

Cat Aeration Task Force meeting

June 18, 2014. Conference call

Attendees: Heather DeBaun, Barbra Goodrich, Martin Thompson, James McCord, Tim Griffin, Greg Miranda, Kevin OMalley, Jim Rutherford, Bob Campbell, Greg Shank, Jim Gutzwiller, Matt Bowden, Caroline Laufer, Elisa Santos, Zack Bishop, Michael Alessi, Sujay Bagi, Mark Cooper, Sean Moyer, Jeff Clark, James Rutherford, Mark Jarrett, Hatuey Campbell, Hind Abi-Akar

The discussion was based on the highlights of the plan that was sent by Caterpillar ahead of the meeting.

Lab Status:

- 1) data correlation between the labs. why are we not reproducing results? Any additional insights?
- 2) must rebuild engines, when? is it in process now? What are the current hours on the engines?

1) Lubrizol will repeat the LZ oil.

2)

- a. SWRI (**Martin Thompson**) has one engine rebuilt and will be ready to break-in.
- b. Intertek (**Tim Griffin**) is ready to rebuild. Current engine hours 1150 including 300 hours of break-in. **It will take them approximately 2 weeks to rebuild and get back in a cell.**
- c. Lubrizol (**Greg Miranda**) has 322 hours on the engine and plans to repeat the last oil test before rebuilding.
- d. For the rebuild, parts have to be changed per the standard Cat C13 process: new PRL, bearings, turbos (single seal), valves, etc. McCord will send a list of the parts to be changed.

Test Specifics

- 1) Verify the calibration of the micro-motion

Review the recommended calibration by the suppliers. Cat will review internally as well. The labs will **share the latest calibration information on** their micromotions and share the methodology used.

- 2) Baseline no aeration density is critical!

- a) Lubricant supplier provided bench data D4052 for the test oil

This may not be available from suppliers or the supplier may request this testing to be conducted at the lab. Hence this option will not be useful as a validation step.

- b) D4052 at test facility (double checking supplier data)

- c) measure density on micro-motion before start of engine test (double checking the micro-motion system) operational conditions.

Measurements per b and c will be conducted by the labs. Micromotion baseline density measurement will be conducted at the end of the second flush. Following the engine cooldown, and before starting the test, the density of the oil that is static in the micromotion will be measured. This data point will be compared with D4052 method.

The group discussed the precision associated with D4052 and the related impact on the precision and acceptable differences between the two methods.

- 3) Review operational conditions.

- a) Should we change the crankcase pressure? 103 kPa to 100kpa

It is noted that oil leak from the turbos were associated with the high crankcase pressure at SWRI. Additionally, there was concern whether the high pressure can damage the turbos. Cat advised to better understand the root cause of the leak.

Note that approximately 4kPa can cause ~1% difference in aeration.

It is important to verify the engine build components per the C13 deposit test. Engines coming from Reman may have the IVAs with the engine brake. The IVA with the engine brake could affect the aeration.

After much discussion we settled on 102kpa as being the new set point for crankcase pressure

- Review exhaust back pressure data;
- Review intake manifold pressure and intake restriction
- Determine if gauge or absolute have to be used?
- Wastegate should be closed during aeration test. Wastegate partially open during break-in (full power) (SWRI will sweep the wastegate from fully open to fully closed)
- Same oil to be run in all labs during break-in: Cat DEO-ULS 15W-40. Change oil at 25 hours to help stabilize Si level. Test Si during the break-in at 0, 30, 40 and 50 hours; ensure that Si is stabilized by the end of the test. If needed, test every 10 hours till Si level is constant (within 4 ppms)
- The two flushes prior to the aeration test should show the Si stable, i.e. within 4 ppm difference than the fresh oil sample.

b) maintain 90C through the micro-motion

- Temperature can be maintained using the correct controllers.
- Labs have been controlling the temperature within ¼ degree.
- Set the temperature average within 1/2 degree. Target ~ 2deg or less temperature drop across the **micromotion** with additional insulation.

Sump temperature:

- Measured and recorded
- All labs are 94.5 – 95.5 at the sump. Oil gallery is 90 C, within 0.3 C.
- Data will be analyzed to determine sump temp impact on aeration

c) engine loading needs to consistent

SWRI and Lubrizol are running uncoupled. Run the engines uncoupled from Dyno to ensure no parasitic loads.

Action: Intertek will modify their setup to run un-coupled.

4) Consistent data acquisition & reporting (critical channels, what freq & averaging)

Drive consistency in data acquisition and reporting:

Sean will put together columns order and labels template.

Cat sent a list of the critical data as input.

Data sampling: every 30 seconds.

Data will be sent raw to Sean

Micromotion should have a consistent filter.

Data filtration is different among labs.

Action: the labs are to review the data filtration settings on their micromotion

Review Test Plan (Hind)

- 1) Concentrate on two oils (not three)
- 2) Repeat tests back to back?

Run the 1005 and the "Poor Aeration" oils

Action: find the availability of the poor aeration oil.

Next Steps & Timeline

- agree on the next steps
- agree on the timeline for next steps

Review operational data following the break-in in order to determine the new data to be generated as well as review older data.

Review early data from SWRI, late next week.

Review prior test data Thursday morning 9:00 to 11:00 CST. Sean will try to send the data early.

TMC will share Packet 2 (Data Acquisition) document.

Action items for the labs

Document time constant (response time) for the micromotion

Document the control parameters of the engine. These will be the same as C13.

Break-in: full power for 50 hours using Cat DEO-ULS (with 25 hour flush). Stop at 50 hours for data review. Measure: elemental analysis (Si is critical), blow-by (using standard C13 meter), oil consumption with oil scale cart (removed prior to aeration test),

Review SWRI data next week. Finalize the procedure.

Use the same TMC template at 6 min sample rate (except for the micromotion) to TMC

Timeline:

1 week: data review and SWRI break-in

~ 2 weeks to start break-in.

Cat will look into cell availability for break-in.

Additional comment (not discussed during the meeting)

Proposal to add ~30 min of stabilization after warm up and prior to the start of test and data collection. This time can allow for a timely transition from the high pressure required to collect baseline density measurements (150 kPa) to the 84 kPa of the aeration measurement. Initial noise in the data may be reduced.