

ASTM D2 Meeting - Chicago, IL
July 11, 2001

**UPDATE ON ASTM LOTRUO
ACTIVITIES AND LOW TEMPERATURE
PROPERTIES OF PC-9 MATRIX OILS**

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MRV Measurements of Sooted Oils

LOTRUO Activities

- Following successful completion of round robin, method modifications and research report are in progress covering measurement of used, highly sooted oils by standard (D4684) and modified (external preheat) methods
 - viscosity precision statements obtained for both
 - expect to go to ballot within ~4-5 weeks

IOL Data on PC-9 E-O-T Matrix oils

- Have received 15 Mack T10 samples and 16 M11-EGR samples for analysis
 - virtually complete CCS/MRV/mod. MRV dataset on T10 samples
 - TMC website lists 11 T10 runs, 7 M11-EGR runs for which IOL has not received samples.

LOW TEMP DATA ON T10 MATRIX OILS

SRC Data, Updated: July 9, 2001

CMIR Code	Matrix Code	Lab Code	TGA		-20°C D4684		-25°C D4684		-20°C Mod. MRV		-25°C Mod. MRV		
			Soot %	D5293	MRV	MRV Y. Str., Pa	MRV	MRV Y. Str., Pa	MRV	MRV Y. Str., Pa	MRV	MRV Y. Str., Pa	
38810	PC-9A	A	6.0	7,030		24,500	0<Y<=35	53,100	0<Y<=35	23,600	0<Y<=35	54,200	0<Y<=35
38811	PC-9A	D	5.5	5,900	11,910	19,900	0<Y<=35	43,900	0<Y<=35	19,800	0<Y<=35	43,100	0<Y<=35
38814	PC-9A	F	5.7	7,990		26,400	0<Y<=35	59,300	0<Y<=35	26,400	0<Y<=35	59,400	0<Y<=35
38942	PC-9A	A	4.8	5,900		19,100	0<Y<=35	42,100	0<Y<=35	19,000	0<Y<=35	41,800	0<Y<=35
38951	PC-9A	G	5.9	7,090		22,800	0<Y<=35	51,000	0<Y<=35	23,100	0<Y<=35	51,500	0<Y<=35
38939	PC-9C	A	5.4	7,650		23,200	0<Y<=35	61,300	0<Y<=35	22,700	0<Y<=35	58,700	0<Y<=35
38949	PC-9C	G	7.6	12,350		37,300	0<Y<=35	95,000	0<Y<=35	37,100	0<Y<=35	96,200	0<Y<=35
38937	PC-9E	A	4.8	5,190		19,500	0<Y<=35	102,400	140<Y<=175	20,100	0<Y<=35	203,500	175<Y<=210
38945	PC-9F	D	5.3	6,020		17,300	0<Y<=35	76,100	35<Y<=70	17,300	0<Y<=35	69,100	0<Y<=35
38947	PC-9H	G	7.1	7,270		19,900	0<Y<=35	57,100	0<Y<=35	19,700	0<Y<=35	58,100	0<Y<=35
38953	PC-9H	F	5.2	5,630		14,600	0<Y<=35	45,300	0<Y<=35	14,400	0<Y<=35	44,900	0<Y<=35
38941	PC-9G	A	5.5	6,460		18,900	0<Y<=35	42,300	0<Y<=35	18,900	0<Y<=35	46,900	0<Y<=35
38938	PC-9J	A	6.2	6,190		17,100	0<Y<=35	42,700	0<Y<=35	17,200	0<Y<=35	44,000	0<Y<=35
38948	PC-9J	G	5.7	6,370		17,600	0<Y<=35	41,000	0<Y<=35	17,300	0<Y<=35	40,900	0<Y<=35
38813				8,290		25,900	0<Y<=35	60,200	0<Y<=35	26,900	0<Y<=35	59,900	0<Y<=35
38940	PC-9E	A	5.9	5,190		23,600	35<Y<=70	262,100	175<Y<=210	24,200	35<Y<=70	260,700	175<Y<=210

LOW TEMP DATA - M11 EGR MATRIX OILS

SRC Data, Updated: July 9, 2001

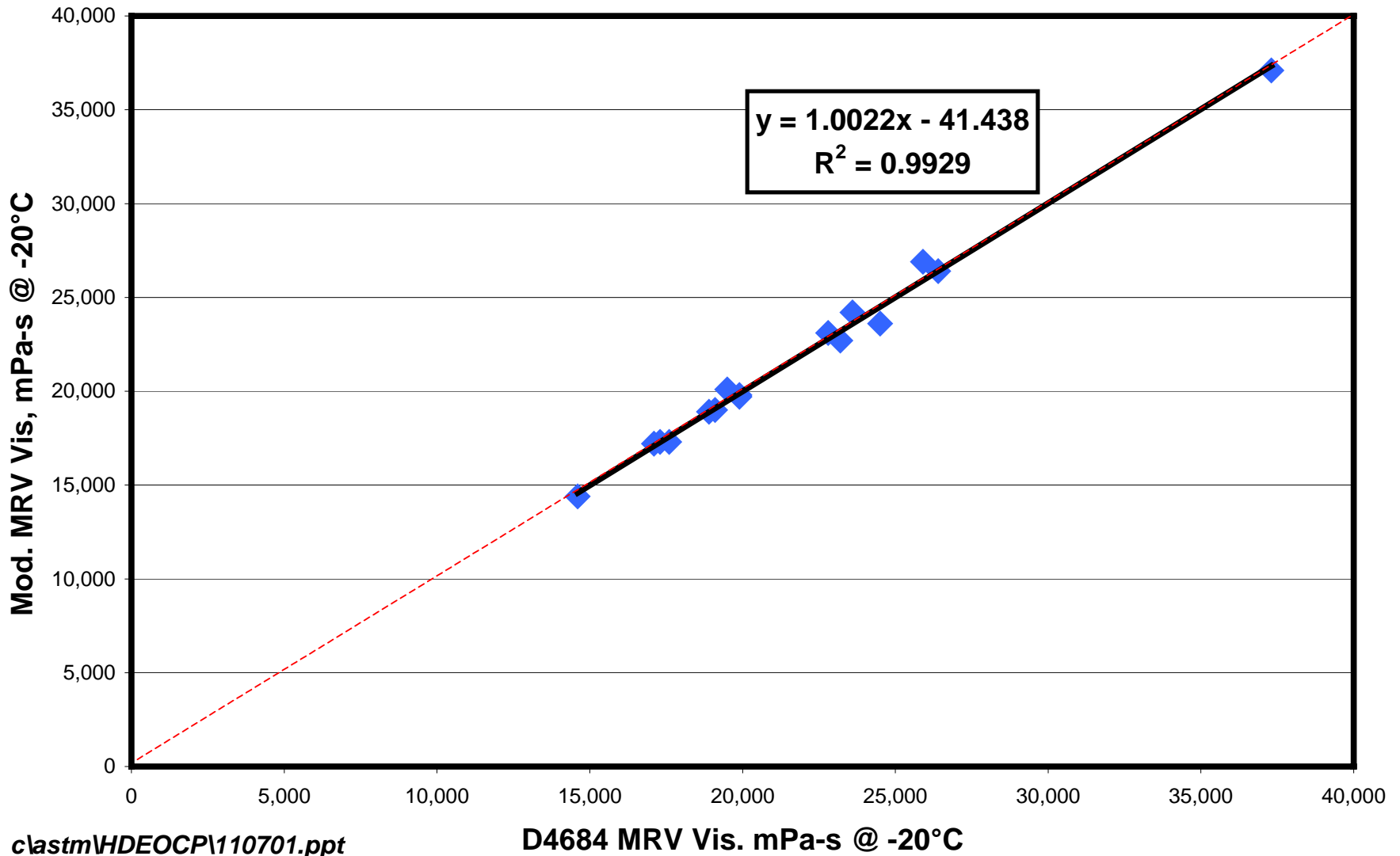
CMIR Code	Matrix Code	Lab Code	TGA										
			Soot %	D5293		-20°C D4684		-25°C D4684		-20°C Mod. MRV		-25°C Mod. MRV	
				-15C, cP	-20C, cP	MRV Vis., cP	Y. Str., Pa	MRV Vis., cP	Y. Str., Pa	-20C MRV Vis., cP	Y. Str., Pa	-25C MRV Vis., cP	Y. Str., Pa
38967	PC-9B	A	8.0	6,320		22,600	0<Y<=35	70,400	0<Y<=35	22,400	0<Y<=35	70,700	0<Y<=35
38927	PC-9E	G	9.1	5,590		26,300	0<Y<=35						
38928	PC-9E	G	7.8			22,300	0<Y<=35						
38929	PC-9E	G	8.8			29,400	0<Y<=35	208,500	140<Y<=175			211,700	140<Y<=175
38930	PC-9E	G	8.6	5,190		32,900	0<Y<=35	343,100	140<Y<=175			289,200	140<Y<=175
38931	PC-9E	D	8.1	5,320		28,200	0<Y<=35	214,100	105<Y<=140			187,700	105<Y<=140
38932	PC-9E	A	8.7	5,630		38,900	0<Y<=35	305,400	175<Y<=210				
38933	PC-9E	A	7.7	5,190		24,000	0<Y<=35	135,000	140<Y<=175			140,600	105<Y<=140
38934	PC-9E	A	7.8	5,380		31,300	0<Y<=35	262,300	140<Y<=175			311,200	140<Y<=175
38962	PC-9F	G	8.7	6,460		28,900	35<Y<=70	133,600	70<Y<=105			106,800	35<Y<=70
38968	PC-9A	A	7.9			23,000	0<Y<=35						
38935	PC-9E	A	8.0			23,800	0<Y<=35						
38969	PC-9G	A	7.8	5,520		64,800	210<Y<=245	683,700	315<Y<=350			529,700	210<Y<=245
38966	PC-9J	A	8.0	5,520		31,800	105<Y<=140	77,900	140<Y<=175			75,900	140<Y<=175
38958	PC-9C	G	7.4*			20,800	0<Y<=35	55,100	0<Y<=35			52,400	0<Y<=35
38970	PC-9F	A	7.9	5,940		24,600	0<Y<=35						

MATRIX TESTS POSTED BY TMC, BUT NO USED OIL SAMPLES RECEIVED

SRC Data, Updated: July 9, 2001

CMIR Code	Matrix Code	Lab Code	<u>TGA</u>
			<u>Soot</u> TMC
38809	PC-9A	A	
38815	PC-9A	B	
38954	PC-9A	F	
38943	PC-9B	D	
38957	PC-9D	B	
38952	PC-9F	F	
40919	PC-9B	B	
38946	PC-9D	G	
38950	PC-9E	G	
38944	PC-9G	D	
38956	PC-9J	B	
38936	PC-9E	B	
38963	PC-9D	D	
38968	PC-9A	A	
38935	PC-9E	A	
38959	PC-9A	G	
38971	PC-9D	B	
38961	PC-9G	G	

Comparison of Standard D4684 vs Modified MRV: T10 E-O-T Samples, -20°C



REPEAT T10 TESTS ON PC-9A, MRV USED/FRESH

CMIR Code	38811	38814	38810	38951	38942		
Ind. Oil Code	PC-9A	PC-9A	PC-9A	PC-9A	PC-9A	PC-9A	PC-9A
Lab Code	D	F	A	G	A		
Engine Source	T-10	T-10	T-10	T-10	T-10		(Fresh)
% Soot Reported	5.5	5.7	6.0	5.9	4.8		

@ -20°C

Averages

MRV Vis., cP	19,900	26,400	24,500	23,400	19,100	22,660	11,600
MRV Y. Str., Pa	0<Y<=35	0<Y<=35	0<Y<=35	0<Y<=35	0<Y<=35		0<Y<=35

@ -25°C

MRV Vis., cP	43,900	59,300	53,100	51,000	42,100	49,880	23,200/23,900**
MRV Y. Str., Pa	0<Y<=35	0<Y<=35	0<Y<=35	0<Y<=35	0<Y<=35		0<Y<=35

@ -20°C

Mod. MRV Vis., cP	19,800	26,400	23,600	23,100	19,000	22,380	
Mod. MRV Y. Str., Pa	0<Y<=35	0<Y<=35	0<Y<=35	0<Y<=35	0<Y<=35		

@ -25°C

Mod. MRV Vis., cP	43,100	59,400	54,200	51,500	41,800	50,000	
Mod. MRV Y. Str., Pa	0<Y<=35	0<Y<=35	0<Y<=35	0<Y<=35	0<Y<=35		

* TMC Website Data

REPEAT T10 TESTS, PC-9C,-9H: MRV USED/FRESH

CMIR Code	38939	38949		38953	38947	
Ind. Oil Code	PC-9C	PC-9C	PC-9C	PC-9H	PC-9H	PC-9H
Lab Code	A	G		F	G	
Engine Source	T-10	T-10	(Fresh)	T-10	T-10	(Fresh)
% Soot Reported	5.4	<u>7.6</u>		5.2	7.1	

@ -20°C

MRV Vis., cP	23,200	37,300	11,700	14,600	19,900	7,600
MRV Y. Str., Pa	0<Y<=35	0<Y<=35	0<Y<=35	0<Y<=35	0<Y<=35	0<Y<=35

@ -25°C

MRV Vis., cP	61,300	95,000	25,800/25,200*	45,300	57,100	18,200/19,100*
MRV Y. Str., Pa	0<Y<=35	0<Y<=35	0<Y<=35	0<Y<=35	0<Y<=35	0<Y<=35

@ -20°C

Mod. MRV Vis., cP	22,700	37,100		14,400	19,700	
Mod. MRV Y. Str., Pa	0<Y<=35	0<Y<=35		0<Y<=35	0<Y<=35	

@ -25°C

Mod. MRV Vis., cP	58,700	96,200		44,900	58,100	
Mod. MRV Y. Str., Pa	0<Y<=35	0<Y<=35		0<Y<=35	0<Y<=35	

REPEAT T10 TESTS, PC-9C,-9H: MRV USED/FRESH

CMIR Code	38937	38940		38938	38948	
Ind. Oil Code	PC-9E	PC-9E	PC-9E	PC-9J	PC-9J	PC-9J
Lab Code	A	A		A	G	
Engine Source	T-10	T-10	(Fresh)	T-10	T-10	(Fresh)
% Soot Reported	4.8	5.9		6.2	5.7	

@ -20°C

MRV Vis., cP	19,500	23,600	14,100	17,100	17,600	7,600
MRV Y. Str., Pa	0<Y<=35	35<Y<=70	0<Y<=35	0<Y<=35	0<Y<=35	0<Y<=35

@ -25°C

MRV Vis., cP	102,400	262,100	62,500/59,300*	42,700	41,000	18,200/19,100*
MRV Y. Str., Pa	140<Y<=175	175<Y<=210	<=140/<=140*	0<Y<=35	0<Y<=35	0<Y<=35

@ -20°C

Mod. MRV Vis., cP	20,100	24,200		17,200	17,300	
Mod. MRV Y. Str., Pa	0<Y<=35	35<Y<=70		0<Y<=35	0<Y<=35	

@ -25°C

Mod. MRV Vis., cP	203,500	260,700		44,000	40,900	
Mod. MRV Y. Str., Pa	175<Y<=210	175<Y<=210		0<Y<=35	0<Y<=35	

PROPERTIES OF FRESH PC-9 MATRIX OILS

Oil	Base Oil	DI Chem	TMC Data				IOL Data	
			KV@ 100°C	CCS@- 15°C	HTHS, cP	MRV @-25C	MRV@-20C	MRV@-25C
PC-9A	1	X	15.20	3304	4.22	23,900/NYS	11,600/NYS	23,200/NYS
PC-9B	2	X	15.18	3466	4.27	27,950/NYS	11,400/NYS	26,100/NYS
PC-9C	3	X	15.14	3500	4.26	25,168/NYS	11,700/NYS	25,800/NYS
PC-9D	1	Y	15.76	3128	4.17	51,600/30g	19,300/35 Pa	73,400/105 Pa
PC-9E	2	Y	15.47	3249	4.29	59,300/40g	14,100/NYS	62,500/105 Pa
PC-9F	3	Y	16.03	3430	4.32	51,100/NYS	11,500/NYS	50,800/NYS
PC-9G	1	Z	15.13	3450	4.07	29,500/NYS	11,200/NYS	37,700/35 Pa
PC-9H	2	Z	15.13	3350	4.14	19,100/NYS	7,600/NYS	18,200/NYS
PC-9J	3	Z	15.07	3155	4.16	17,300/NYS	7,700/NYS	16,500/NYS

Recommendations

- **If HDEOCP requires Mack T10 used oil MRV measurements at 5°C above fresh oil pumpability temperature (e.g. -20°C for test oil originally an SAE 15W-40), then the standard D4684 method should work well (based on PC-9 matrix oil data)**
 - **used oil viscosities very similar for both methods at this temperature**
 - **low evidence of yield stress at this temperature for either method**
 - **more straightforward for labs to run**
 - **modified method will be available should future requirement encompass higher soot level of used oil**