Chevron Oronite

T-12A for Used Oil MRV

- as a substitution for T-10A

June 29, 2010

Mark Cooper

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T-12A - A Brief History

Used Oil MRV requirement in CI-4

- MRV measurement of 75h Oil Sample from T-10 (T-10A)
- T-10A currently unavailable (perhaps indefinitely)

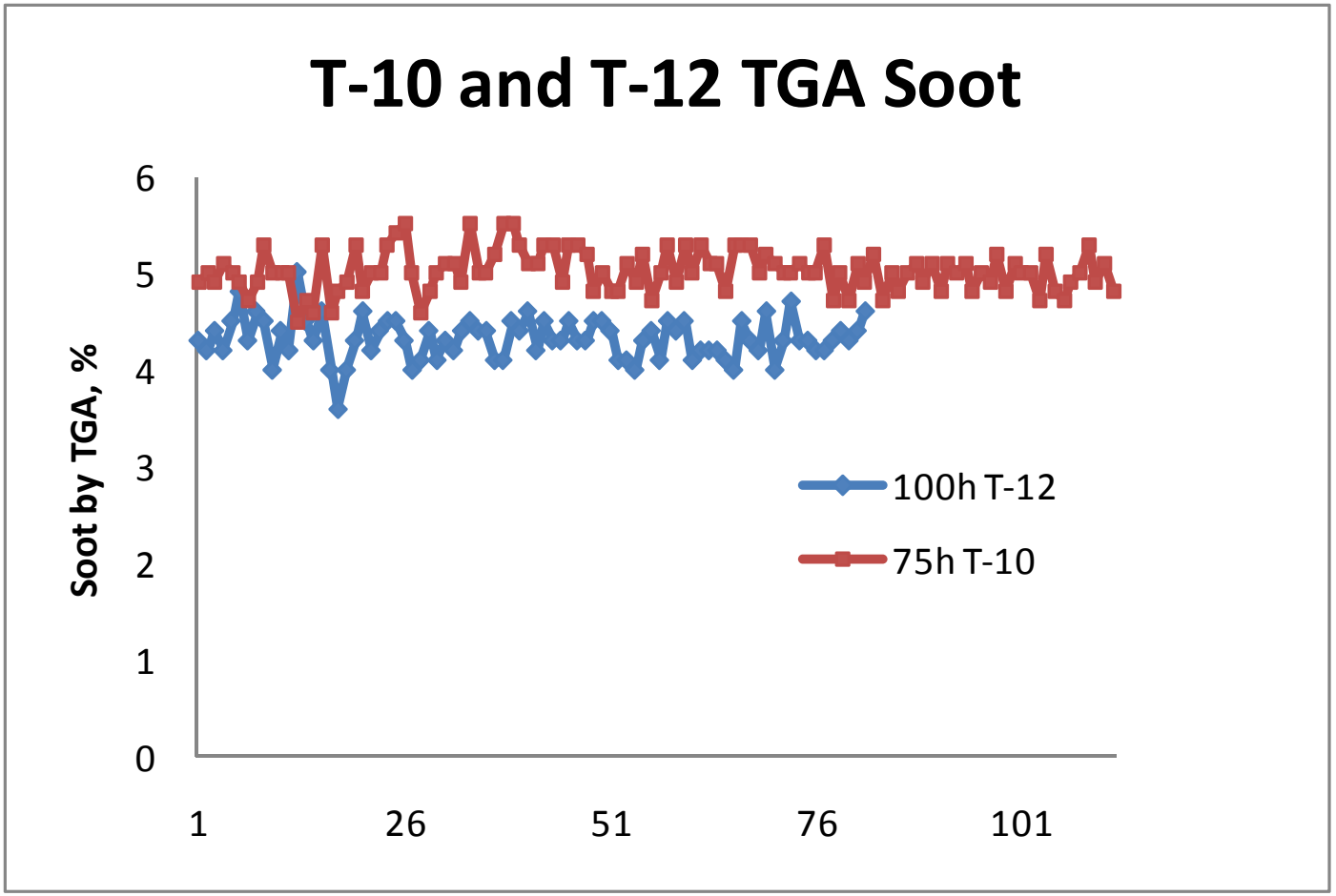
T-12 is a logical alternative to T-10A

- Similarities between T-12 and T-10
- 100h T-12 has closest soot level to 75h T-10 oil sample

Mack Surveillance Panel actions

- Unanimous approval of T-12A Procedure and Ref Oil Targets
- recommendation to HDEOCP

Comparison of Soot Level



T-12A Test Procedure

Approved on May 25, 2010 by Mack Surveillance Panel

(Revises D 7422-09a, as amended by Information Letter 10-01)

1.1.1 This test method also provides the procedure for running an abbreviated length test, which is commonly referred to as the T-12A. The procedures for the T-12 and T-12A are identical with the exception of the items specifically listed in Annex A9. Additionally, the procedure modifications listed in Annex A9 refer to the corresponding section of the T-12 procedure.

A9. T-12A ABBREVIATED LENGTH TEST REQUIREMENTS

A9.1 *Overview* —The purpose of the T-12A is to provide the low temperature viscosity result for used oil. The low temperature result in question is the MRV viscosity after 100 h at Phase I T-12 conditions. This result may be obtained two different ways. First, it may be obtained from an operationally valid standard T-12 test. Second, it may be obtained from a test stand setup that runs only the first 100 h of T-12 conditions. Unlike the standard T-12 test, this form of the T-12A does not require a new engine build with each test. Instead, it is a flush-and-run setup. With the exception of A9.4, A9.5.2, A9.5.3, and A9.6, no special instructions are necessary to obtain a T-12A result from a standard T-12. The special instructions necessary to obtain a T-12A result from a flush-and-run setup are contained in the remainder of this annex.

A9.2 *Preparation of Apparatus at Rebuild (refer to Section 8)*—Rebuild each T-12A flush-and-run engine after three calibration periods or 1500 h.

A9.2.1 *Injectors (refer to* 8.4.1*)*—Check the injector opening pressure at the start of each calibration. Reset the injector opening pressure if it is outside the specification of 24000 ± 2000 kPa.

A9.3 Procedure (refer to Section 9):

A9.3.1 *Pretest Oil Flush*—The pre-test flush is not performed on a new engine build. For new engine builds, run the break-in sequence according to A9.3.2. For existing engine builds, flush the engine and auxiliary oil system with test oil for 15 min. Drain the oil. Repeat the flush and drain sequence two more times. Use the same set of oil filters for all three flushes. At the completion of the third flush, drain the oil, change the oil filters, and charge the engine and auxiliary oil system with test oil. Proceed with the test according to A9.3.3.

A9.3.2 *Pretest Break-In (see* 9.1.2*)*—The pre-test break-in is not necessary for every test; it is only necessary for a new engine build. For a new engine build, run a 30-min break-in at Phase I conditions. To do this, follow the Phase I start-up sequence shown in Table A5.2, and once the start-up sequence is complete, hold the conditions for 30 min. Change all oil filters at the completion of the break-in.

A9.3.3 *Test Cycle (see* 9.4*)* —Conduct the test by operating for 100 h at Phase I conditions, which are shown in Table 1.

A9.3.4 *Post-Test Oil Flush*—At the completion of the test, drain the oil and change the oil filters. Hot flush the engine and auxiliary oil system with Bulldog Premium Oil for 15 min. Drain the oil. Repeat the flush and drain sequence two more times. Use the same set of oil filters for all three flushes.

A9.4 *Oil Inspection (see 10.3)*—Analyze the 100 h oil sample for MRV viscosity according D 6896. As part of the MRV measurement procedure, be sure to prepare the sample in accordance with A4.3 (Annex A4) of Test Method D 5967.

A9.5 *Laboratory and Engine Test Stand Calibration/Non-Reference Oil Requirements (Section 11)*:

A9.5.1 *Test Stand/Engine Calibration (refer to* 11.5*)*—The calibration period for a flush-and-run T-12A is five operationally valid non-reference oil tests or ten months since the completion of the last successful calibration test.

A9.5.1.1 A T-12A flush-and-run stand may be installed in a stand that originally calibrated as a standard T-12 without impacting the standard T-12 calibration status. However, the flush-and-run setup will only be calibrated for the first non-reference oil test. To re-establish calibration, a reference oil test shall be run following the first test on the flush-and-run engine.

A9.5.1.2 A newly rebuilt engine requires a reference oil test to establish test stand calibration. Additionally, a T-12A cannot be run on an engine build that has seen Phase II test conditions (break-in conditions are excluded for a T-12A obtained as part of a standard T-12).

A8.5.2 *Test Result (see* 11.6*)* —The specified test result is MRV viscosity at 100 h. Report the results on the appropriate forms.

A8.5.3 *Non-Reference Oil Test Result Severity Adjustments (see* 11.8*)*—This test method incorporates the use of an SA for non-reference oil test results. A control chart technique, described in the LTMS, has been selected for identifying when a bias becomes significant for MRV viscosity at 100 h. When calibration test results identify a significant bias, an SA is determined according to LTMS. Report the SA on Form 4 in the space for SA. Add this SA value to non-reference oil test results, and enter the SA adjusted result in the appropriate space. The SA remains in effect until a new SA is determined from subsequent calibration test results, or the test results indicate the bias is no longer significant. Calculate and apply SA on a laboratory basis. Be aware that the SA applied to non-reference results is the laboratory SA that is in place at the completion of the 100th hour of the test (that is, for T-12A results that are obtained through a standard length T-12, do not use the SA at EOT of the T-12, instead use the SA that is in place at 100 h).

A9.6 *Precision and Bias (refer to Section 13)*:

A9.6.1 *Precision*—The test precision for MRV Viscosity at 100 h, as of April 19, 2010, is shown in Table A9.1.

A9.6.2 *Bias*—Bias is determined by applying the LTMS control chart technique (see A8.5.3) and when a significant bias is determined, a severity adjustment is permitted for non-reference oil test results.

TABLE A9.1 Test Precision

Test Result	Intermediate Precision (*i.p.*)	Reproducibility (*R*)
MRV viscosity at 100 h (cP)	1550	1550

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Analysis of T-12 MRV at 100 hours versus T-10A MRV at 75 hours

For Mack Surveillance Panel

June 14,2010

Jim Rutherford

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Summary

- Using reference data from tests with the only oil for which MRV was measured in both the 75h T-10A and 100h T-12
  - Whether we restrict to labs with MRV from both tests and use two way analysis of variance, or
  - Lump data from all labs for a t-test,
  - The difference between 75h T-10A and 100h T-12 is significant ($p<0.05$) with 75h T-10A about 500 mPa-s higher than 100h T-12.
  - However, within the short time period for which 100h T-12 results are available, results from the two tests are in the same range.

MRV from Chartable 75h T-10A and 100h T-12 Samples

Analysis Variable : MRV

IND	LAB	type	N	Mean	stdev	Median
820-1	A	T10A	2	13300	707	13300
820-2	A	T10A	22	13145	561	13250
	B	T10A	4	12975	618	13150
		T12	3	12667	551	12400
	D	T10A	4	13412	328	13434
		T12	3	12383	349	12415
	F	T10A	3	13395	516	13686
	G	T10A	19	13132	669	13000
		T12	3	12767	737	12500
821	B	T12	1	11700	.	11700
	G	T12	3	11167	1041	11500
821-1	B	T12	1	11400	.	11400
	G	T12	3	11767	404	12000
PC-9A	A	T10A	11	14682	679	14400
	B	T10A	1	13200	.	13200
	D	T10A	1	13888	.	13888
	F	T10A	2	14550	354	14550
	G	T10A	5	15440	1378	14900
PC10B	B	T12	1	11800	.	11800
	D	T12	1	11575	.	11575
PC10E	B	T12	3	11767	379	11600
	D	T12	2	12100	104	12100
	G	T12	1	11700	.	11700

Analysis Variable : MRV

IND	type	N	Mean	stdev	Median
820-1	T10A	2	13300	707	13300
820-2	T10A	52	13162	582	13100
	T12	9	12605	521	12415
821	T12	4	11300	891	11600
821-1	T12	4	11675	377	11700
PC-9A	T10A	20	14744	973	14750
PC10B	T12	2	11688	159	11688
PC10E	T12	6	11867	305	11863

Two Way Analysis of Variance: Oil 820-2 Chartable Tests in Labs B, D, &G

Class Level Information		
Class	Levels	Values
LTMSLAB	3	B D G
type	2	T10A T12
Number of Observations Used	36	

Dependent Variable: MRV

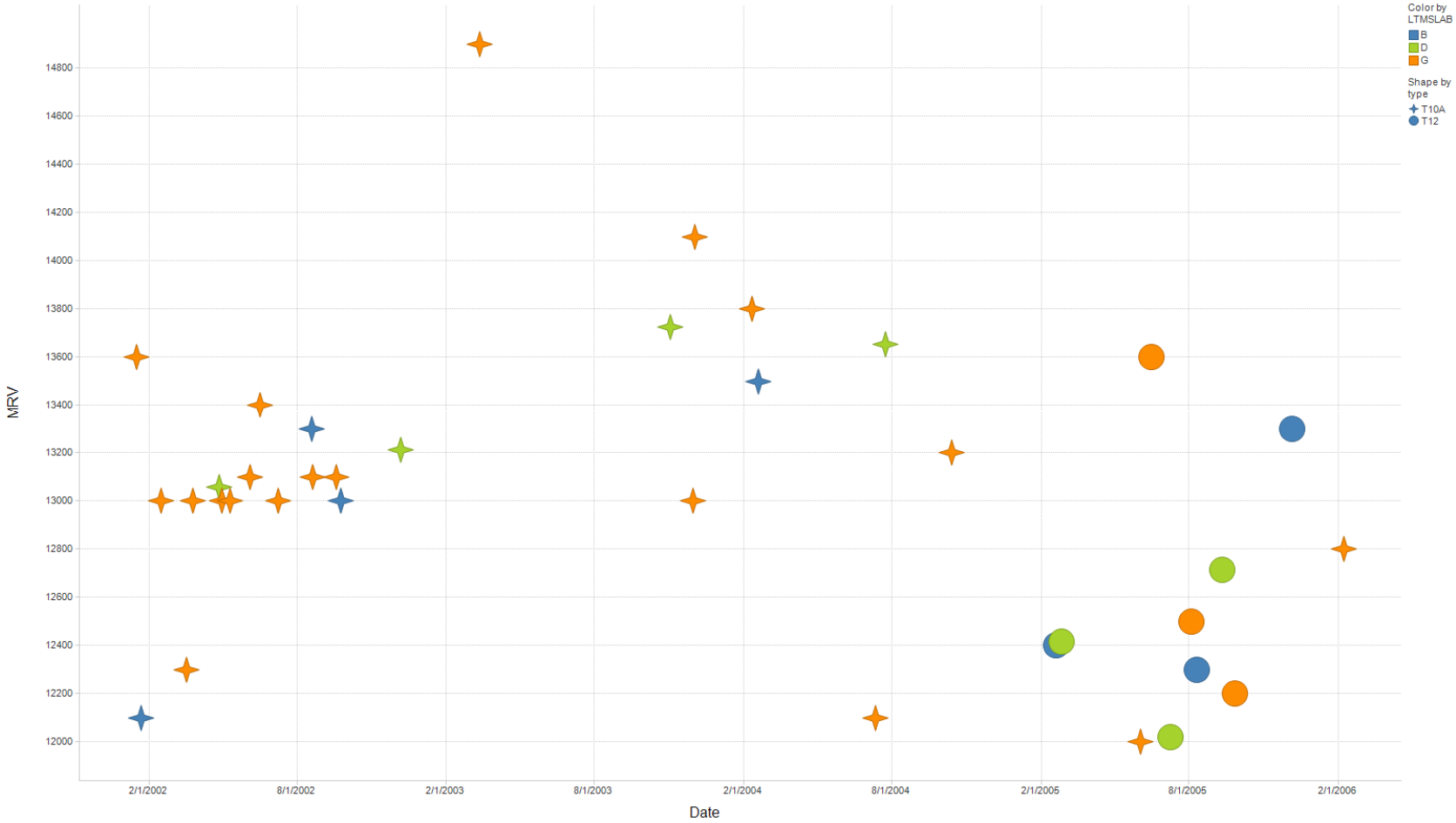
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	2061344.58	687114.86	1.82	0.163
Error	32	12050874.42	376589.83		
Corrected Total	35	14112219			

R-Square	Coeff Var	Root MSE	MRV Mean
0.146068	4.715514	613.6691	13013.83

Source	DF	Type III SS	Mean Square	F Value	Pr > F
LTMSLAB	2	59966.77	29983.385	0.08	0.924
type	1	1742274.572	1742274.572	4.63	0.039

type	MRV LSMEAN
T10A	13143
T12	12605

MRV versus Time:
Oil 820-2 Chartable Tests in Labs B, D, &G



T-test:
Oil 820-2 Chartable Tests

type	N	Mean	stdev	Std Err	Minimum	Maximum
T10A	52	13162	581.7	80.664	12000	14900
T12	9	12605	521.4	173.8	12019	13600
Diff (1-2)		556.8	573.9	207.2		

type	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
T10A		13162	13000	13324	581.7	487.5	721
T12		12605	12205	13006	521.4	352.2	999
Diff (1-2)	Pooled	556.8	142.2	971.3	573.9	486.4	700
Diff (1-2)	Satterthwaite	556.8	138.2	975.3			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	59	2.69	0.0093
Satterthwaite	Unequal	11.733	2.91	0.0135

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	51	8	1.24	0.7951

MRV versus Time:
Oil 820-2 Chartable Tests All Labs