CAT Aeration Test Task Force meeting
Feb 10, 2015

Matrix Progress and Data Review

Meeting at South West Research Institute

Attendees: Names Highlighted in Yellow attended the meeting

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Key questions prior:
Can we use the Matrix data and any given test should be used?
Is the data where we need to support moving forward?

Summary of action items

Parameter	Action	Comment
RPM	Need tighter control for future tests	Impact on aeration is not well understood
Blow by		Different JTEC devices used
Fuel pressure	Determine fuel filter change interval	
Intake air pressure (96 kPa)	Add one decimal point to LTMS average. Review LZ test 5 (@35 hrs): change in intake air and manifold.	Impact on aeration is not well understood
Oil Gallery Pressure	Different among labs (lower at SwRI): Need to determine root cause through focused tests. Issue will be discussed in a separate call.	hardware changes for testing can include: shimming valves to increase pressure; springs replacement; oil pumps; etc.
Pre-filter pressure is not in LTMS	Pump output will be added to the data dictionary Oil filter date code will be added: 6 characters	
Pressure regulator	Bring the values close among all labs. SWRI will remove and inspect the research valve and follow it with a shakedown test.	Pressure valves are partially open or partially closed among the labs. Pump control (speed or controller output) should be the same among labs.
Oil sample pressure (84 kPa)	Control the band width (Now controlled to +/- 1 kPa)	SWRI and EG to work with LZ to tighten the control of this parameter.
Crankcase pressure (103 abs. +/- 1)	Test 4 at EG has higher CCP and appears to show higher aeration.	Note that CCP is confounded with engine hours.
Exhaust restriction control (104 kPaA)	Test 6 of SWRI has initial high values for this parameter.	
Temperatures	Most need to be better controlled Add one decimal point Cooler size needs to be appropriate	Fuel (40C), intake (25C), Manifold (40C), coolant out (90C)
Box temperatures	Needs tighter control	Aeration appears to follow changes in this Temp.
Oil sample temp	Need to be better controlled (90C)	Measured across MM
Oil sample density	Predicted value will be used R^2 value has to be >0.9999. R2 will be added to the data dictionary	

Critical parameter

Operational parameters review:
RPM: 1800 target. Data is useable for matrix analysis – but need tighter data for tests.
The data does not look very controlled. The question is the impact on the aeration.
Labs are controlling this parameter differently: ex what volt trim or signal need to be improved.
Data for aeration are also confounded with other parameters.

Blowby: Difference is in the size of the meters.
SWRI: VF563A
EG: VF563B
LZ: VF563A
Fairly steady during the tests.

Fuel rate: range was high at EG due to tank configuration. Data was tightened afterwards. Flow 118 and 123 g/min. (grams / min)

Fuel pressure: after the pump at the filter head. The differences are mainly due to electronic filtering of the signal.

Filter fuel: determine when to change filter

Intake air pressure: target is 96 kPaA.
Correlated to intake manifold pressure and turbo speed (boost).
Average in LTMS report is rounded to the nearest whole number. Instead it needs one decimal place.
LZ has one test with change in the Intake air and intake manifold. This could be due to manual adjustment.
(Need to look at the aeration results of this test: LZ run 5 at 35 hours: preliminary info shows that no impact on aeration)

Coolant system pressure: 99 to 107 kPaG, per the C13 deposit test range.
All are measuring at the top tank.

Oil Gallery Pressure: Critical
There are differences among the labs. SWRI is lower than the other tests. Root cause analysis is needed. Options are measuring the springs or shimming the valve to increase pressure.
375 is the design pressure for the engine to open the valve for bypass.
Hardware differences among labs are the cause. This is hard to control since it is impacted by the tower water temperature pulses.

(Prefilter pressure is not in the LTMS – pump output will be added to the data dictionary (Sean); oil filter date code will be added: 6 characters)

Analysis should be done: need to determine the experiments and hardware changes (springs replacement and other replaceable parts; oil pumps can also be replaced and tested). A separate call will be done.

Pressure regulator report: **critical.** Clear differences among labs. Pressure valves are partially open or partially closed among the labs.
Pump controll should be the same among labs. This is pump speed or pump controller output.
Action: Bring the values close among all labs. SWRI will remove and inspect the research valve and follow it with a shakedown test.

Oil sample pressure: critical (at the micromotion, average of P MM in and out): target is 84 kPa.
This test parameter needs to be better controlled due to its potential impact on the aeration data. This control will result in a better controlled aeration data.
Now this controlled to +/- 1 kPa
Discussion if the variation of aeration is parallel to the variation of oil sample pressure (not the average, but the width of the data band)
LZ data is tightly controlled. SWRI and EG to work with LZ to determine how to tighten the control of this parameter.

Atmospheric pressure

Crankcase pressure (kPaA): **Critical** 103 absolute +/- 1. (Higher crankcase pressure increases aeration)
Test 4 at EG has higher CCP and appears to show higher aeration.
This test has questions. Note that CCP is confounded with engine hours.

Exhaust restriction control 104 kPaA is the target.
Test 6 of SWRI has initial high values for this parameter.

Fuel Temperature (deg C): 40 deg C is target value. May need to be improved, but not a critical parameter.

Intake Air temperature (deg C): Target is 25 C. Measured after the filter and before the intake manifold. Proposal to add one decimal point (for all Ts).

Manifold temperature: 40 deg C is target value. Proposal to add one decimal point. This parameter can be better controlled and needs to be for future testing. A different cooler that is more appropriate for this engine.

Q: try to determine if this parameter has an impact on the aeration data.

Coolant out temperature: 90 deg C is target value.
EG test 7 had lower coolant temperature of 84 deg (valve accidentally opened and fixed later in the test). This can be improved.

Proposal: Av of the temperatures reported should have one decimal point. Temperatures are measured to one decimal point, hence the reported average should also have the decimal point.

Sump Temperature: This cannot be controlled, but the gallery temperature is controlled. Discussion if the coolant temperature has to be moved to control the sump temperature

Ambient and Box temperatures: Tighter controlled than before the box, but needs to be tighter controlled. SWRI data is noisy.
Aeration data appear to dip as the box temperature dips. Excursions in the box temperature can skew the test results. The excursions can be due to shutdown and then when the temperature

Oil sample temperature: Critical. Measured across the micromotion. Target is 90 deg C. Measurements are noisy at SWRI and to a lesser degree at EG. This parameter can be better controlled.

Temperature drop across MM: these were high for the first run at lab G and last run at lab A.

> **Oil K, last test, at lab A will be rerun** due to the high difference in MM in-out temperature. SWRI will implement a new P regulator and heated line for the new rerun. Approximate time to finish the test: by the 19th.

Exhaust temperature: this is a "record" parameter.

Pump speed control (through MM): the labs show different pump speeds while the sample flow rate is the same. As oil sample flow decreases, aeration increases. But this could be a result of the aeration and corresponding density shifts.

Oil sample density:
Raw density from micromotion
When the density is calculated based on the predicted value (vs. actual measurement that is used by two labs), the aeration changed by 0.01 to 0.02%.
As agreed to in the prior meeting: the predicted value is to be used and the R^2 value has to be >0.9999. R2 will be added to the data dictionary.

Oil sample flow (l/min): output signal from MM.

Temperature corrected density: per the equation agreed to. The data is noisy highlighting the reason this parameter is not used in the calculation of the Dvt.

Dvt per D4052: although all are using predicted values which are very accurate, the slope is different among the labs shows differences. EG values are higher (difference is in the fourth decimal place), which may drive the aeration values higher for EG.

Base line density impact: Impact on the final aeration is ~0.03% if the density varies at the fourth decimal point.

Note: the oil pump part number at all the labs is 223-1608.

Review of statistical data by Elisa:
Confounding factors: engine hours is rather easy to see. However, there are many confounding factors that complicate the simple inclusion of engine hours.

Ex: lab G shows consistent decrease of aeration with hours. But the first 7 tests the CCP was higher.

Discussion: how do we determine the engine hour's impact. There is a sense that this impact exists, but if data is removed to reduce the pool of data,