

Ford ValveTrain Wear (VTW) test – Feb 25, 2020

Agenda: Review of Valve Train Test history and answering questions received from Cat.

Review of history: Excessive wear of valve train. Internal durability is 1200 hours or more. Hence accelerated test to target 200 hours.

Ford came up with their own spec, based on CK-4, to protect their engines.

Oils ran at Ford initial development work showed effects of viscosity and P on the test. P was considered a big actor in this test. After developing the cycle and showing discrimination, ran the hi P and low HTHS combinations.

At 200 hours, best discrimination was obtained. Test to (150) showed little discrimination.

Average Rocker arm weight shows discrimination. **Ford to provide pictures of HWO/LWO wear.**

Rocker Arm Pedestal, Lifter Roller Pin, and Push rod weight did not show discrimination.

Q: what is the source of iron

A: valve train is main source since there is no cylinder wear. Short blocks are planned to be used up to 5 tests. Leak tests and compression tests at EOT do not indicate wear.

See PDF dated 12/5/2017, Blue oil is high P low HTHS did not show wear. Indicated impact of P.

5W-30 FA-4 prototype: high wear oil (HWO) and 10W-30 CJ-4 is low wear(LWO).

Majority of wear was on rocker arms.

Q: Characteristic of the test oils: Visc, TBN/TAN, oxidation, nitration or other properties

A: Visc shown, with verbal on oxidation, **Team to provide data.**

Q: Can manufacturing variability be a factor in the rocker arm push rods.

A: all parts were batched where variability was reduced as much as possible

Q: can the wear be quantified with scanning or other methods?

A: it is very difficult to measure weight on the rocker arm pedestal and roller pin. Team looking into using Keyence on the Rocker Arm Pedestal Pivot Ball locations. Roller pin wear measurements have been completed with no discrimination noted.

The work team came up with a way to generate soot in collaboration with the three labs. Soot level was adjusted through Coolant Temp Voltage Signal adjustment to PCM during wear phase (10 to 210 test hrs).

Q: Filter bypass?

A: Single filter would go into bypass. Changed procedure to controlled by using (2) filter setup.

Q: are there oil adds?

A: Yes, fixed add at a specific volume similar to ISB. Forced drain then add 1400 g to bring it back to full mark.

Q: is the test within the window of ECM setup.

A: false voltage signal is fixed. Tight range and close to natural operating conditions.

Q: Any intermediate samples between 0 and 10 test hours soot?

A: Option to take them, but it behaved fairly well with the window being reasonably large and the soot is within it.

Q: is injection timing actively monitored

A: Yes, on the CAM bus.

Q: is there consideration for looking at lower soot levels? This level is high

A: Mimic 1200-hour durability wear levels. Soot levels had to be increased to shorten the test and accelerate wear conditions. The engine produces this soot naturally. In early tests there was no change to injection timing. Last (4) tests used the false voltage signal for coolant temperature which changes injection timing to raise or lower soot levels to meet targets. Even at the labs, in order to control the soot, injection timing was changed to meet targets.

Q: after first 10 hours, does engine runs at constant load and rpm?

A: Yes, the injection timing actively controlled if necessary, with an expected Hp & Tq to be met while monitoring Fuel usage.

Rocker arm mass used to develop discrimination. Worked with statistician who felt the discrimination is reasonable. Transformation can be also done in the future

For Precision Matrix: 15 tests would be run to improve repeatability and reproducibility (Matrix 3 recommended)

Now: Trying to get a task force together to develop precision matrix.

Next: Review of Q's and A's

In response to EMA request for streamlining tests and reducing redundancy: evaluating GM, ISB and Ford test

Further Q: Is there VG TURBO on this engine

A: yes

Q: would the "hook" increase variability? This hook happens above 6%, so does this impact wear mechanisms

A: we will keep an eye on it and **provide the data regarding oxidation to understand which ASTM method for viscosity should be used.**

Q: are you going to scrutinize operational data to validate they are run operationally similar

A: the last four tests definitely did that. **Team to provide.**

Lab: data reviews was done. Tweaks during development were taken into consideration. Operational parameters are fairly tightly held.

Test procedure is on the TMC website. Working with Sid Clark to clean it up further.

Q: Why was the soot controlled rather than keep it at the natural rate? If soot level is maintained at a certain rate, as you adjust the timing to help the soot rate, are you helping the oil – soot carrying capacity?

A: Decided to avoid adding a soot factor, similar to ISM/ISB. When additional labs or new engines were run, different soot rates were noted. Believe controlling the rates would be the best way to manage potential wear variation.

Q: Is the soot in the oil, actually soot or degraded oil? This would impact the lower oxidation oils?

A: will look into this question.

Q: Oils of different dispersing may land at different soot levels and hence wear

Q: soot by TGA?

A: Yes

Q: Viscosity test measured by ?

A: Normal D445 not TGA.

Q: Do have oxidation data? If the oil is not oxidized, then no impact.

A: yes, around 20%. **Data to be provided.**

Q: Oil severity may not be impacted – also oil consumption can be a factor

A: Oil consumption is not controlled.

What are next steps?

Several ideas are planned for Precision Matrix (PM) based on statistical input. Currently working through labs and estimating cost:

PM Design options were reviewed. The tests will start with new engines to validate the 5 runs per block.

Presentation will be sent.

Suggestion: need to step back and dig deep into the procedure and reproducibility

Need a face to face to go through data, engine build and setup.

Q: Are there other wear on the engine: cam, others.

Looked at the pins, push rod (part of comparison to ISM). Only discrimination is the rocker arms.

Planning to use Keyence where we cannot weigh parts.

Face to Face Meeting time: may be difficult in 2 – 3 weeks and trying to coordinate with another HD SP.

- Cummins is working on new hardware to be discussed.
- Does Cat have topics for discussion?
- Need to review final procedure for COAT

Recommendation: coordinate with other panel chairs and coordinate a meeting.

Final review: Look at oil oxidation levels and other oil tests; **additional info on statistical data**

Q: data dictionary in place?

A: can put it on TMC site – **TMC is working on it**

Will have a touch point in two weeks and work on date for face-to-face. Also working non common share point to collaborate. **Will load TMC Website for the communication for the Task Force.**

TMC website has been used before to access public information. Sean will help with this area.