

T11 MRV Standard Deviation Review

Statistics Group

July 15th, 2020

Statistics Group

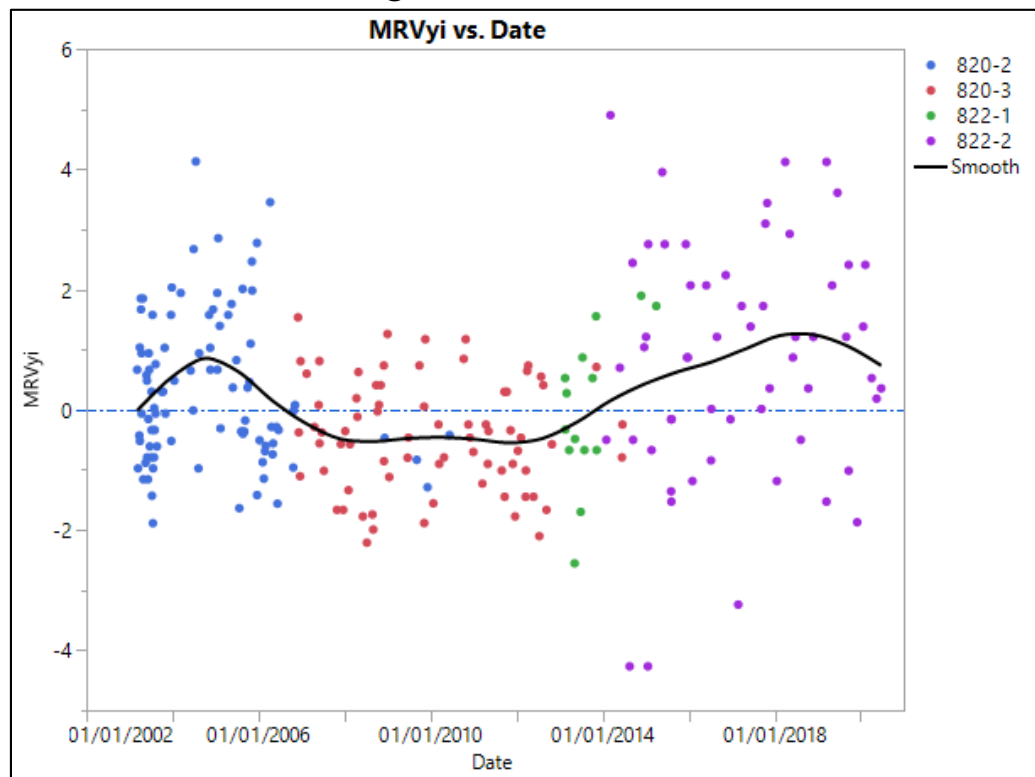
- Elisa Santos, Infineum
- Jo Martinez, Chevron Oronite
- Sean Moyer, TMC
- Abaigh Ritzenthaler, Afton
- Todd Dvorak, Afton
- Travis Kostan, SwRI

Outline

- MRV Standard Deviation Review
 - to be used for Lab calibration, based on current reference oil 822-2
 - to be used for laboratory Severity Adjustments (SA), based on data from all reference oils: 820-2, 820-3, 822-1, 822-2

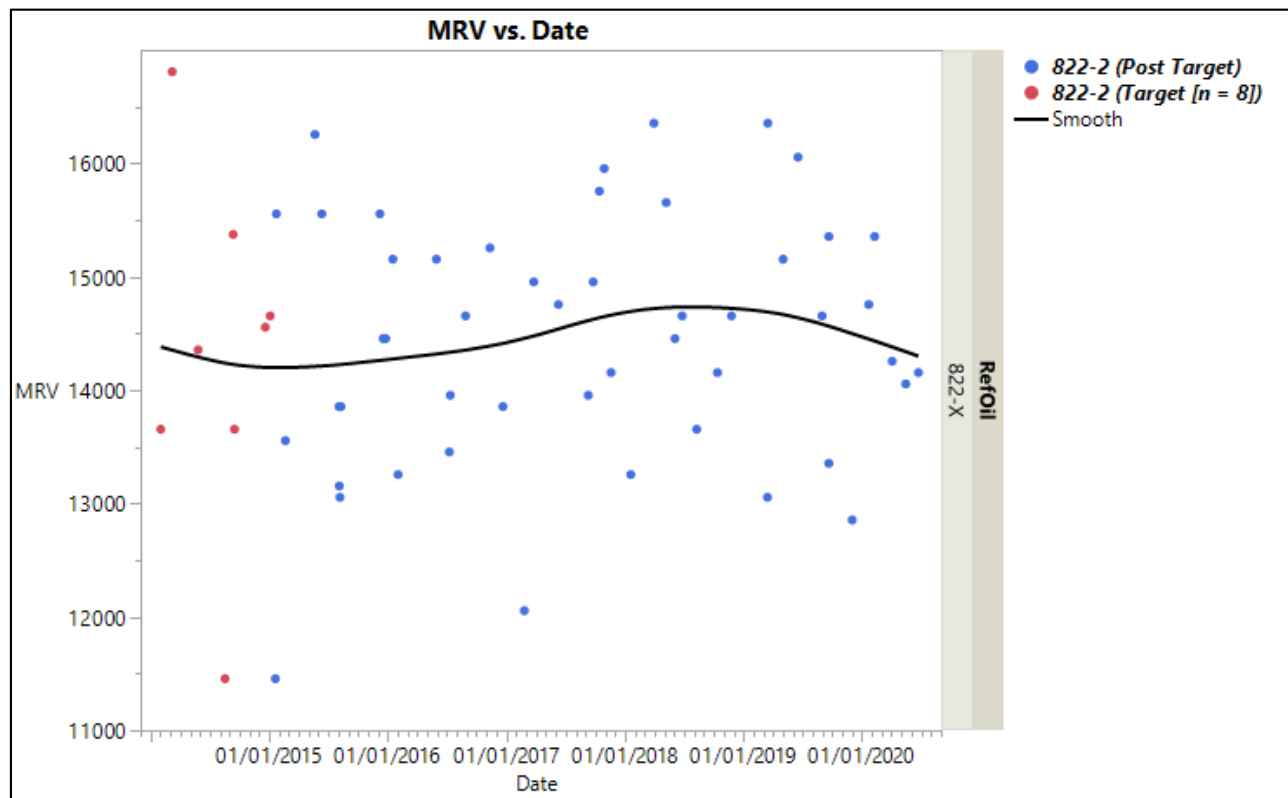
MRV Standard Deviation Review

- Plot of all Yi chartable results are shown below
 - Yi variance for RO822-2 appears higher as compared to other reference oil results
 - Unknown if hardware changes are confounded with reference oil (RO822-2) re-blend



MRV Standard Deviation Review

- Plot of all RO822X (Chartable = Y) data shown below
 - Chart suggests that current standard deviation of 584 for RO822-2 may be too low.



How were Original Targets Set for 820-2 (PM)?

- Calculated (RO820-2) MRV raw means and standard deviations are equivalent to original targets

MRV			
IND	N	Mean	Std Dev
820-2	32	14968.96875	1097.2786715

205 rows have been excluded.

- T11 Reference Oil Target Summary:

Oil	n	Effective Dates		Soot @ 4.0 cSt Vis. Inc		Soot @ 12.0 cSt Vis. Inc		Soot @ 15.0 cSt Vis. Inc.		MRV Viscosity	
		From	To ¹	\bar{X}	S	\bar{X}	s	\bar{X}	s	\bar{X}	s
820-2	32	3-8-03	***	--	--	5.78	0.21	--	--	14969	1097
820-2	16	5-28-05	5-31-10	3.81	0.23	5.78 ²	0.21 ²	6.36	0.26	14969 ²	1097 ²
	-- ³	6-1-10	***	3.95	0.30	5.92	0.22	6.51	0.20	14981	916
820-3	11	9-7-07	***	3.95	0.30	5.92	0.22	6.51	0.20	14981	916
822-1	4	2-1-2013	7-2-2013	3.99	0.21	5.65	0.54	6.35	0.66	14408	314
	8	7-3-2013	***	4.09	0.20	5.81	0.50	6.48	0.61	13948	584
822-2	8	1-1-2014	***	4.09	0.20	5.81	0.50	6.48	0.61	13948	584

- *** = currently in effect
- Value based on earlier data set (n=32)
- Targets based on oil 820-3

How were Original Targets Set for Re-blend 822-2?

- T11 MRV Targets set with $n = 8$ for RO822-2:

T-11 Reference Oil Targets											
Oil	n	Effective Dates		Soot @ 4.0 cSt Vis. Inc		Soot @ 12.0 cSt Vis. Inc		Soot @ 15.0 cSt Vis. Inc.		MRV Viscosity	
		From	To ¹	\bar{X}	S	\bar{X}	s	\bar{X}	s	\bar{X}	s
820-2	32	3-8-03	***	--	--	5.78	0.21	--	--	14969	1097
820-2	16	5-28-05	5-31-10	3.81	0.23	5.78 ²	0.21 ²	6.36	0.26	14969 ²	1097 ²
		-- ³	6-1-10	***	3.95	0.30	5.92	0.22	6.51	0.20	14981
820-3	11	9-7-07	***	3.95	0.30	5.92	0.22	6.51	0.20	14981	916
822-1	4	2-1-2013	7-2-2013	3.99	0.21	5.65	0.54	6.35	0.66	14408	314
	8	7-3-2013	***	4.09	0.20	5.81	0.50	6.48	0.61	13948	584
822-2	8	1-1-2014	***	4.09	0.20	5.81	0.50	6.48	0.61	13948	584

- *** = currently in effect
- Value based on earlier data set (n=32)
- Targets based on oil 820-3

- Calculated MRV raw mean and standard deviations w/ Chartable = Y data are not equivalent to targets:

RO822-2 Target Group = 822-2 (Target [n = 8])

RO822-2 Target Group	MRV		
	N	Mean	Std Dev
822-2 (Target [n = 8])	8	14315.125	1538.4180592

229 rows have been excluded.

- ANOVA analysis approach also does not match targets

Recommended Standard Deviation for RO822-2 to be used for Lab calibration

- Calculated MRV raw mean and standard deviation using all available RO822-2 (*Chartable = Y*) data:

IND = 822-2

		MRV	
IND	N	Mean	Std Dev
822-2	57	14436.22807	1155.9133219

180 rows have been excluded.

- Recommend revising RO822-2 standard deviation to be changed from 584 to 1156

Recommended Standard Deviation to be used for laboratory Severity Adjustments (SA)

- Data: 237 tests results (Validity equal to AC or OC) – all chartable data

Oil	#of tests
820-2	93
820-3	73
822-1	14
822-2	57

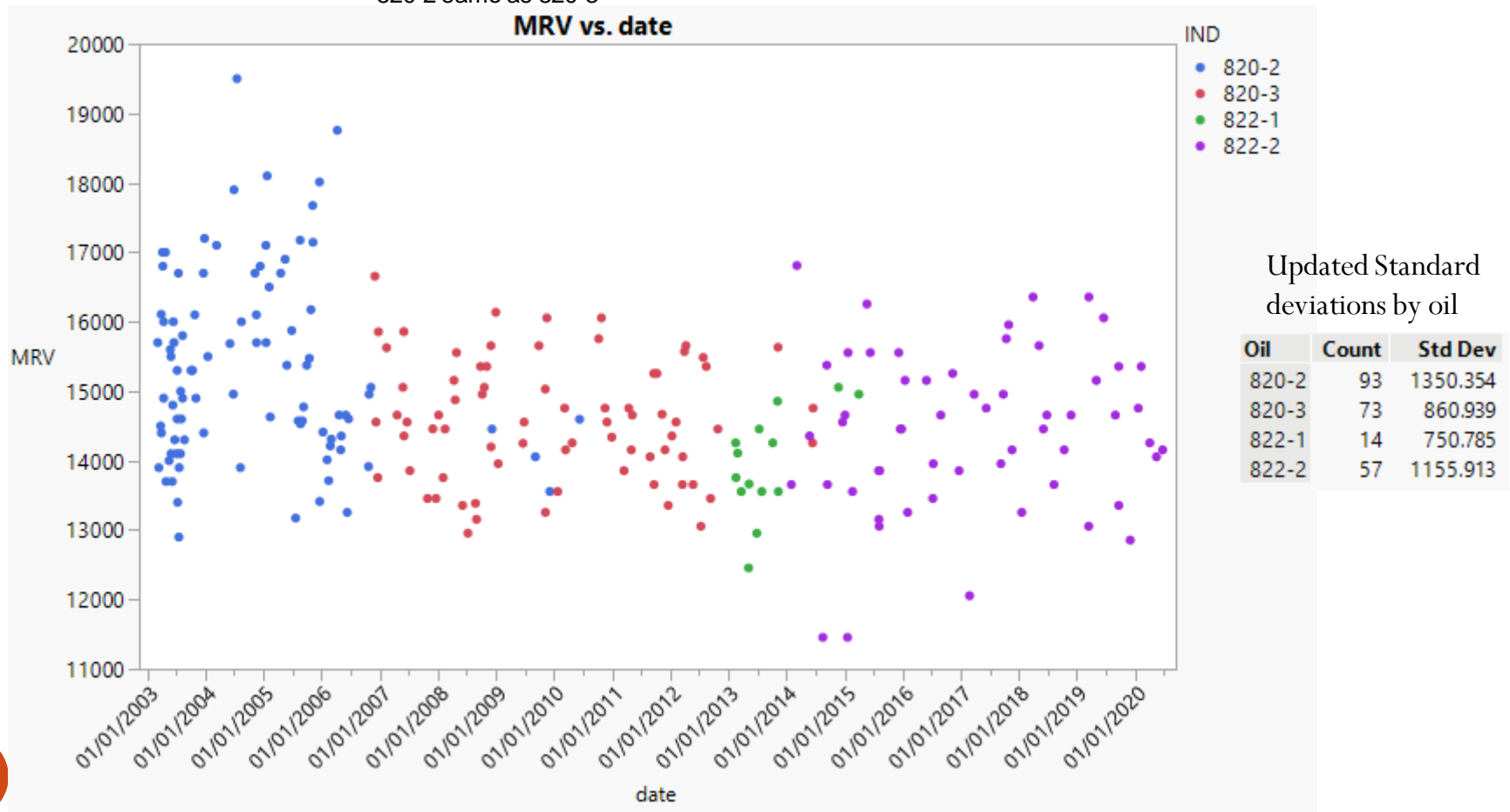
- Plot of the data and model details are presented in the next two slides
 - T-11 is a lab based system
 - MRV data is modeled by Lab and Oil
 - RMSE from the model is equal to 1,117 cP
- Recommend revising current SA standard deviation to be changed from 584 to 1,117 cP

MRV (after current CF) versus time by oil type

Current LTMS Target Mean and Standard deviation by oil

Reference Oil	Mean	Standard Deviation
820-3	14981	916
822-1	13948	584
822-2	13948	584

820-2 same as 820-3



MRV Model: Lab (T-11 is a lab based system) and Oil

RMSE: 1,117cP

Response MRV

Whole Model

Summary of Fit

RSquare	0.183117
RSquare Adj	0.154454
Root Mean Square Error	1116.63
Mean of Response	14797.12
Observations (or Sum Wgts)	237

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	8	63726803	7965850	6.3887	
Error	228	284284685	1246863		Prob > F
C. Total	236	348011489			<.0001*

Effect Tests

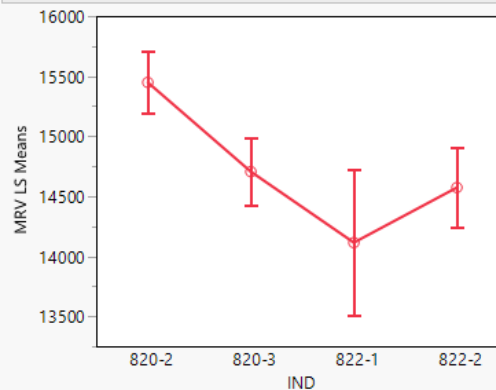
Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
IND	3	3	32075561	8.5750	<.0001*
LTMSLAB	5	5	18992387	3.0464	0.0111*

IND

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
820-2	15448.816	129.93540	15308.5
820-3	14705.581	143.46781	14587.9
822-1	14114.325	308.41622	13960.4
822-2	14573.095	167.83321	14436.2

Least Squares Means Plot

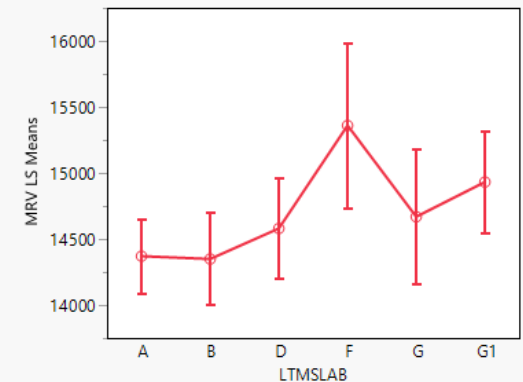


LTMSLAB

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
A	14370.766	141.53663	14609.9
B	14349.387	176.98664	14528.2
D	14580.676	193.72920	14678.1
F	15360.436	316.45710	15833.4
G	14669.341	259.83013	15407.7
G1	14932.118	198.16078	14802.7

Least Squares Means Plot



Updated Standard deviations by oil

Oil	Count	Std Dev
820-2	93	1350.354
820-3	73	860.939
822-1	14	750.785
822-2	57	1155.913