Sequence X Severity Task Force

Meeting Minutes

07/29/21 and 08/04/21

Attendance

- Michael Deegan
- Rich Grundza
- Christian Porter
- Christine Eickstead
- Amol Savant
- George Szappanos
- Jason Soto
- Alfonso Lopez

Agenda 07/29/21

- Amol's testing results
  - Is there any difference in the chem or operational data compared to the unmodified tests?
  - Are there any other indicators that might the explain the root cause/relationship between CCP and chain wear
  - Does the group feel we need to incorporate this modification to address the severity issue?
  - How will that be done (matrix?, with a reference?,…)

- LTMS crankcase pressure data analysis (with old data added)
  - Has that work been completed? does it show a correlation to chain wear?

- Honing requirements in the procedure
  - What surf finish analyzer should be used?
  - **What surf finish values have labs been getting on new and honed blocks?**
  - What should the Ra in the procedure be set to?

- Blowby measurement, allowance of alternate devices
  - For example, AVL PD442

Meeting Minutes 07/29/21

- Block honing, surface finish
  - Jason gave a review of the early test development details of block honing
    - IAR was using the 325 KD profilometer
    - Target surface finish was 9-13 Ra – This finish was measured in new blocks and carried into all rebuilds
    - The 320 grit honing ball was used
    - Other labs had trouble achieving the 9-13 Ra but were using the SJ-410 profilometer
    - Lab divergence in procedure began at this point
  - The group agreed on the following and the changes to the procedure are noted on the next slide
    - SJ-410, 320 grit hone, range of 7-13 Ra (Add SI units .178 - .330 micro m)
    - Labs were to confirm the range of surface finish before the procedure edits are made

Proposed Changes to Procedure

- 8.13.1 General—Carry out deglazing after ultrasonic cleaning for both new and previously used engines under the following conditions to achieve a per-cylinder average surface roughness (Ra) of 0.178 µm to 0.330 µm (7 µin to 13 µin) ~~and 30° ± 5° crosshatch~~ using a Mitutoyo SJ-410 profilometer. *(Comment: the crosshatch spec is already spelled out in 8.14.3.3)*
- 8.2.1 Use a silicon carbide, 320 grit flexible cylinder hone Flex Hone Model GB31232[7,20] and pneumatic honing drill Westward, 500 r/min, 600 kPa (90 psig) max, Model 5ZL26G[7,20] to deglaze the cylinder walls (see 8.13 and Figs. A9.3 and A9.4). (no change)
- 8.19.3.3 Install the pistons with the arrows facing forward and connecting rods with the notches facing the ~~rear~~ front.
- 6.2.2.1 Crankshaft ~~and bearings~~, connecting rods ~~and bearings~~, pistons, camshafts, ~~timing-chain covers~~, cylinder blocks, and cylinder-head assemblies, ~~turbocharger, and fuel injectors~~ can ~~also~~ be used for a maximum of six tests provided they remain serviceable. However, keep these parts together as a set for all six tests.
- 8.23.2.10 Blowby Gas—Install a sensor at the gas outlet of the blowby heat exchanger. Orient the thermocouple such that water condensate does not affect the temperature measurement of the gas. *(comment: there seems to be no specific requirement as to the configuration or orientation of the blowby stack components. It's left up to the labs to determine what works for them in addressing the newly included note.)*

Meeting Minutes 07/29/21 (cont'd)

- Meeting discussion was mostly spent on block honing and procedure change.
- We turned to Amol and began discussion on his test with the BB restriction tests at Valvoline
  - Oil consumption was on the level with IAR when IAR was on target
- Meeting was adjourned

Meeting Minutes 08/04/21

- The meeting continued with the 07/29/21 agenda
- Jason presented his findings and results of the BB orifice restrictor tests. See slides below.
- Jason has a suspicion that oil is being pushed through the turbo seals
- Oil consumption for the IAR tests has been very low and not at the level seen in the early years of test when IAR was on target.
- The orifice tests at IAR were mild of target for oil 271. IAR did not reproduce the test results seen at Valvoline. One main difference was oil consumption. Valvoline oil consumption was in the 1000 gm range. This level of oil consumption matches what IAR had in the past.

Meeting Minutes 08/04/21

- Discussion of oil consumption and oil analysis
  - Was oil consumption looked at in Travis' presentation? The March presentation did not show oil consumption.
  - A difference is seen with the Valvoline vs IAR tests
  - Amol suggested reviewing oxidation and nitration. All labs to turn in data.
  - Amol saw more water in the on-target tests. Labs to supply data for master table of test details
- Operational data from the Valvoline tests to be turned in for comparison to IAR and other test in the data base
- Discussion of BB stack flow
  - Labs to provide detail of coolant flow control, direction of flow and humidity data at the valve cover and post heat exchanger. Amol will send details of how he measured and his data.
  - Test developed with coolant flow control (12L/m) but later changed to BB gas temp control. Unknown if labs are still controlling flow
- IVB test measured BB gas humidity. Review the data - Al
- George described the thermodynamics he observed in the bb stack when transitioning from the cold first stage to the hot second stage. At this point in the test, the condensation seems to be the greatest. Critical for labs to control the temperatures and flow rates at this time.
- Mike to look at the PCV valve prints. There is concern that the valve has changed and may be affecting the gas flow.

Action Items

- Labs to provide the following for comparison
  - BB stack coolant flow control detail
    - Flow rate, counter flow or parallel
  - Plumbing details
    - BB gas thermocouple plumbing to prevent condensation from saturating the thermocouple (45 degree fittings)
    - Size of hose from 3 –way valve to the air duct.
  - Oil analysis (Ni , Ox, Water content, Fuel dilution, Oil Consumption)
- Amol to provide op data for 3 tests that were on target. Template sent.
- Oil consumption data review – Al /Jason
- Review IVB work on BB gas humidity measurements – Al
- Study PCV valve flow design change (Oil Separator Part # AG9Z6A785A/AG9G6A785CA) – Mike
- Send Procedure changes to E-ballot - Al

Seq X crankcase experiment

By: Jason Soto

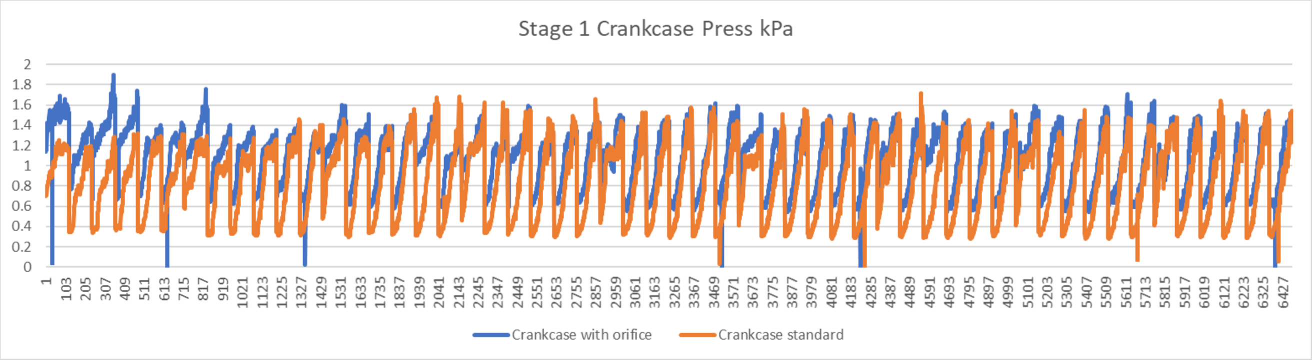
Crankcase restriction

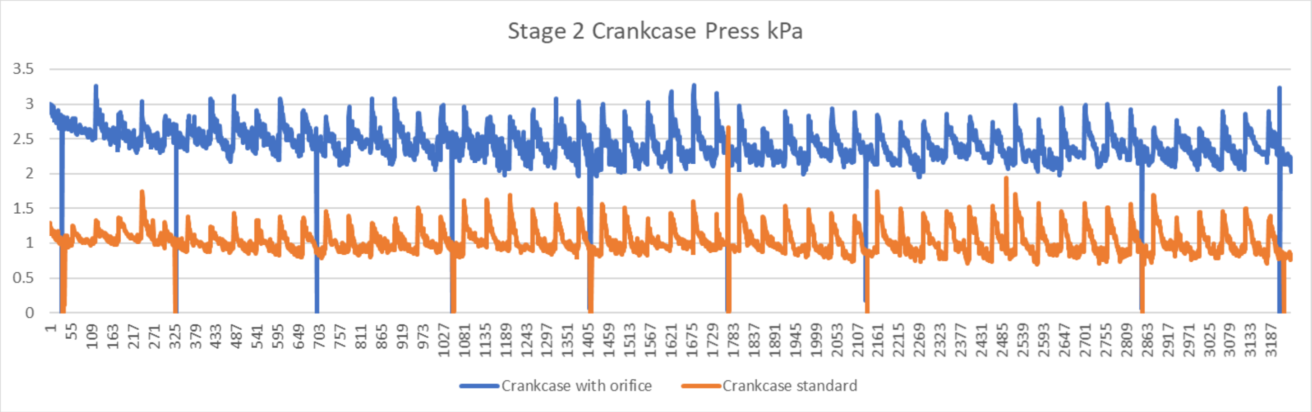
- Blowby system was being cleaned with a flush cart.
- 07//2018- we tripped a high crankcase alarm. We found that the high crankcase was being caused by the clogged oil separator filter.
- Most of the oil was found in the intercooler.

Crankcase orifice

- A 15/64” orifice was added to the outlet of the oil separator in order to increase crankcase pressure.

Crankcase Pressure Comparison





- Both tests run on TMC oil 271.
- Both tests were run back-to-back on the same stand.
- The orifice increased the crankcase pressure by roughly 1.5 kPa during stage 2.

Chain Wear Test Results

Test Number:	93-0-130	Standard crankcase		
		Pre Break In	0 Hour	216hr
Reference	1	-0.0110	-0.0111	-0.0110
	2	-0.0110	-0.0111	-0.0110
	3	-0.0110	-0.0110	-0.0110
	Average	-0.0110	-0.0111	-0.0110
Test Chain	1	-0.0085	-0.0031	0.0048
	2	-0.0084	-0.0030	0.0048
	3	-0.0084	-0.0030	0.0048
	Average	-0.0084	-0.0030	0.0048
	% Change			**0.0362**
		Current Severity Adjustment		0
			Final % Change	**0.0362**

Test Number:	93-0-131	Crankcase orifice		
		Pre Break In	0 Hour	216hr
Reference	1	-0.0109	-0.0109	-0.0110
	2	-0.0109	-0.0109	-0.0110
	3	-0.0110	-0.0109	-0.0110
	Average	-0.0109	-0.0109	-0.0110
Test Chain	1	-0.0069	-0.0012	0.0070
	2	-0.0068	-0.0012	0.0071
	3	-0.0068	-0.0012	0.0071
	Average	-0.0068	-0.0012	0.0071
	% Change			**0.0383**
		Current Severity Adjustment		0.0000
			Final % Change	**0.0383**

Oil Consumption- Restriction in crankcase ventilation

Engine oil under pressure enters the bearing housing of the impeller shaft from the oil inlet side. This oil passes bearing and the wheel journal surfaces lubricating and cooling the moving components. Here it depressurize and flows by gravity through the oil drain line and into the engine sump.

Faults in the crankcase ventilation system can result in positive pressure being built up in the crankcase and restrict the oil from flowing down into the oil sump. This restriction allows the oil pressure to build up in the turbocharger which then allows the oil to escape past the oil seals at either end. The oil then enters the intake tract where it is sucked into the combustion chamber or it is blown out the turbine side into the exhaust.

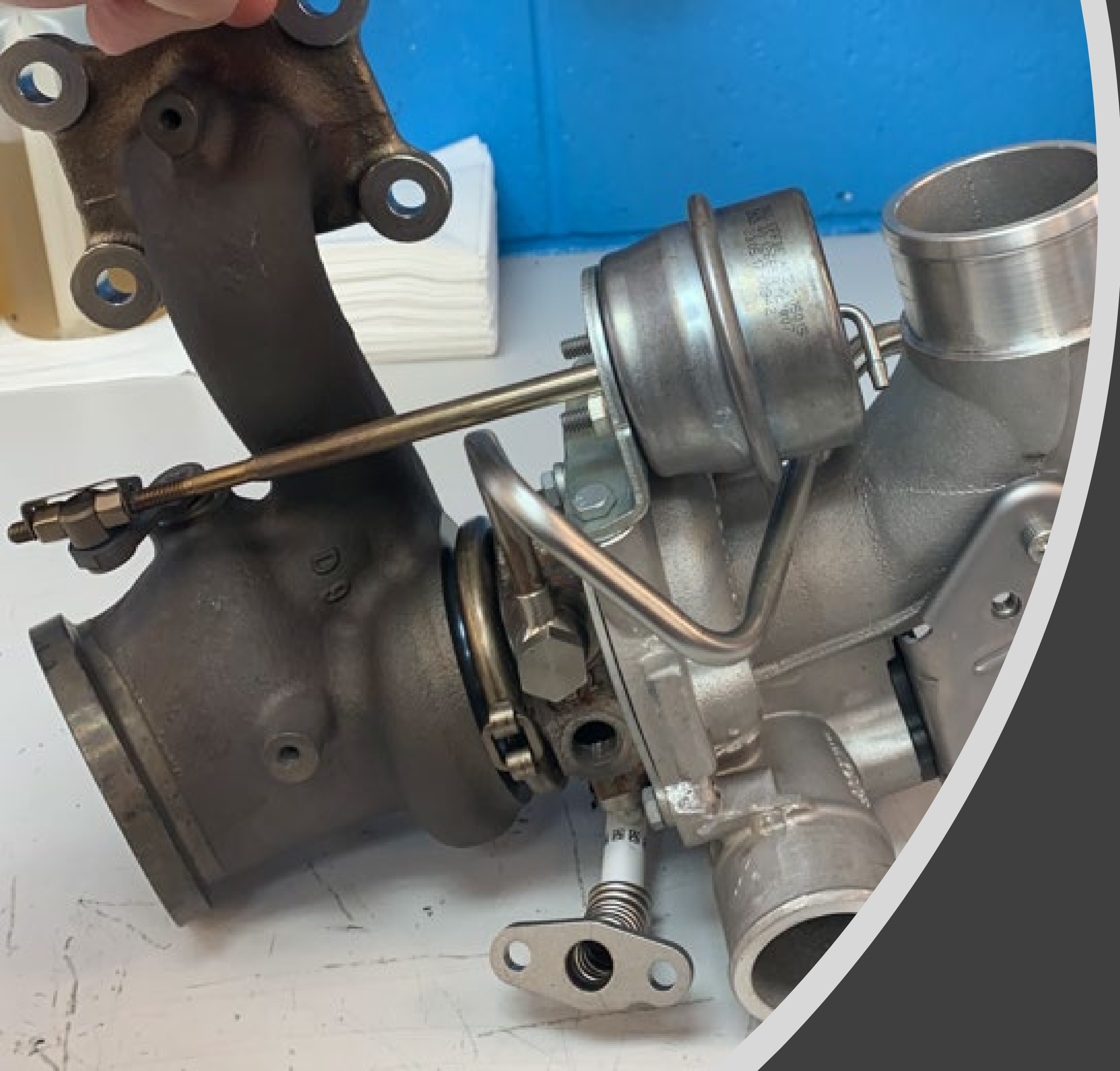
https://www.boosttown.com/engine/oil_consumption_crankcase_ventilation.php

In contrast to other parts of the engine, turbochargers do not have radial oil seals made of elastomer material. This is because of the high temperatures and high engine speeds (up to 330,000 rpm) they are subject to.

A labyrinth seal is located behind the turbine and compressor impeller which not only inhibits escape of engine oil, but also the entry of compressed air and hot exhaust gases into the bearing housing. The gas pressures at the turbine impeller and compressor impeller end prevent engine oil from escaping. The washers on the turbocharger shaft have the effect of forcing engine oil escaping from the bearing positions out from the shaft by centrifugal force. Engine oil escaping from the radial bearings as well as intake air and exhaust gases that find their way into the inside of the turbocharger are taken back to the oil pan via the return line.

If the turbocharger is losing engine oil via the intake or exhaust gas port, this usually means the pressure equilibrium is impaired due to problems with the oil/gas return line.

https://www.ms-motorservice.com/en/technipedia/post/oil-consumption-caused-by-unfavourable-operating-conditions-for-turbocharger/



Turbocharger Oil Drain

Turbocharger oil seals

Oil is pushed out of the compressor side into the intercooler.