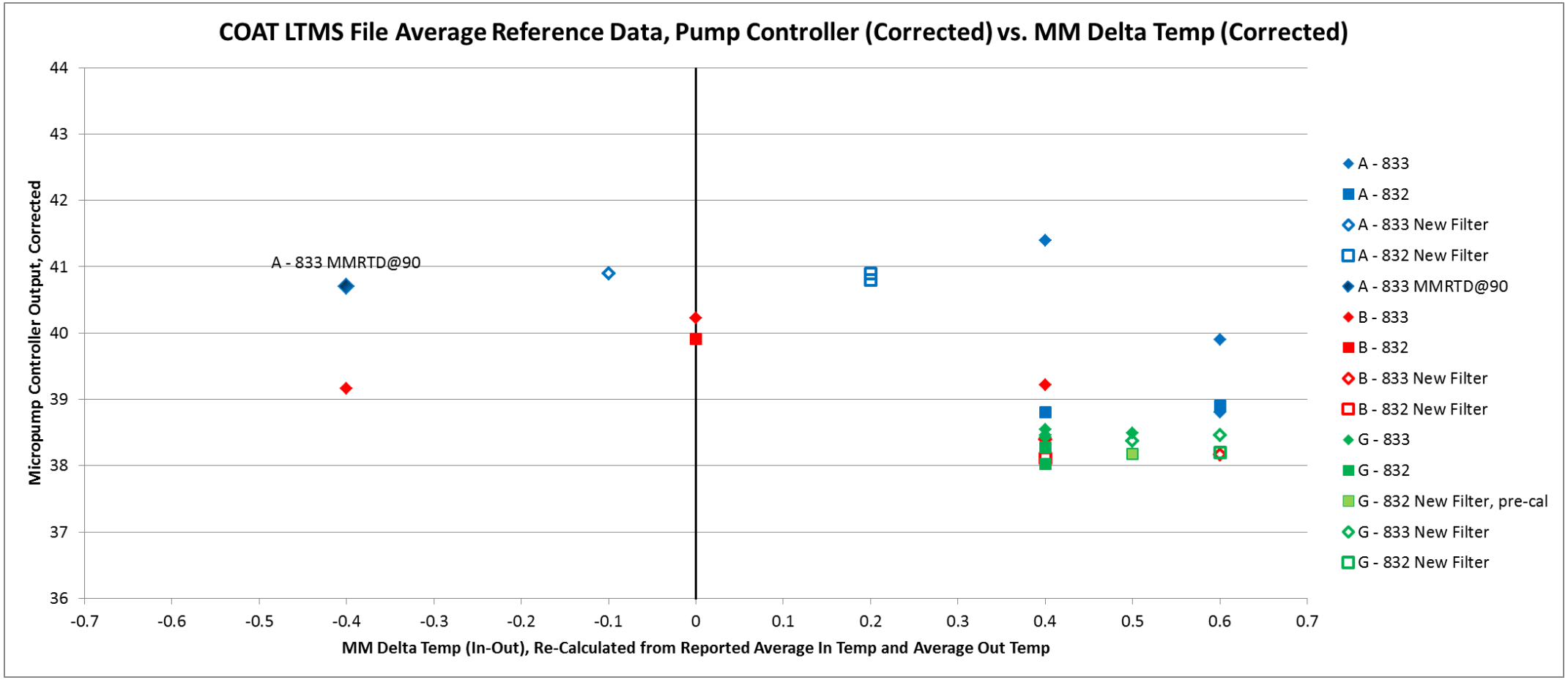
AVERAGE CORRECTED MICROPUMP CONTROLLER POSITION BY LTMS DATE



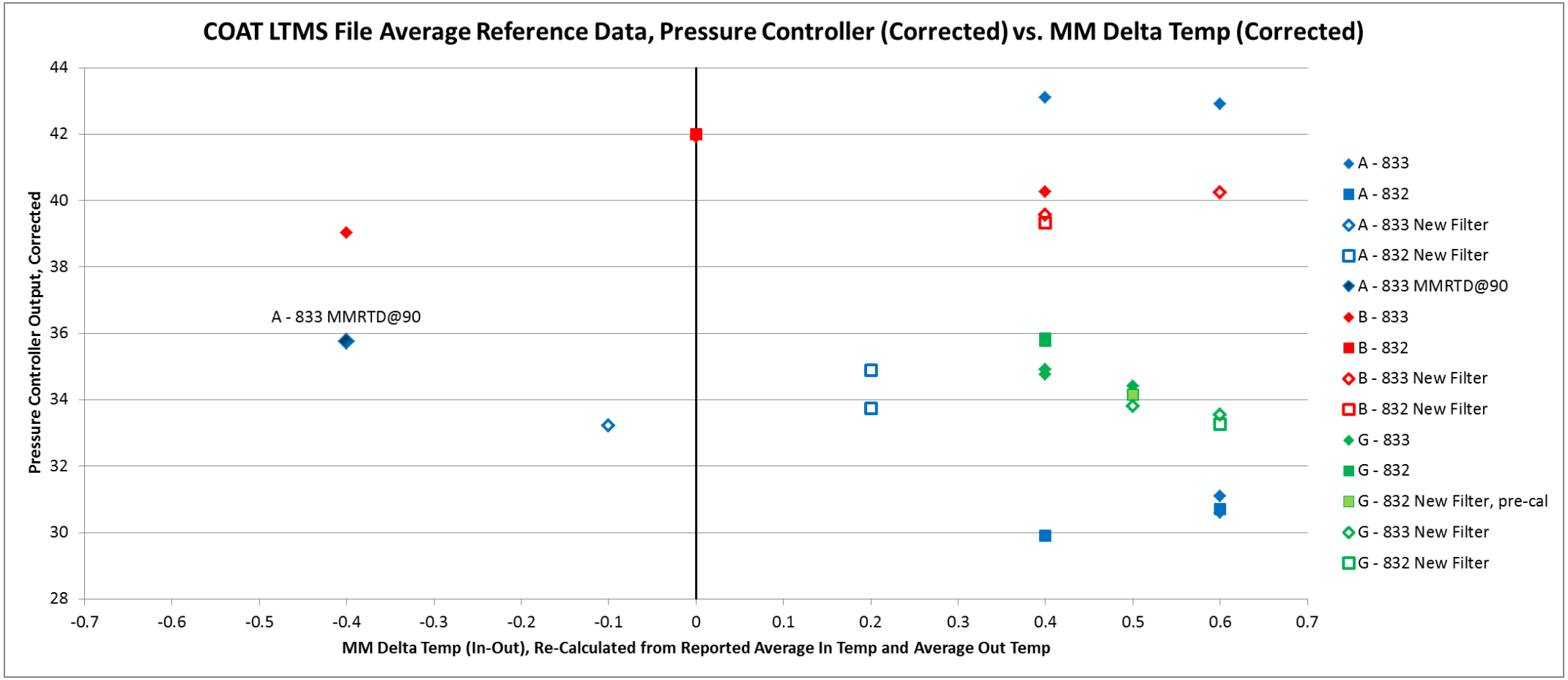
AVERAGE CORRECTED PRESSURE CONTROLLER POSITION BY LTMS DATE



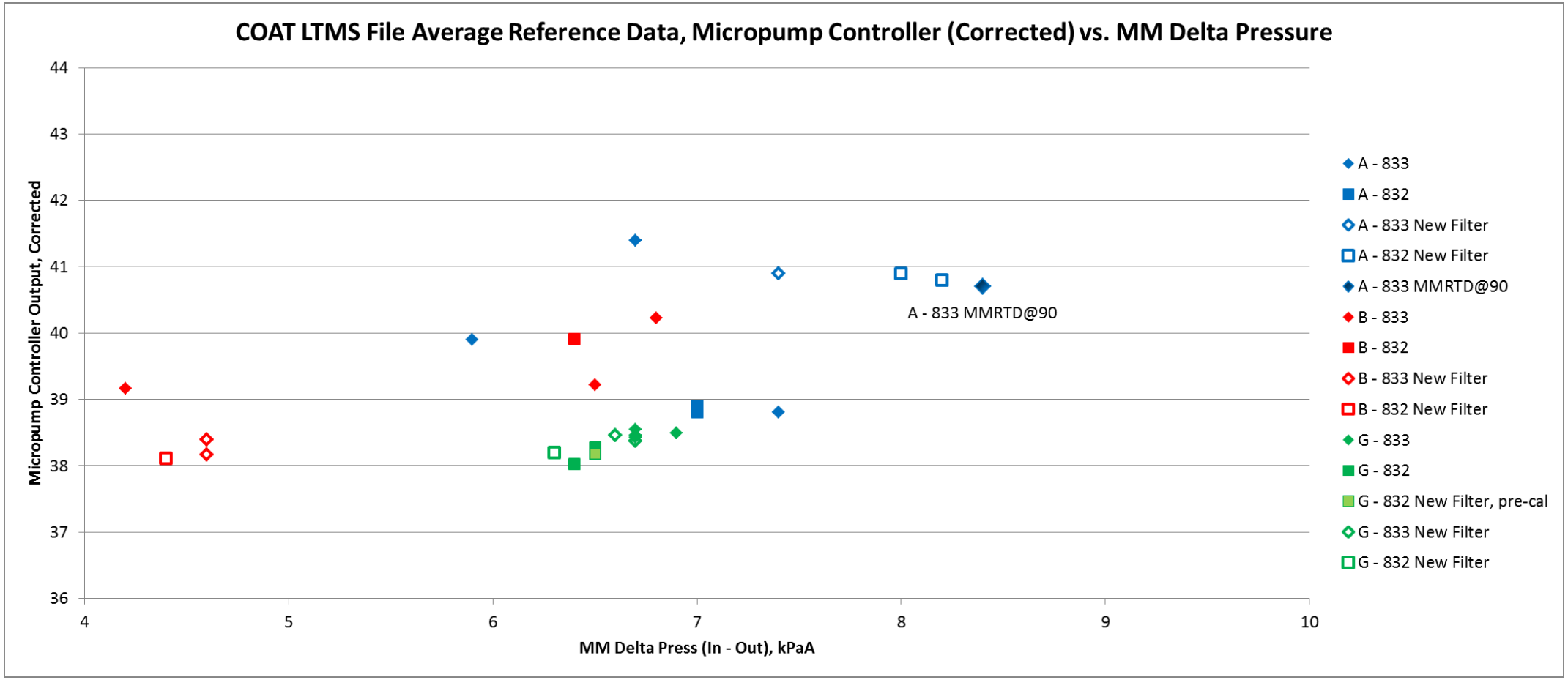
AVERAGE CORRECTED MICROPUMP CONTROLLER POSITION VS. CORRECTED MM SAMPLE DELTA TEMPERATURE.



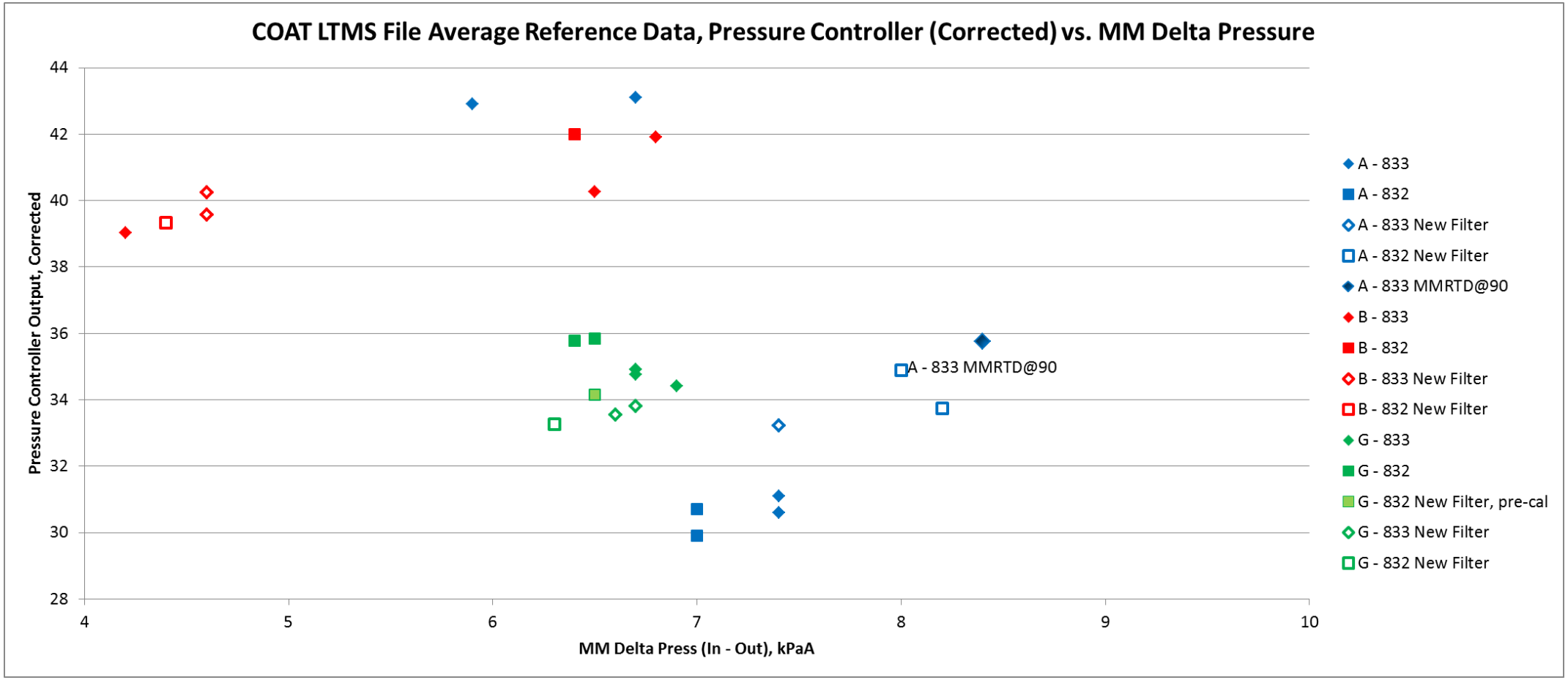
AVERAGE CORRECTED PRESSURE CONTROLLER POSITION VS. CORRECTED MM SAMPLE DELTA TEMPERATURE.



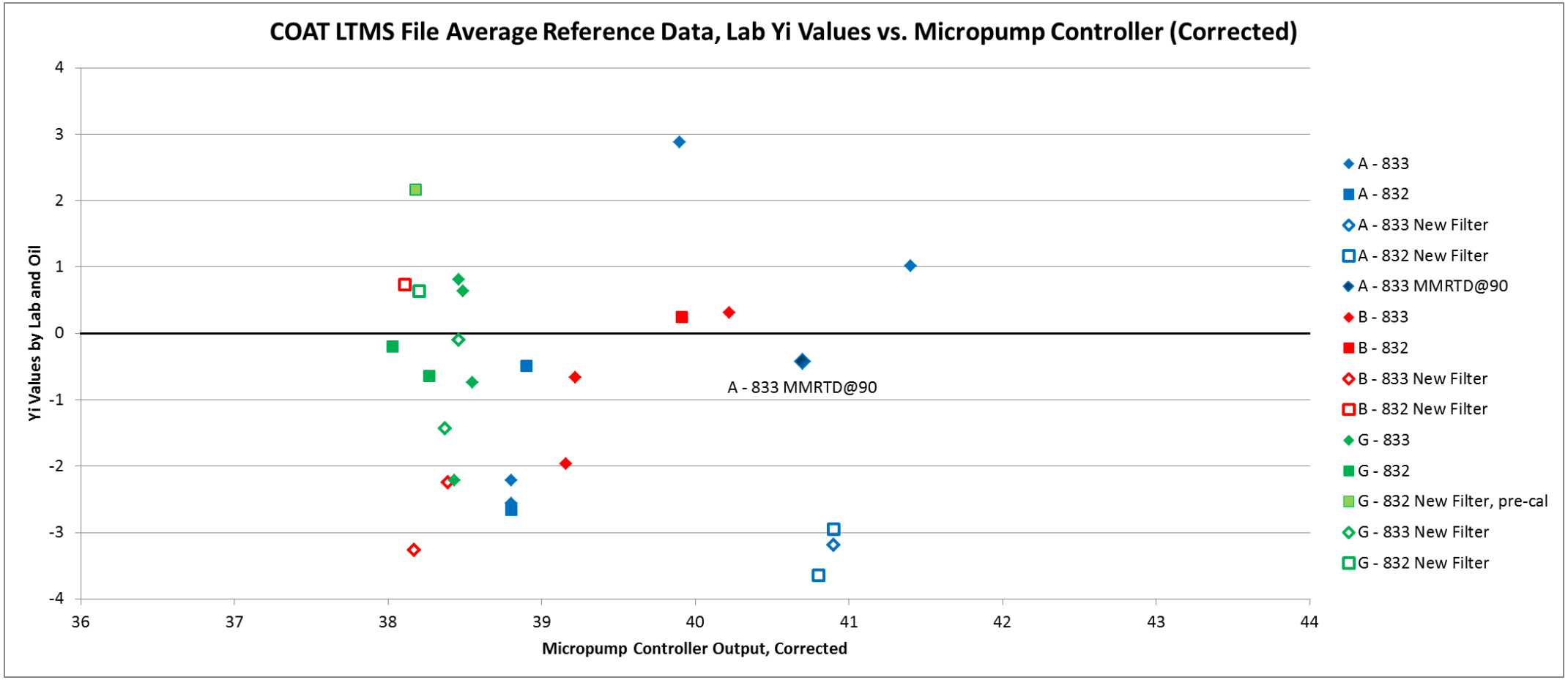
AVERAGE CORRECTED MICROPUMP CONTROLLER POSITION VS. CALCULATED MM SAMPLE DELTA PRESSURE.



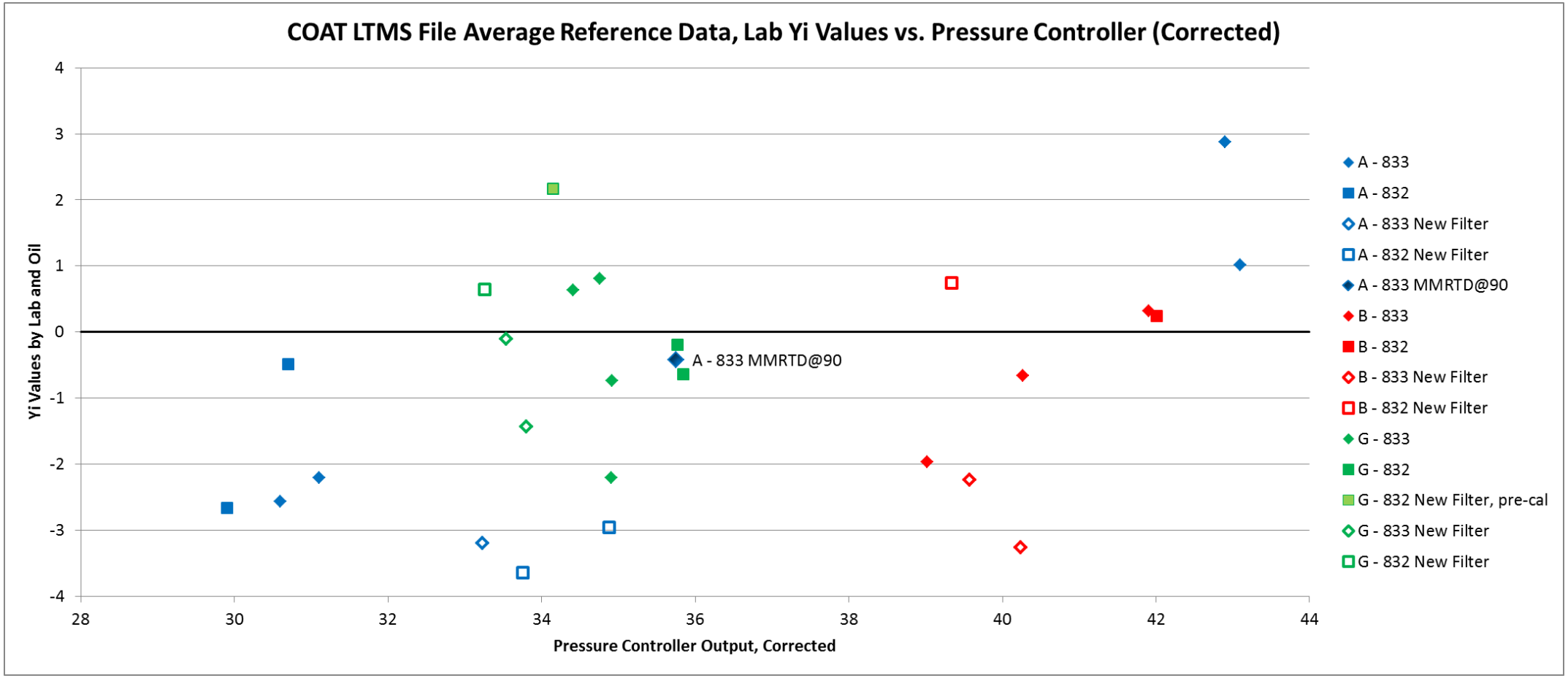
AVERAGE CORRECTED PRESSURE CONTROLLER POSITION VS. CALCULATED MM SAMPLE DELTA PRESSURE.



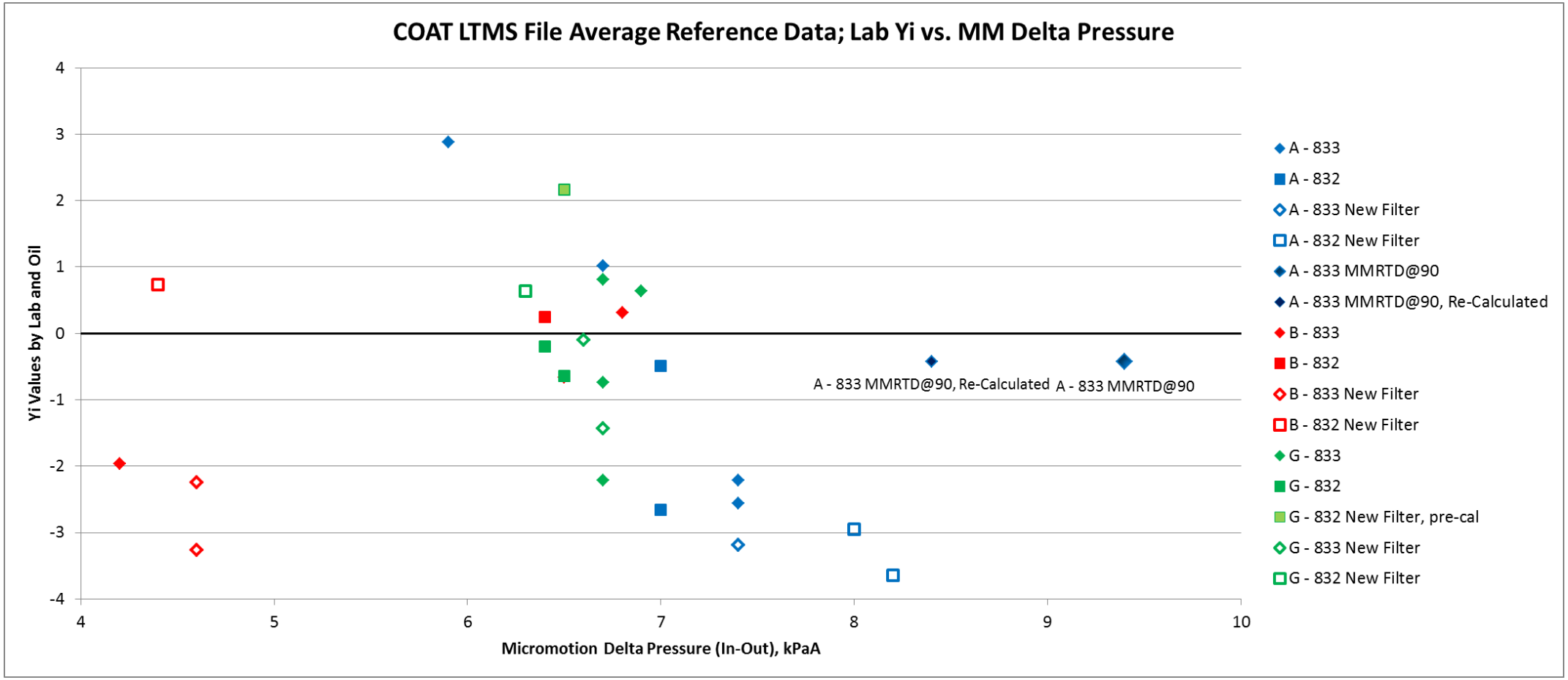
LAB YI VALUES PLOTTED AGAINST CORRECTED AVERAGE MICROPUMP CONTROLLER POSITION.



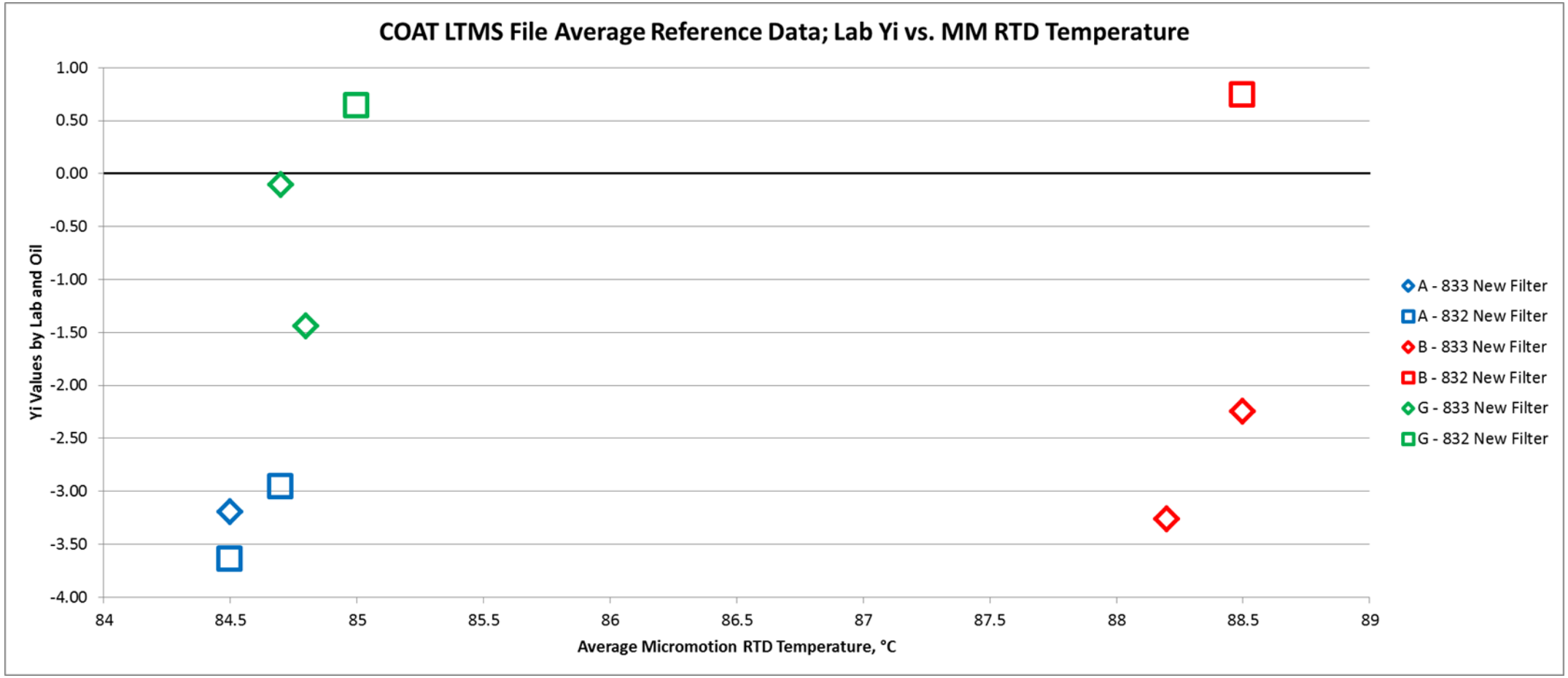
LAB YI VALUES PLOTTED AGAINST CORRECTED AVERAGE PRESSURE CONTROLLER POSITION.



LAB YI VALUES PLOTTED AGAINST CALCULATED AVERAGE MM SAMPLE DELTA PRESSURE.



LAB YI VALUES PLOTTED AGAINST AVERAGE MICROMOTION TUBE TEMPERATURE FOR FIRST 9 TESTS WITH NEW FILTER AND CAL METHOD.

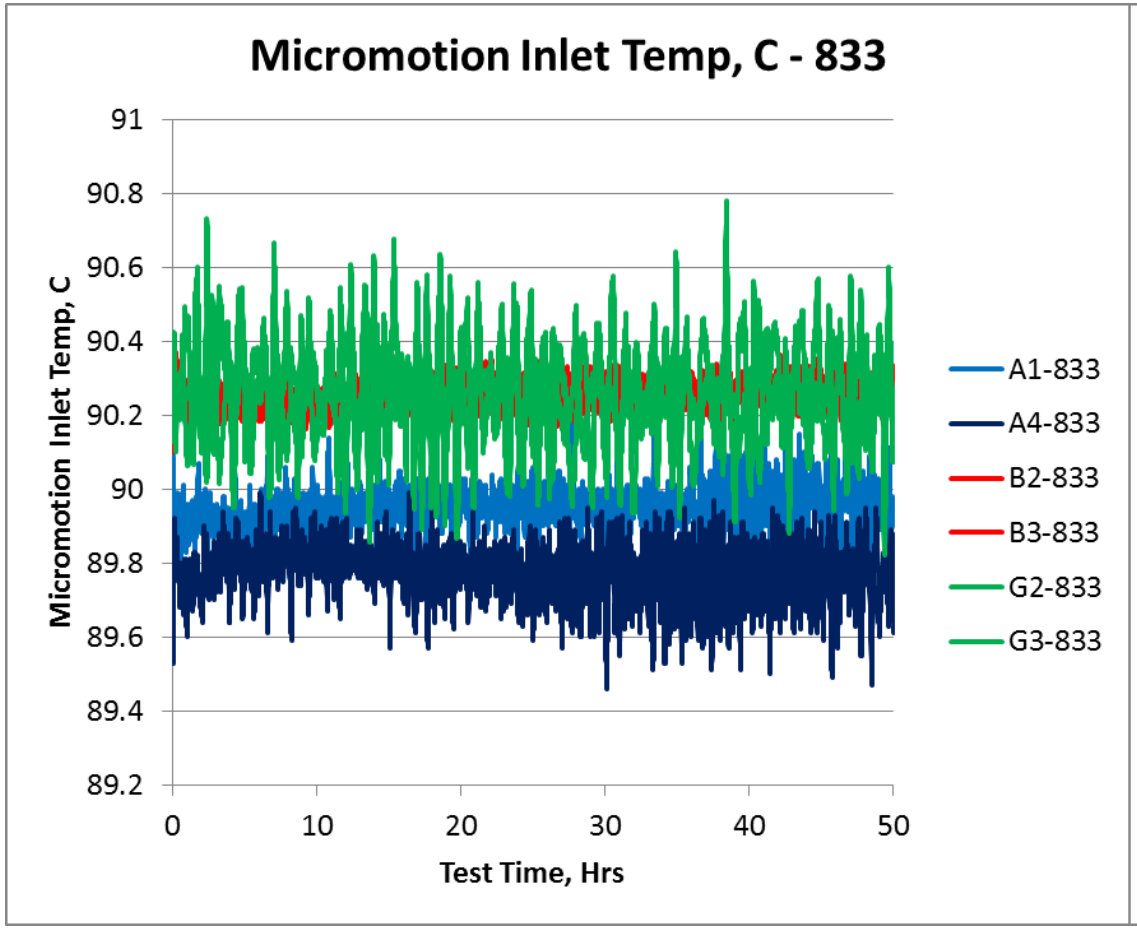


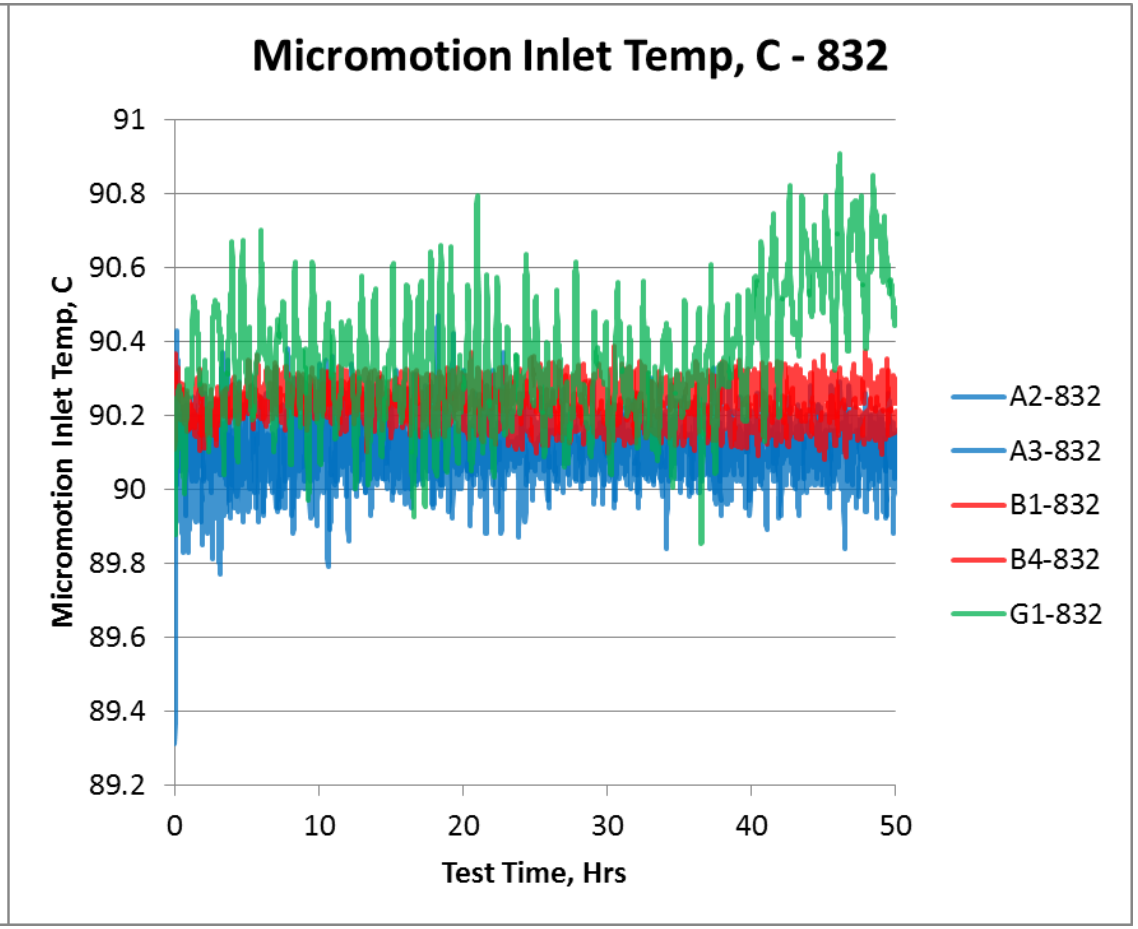
03

OPERATIONAL DATA PLOTS FROM TESTS WITH NEW FILTER AND CAL METHOD

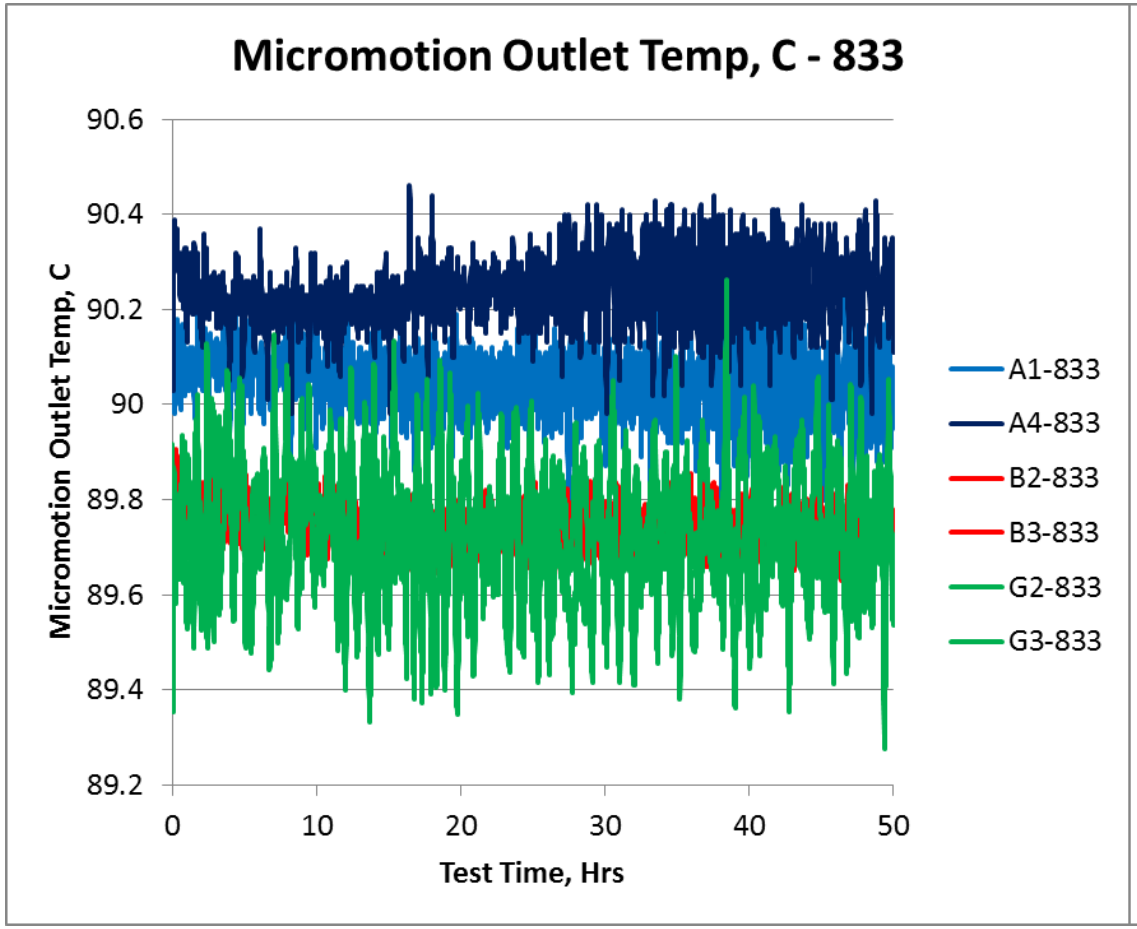
All 11 tests used where data are available

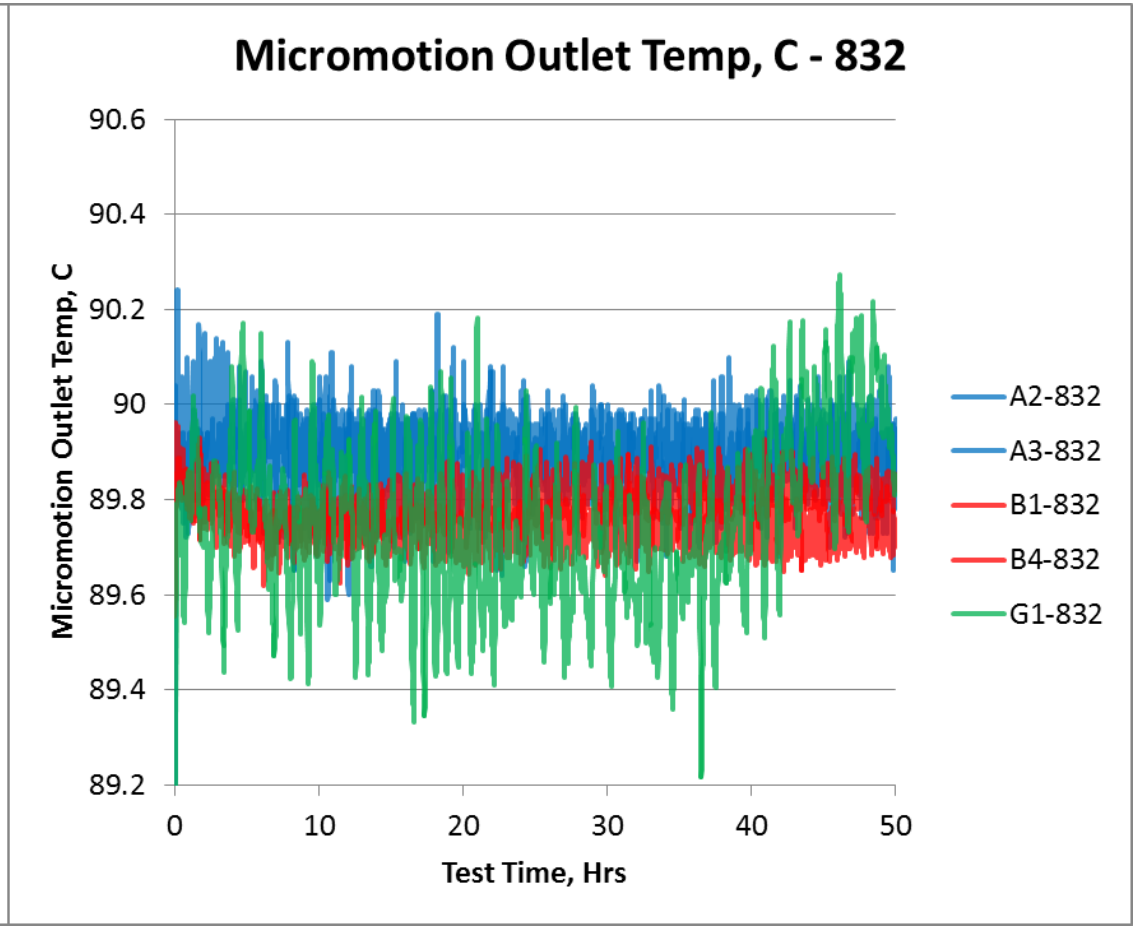
MICROMOTION OIL SAMPLE INLET TEMP BY RUN OVER TEST HOURS



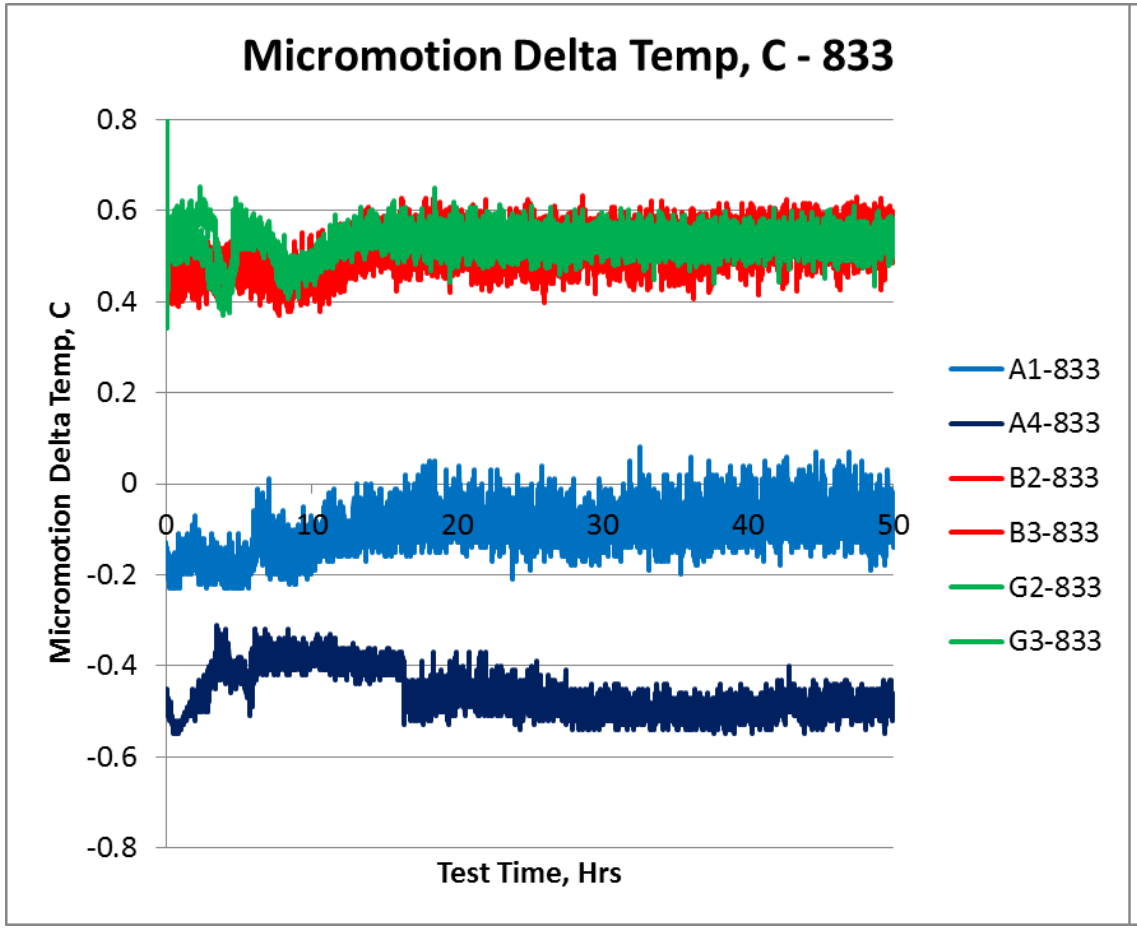


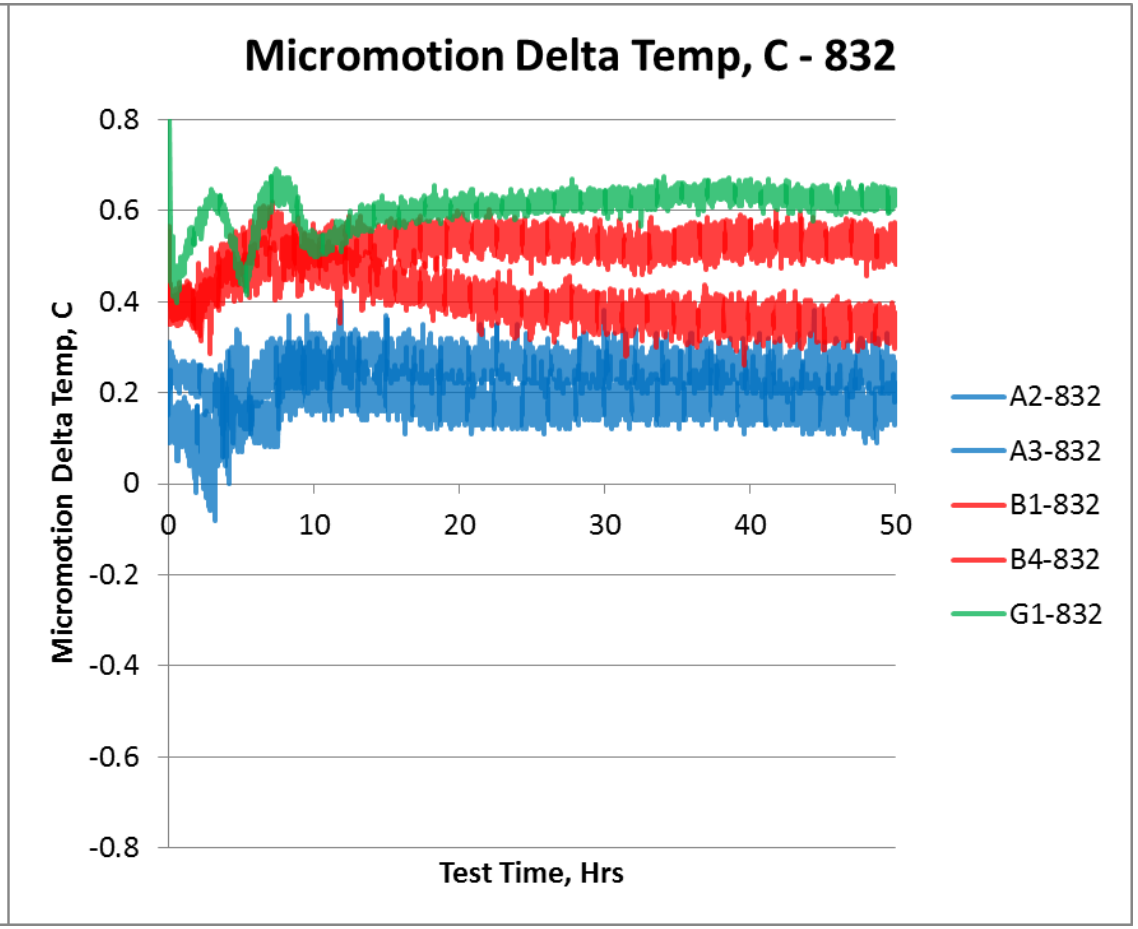
MICROMOTION OIL SAMPLE OUTLET TEMP BY RUN OVER TEST HOURS



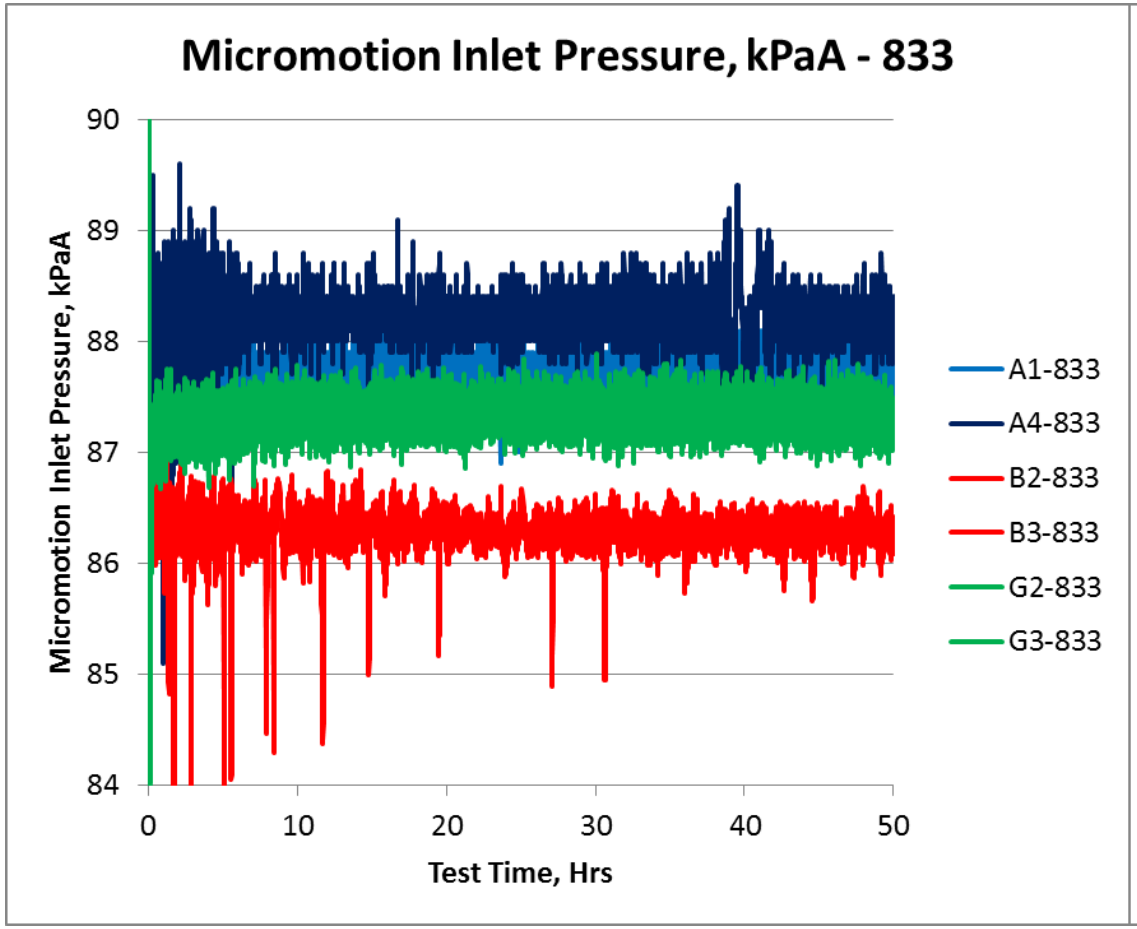


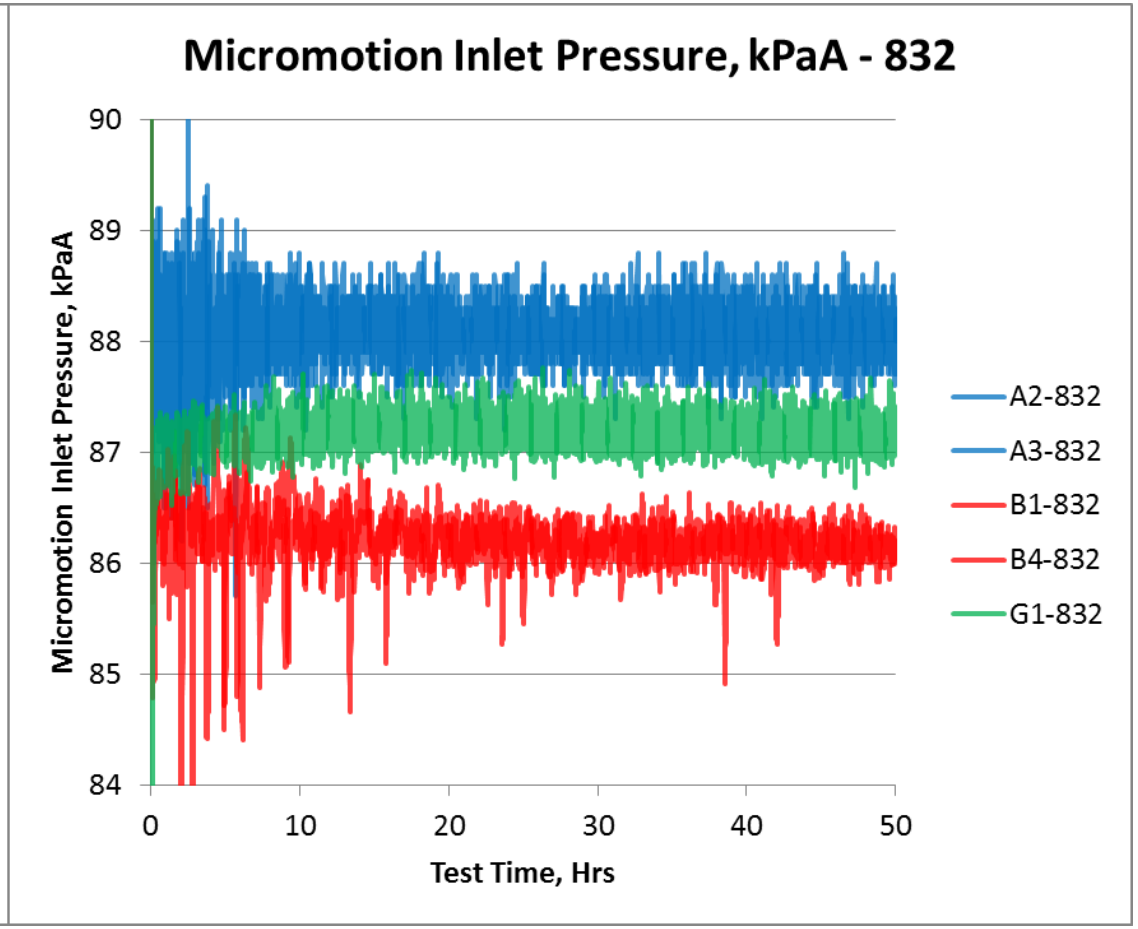
MICROMOTION OIL SAMPLE DELTA TEMP BY RUN OVER TEST HOURS



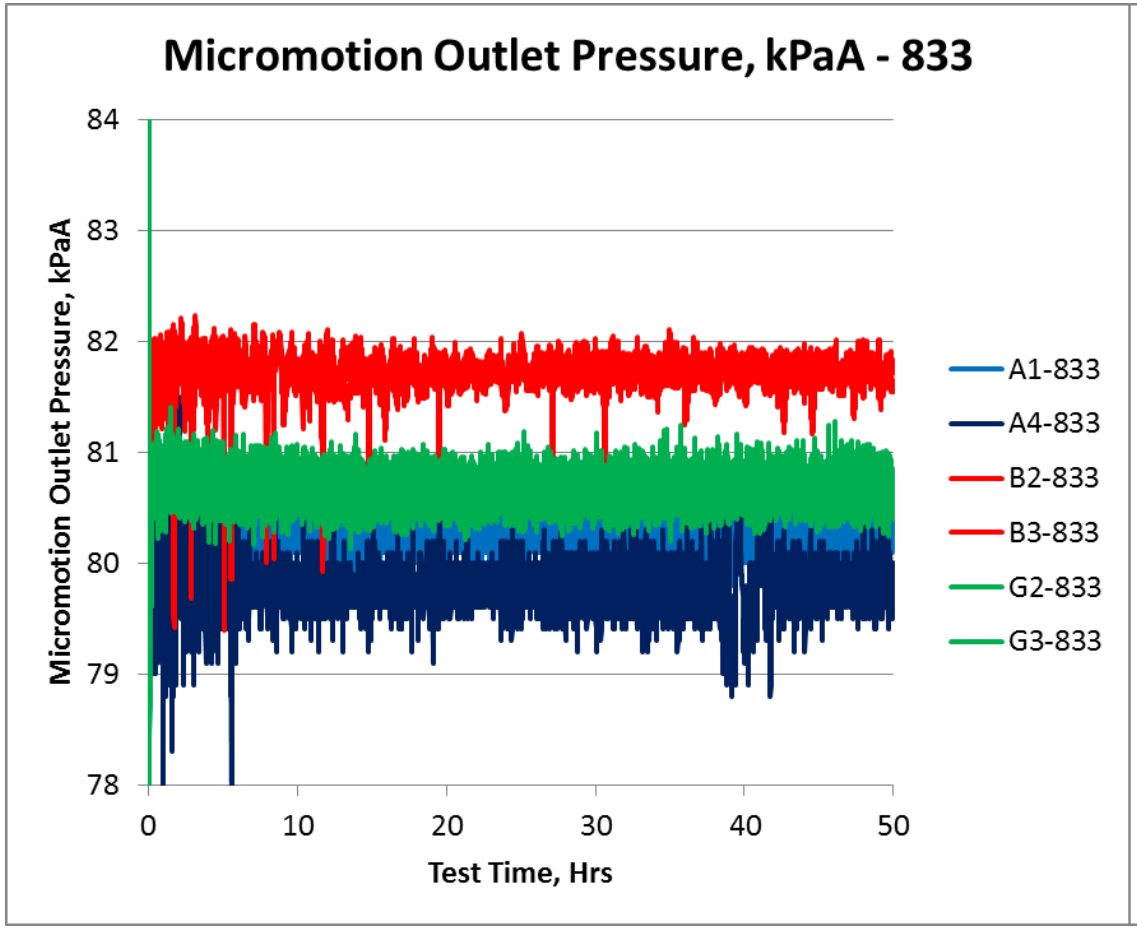


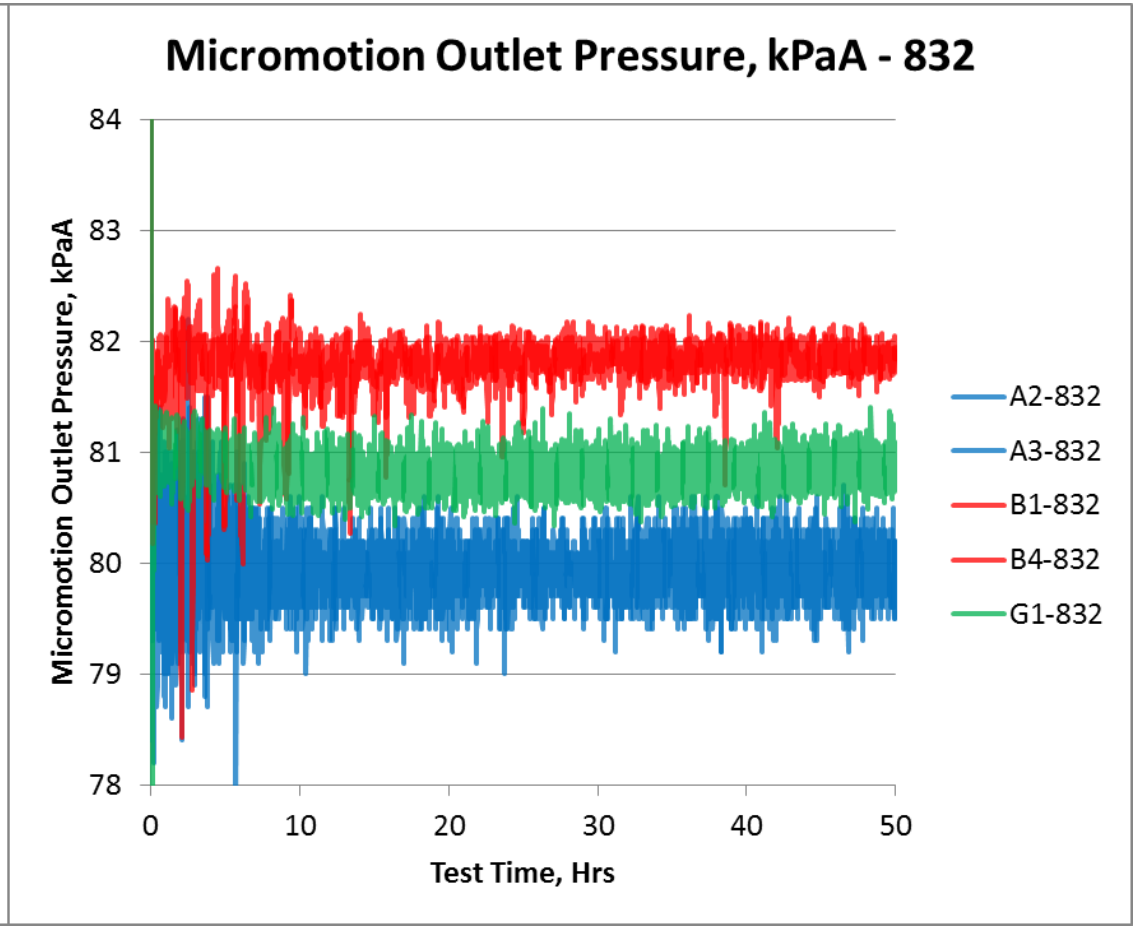
MICROMTION OIL SAMPLE INLET PRESSURE BY RUN OVER TEST HOURS



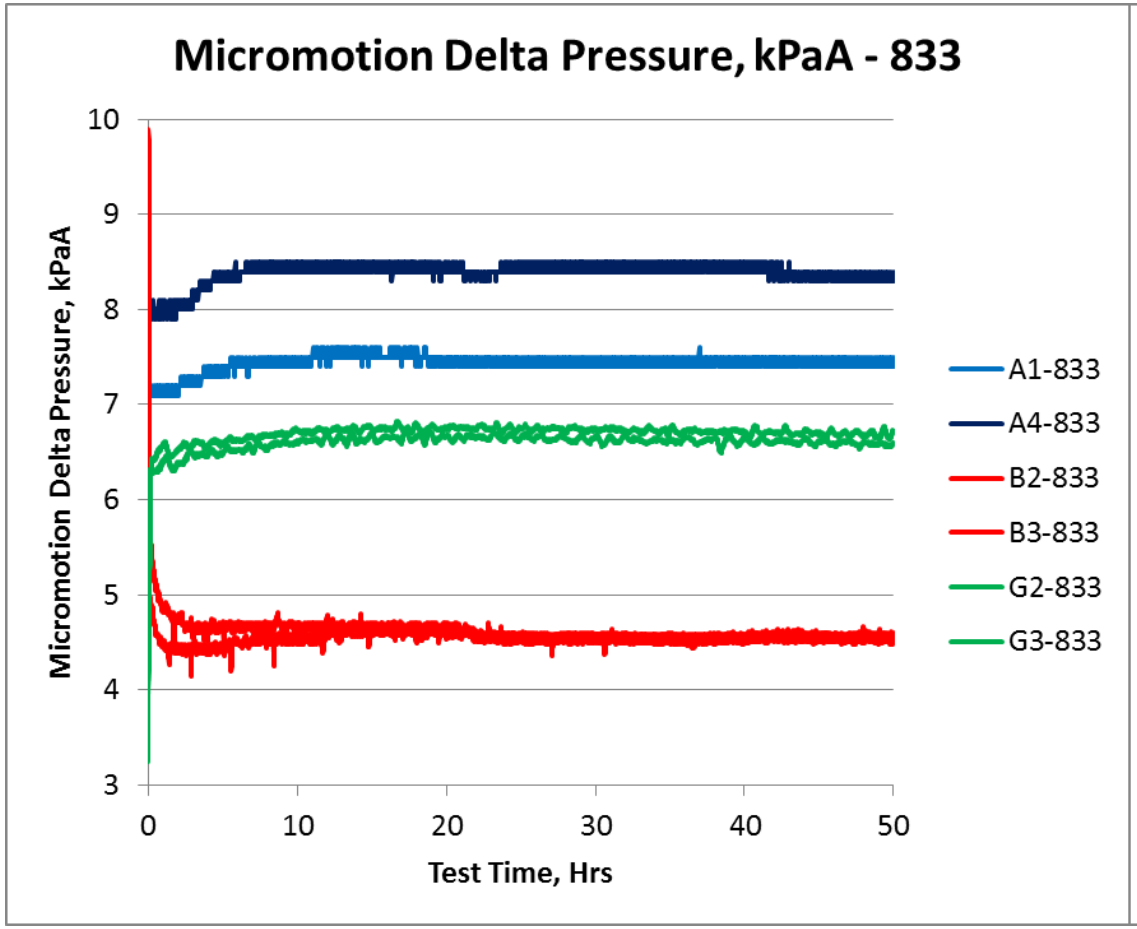


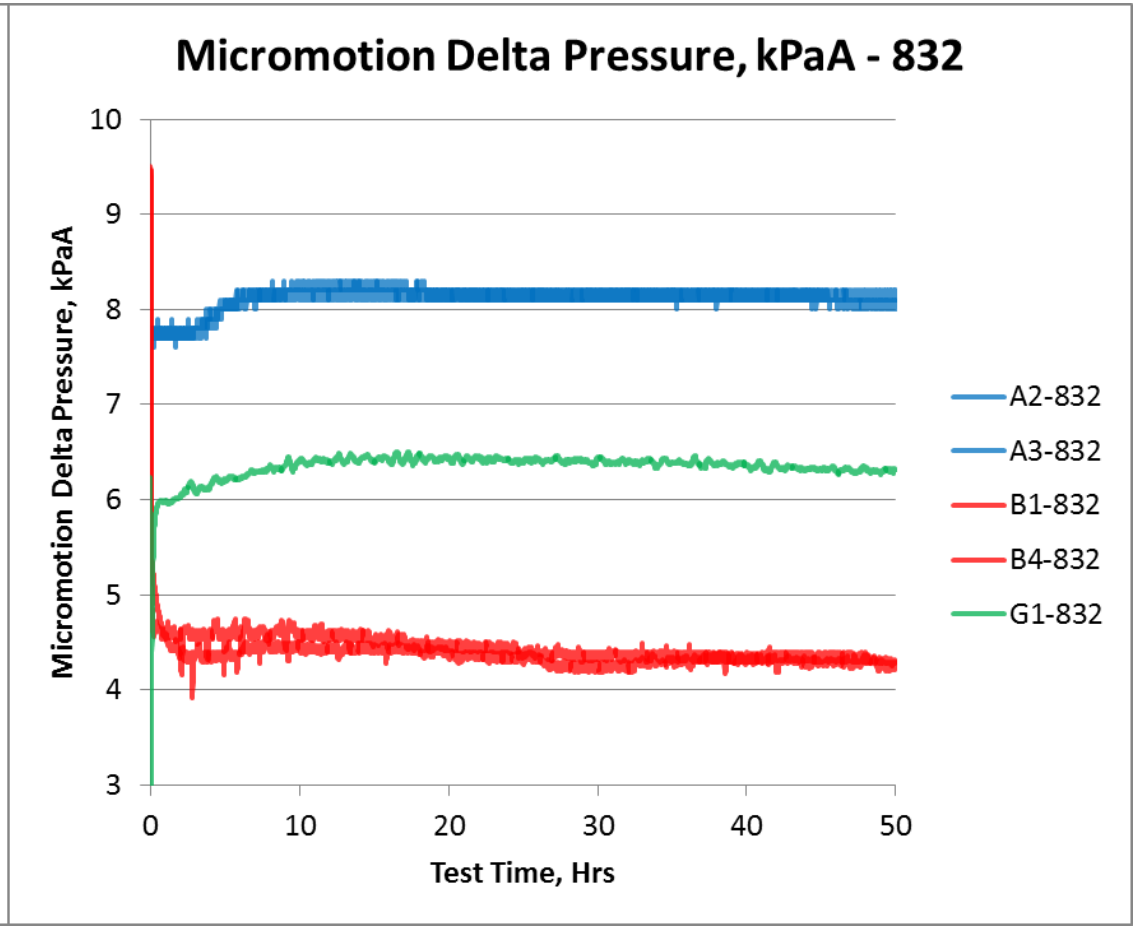
MICROMTION OIL SAMPLE OUTLET PRESSURE BY RUN OVER TEST HOURS



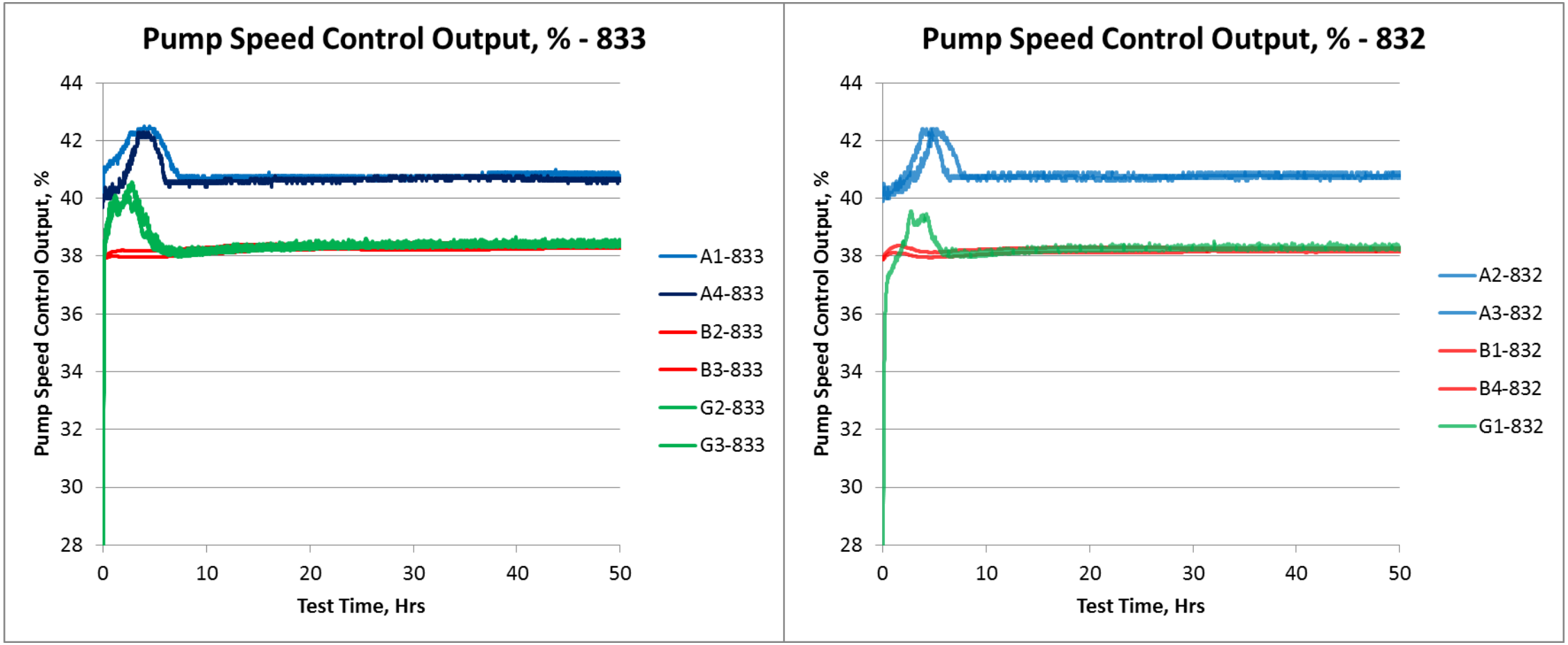


MICROMTION OIL SAMPLE DELTA PRESSURE BY RUN OVER TEST HOURS

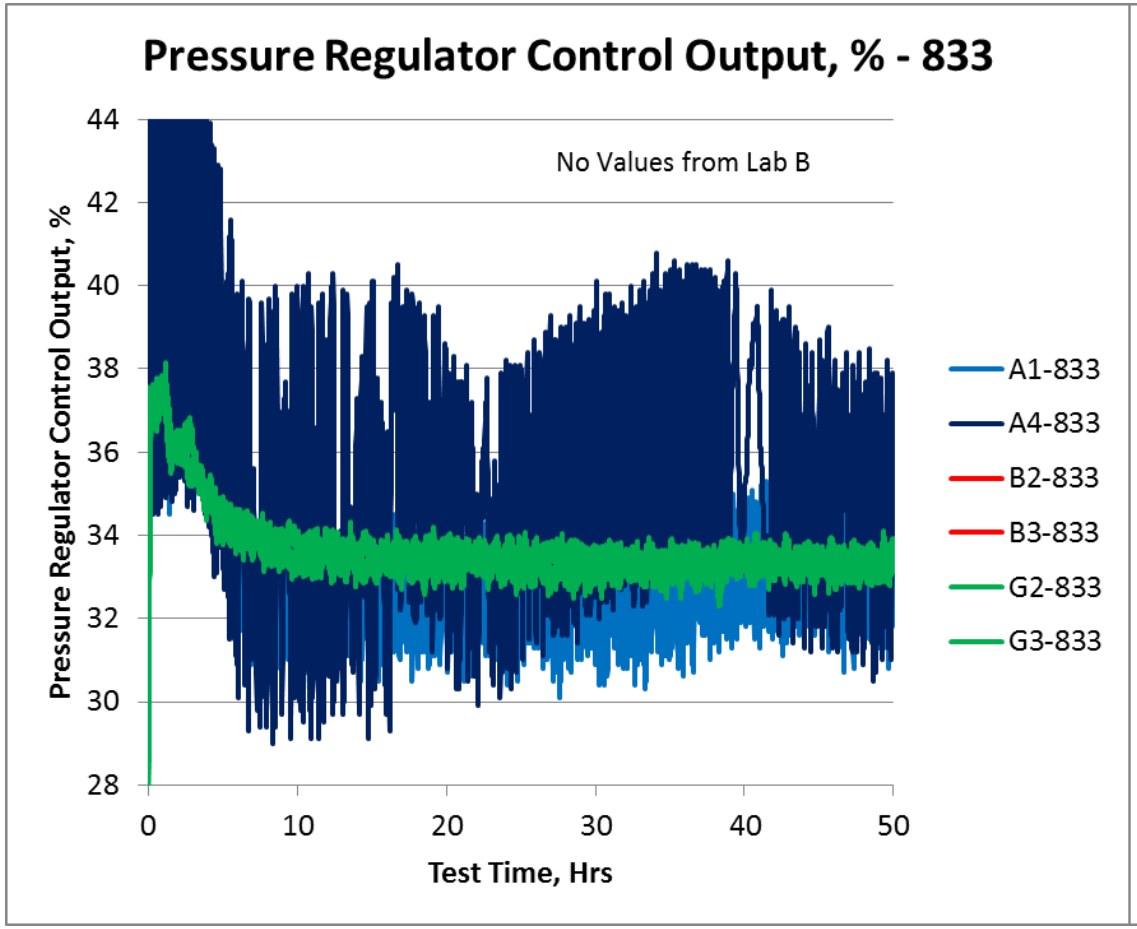


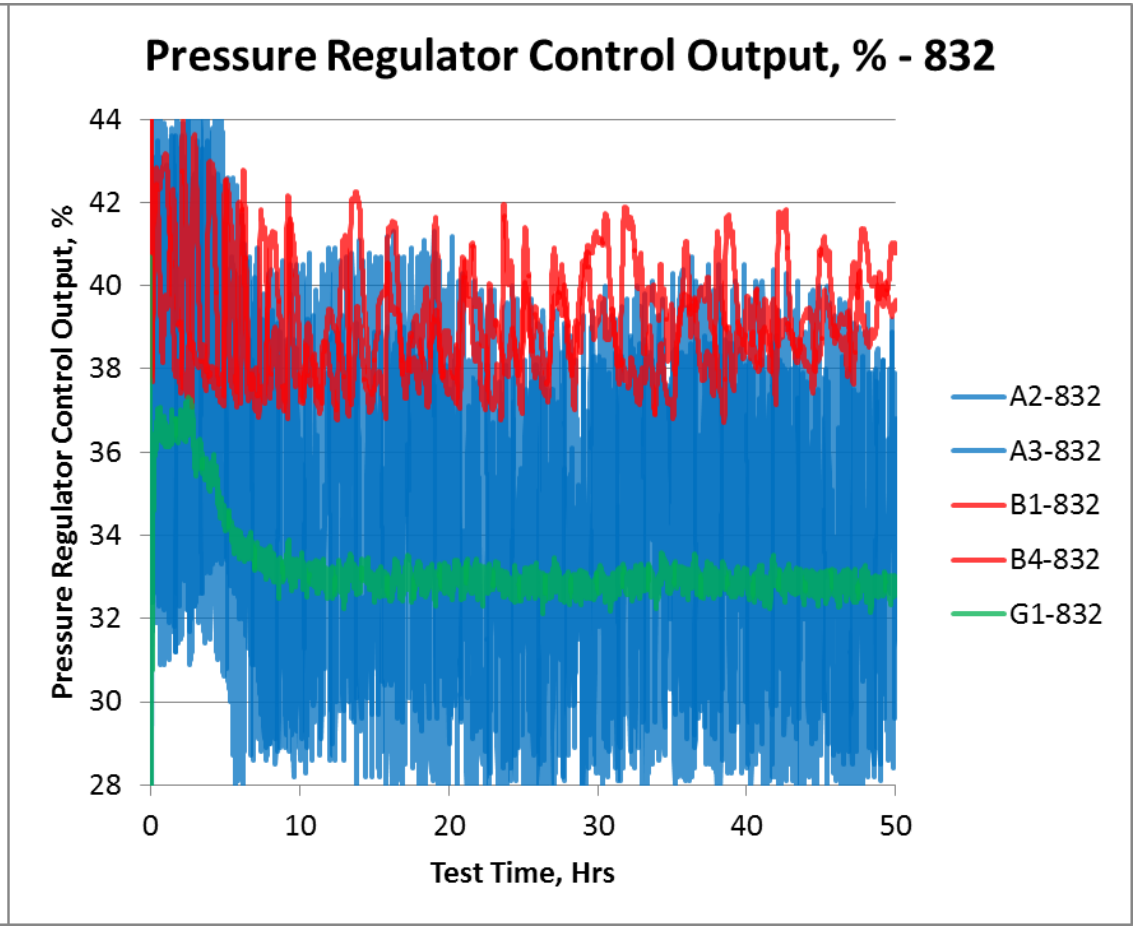


OIL SAMPLE FLOW RATE MICROPUMP CONTROLLER OUTPUT BY RUN OVER TEST HOURS

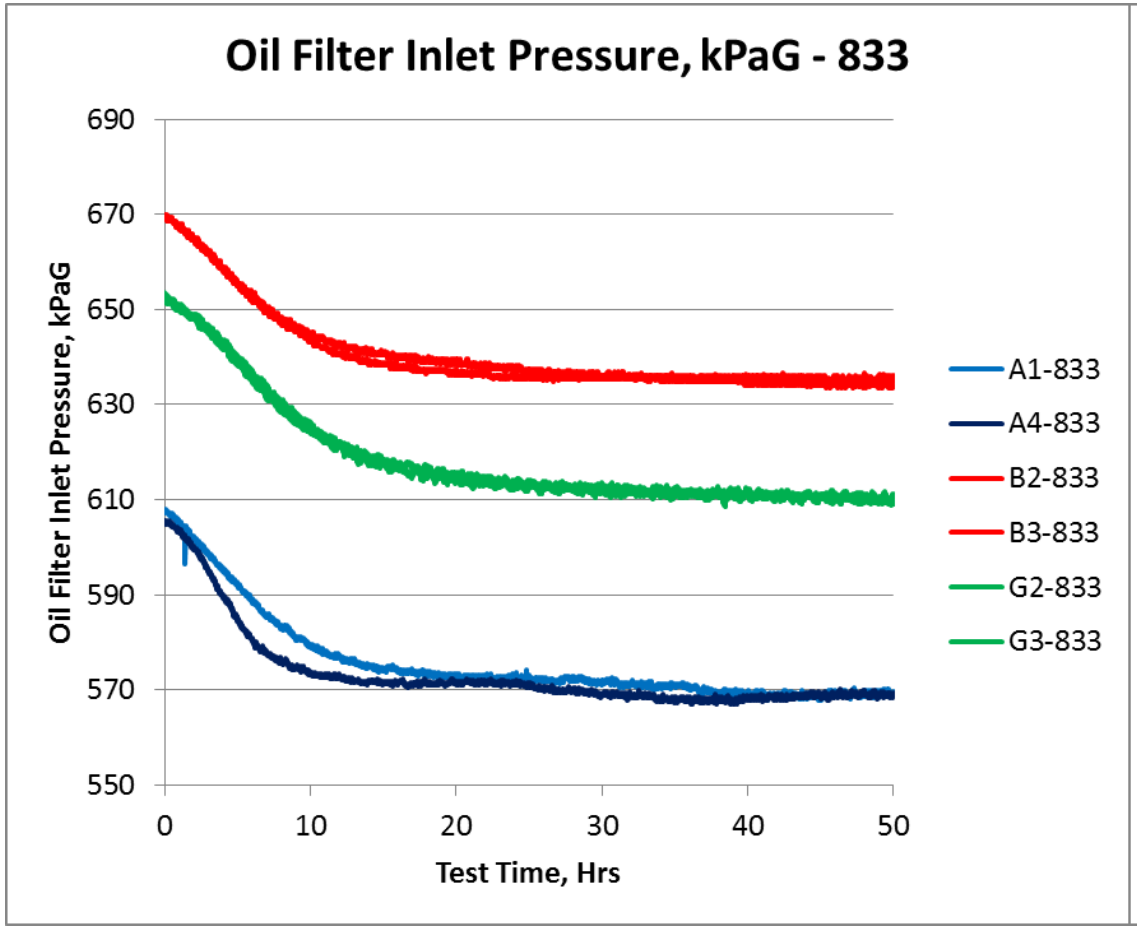


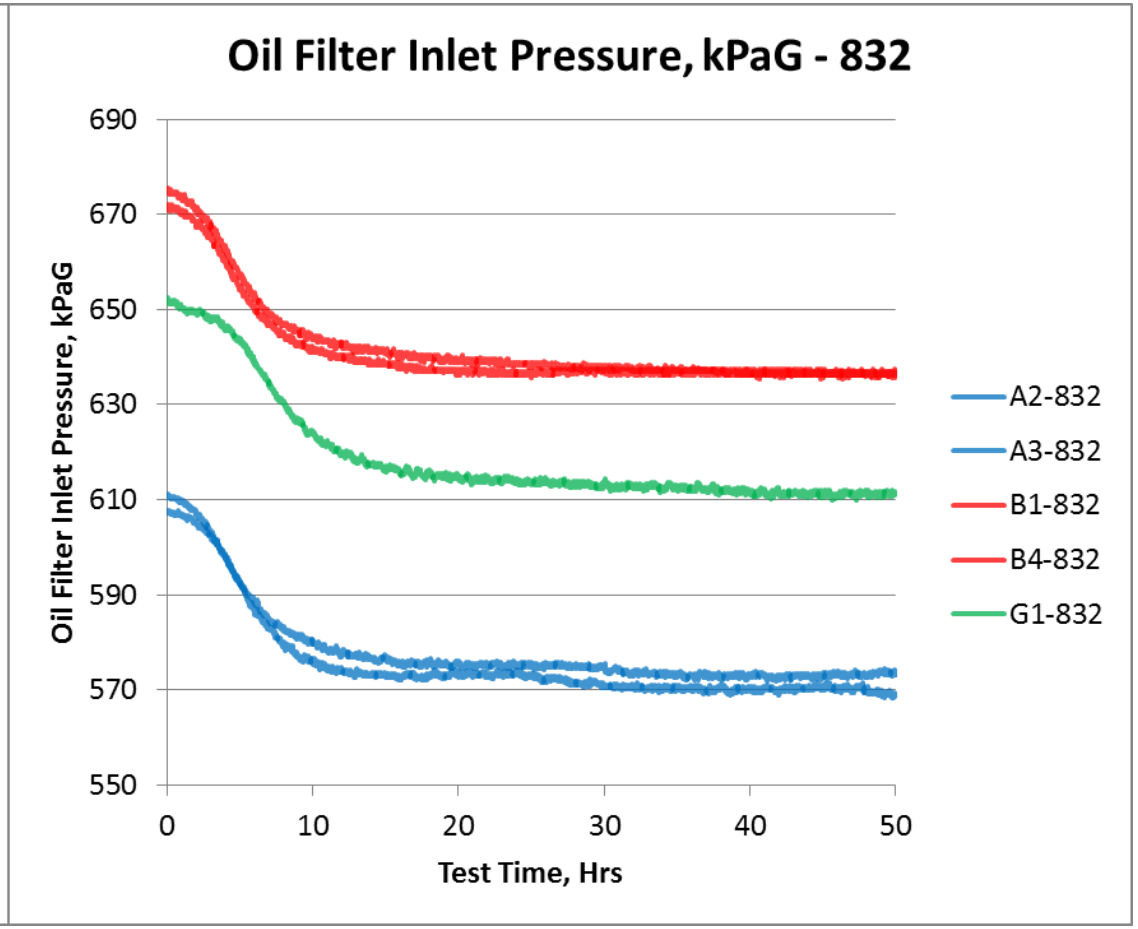
OIL SAMPLE PRESSURE CONTROLLER OUTPUT BY RUN OVER TEST HOURS



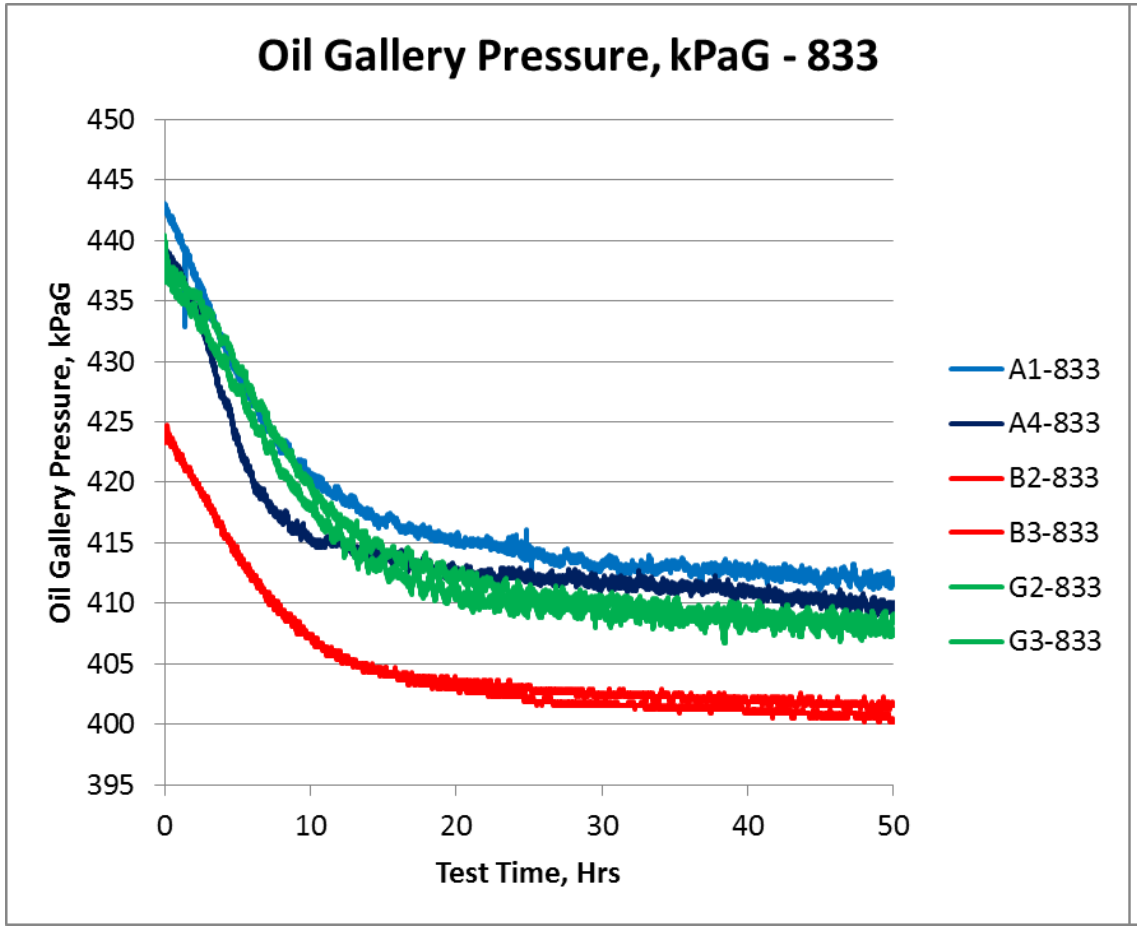


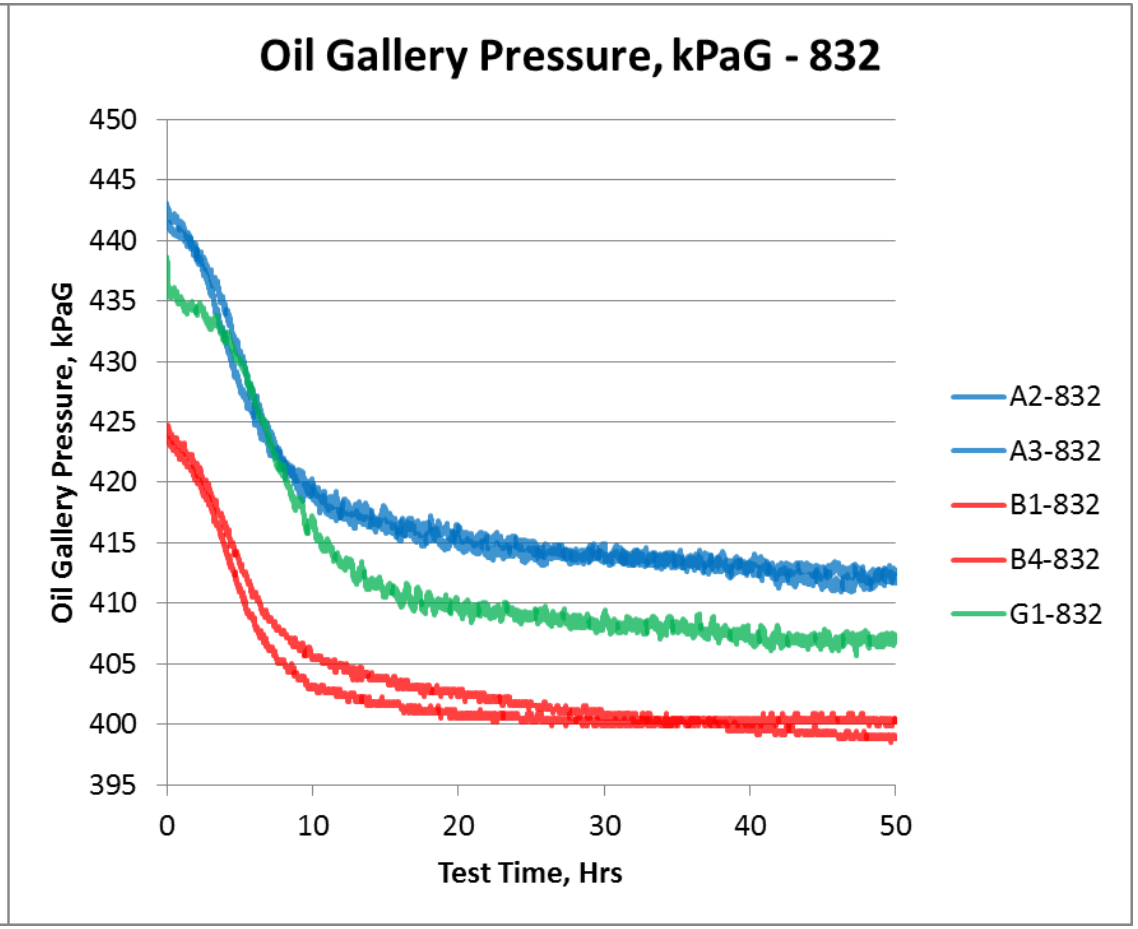
ENGINE OIL FILTER INLET PRESSURE BY RUN OVER TEST HOURS



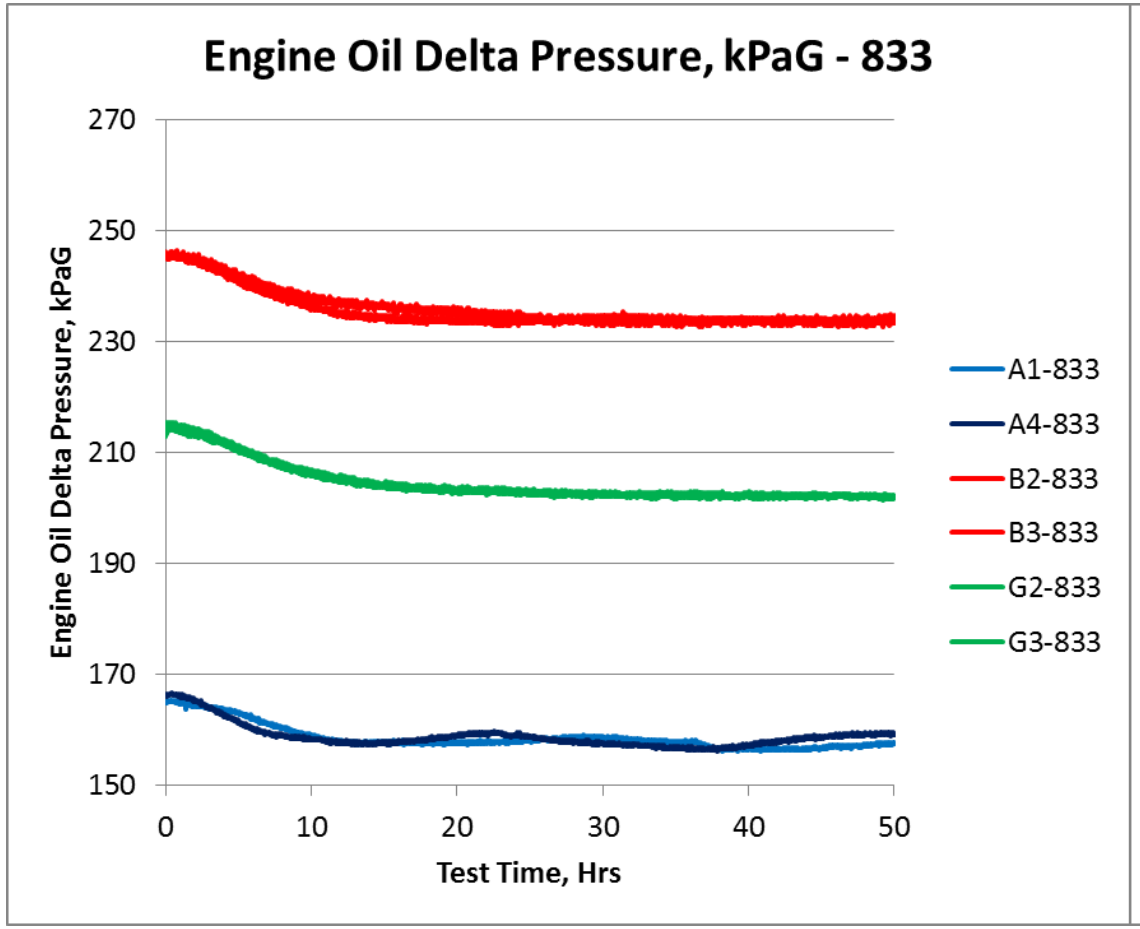


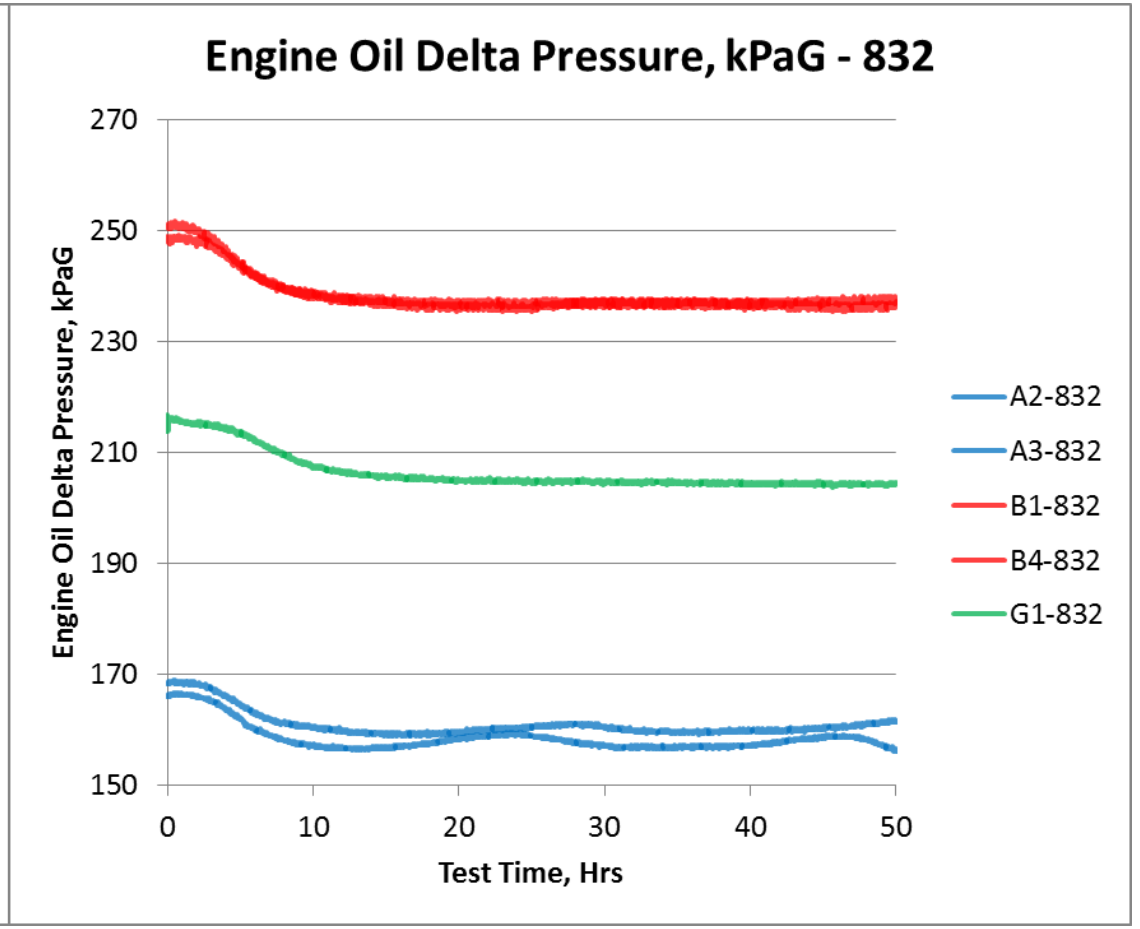
ENGINE OIL GALLERY PRESSURE BY RUN OVER TEST HOURS



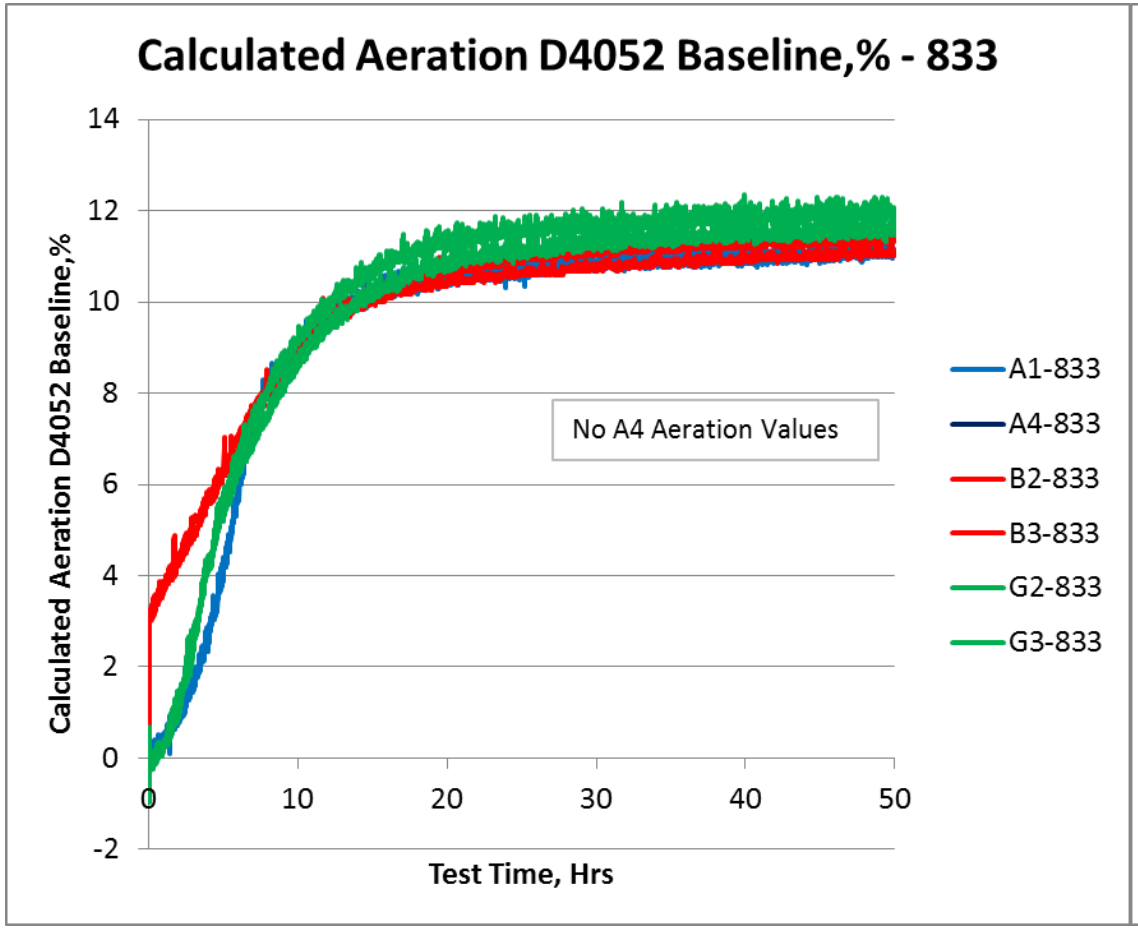


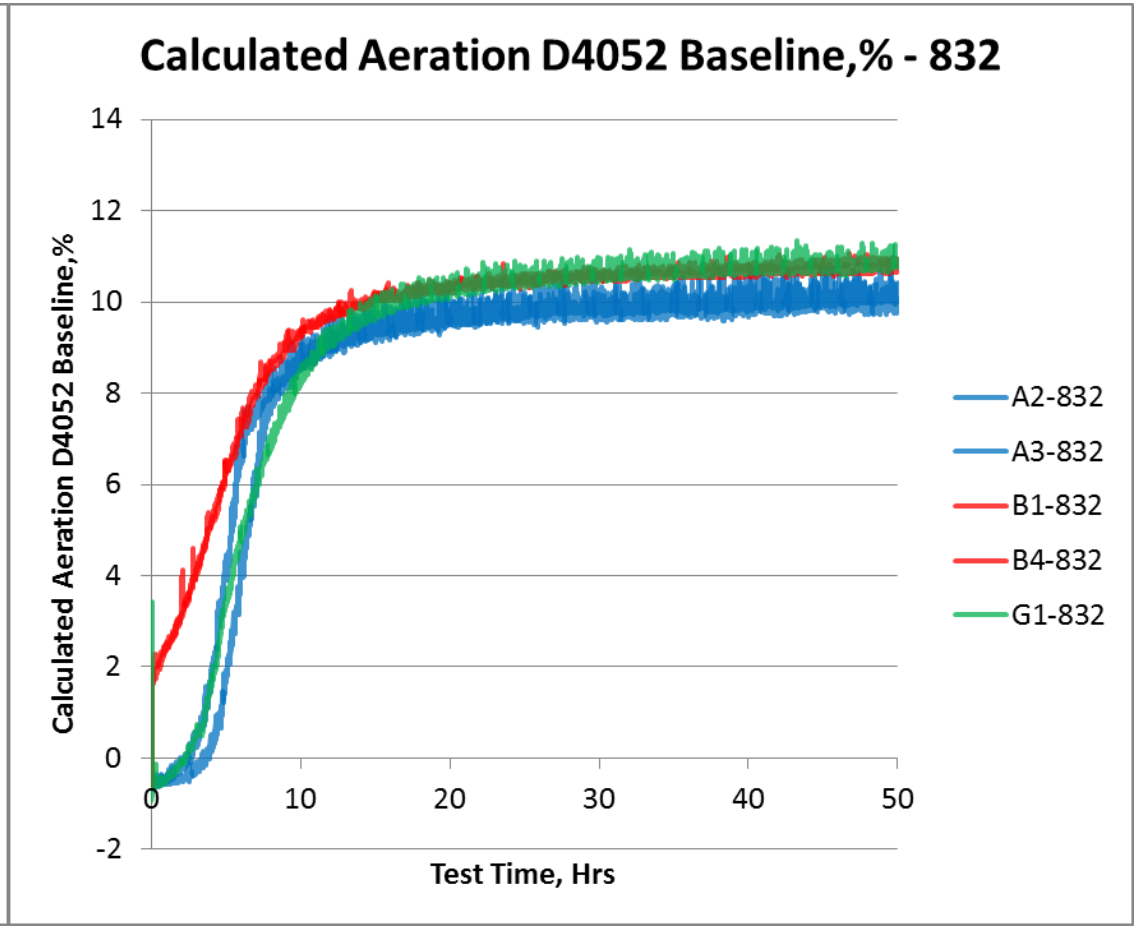
ENGINE OIL DELTA (FILTER INLET – GALLERY) PRESSURE BY RUN OVER TEST HOURS



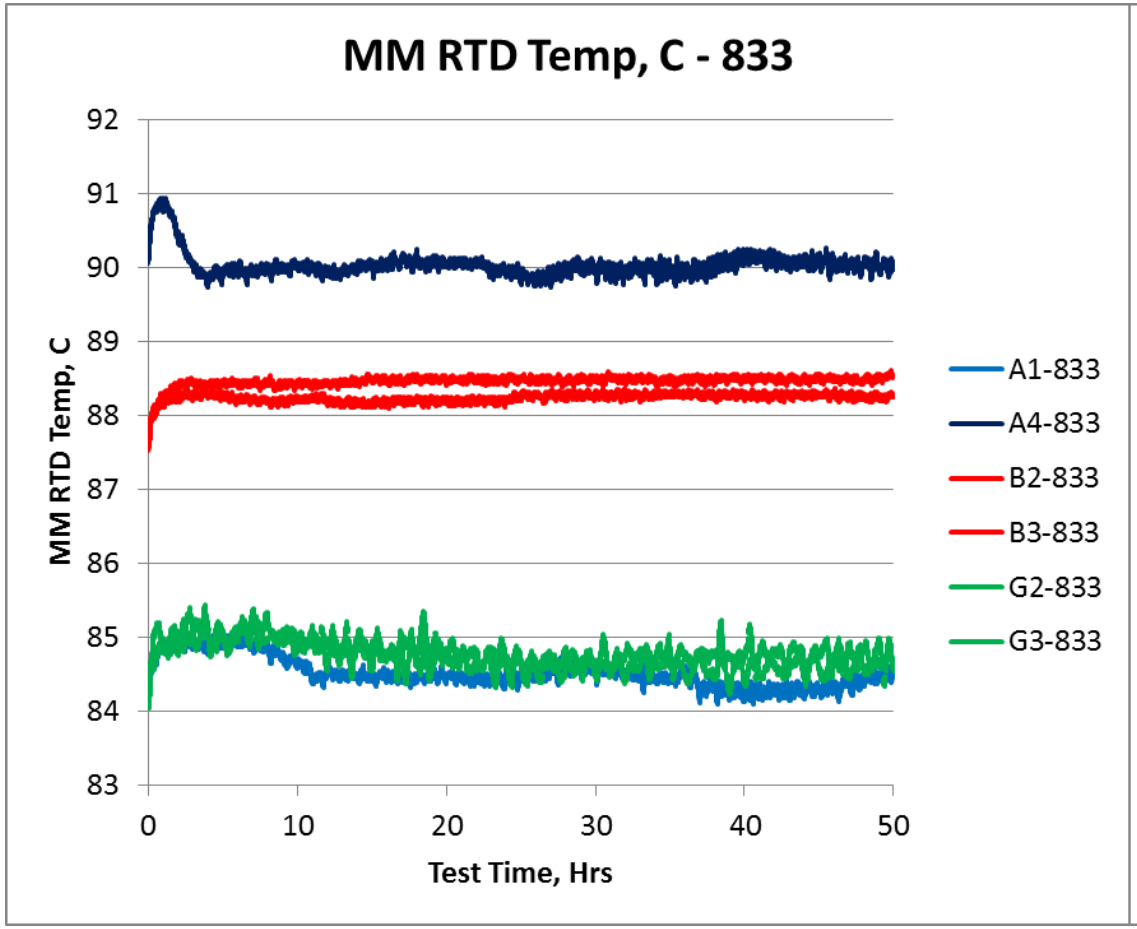


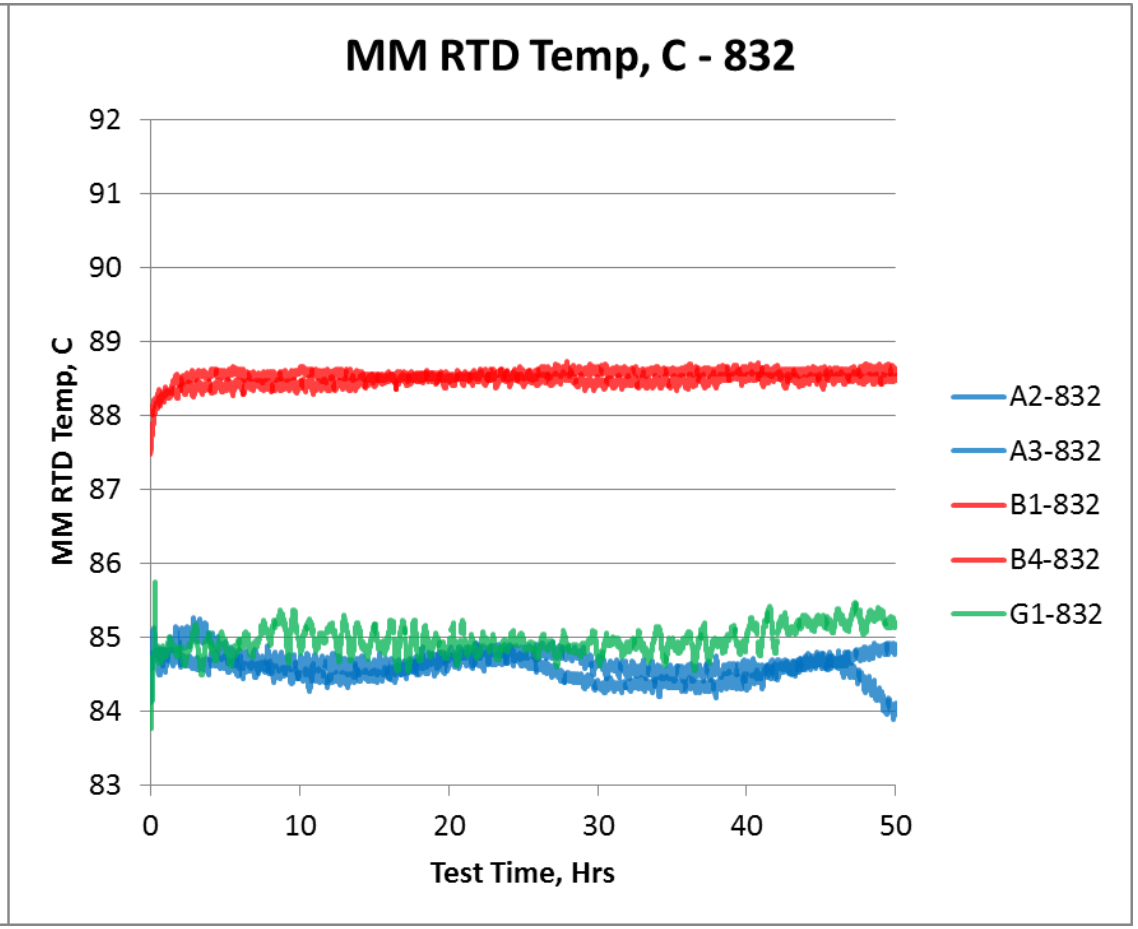
ENGINE OIL AERATION BY RUN OVER TEST HOURS



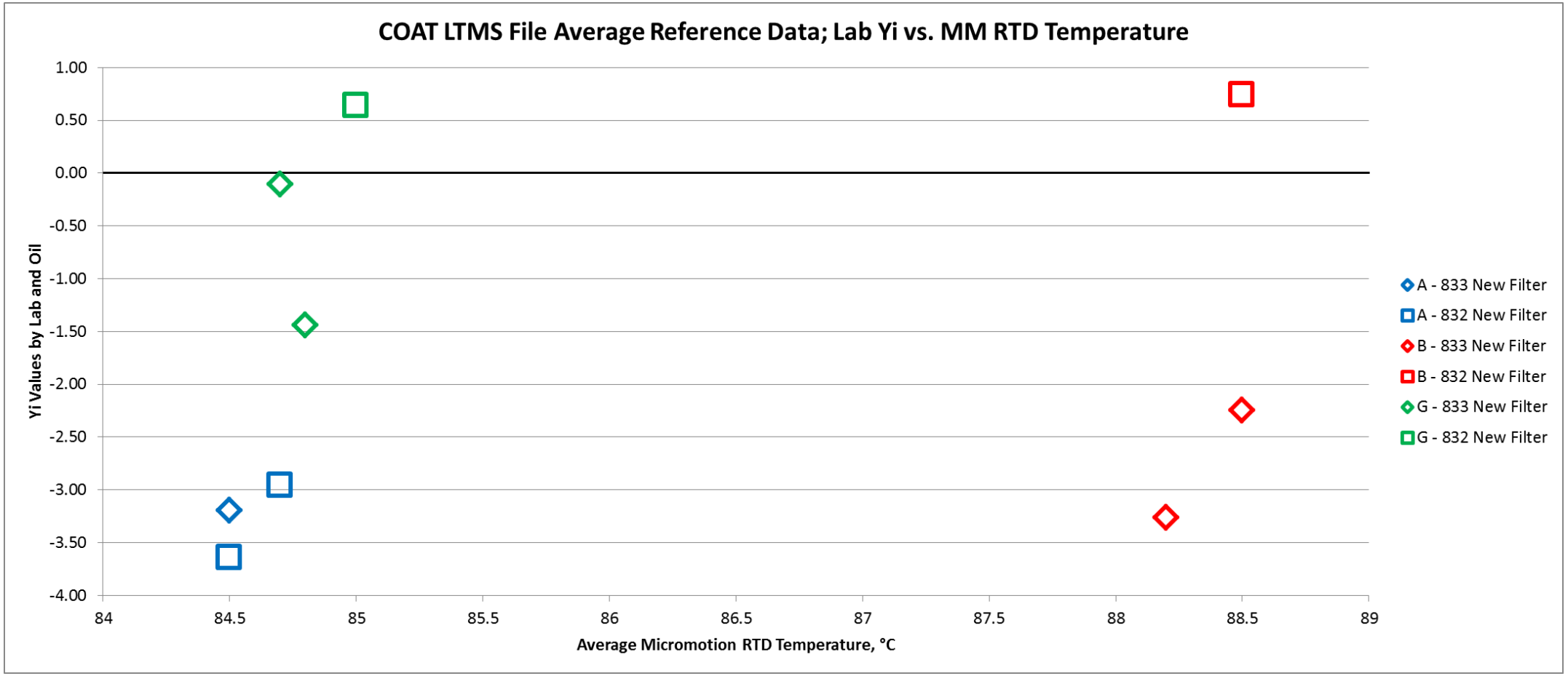


MICROMOTION INTERNAL TUBE TEMPERATURE BY RUN OVER TEST HOURS





LAB YI VALUES PLOTTED AGAINST AVERAGE MICROMOTION TUBE TEMPERATURE FOR FIRST 9 TESTS WITH NEW FILTER AND CAL METHOD. 2 LABS HAD VERY SIMILAR MM RTD VALUES WITH VERY DIFFERENT YI VALUES.



04

SUMMARY AFTER DATA MINING

Includes Suggested Future Actions

SUMMARY COMMENTS

Summary Comments:

- Some of the shifts in Lab Yi results line up with shifts in operational performance.
- With the new oil filter and MicroMotion calibration procedure, 2 additional changes were just introduced that don’t seem to be fully understood yet.
- There are still existing operational parameters that would benefit from tighter control within labs.
- Without tighter internal controls within labs on existing parameters and set-ups, the test could easily drift.
- Inconsistencies exist in reporting operational data.
- Doesn’t seem like MM Sample Out Temp should be higher than MM Sample In Temp with box at 50C.
- Pressure Controller Output and MM Sample Pressure Delta seem correlated within a lab. Both parameters also seem correlated with Lab Yi.

SUGGESTED FUTURE ACTIONS

Future Actions:

- Review the observations from the stand visits; differences were noted.
- Labs report exactly what model MM sensor and transmitter are used.
- Discuss what changes were made to measurement systems over time (if any).
- Group confirm new MM calibration method is fully understood and done the same at all labs.
- Capture Heated Line Temperature and Controller Output values.
- Decide how to report Sample Delta Temp: absolute value or actual value.
- Report MicroMotion Sample Pressure Delta.
- Dig up old, original system set-up documentation that didn’t make it into the test procedure and compare measurement set-ups.
- Dig up the information we received from Emerson last year when they answered our questions.

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