

CATERPILLAR 1P

ANALYSIS OF NEW LINER SUPPLIER

July 21st, 2015

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Performance you can rely on.



Outline



- Summary
- Data
- Analysis by test parameter
 - Weighted Demerits
 - Top Groove Fill
 - Top Land Carbon
 - Oil Consumption

Summary



- Based on three test results for “1Y3997 New” modified liner, there is no evidence to contradict that the liners seem to be similar.
 - Differences among liners are not statistically significant (considering multiple comparisons and a specific contrast - 1Y3997 New vs. 1Y3997).
- There is an additional test running right now.

Data (part 1)

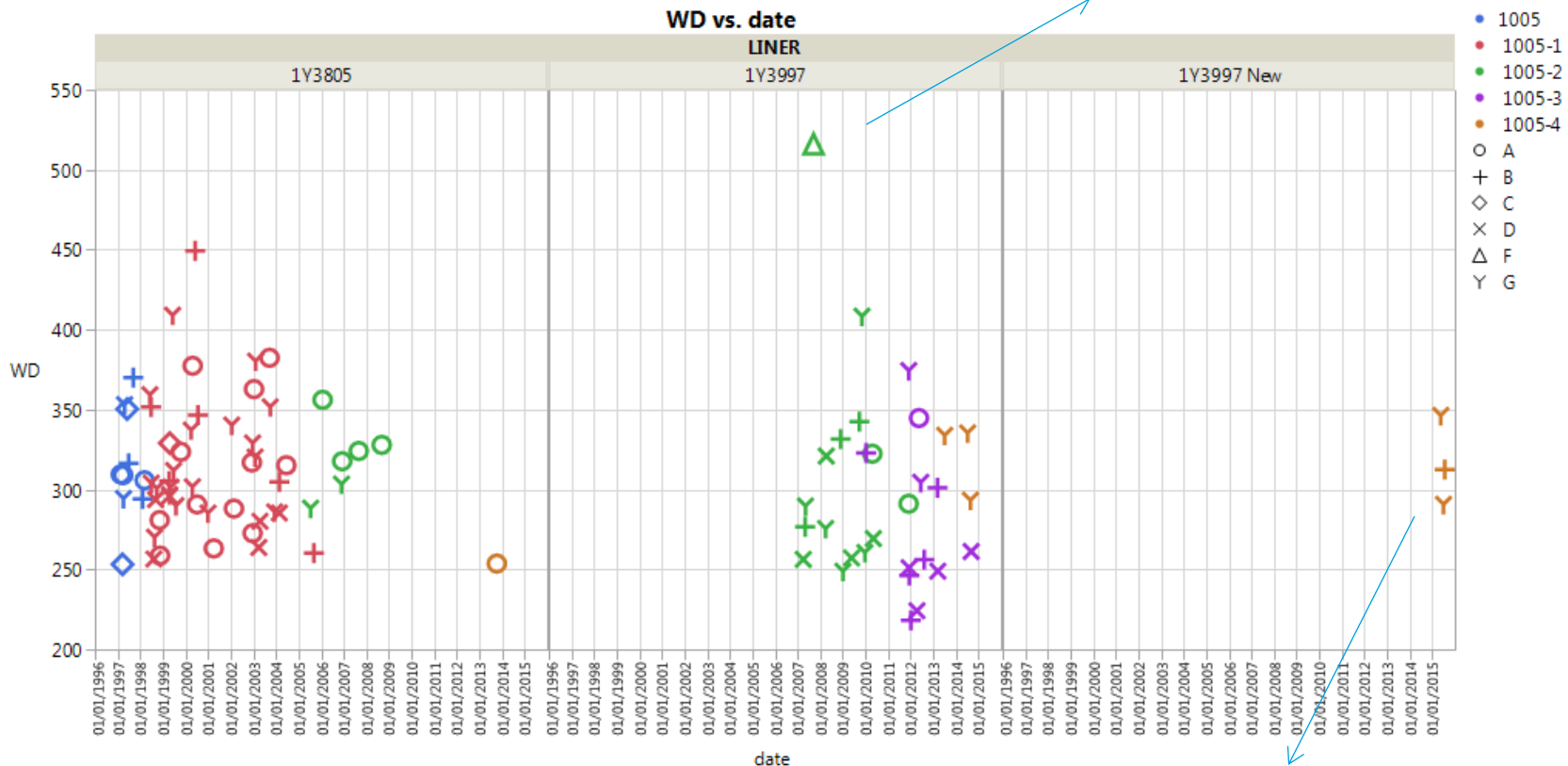


- Fields in the LTMS file related to liner
 - LINERP: LINER PART NUMBER
 - LINERSN: LINER SERIAL NUMBER
 - LINERDC: LINER DATE CODE
- This analysis uses only LINERP
- Only LINERP = 1Y3805 and 1Y3997 are used in this analysis
- Six test results are missing LINERP and were excluded. LINERP= 1Y3822 has been also excluded
- Some LINERP seem to be typos (talked to and Jim Moritz about it and corrected assuming they were typos)
- PC-7 matrix tests were excluded
- There is only one test on (1004-3; 1Y3997) and the last 1P test with 1004-3 completed in 02/01/2008. Decided to exclude 1004-3 data
- Will focus the analysis on 1005 and re-blends
- **Final data: 93 tests**

Weighted Demerits (WD) vs. date by liner type



Is this an “atypical” test result?
62977-1P; F/2; 1005-2; 09/15/2007



Test results seem to be similar to 1Y3997 test results – refer to middle panel to compare

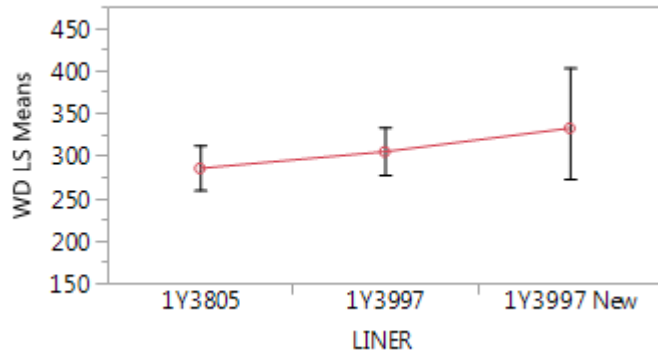
WD: excluding a high value from stand F/2 oil 1005-2 09/15/2007



Model Log WD: Lab, Lab(Stand), Oil, Liner

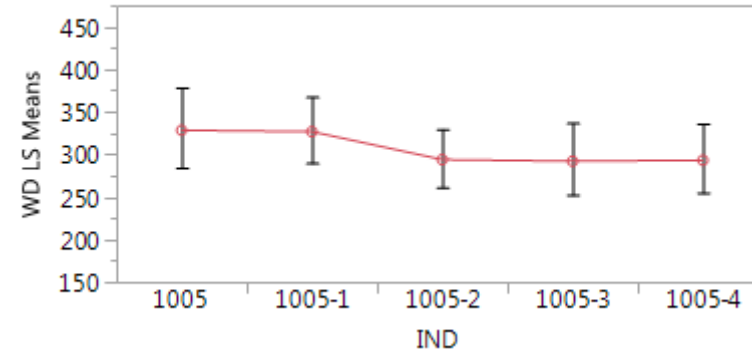
Differences among Stand within lab are not stat. significant

LS Means Plot: Liner



Liner	Least Sq Mean
1Y3997 New A	331.87
1Y3997 A	304.28
1Y3805 A	284.74

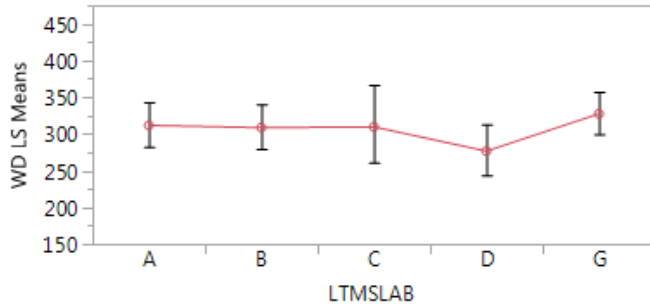
LS Means Plot: Oil



Oil	Least Sq Mean
1005	328.39055
1005-1	326.76707
1005-2	293.86449
1005-4	293.11149
1005-3	291.98415

Differences among liners or oil re-blends are not stat. significant. Note that, over time, average for re-blends is going down slightly

LS Means Plot: Lab



Lab	Least Sq Mean
G	327.44140
A	311.67377
C	309.63672
B	308.66134
D	276.69392

Summary of Fit

RSquare	0.3948
RSquare Adj	0.1528
Root Mean Square Error	0.1249
Mean of Response	5.7193
Observations (or Sum Wgts)	92

Analysis of Variance

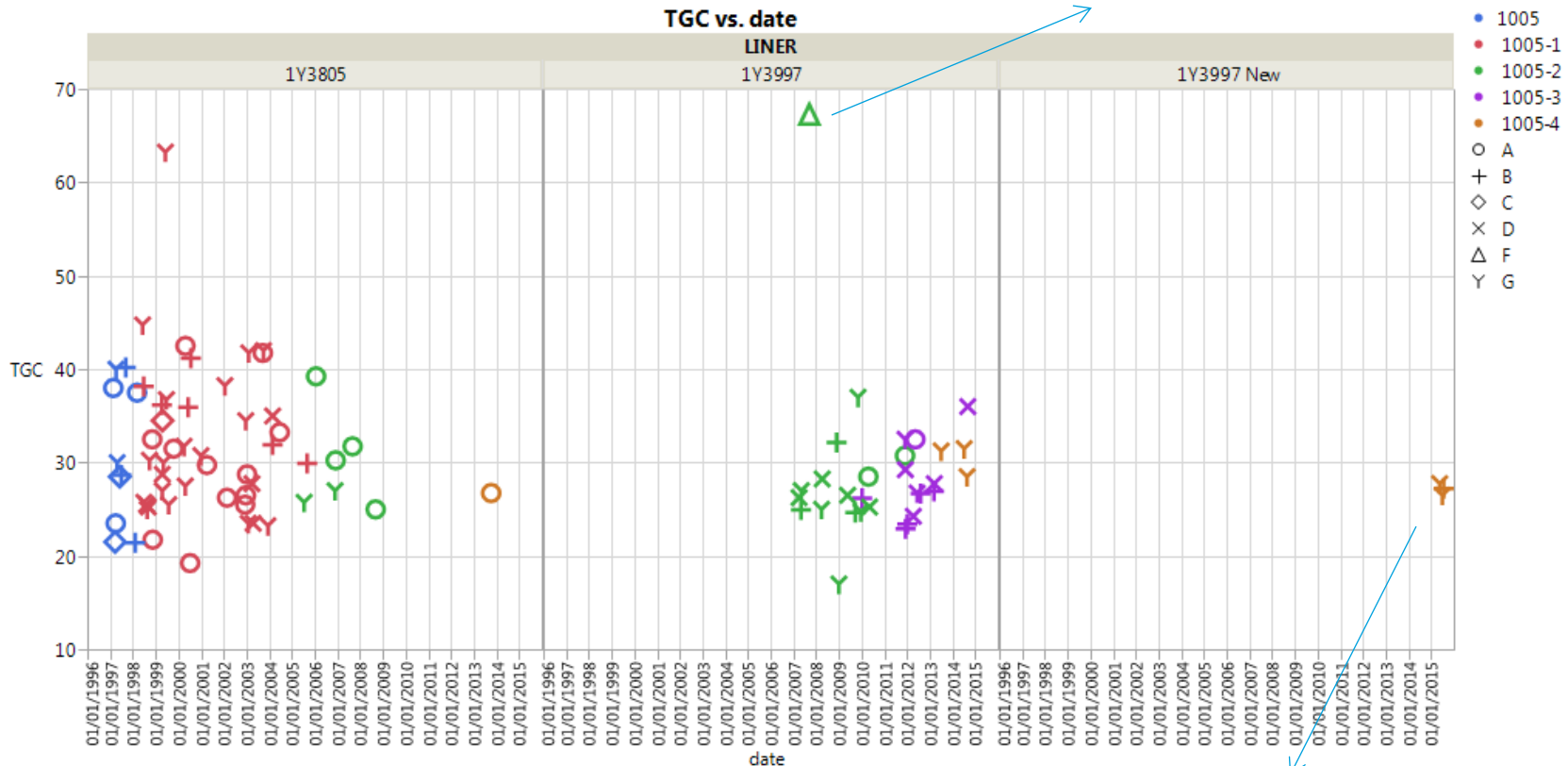
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	26	0.662	0.0255	1.6311	
Error	65	1.015	0.0156		Prob > F
C. Total	91	1.676			0.0575

Levels not connected by same letter are significantly different.

Top Groove Carbon (TGC) vs. date by liner type



Is this an “atypical” test result?
62977-1P; F/2; 1005-2; 09/15/2007



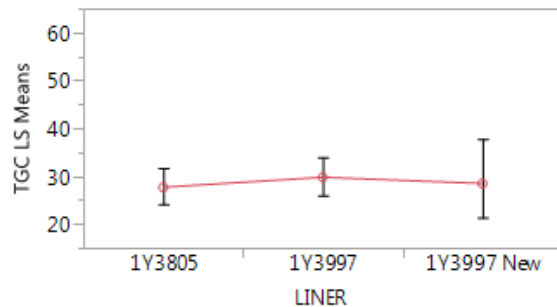
Test results seem to be similar to 1Y3997 test results – refer to middle panel to compare

TGC: excluding a high value from stand F/2 oil 1005-2 09/15/2007



Model Log TGC: Lab, Lab(Stand), Oil, Liner; transformation is debatable; few high results; similar conclusions are reached with and without it

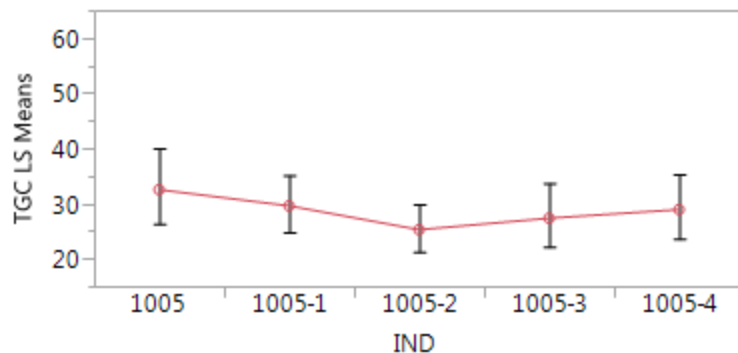
LS Means Plot: Liner



Liner		Least Sq Mean
1Y3997	A	29.751580
1Y3997 New	A	28.452016
1Y3805	A	27.668553

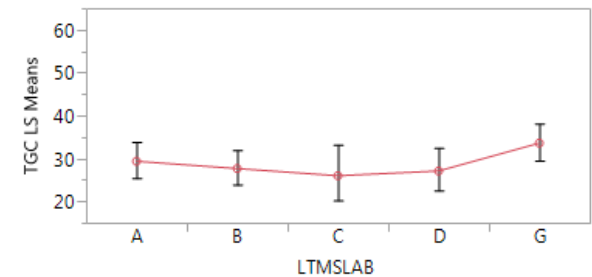
Two Stand within Lab differences are stat. significant: G/6 and B/1 and G/6 and A/1

LS Means Plot: Oil



Oil		Least Sq Mean
1005	A	32.496240
1005-1	A	29.574431
1005-4	A	28.896839
1005-3	A	27.340285
1005-2	A	25.251063

LS Means Plot: Lab



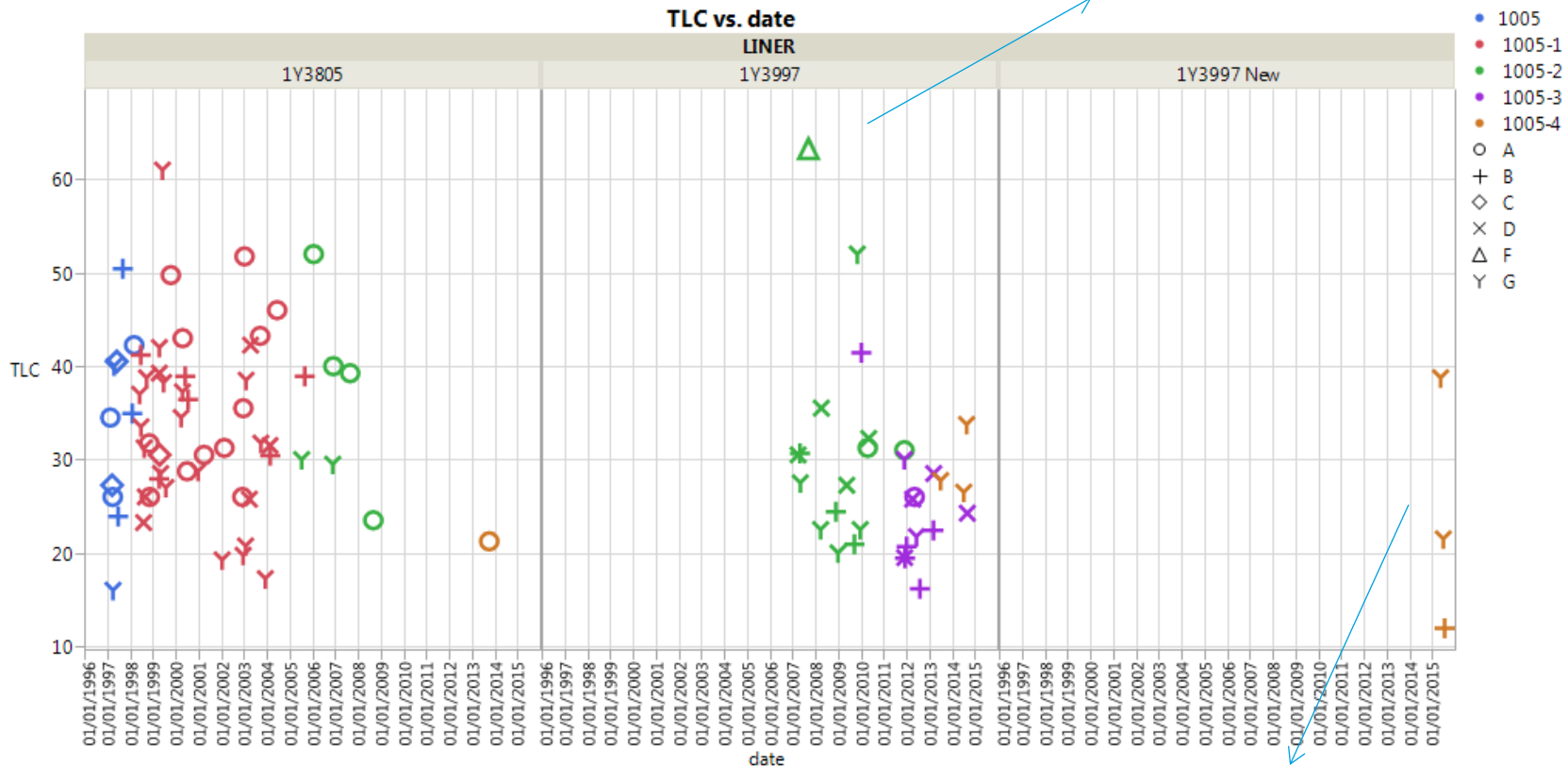
Lab		Least Sq Mean
G	A	33.584645
A	A	29.345561
B	A	27.657126
D	A	27.076914
C	A	25.977249

Differences among liners or oil re-blends are not stat. significant
Note that, over time, average for re-blends is going down slightly

Top Land Carbon (TLC) vs. date by liner type



Is this an “atypical” test result?
62977-1P; F/2; 1005-2; 09/15/2007



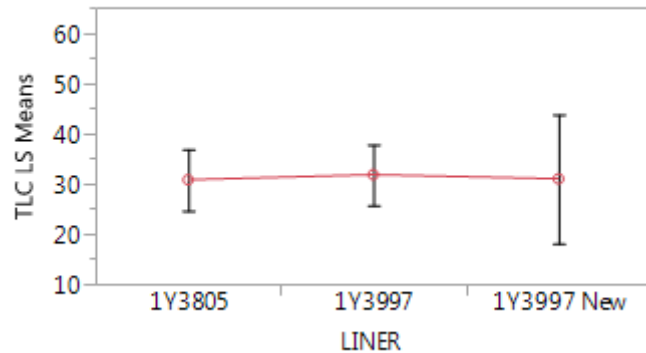
Test result seems to be somewhat similar to 1Y3997 test results – refer to middle panel to compare

TLC: excluding a high value from stand F/2 oil 1005-2 09/15/2007



Model Log TLC: Lab, Lab(Stand), Oil, Liner; transformation is debatable; few high results; similar conclusions are reached

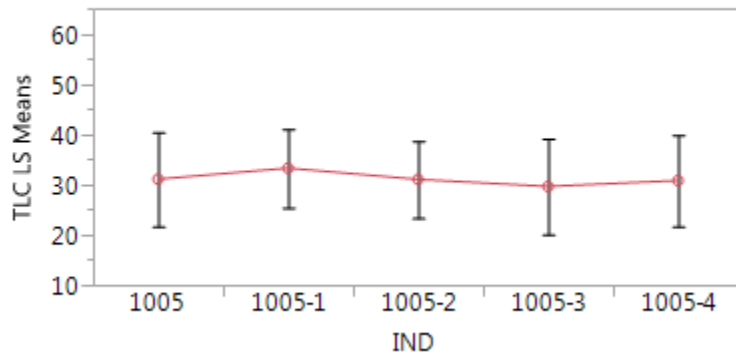
LS Means Plot: Liner



Liner		Least Sq Mean
1Y3997	A	31.758191
1Y3997 New	A	30.925335
1Y3805	A	30.746448

Differences among “Stands within Labs” are not stat. significant

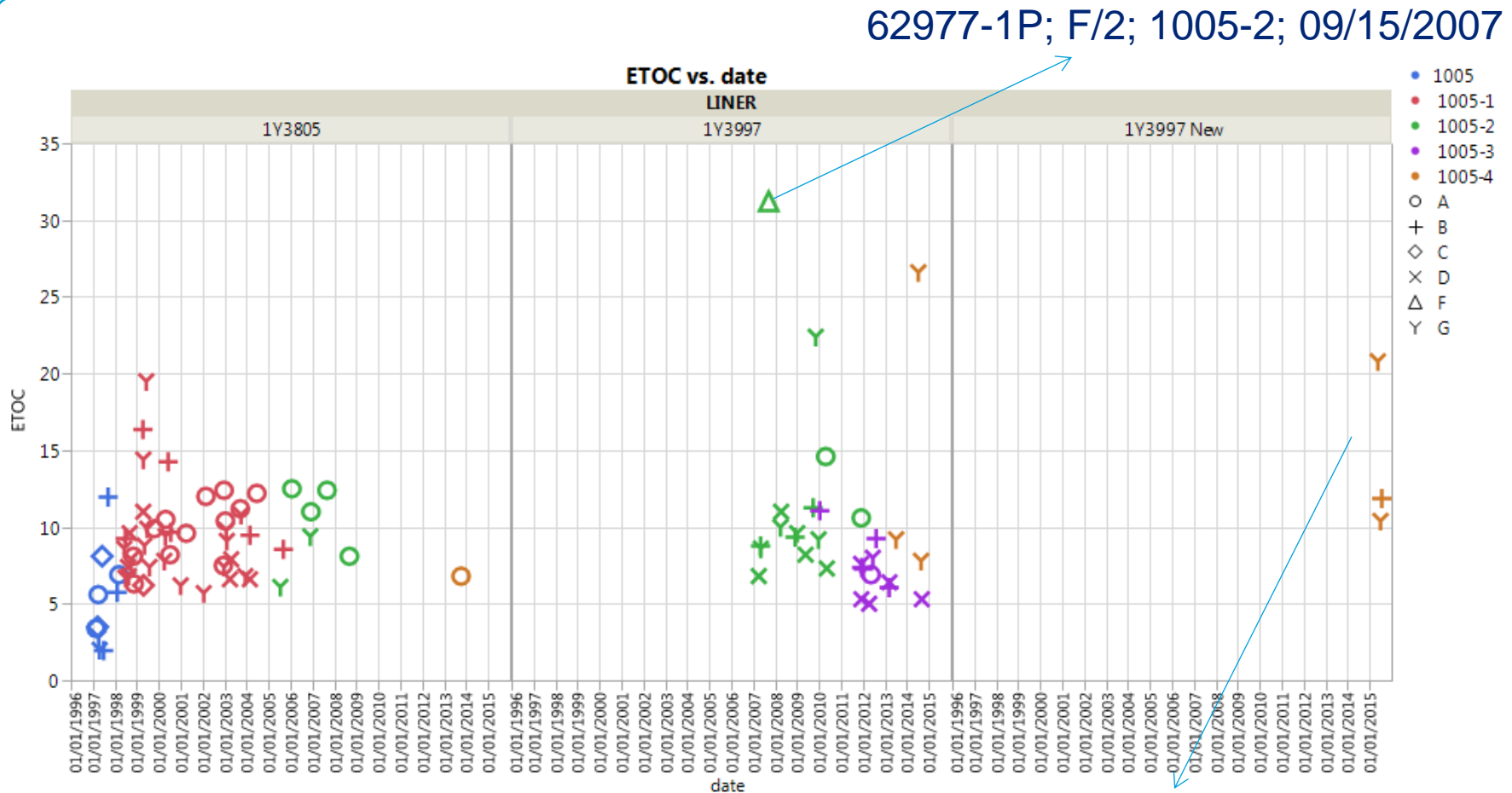
LS Means Plot: Oil



Oil		Least Sq Mean
1005-1	A	33.241677
1005	A	31.060791
1005-2	A	31.018539
1005-4	A	30.786031
1005-3	A	29.609586

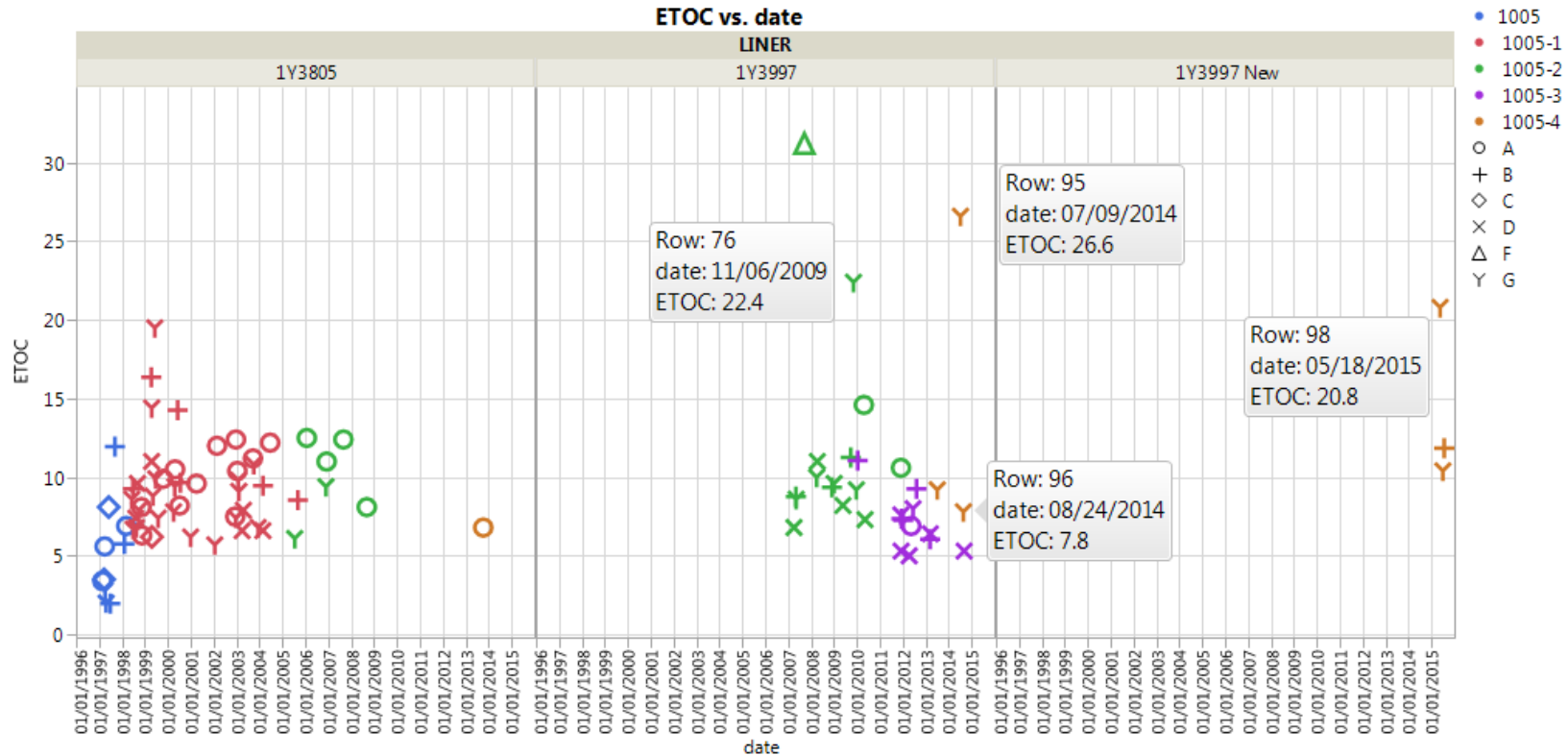
Differences among liners or oil re-blends blends are not stat. significant

End of Test Oil Consumption vs. date by liner type



Test results seem to be a bit higher when compared to 1Y3997 test results – refer to middle panel to compare

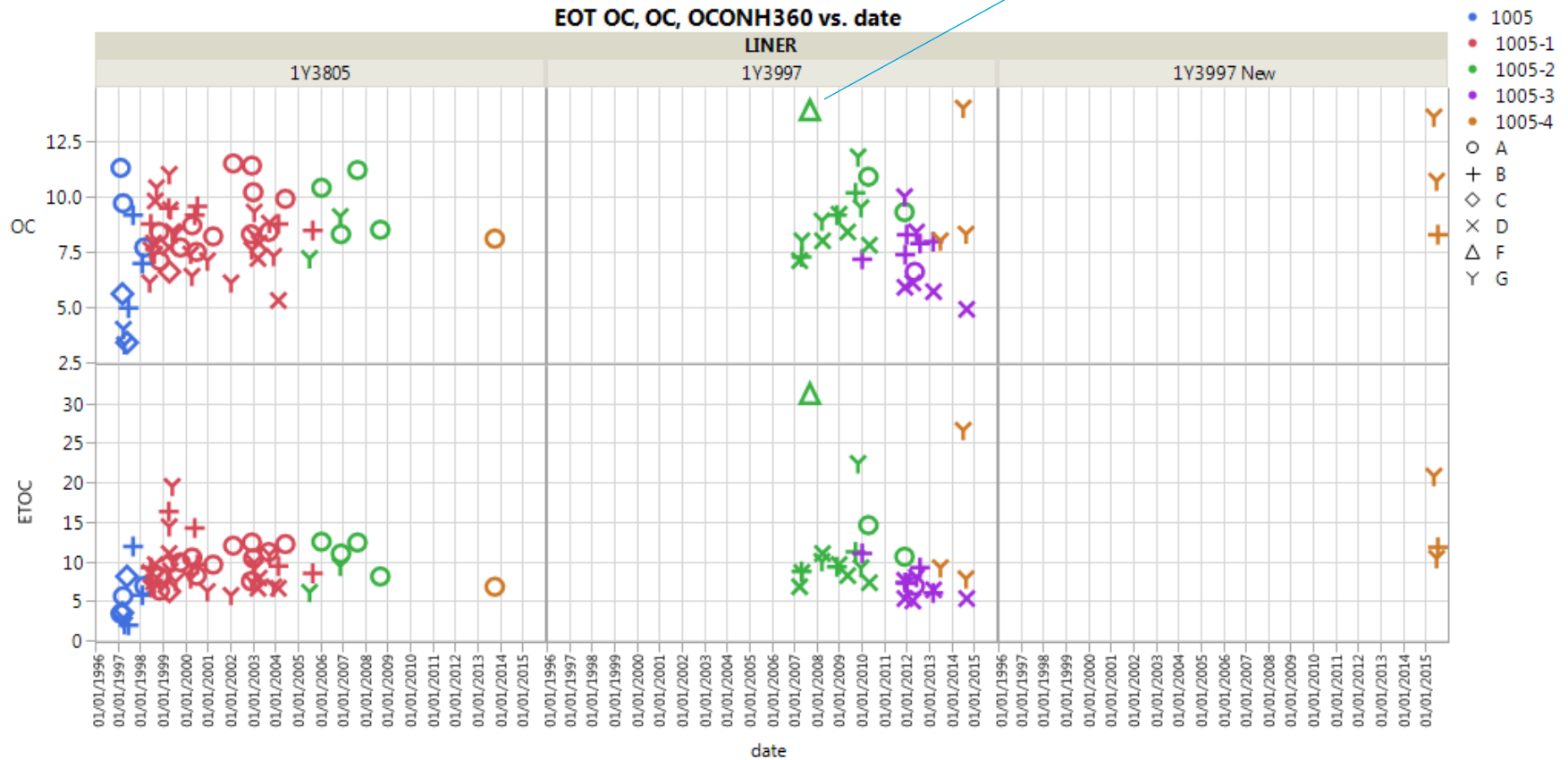
With labels...



Oil Consumption vs. date by liner type: Avg. OC and EOT OC (avg. at end of test)



62977-1P; F/2; 1005-2; 09/15/2007

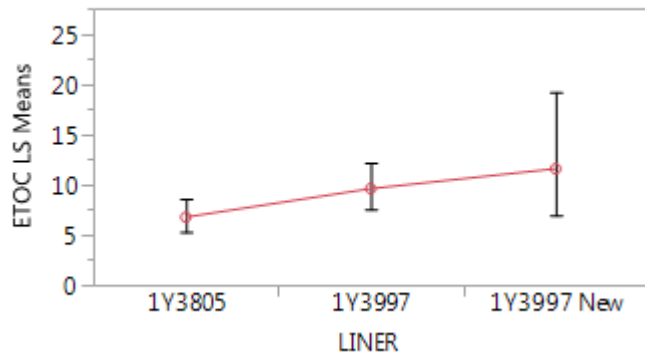


EOT OC: excluding a high value from stand F/2 oil; 1005-2; 09/15/2007



Model Log EOT OC: Lab, Lab(Stand), Oil, Liner;

LS Means Plot: Liner



Liner	Least Sq Mean
1Y3997 New A	11.566905
1Y3997 A	9.586416
1Y3805 A	6.754330

Summary of Fit

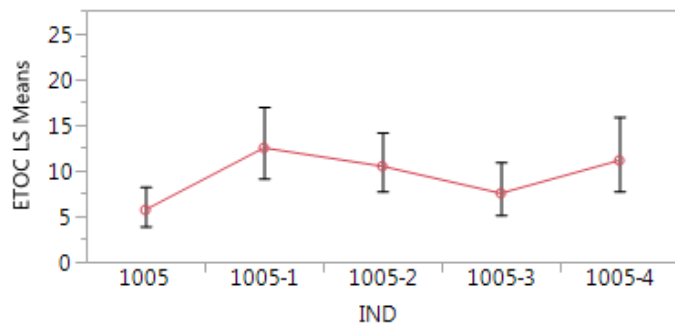
RSquare	0.58
RSquare Adj	0.411
Root Mean Square Error	0.325
Mean of Response	2.131
Observations (or Sum Wgts)	92

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	26	9.454	0.364	3.4464
Error	65	6.858	0.106	Prob > F
C. Total	91	16.312		<.0001*

Differences among Stands within Labs are not stat. significant

LS Means Plot: Oil



Oil	Least Sq Mean
1005-1 A	12.46
1005-4 A B	11.09
1005-2 A B	10.46
1005-3 A B	7.51
1005 B	5.69

Difference between 1005 and 1005-1 is stat. significant, but not among liners.

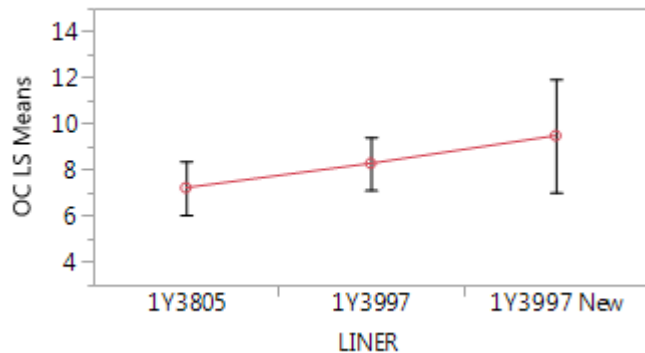
Levels not connected by same letter are significantly different.

OC: excluding a high value from stand F/2 oil; 1005-2; 09/15/2007



Model OC: Lab, Lab(Stand), Oil, Liner;

LS Means Plot: Liner



Liner		Least Sq Mean
1Y3997 New	A	9.48
1Y3997	A	8.28
1Y3805	A	7.22

Summary of Fit

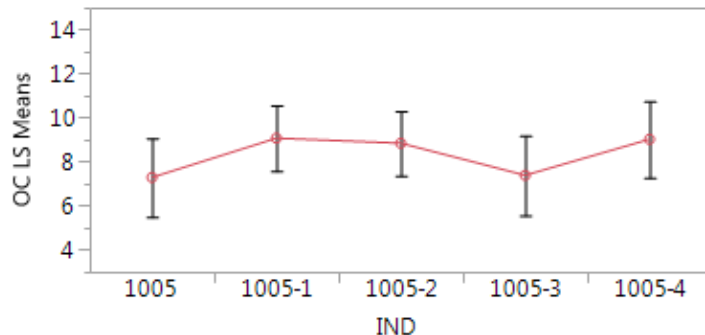
RSquare	0.512956
RSquare Adj	0.318138
Root Mean Square Error	1.570709
Mean of Response	8.295652
Observations (or Sum Wgts)	92

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	26	168.89494	6.49596	2.6330
Error	65	160.36332	2.46713	Prob > F
C. Total	91	329.25826		0.0008*

Differences among Stands within Labs are not stat. significant

LS Means Plot: Oil



Oil		Least Sq Mean
1005-1	A	9.08
1005-4	A	9.03
1005-2	A	8.85
1005-3	A	7.39
1005	A	7.30

Differences among liners or oil re-blends blends are not stat. significant using Tukey HSD. However, there a stat. sign. difference between 1005 and 1005-1 using Dunnett, when 1005 is the control group

Levels not connected by same letter are significantly different.

Appendix A: Distribution of tests within stands

	Lab/Stand	N Rows
1	A/1	4
2	A/2	4
3	A/3	1
4	A/4	1
5	A/5	4
6	A/6	5
7	A/7	3
8	A/8	1
🚫🚗	9 A/9	0
10	B/1	1
11	B/2	10
12	B/3	2
🚫🚗	13 B/4	0
14	B/5	4
🚫🚗	15 C/1	0
16	C/2	3
17	D/	11
18	D/1	2
19	D/2	1
🚫🚗	20 F/1	0
🚫	21 F/2	0
22	G/1	6
23	G/2	5
24	G/3	5
25	G/4	15
🚫🚗	26 G/5	0
27	G/6	2

62977-1P Excluded from the exploratory models but not excluded from the plots

62977-1P
F/2 is obs 136
Atypical?

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