Unapproved Minutes of the February 4, 2014
Sequence VG Surveillance Panel
Conference Call

The meeting was called to order by Chairman Andy Ritchie at 2:00 PM EST.

Mike McMillan agreed to take the minutes of the meeting.

A list of the attendees on the call is included as Attachment 1.

Chairman Ritchie listed the agenda items he would like to cover in this call:

1) Approval of the minutes from the December 19, 2013 Sequence VG Panel conference call
2) Discussion of Haltermann's request for a commitment from the VG Panel for a future fuel batch
3) Old Business
4) New Business
5) Decision of future Sequence VG Panel conference calls

Chairman Ritchie asked if there were any corrections to the minutes from the December 19, 2013 VG Panel Conference call. There being none, Jason Bowden moved and Ed Altman seconded a motion to approve the minutes. The motion was approved unanimously.

Chairman Ritchie read several sections from the minutes of the December 19 VG Panel conference call minutes in which Mark Overaker had indicated that Haltermann would need assurances from the VG Panel that they would be selected as the fuel supplier before they could agree to making plans for producing and storing a 1-million gallon batch of fuel. Mark again stated that, in his opinion, Haltermann would not be able to agree to move forward with plans for such a large fuel batch without such a commitment from the Panel.

Chairman Ritchie reiterated that while, in principle, he supports a larger batch based on the extended time between fuel batch approvals that a larger batch would offer, there is really nothing this Panel can do to guarantee

Haltermann would be selected as the supplier for the next batch sometime in the future, since the Panel is not a legal entity and could not enter into such an agreement. Chairman Ritchie went on to reiterate further though that because Haltermann is the current supplier, and because they are the only ones with knowledge of the current fuel formulation details, the Panel believes they are in an extremely advantageous position when it comes to deciding who to select to formulate future batches. Ron Romano supported Chairman Ritchie's position that the VG Panel has no authority to make a commitment for future fuel batches. Mark indicated he would take this position of the VG Panel back to his management and report Haltermann's response back to the Panel at a later date.

Old Business: None

New Business: Al Lopez brought up the question of how negative (Oil Screen Clogging - OSC) values which originate from the fuel severity correction factor calculation procedure should be handled. Ed Altman indicated that his lab reports such values as zero. Rich Grundza agreed that this practice was probably appropriate. Al made a motion that any OSC value calculated to be a negative number be recorded on the test report as zero. Ed seconded the motion. Chairman Ritchie asked if there were any objections to the motion, and there being none, the motion was deemed to have passed unanimously.

Based on a request for all PCMO engine test surveillance panels to look into any problems which might have been encountered in running SAE 0W-16 formulations, Chairman Ritchie reported that he had asked Rich Grundza to investigate that question for VG tests. Rich reported that 3 of the labs had not run any SAE 0W-16 formulations. One lab had reported some problems maintaining oil pressure during a run with a 0W-16 oil, while a second lab reported they had had some problems maintaining both temperature and pressure with a 0W-16 oil. That lab also found elevated fuel dilution with the same oil. It was not clear whether any of these problems caused any of the tests to be declared operationally invalid.

Rich also reported that the data dictionary is being worked on for the VH test being developed. Jason Bowden reported that OHT has a very limited supply of 6 ECUs available for setting up VH stands. However, OHT is reluctant to commit all of these for VH stand buildup, since the same ECU is used for the VG test, which is still an active test in GF-5.

Ron Romano updated the Panel on progress on Sequence VH test development. Two tests on REO 1009 have been run recently, one each at Intertek and SwRI. (See Attachment 2). One test was severe at 192 hr, with most of the sludge formed in the last few hr. The second test ran to 216 hr, gave a 7.61 AES rating, but also didn't turn severe until the final 24 hr. Ron is concerned that we may not be able to shorten the VH test to 180 hr as originally thought. He is currently running tests on oil 1009 using 2013 rings at both S.A. labs to see how they compare. Ford is still aiming to complete VH test development by May 2014.

Ron also gave an update on Chain Wear Test development. Previously, Ford had been seeing some reversals in tests with different chain materials. In attempting to sort out these results, they decided to conduct break-in measurements during the first 24 hr of testing, instead of assuming that break in was equal for the different chain materials. When the results were analyzed in this manner they seemed to fall in line. Because Ford does not have what they consider to be a passing chain wear oil, they decided to adopt an SAE 10W-30 API CJ-4 oil as the passing oil. They have just started running tests with this oil. The first test ran to 144 hr before taking a dip. A repeat test in the other lab didn't look as good, although higher blowby in the second test may explain this result. The next tests will be with EEE fuel and the failing oil; they have exhausted their supply of 50 ppm S fuel, and hope to be able to use the same EEE fuel that other Sequence tests utilize.

Future Meetings: Chairman Ritchie indicated that it was his preference to keep the first Tuesday of each month at 2pm as a placeholder for a VG Panel call. Then, if a call is not deemed necessary in a given month, it could be cancelled, but at least the date and time would be in place. Ron Romano said he agreed with planning for a monthly call, as did several of the other Panel members. So, putting that plan in place, the next scheduled call would be March 4.

Next Meeting: The next VG Panel conference call will be held Tuesday, March 4, 2014 at 2:00 PM EDT.

Attachment 1

Sequence VG Attendance for 2/4/14 Call

Infineum: Andrew Ritchie, Gordon Farnsworth, Mike McMillan, Doyle Boese

Ford: Ron Romano

GM: Bruce Mathews, Robert Stockwell

SwRI : Dan Worcester, Janet Buckingham

Intertek: Al Lopez,

Afton: Ed Altman

TMC: Rich Grundza

Lubrizol: Jerry Brys, Chris Mileti, George Szappanos

Haltermann: Mark Overaker

Oronite: Kaustav Sinha

OHT: Jason Bowden, Mathew Bowden

TEI: Zack Bishop, Clayton Knight

Attachment 2

Ford EngineTest Development Update

Sequence VH

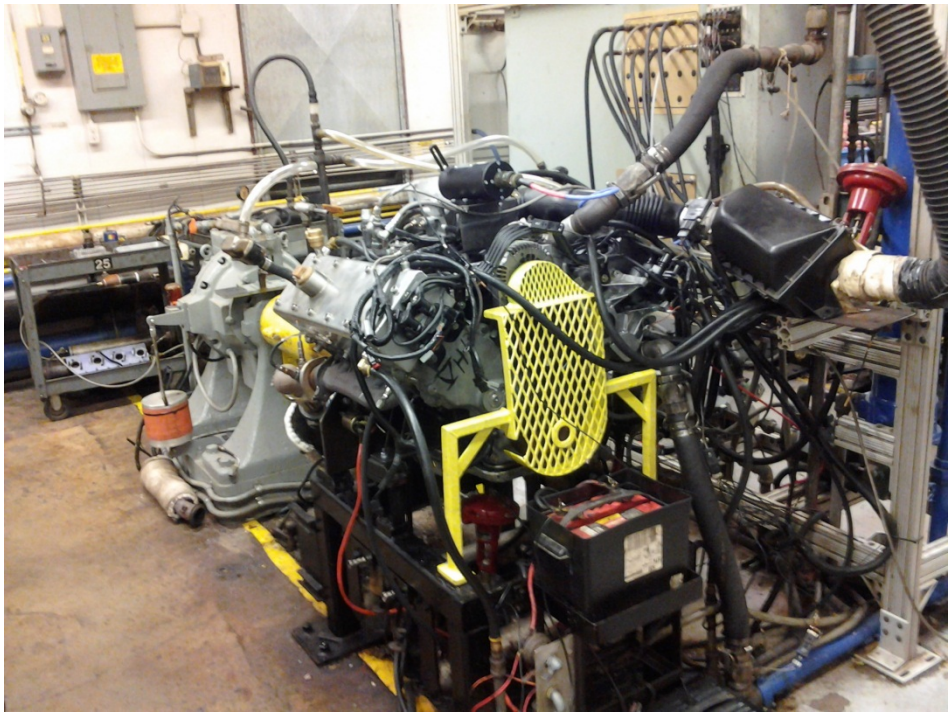
Chainwear

Low Speed Pre-ignition

Ron Romano
Ford Motor Company
January 14, 2014

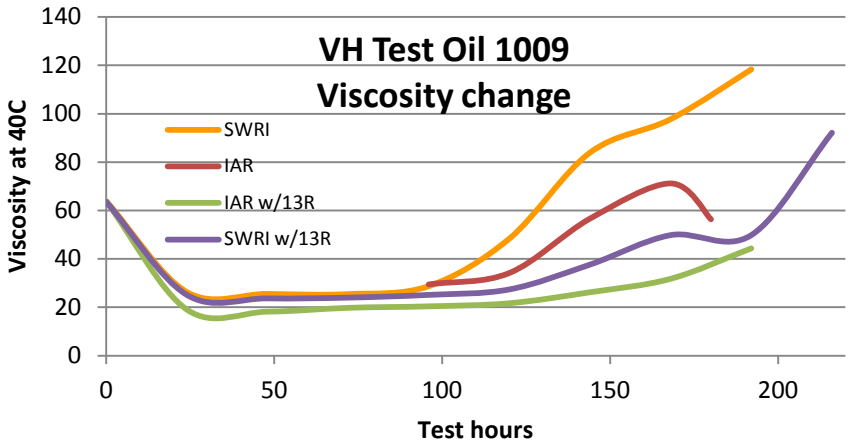
Sequence VH Sludge Test Overview

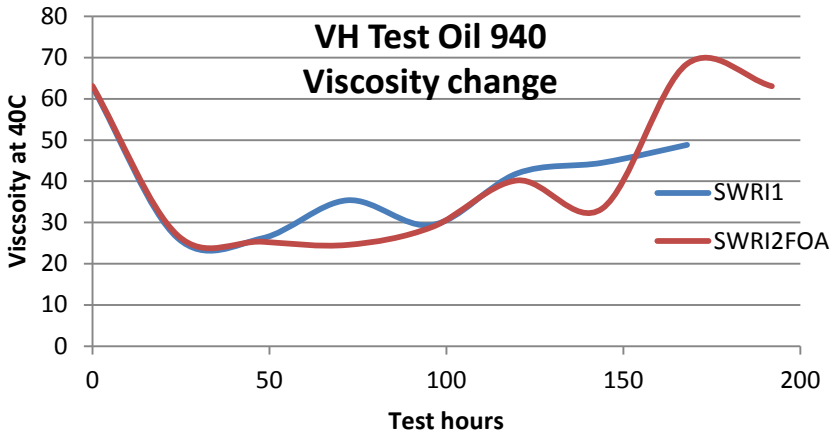
- 2013 4.6L 2V V8 engine
  - 178 Kw@4900
  - 389 N-m@4100
- Same 3 stage conditions as the Sequence VG.
- VG fuel
- Test duration TBD, possibly shorter than Seq VG.



Sequence VH (4.6L 2V)

VH Sludge and Varnish Ratings								FUEL
	Test hours	AES	AEV	RAC	APV	OSC		DILUTION
940 VG Historic		**6.55**	**8.60**	**8.68**	**7.10**	**77.71**		
VH 940 SWRI VG procedure	168 Hours	7.18						
	180 Hours	6.90	7.86	7.99	6.71	95.00		22.30
VH 940 SWRI 200 gr FOA	180 Hours	8.01		9.33				
	192 Hours	7.27	7.98	9.00	7.80	34.00		19.10
1009 VG Targets		**7.94**	**8.99**	**9.29**	**7.79**	**8.00**		
VH 1009 SWRI VG Procedure	180 Hours	7.57		9.14		5.00		
	192 Hours	7.10	8.56	9.15	7.34	40.00		19.60
1009 IAR VG Procedure	168 Hours	7.82		9.10				
	180 Hours	7.06	8.56	9.3	8.07	94		19.4
1009 IAR VG Procedure W/ 2013 rings	168 Hours	9.54		9.73				
	180 Hours	9.26		9.65				
	192 Hours	7.02	8.77	9.57	8.43	20.00		20.50
1009 SWRI VG Procedure W/ 2013 rings	180 Hours	8.80		9.43				
	192 Hours	8.57		9.39				
	216 Hours	7.61	8.67	9.37	7.37	83.00		22.80





Sequence VH Test Conditions

Condition	Stage I	Stage II	Stage III
Duration, min	120	75	45
Engine speed, r/min	1200 ± 5	2900 ± 5	700 ± 15
Engine power, kW	record	record	1.30 6 0.2
Manifold abs press, kPa (abs)	69 ± 0.2	66 ± 0.2	record
Engine oil in, °C	68 ± 0.5	100 ± 0.5	45 ± 1
Engine coolant out,° C	57 ± 0.5	85 ± 0.5	45 ± 1
Engine coolant flow, L/min	48 ± 2	record	record
Engine coolant pressure, kPa (gage)	70 ± 10	70 ± 10	70 ± 10
RAC coolant in, °C	29 ± 0.5	85 ± 0.5	29 ± 1
Rocker cover flow, L/min	15 ±1	15±1	15± 1
Intake, air, °C	30 ± 0.5	30 ± 0.5	30 ± 0.5
Intake air press, kPa (gage)	0.05 ± 0.02	0.05 ± 0.02	0.05 ± 0.02
Lambda, typical values	1.0	1.0	0.75
Blowby flow rate, avg, L/min	record	60-70	—
Intake air humidity, g/kg	11.4 ± 0.8	11.4 ± 0.8	11.4 ± 0.8
Exhaust back pressure, kPa abs	104 ± 2	107 ± 2	record
Fuel flow, kg/min	record	record	record
3000 gram oil charge			

Additional testing:

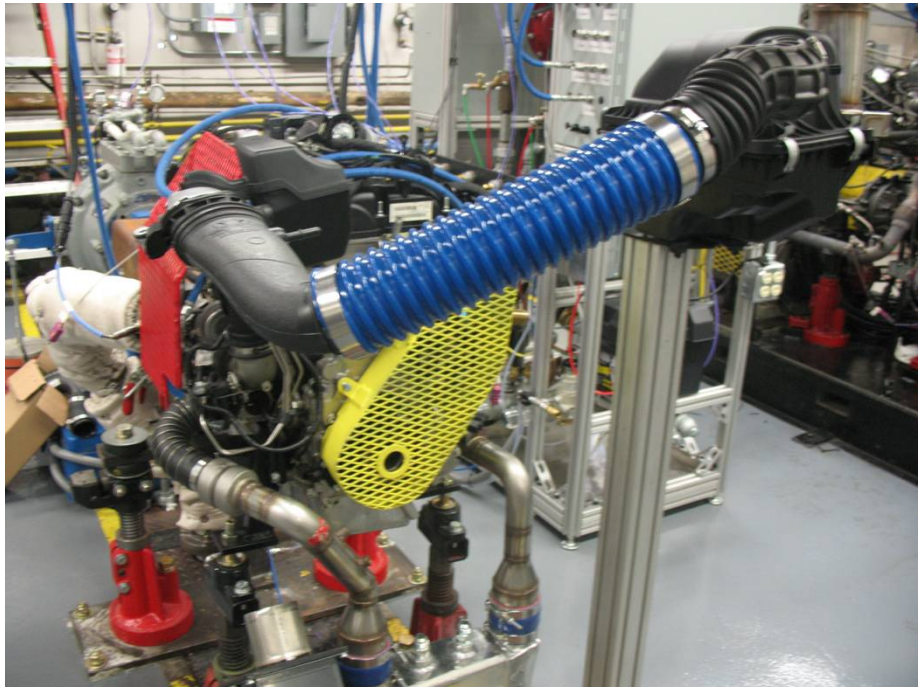
1) Testing was conducted with no oil adds . Starting with a 4000 gram oil charge turned the test mild. 9+ AES after 192 hours on oil 1009

2) Forced oil adds of 200 grams of new oil every 24 hours starting at 72 hours and 3000 initial oil charge made the test mild so this was abandoned.

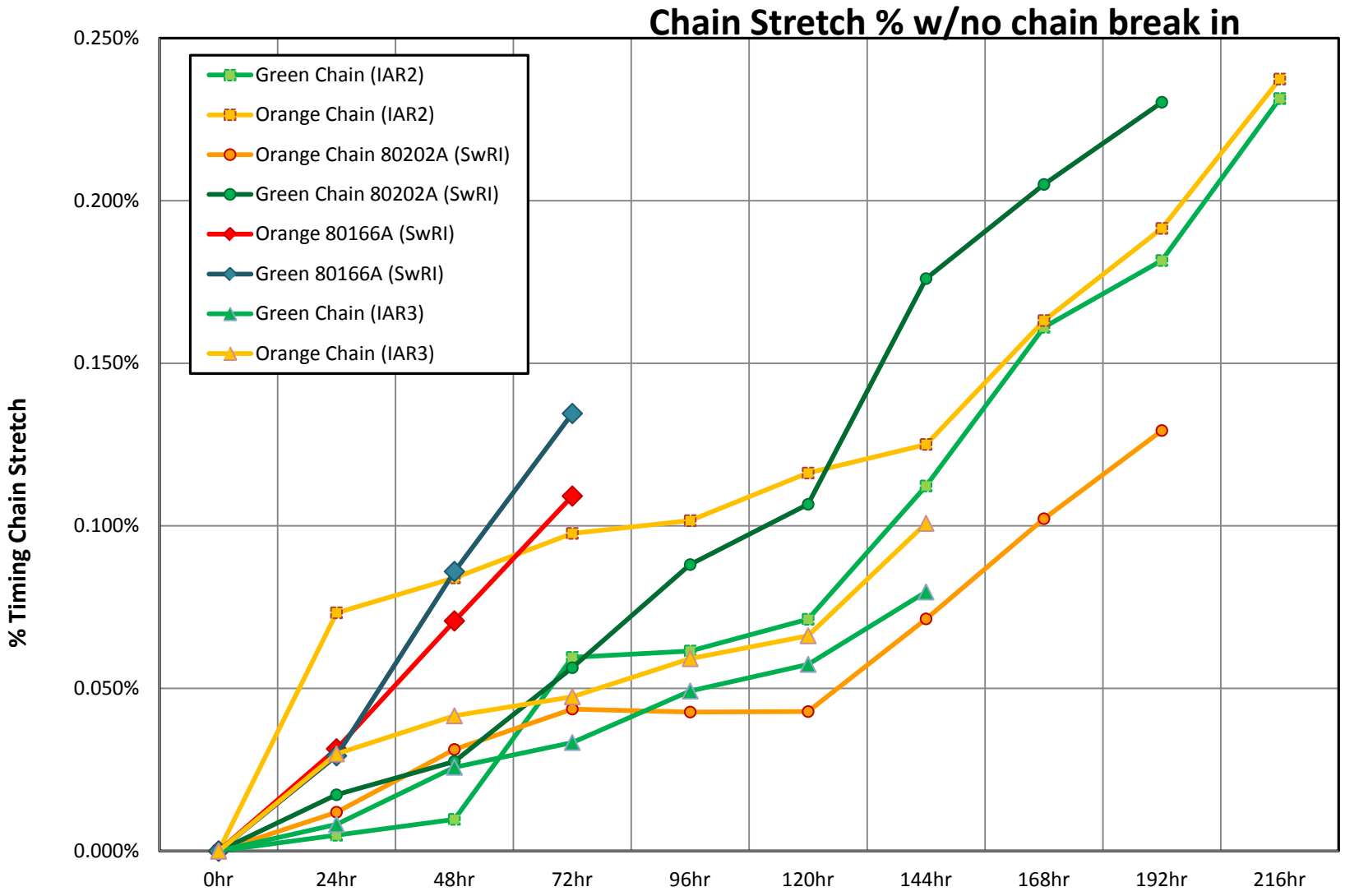
3) Presently testing to evaluate affect on 2013 piston rings

Timing Chain Wear Test Overview

- Test engine: 2012 Ford 2.0L, EcoBoost, 4-cylinder
  - 178Kw@5500
  - 366N-m@3000
- Soot induced chain wear
- Low- moderate speed and load.
- Two stage test, low and normal running temperatures.



Chain Wear (2.0LGTDI)



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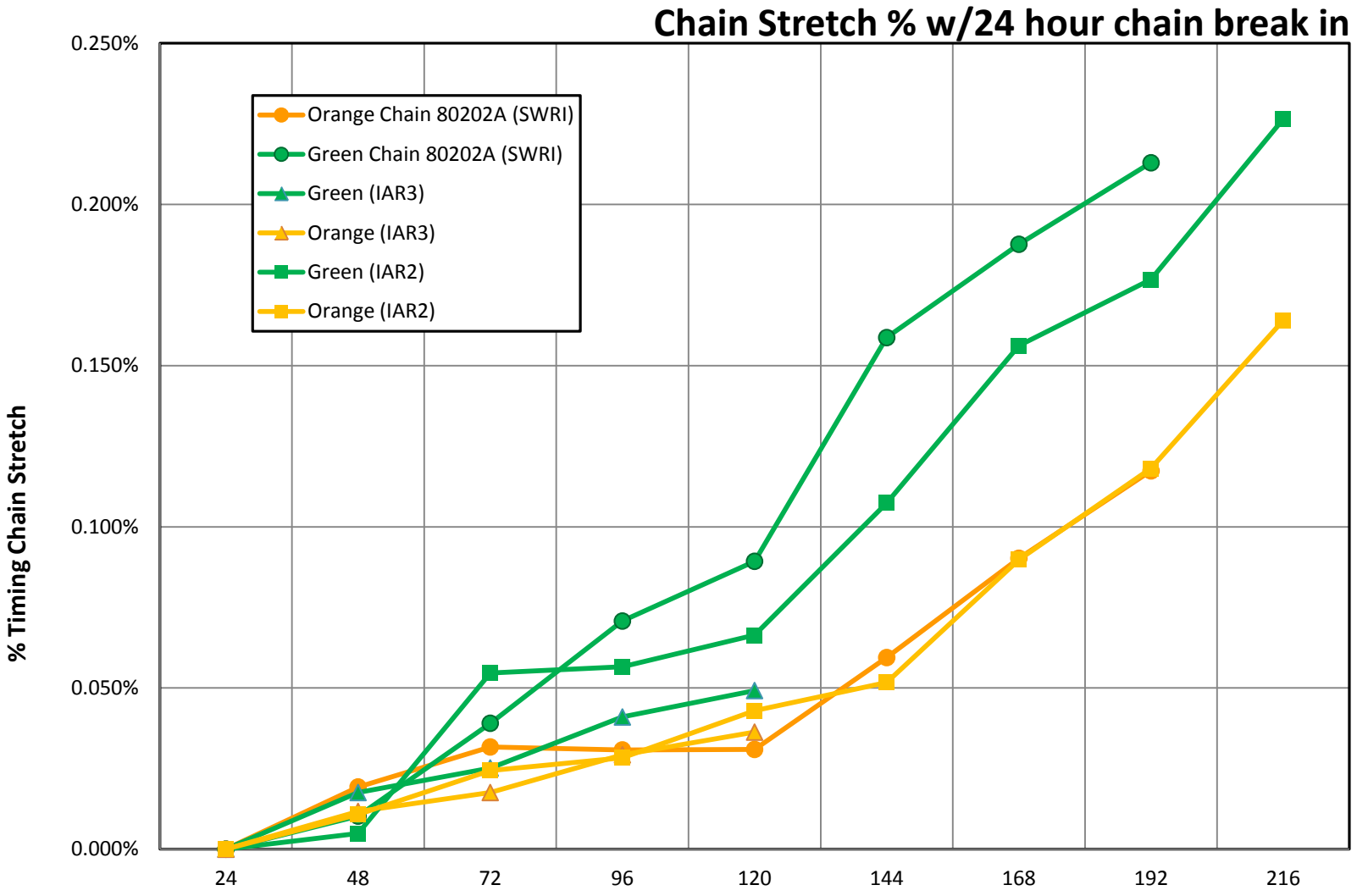

Calculating chain stretch with a 24 hour break in shows green chain wears more than the orange chain as expected.

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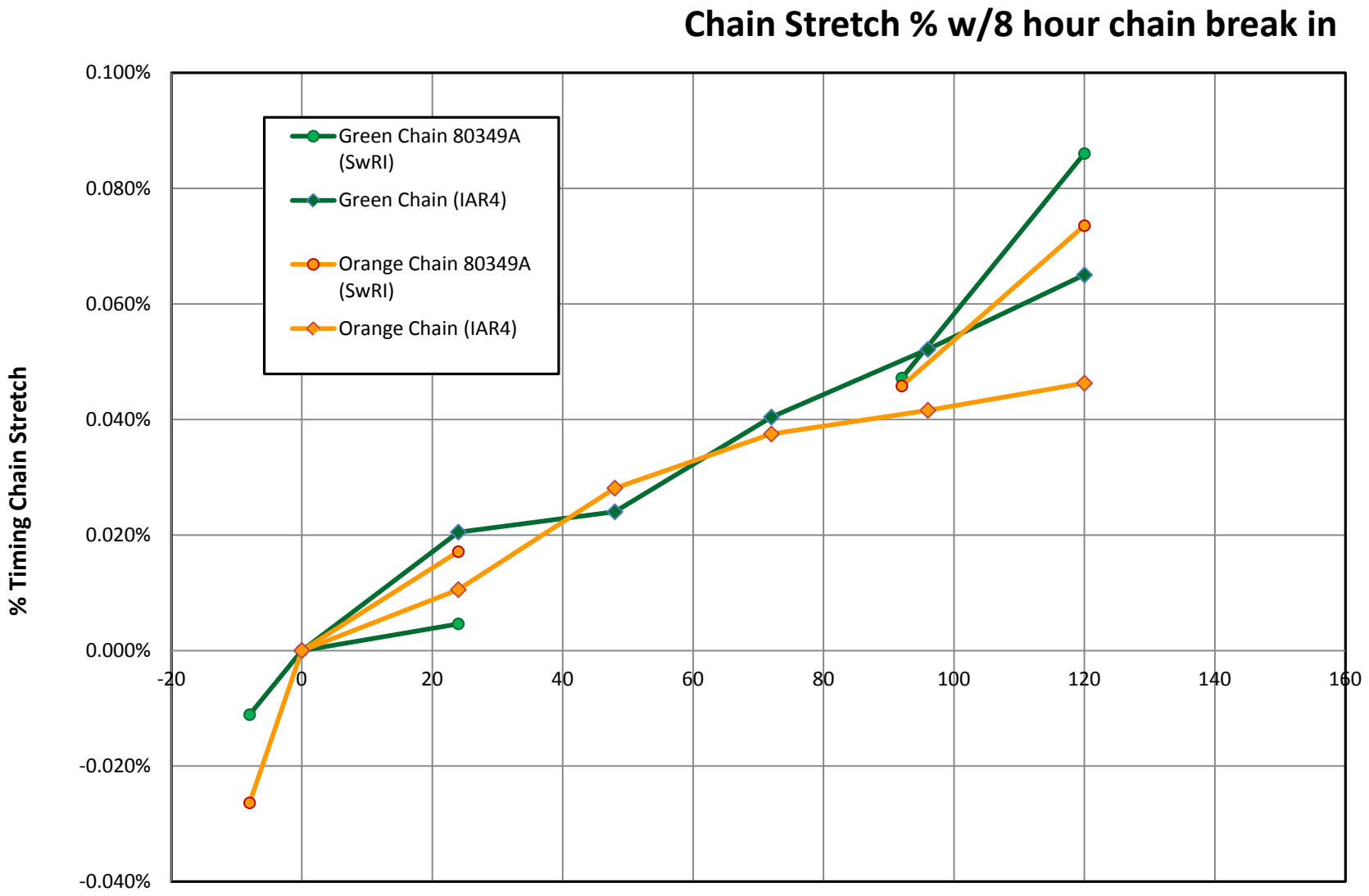

Calculating chain stretch with an 8 hour break in also shows green chain wears more than the orange chain as expected.

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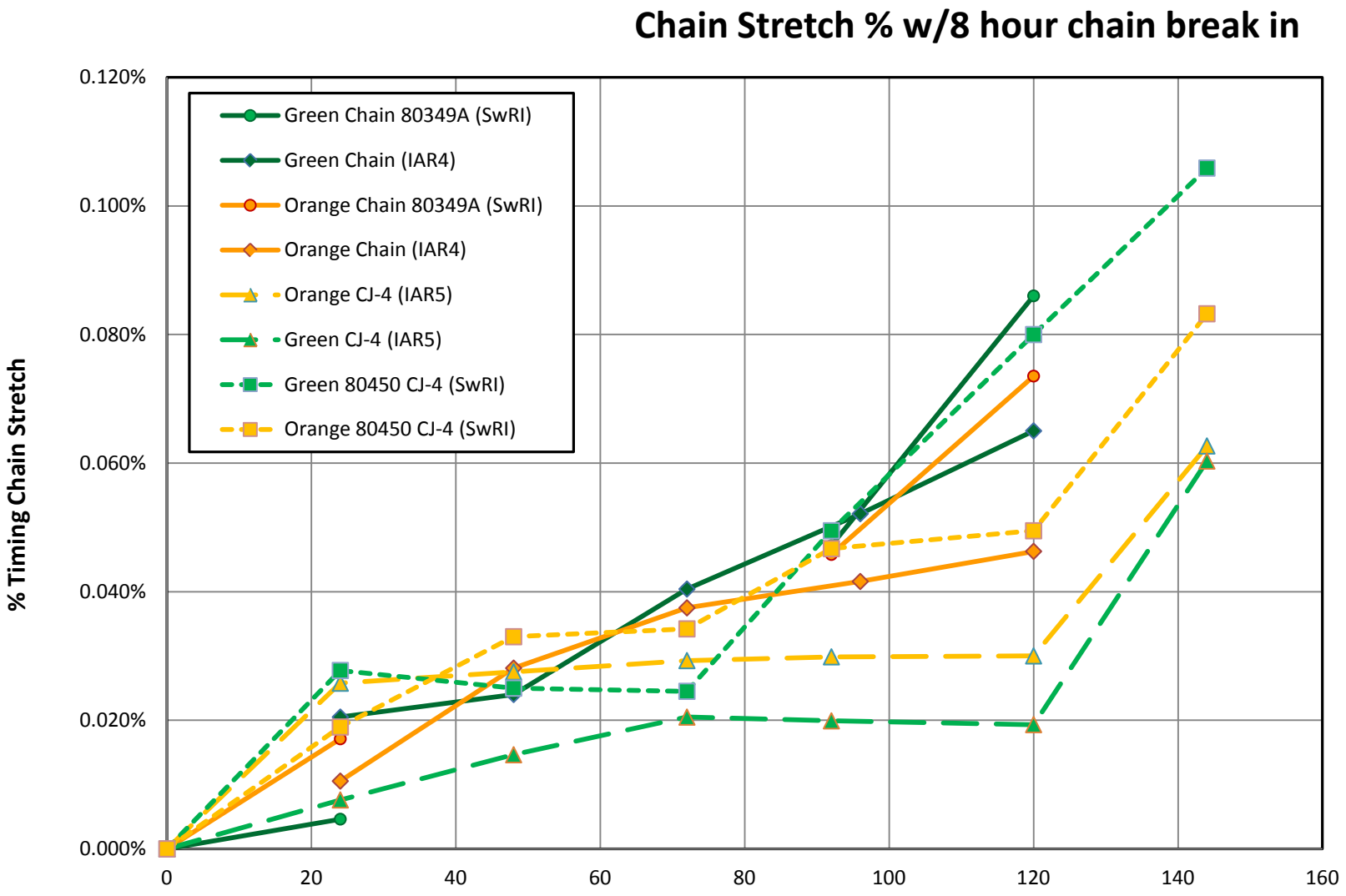


Calculating chain stretch with an 8 hour break in also shows green chain wears more than the orange chain as expected

Chain Wear (2.0LGTDI)

IAR2 Chemical Analysis Reference Oil

TEST HRS	FUEL DIL.	Fe	TAN	TBN	TGA% Soot	VIS 100 C	VIS 40 C	1ST BB l/m	2nd BB l/m
0	1.5	0	2.24	5.7	0.052	9.95	58.76	41.00	75.44
24	14.8	30	1.86	4.5	0.163	6.46	31.19	38.93	70.26
48	9.5	43	2.43	3.3	0.257	6.35	31.1	41.27	69.47
72	11.6	59	2.78	2.6	0.462	6.26	30.51	36.07	66.14
96	7.5	69	2.82	1.5	0.583	6.07	29.2	39.19	73.74
120	7.8	87	3.5	0.6	0.721	5.98	28.86	33.77	69.70
144	8.6	109	3.99	1.1	0.903	5.9	28.31	35.28	65.91
168	10.2	150	4.3	0.9	1.043	5.86	28.43	33.03	64.56
192	10.1	182	4.85	0.9	1.191	5.81	28.11	34.97	70.40
216		274	5.47	0.9	1.408	5.71	27.42	35.29	67.87
240									

SWRI 80202A Chemical Analysis Reference Oil

TEST HRS	FUEL DIL.	Fe	TAN	TBN	TGA% Soot	VIS 100 C	VIS 40 C	1ST BB l/m	2nd BB l/m	
0	0	3	1.43	5.88	0.104	9.371	54.751	48.72	64.7	
24	14	26	1.12	3.59	0.242	7.049	36.104	41.93	52.23	
48	5.4	47	1.49	2.5	0.39	8.166	42.753	32.42	74.43	
72	8.3	57	1.77	1.26	0.502	6.375	31.714	49.41	71.36	
96	9.6	66	2.14	0.69	0.617	5.948	28.775	44.68	62.87	
120	8.8	82	2.31	0.42	0.792	6.201	30.995	36.12	58.95	
144	9.3	105	2.52	0.34	0.865	5.709	27.363	37	70.66	
168	8.2	145	2.98	0.25	1.114	6.213	31.428	47.42	72.79	
192	7.3	170	3.37	0.19	1.164	6.345	31.874	45.34	63.73	
216	7.7	215	3.56	0.18	1.398	6.376	32.707	35.07	55.53	New Chain
240	7.8	297	4.14	0.11	1.622	6.355	32.781	34.28	59.86	

New chain installed at 192 hours to see wear rate in used oil

Chain Wear (2.0LGTDI)

SWRI 80450 Chemical Analysis CJ-4

									1ST	2nd
TEST HRS.	FuelDilu	Fe	Pentane	TAN	TBN	Soot	Viscosity	Viscosity	BB (l/m)	BB (l/m)
0	0.4	1	0.01	2.13	8.32	0.204	12.288	83.253		
24	9.8	12	0.02	1.67	6.73	0.307	9.107	52.209	53.8	77.08
48	8.8	16	0.01	2.24	5.56	0.404	8.593	47.89	61.83	73.98
72	9.7	22	0.02	2.46	3.6	0.606	8.218	45.463	57.79	66.07
96	10.6	26	0.03	2.76	2.76	0.663	7.296	37.347	59.14	77.79
120	10.6	32	0.02	3.26	2.36	0.772	7.928	43.528	52.44	71.25
144	14.2	40	0.02	3.4	2.07	0.933	7.871	43.649	51.94	66.51

IAR 5 Chemical Analysis CJ-4

									1ST	2nd
TEST HRS.	FuelDilu	Fe	Pentane	TAN	TBN	Soot	Viscosity	Viscosity	BB (l/m)	BB (l/m)
0	1.3	1	0.1	3.11	8.3	0.06	12.37	83.32	42.58	70.41
24	8.3	9	0	2.86	7.3	0.019	8.68	47.69	38.8	70.76
48	7.1	13	0	3.87	6.3	0.363	8.78	49.51	40.63	63.78
72	8.3	17	0	4.43	4.8	0.423	8.6	48.18	41.9	62
96	6.5	24	0.1	5	3.5	0.436	8.44	47.45	39.01	62.62
120	6.7	29	0	5.43	3	0.776	8.34	46.82	39.54	61.17
144	5.9	37		6.77	2.4	1.019	8.33	47.14	39.63	59.31

Chain Wear (2.0LGTDI)

Condition	Stage 1	Stage 2
Duration, min	120	60
Speed (rpm)	1550	2500
Torque (N-m)	50	128
Engine oil in, °C	50+/- 0.5	100+/- 0.5
Engine coolant out,° C	45+/- 0.5	85+/- 0.5
Engine coolant pressure, kPa (gage)	70 +/- 10	70 +/- 10
PCV cooler coolant in, °C	20+/- 0.5	85+/- 0.5
PCV cooler flow, L/min	12 +/-1	12+/-1
Intake, air, °C	30+/- 0.5	30+/- 0.5
Intake air press, kPa (gage)	0.05 +/- 0.02	0.05 +/- 0.02
Air/Fuel Ratio (lambda)	0.78	0.98
Blowby flow rate, SOT, L/min record		60-70
3600 gram initial oil charge, no oil additions		

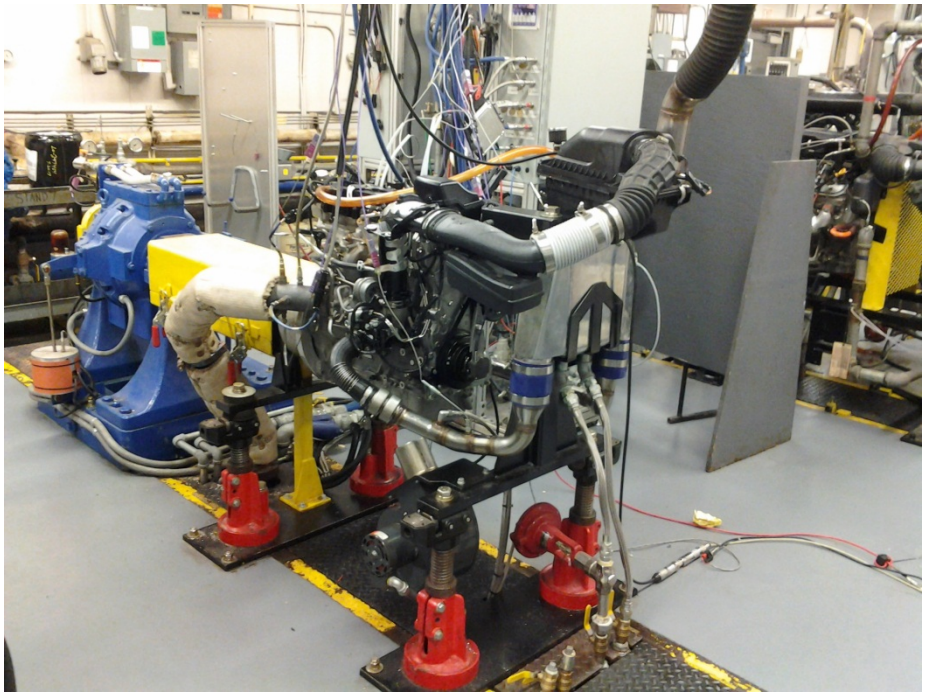
30 minute temp ramp between stages
30 sec speed/load ramp between stages
Ramp time is not counted in the stage time
Test chain used during 8 hour engine break in
Post 8 hour break in chain length measurement used as initial length for calculating chain stretch

Low Speed Pre-Ignition Test Overview

- Test engine: 2012 Ford 2.0L, EcoBoost, 4-cylinder

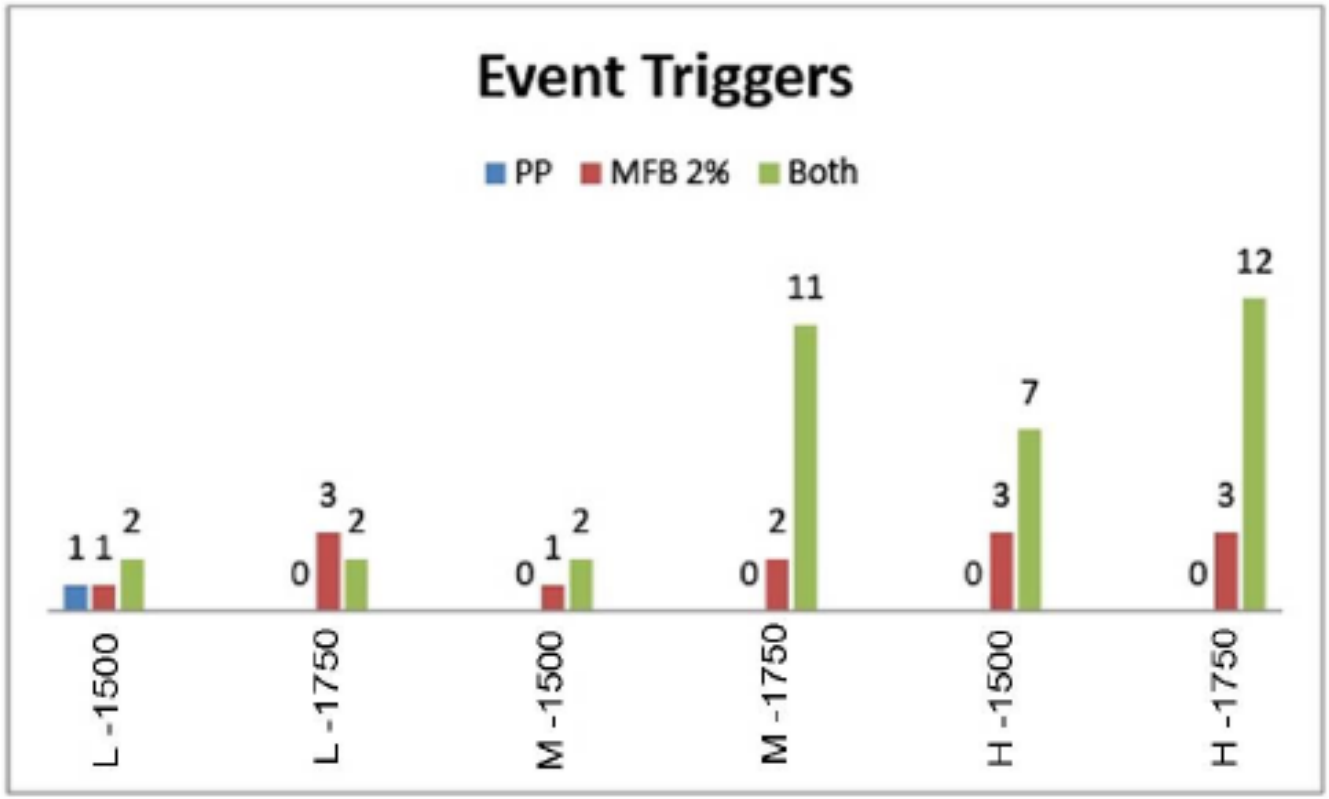
  178Kw@5500

  366N-m@3000
- Combustion analysis data acquisition system: AVL IndiSmart Gigabit 612
- Running conditions
  - Low speed, < 2000 rpm
  - High Load, >70% max BMEP



LSPI Results

4 hour test duration
1500 RPM/80% BMEP
1750 RPM/80% BMEP
Test run on 3 oils with low, medium and high tendency to cause LSPI



Still investigating pressure transducer installation.