

# Sequence IX

## Oil Aging Data Review

Statistics Group

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# Statistics Group

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# Executive Summary

- Oil A and Oil B are significantly different
- “New” and “Aged” are significantly different
- Directionally, the effect of aging on Oil B is severe of the effect of aging on Oil A – but the difference is not statistically significant
  - With limited data, there is not enough evidence to conclude that the “aging” rate is different for the two oils

# Sequence IX Test Oils – Results from Aging Tests

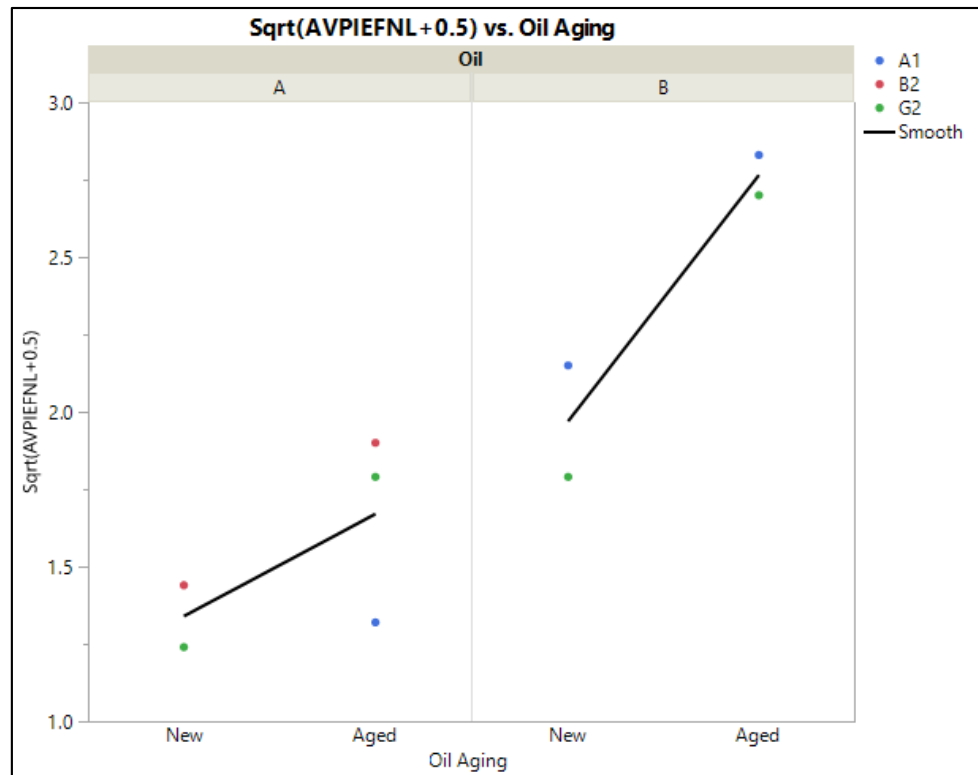
- All Analytical Measurements were performed at the same test lab
- Total Number of Tests = 9
- Number of Lab-Stands = 3
  - A1, B2, and G2
- Number of Oils
  - Oil A: (3) “Aged” and (2) “New”
  - Oil B: (2) “Aged” and (2) “New”

## LSPI Data Summary:

Obs	TESTKEY	LTMSLAB	LTMSAPP	Lab-Stand	IND	TOTNOPRE	VAL	CHART	LTMSDATE	AVPIE	MXPIE	LTMSTIME	ENGINEHR	HEADHRS	AVPIEyi	AVPIEFNL	Sqrt(AVPIEFNL+0.5)
1	156962-IX	B	2	B2	Oil_A_New	6	NI	N	20200621	1.5	2	05:54	349	349	.	1.58	1.44
2	156965-IX	G	2	G2	Oil_A_New	5	NI		20200627	1.25	2	03:35	452	452	.	1.04	1.24
3	156970-IX	A	1	A1	Oil_A_Aged	4	NI	N	20200627	1	2	21:52	308	308	.	1.24	1.32
4	156963-IX	B	2	B2	Oil_A_Aged	12	NI	N	20200624	3	5	09:19	369	369	.	3.11	1.90
5	156967-IX	G	2	G2	Oil_A_Aged	12	NI		20200625	3	4	16:06	426	426	.	2.7	1.79
6	156971-IX	A	1	A1	Oil_B_New	15	NI	N	20200623	3.75	6	21:58	288	288	.	4.14	2.15
7	156966-IX	G	2	G2	Oil_B_New	12	NI		20200628	3	6	08:03	471	471	.	2.7	1.79
8	156969-IX	A	1	A1	Oil_B_Aged	28	NI	N	20200620	7	9	18:31	266	266	.	7.52	2.83
9	156968-IX	G	2	G2	Oil_B_Aged	29	NI		20200630	7.25	10	07:23	491	491	.	6.81	2.70

# Model Regression Summary

- Plot of LSPI vs. New and Aged Oil Data
  - Plot suggests higher LSPI with Aged Oils



# Model Regression Summary

- Initial ANOVA Summary with Oil, Aging, and Lab Factors:
  - Model includes only 3 residual degrees of freedom (dof)
    - With 3 residual dof, Oil Aging and Oil factors are statistically significant
  - Removing (*insignificant*) Lab effect from model to increase residual dof

Response Sqrt(AVPIEFNL+0.5)

**Whole Model**

Actual by Predicted Plot

Effect Summary

Residual by Predicted Plot

**Summary of Fit**

RSquare	0.92635
RSquare Adj	0.8036
Root Mean Square Error	0.251419
Mean of Response	1.906667
Observations (or Sum Wgts)	9

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	2.3851659	0.477033	7.5466
Error	3	0.1896341	0.063211	Prob > F
C. Total	8	2.5748000		0.0634

**Parameter Estimates**

Term	Estimate	Std Error	t Ratio	Prob>  t
Intercept	1.9713636	0.090227	21.85	0.0002*
Oil[A]	-0.490909	0.100281	-4.90	0.0163*
Oil Aging[New]	-0.293523	0.086846	-3.38	0.0431*
Oil[A]*Oil Aging[New]	0.1039773	0.086846	1.20	0.3172
LTMSLAB[ A]	-0.098182	0.138401	-0.71	0.5292
LTMSLAB[ B]	0.1895455	0.157802	1.20	0.3159

**Effect Tests**

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Oil	1	1	1.5148052	23.9641	0.0163*
Oil Aging	1	1	0.7220659	11.4230	0.0431*
Oil*Oil Aging	1	1	0.0906088	1.4334	0.3172
LTMSLAB	2	2	0.0934159	0.7389	0.5484

**Oil**

Leverage Plot

**Least Squares Means Table**

Level	Least Sq Mean	Std Error	Mean
A	1.4804545	0.11985916	1.53800
B	2.4622727	0.14841901	2.36750

**Oil Aging**

Leverage Plot

**Least Squares Means Table**

Level	Least Sq Mean	Std Error	Mean
New	1.6778409	0.12899950	1.65500
Aged	2.2648864	0.12134815	2.10800

**Oil\*Oil Aging**

Leverage Plot

**Least Squares Means Table**

Level	Least Sq Mean	Std Error	Mean
A,New	1.2909091	0.19077322	
A,Aged	1.6700000	0.14515666	
B,New	2.0647727	0.19450204	
B,Aged	2.8597727	0.19450204	

**LTMSLAB**

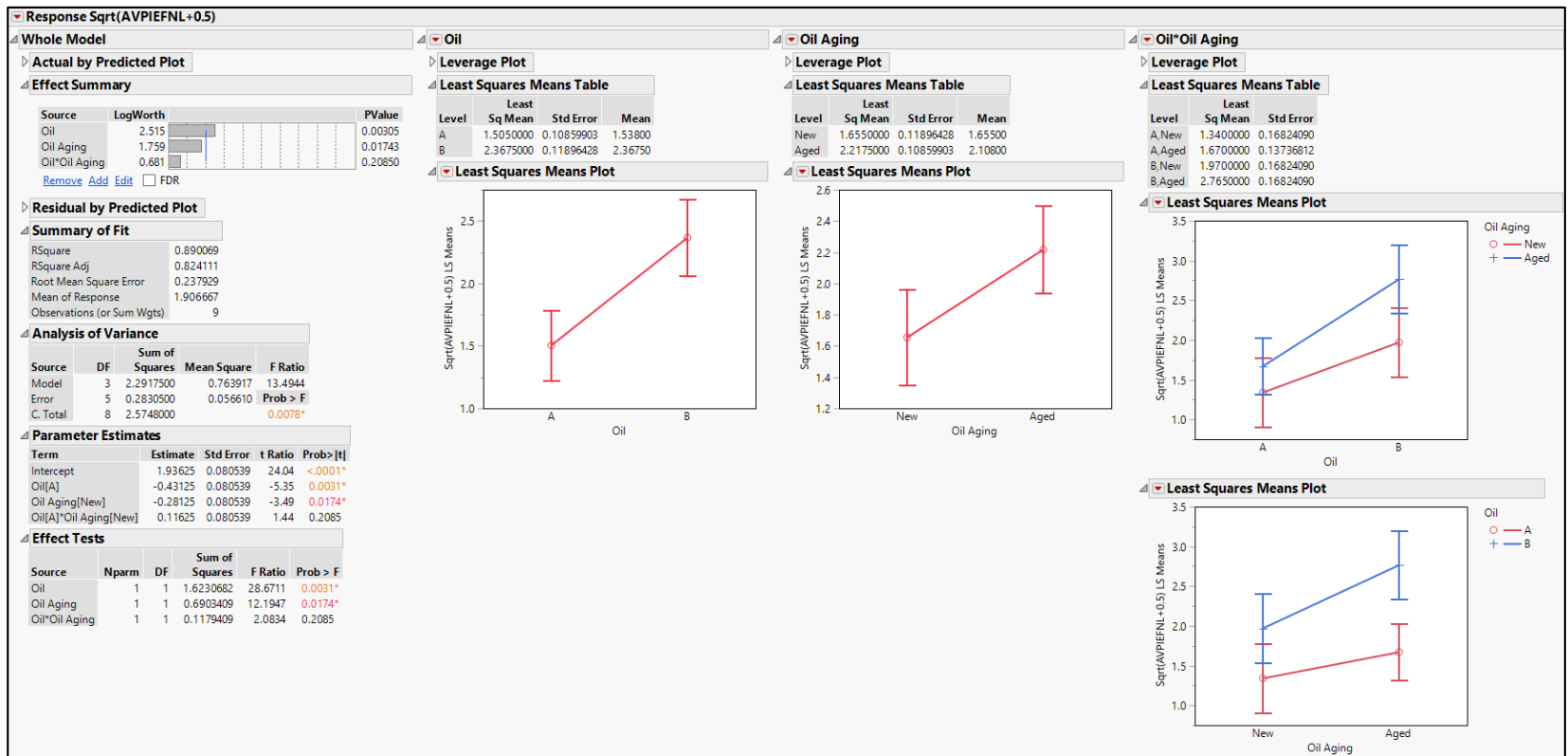
Leverage Plot

**Least Squares Means Table**

Level	Least Sq Mean	Std Error	Mean
A	1.8731818	0.15627723	2.10000
B	2.1609091	0.20411280	1.67000
G	1.8800000	0.12570935	1.88000

# Model Regression Summary

- Analysis Highlights (without lab effect in model):
  - Oil A and Oil B are significantly different
  - “New” and “Aged” are significantly different
  - Directionally, the effect of aging on Oil B is severe of the effect of aging on Oil A – but the difference is not statistically significant
    - With limited data, there is not enough evidence to conclude that the “aging” rate is different for the two oils

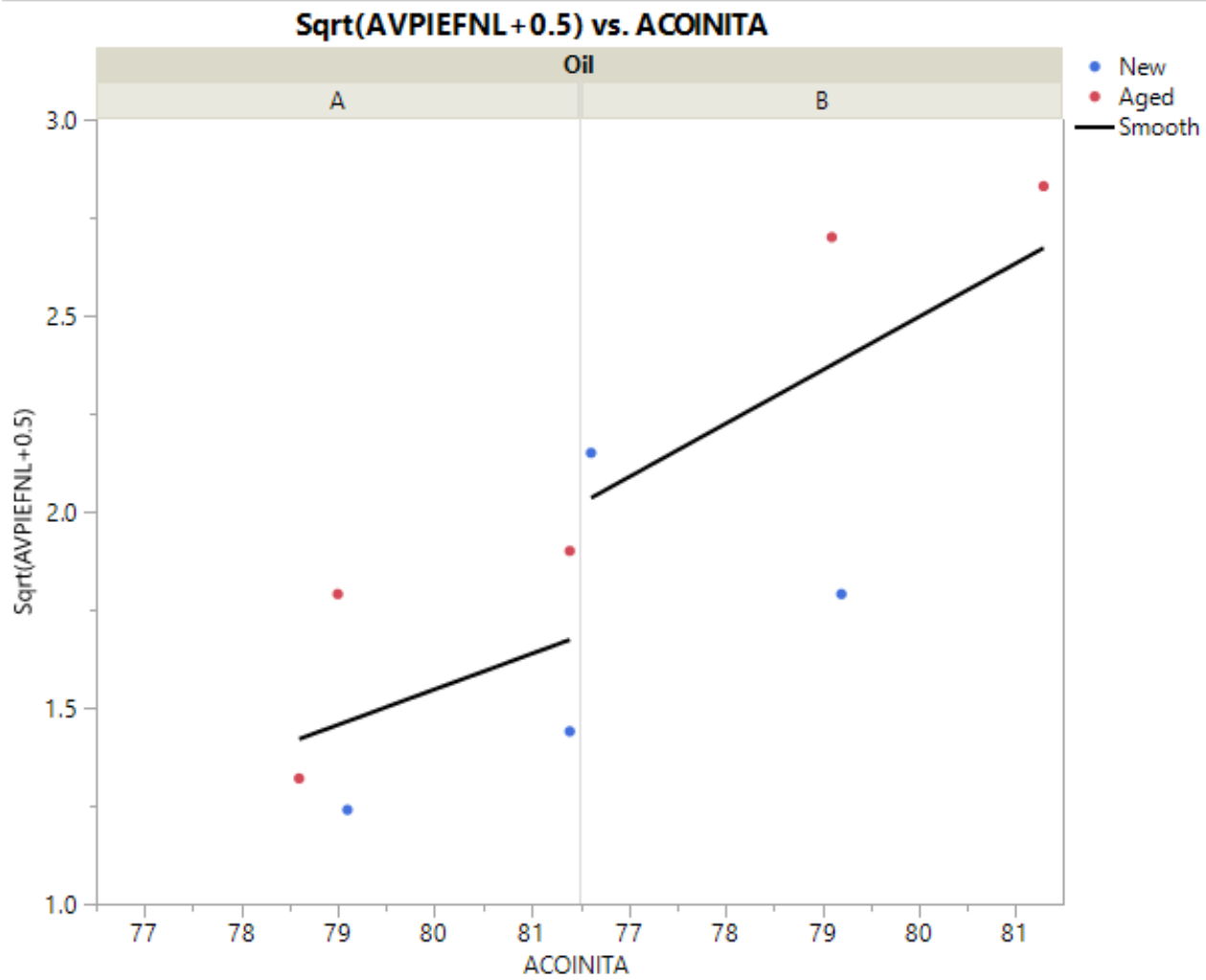


# Appendix

*The following plots are those that exhibited some relationship with LSPI Results*



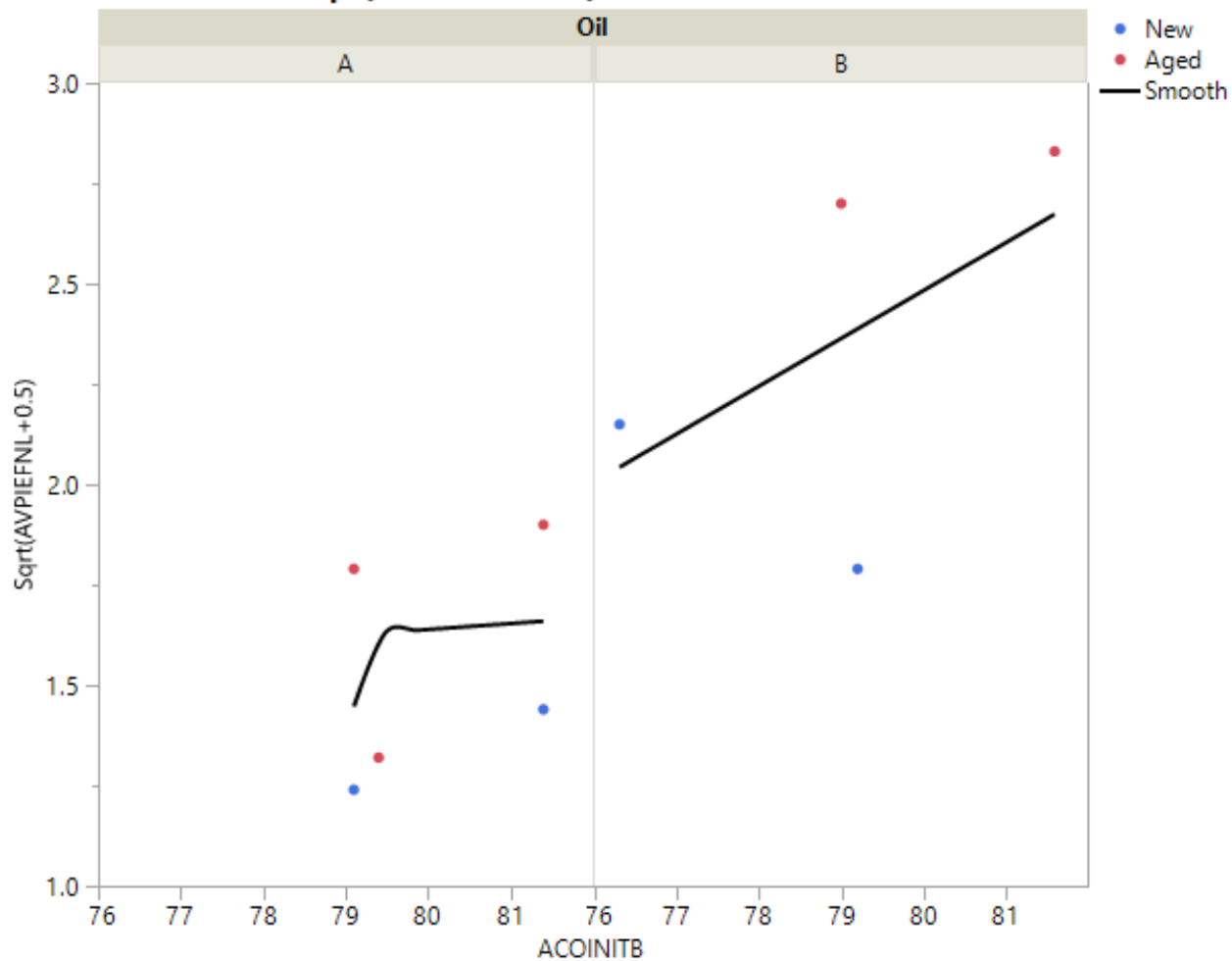
Graph Builder



AVERAGE COOLANT IN TEMPERATURE ITERATION A

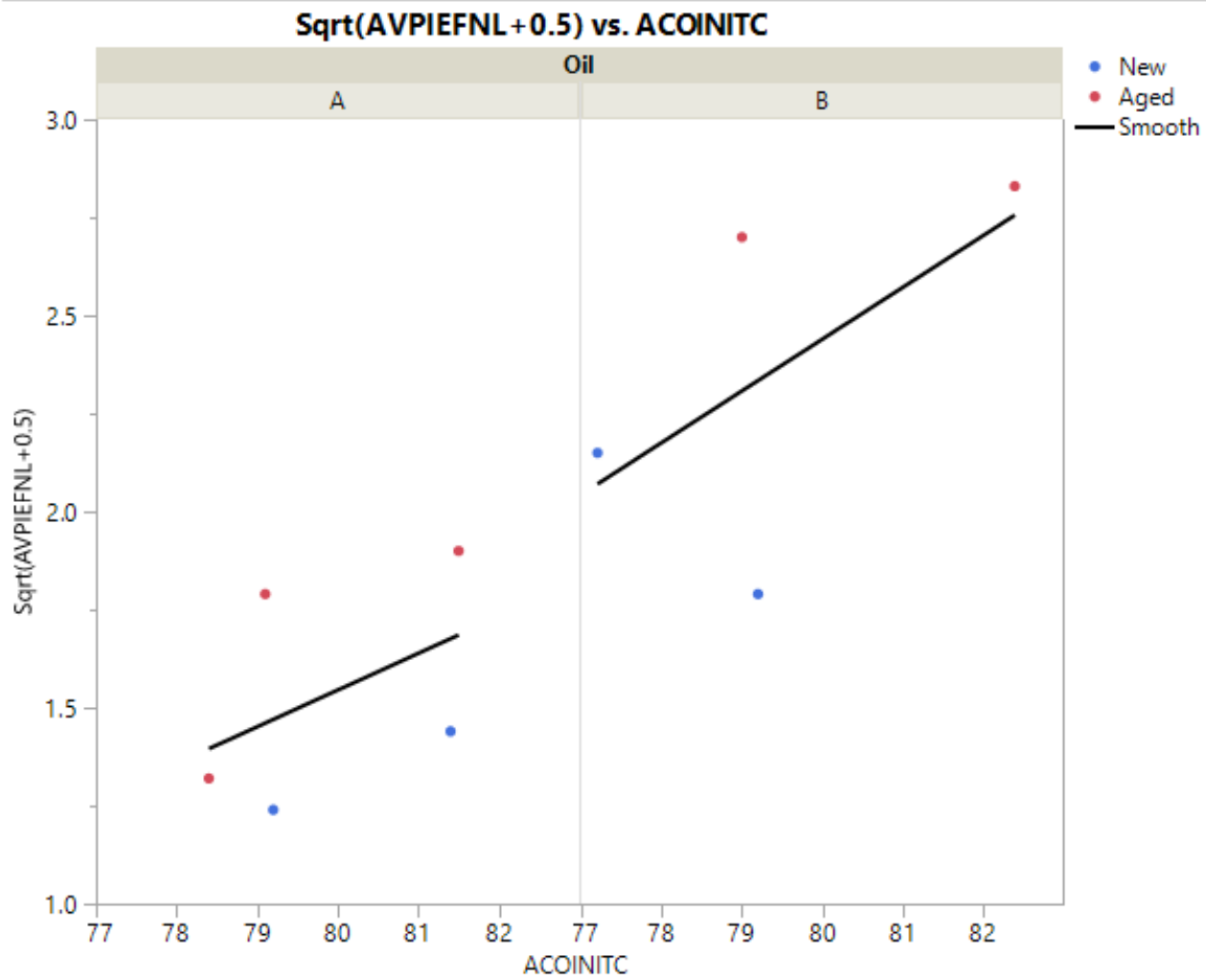
Graph Builder

Sqrt(AVPIEFNL+0.5) vs. ACOINITB



AVERGE COOLANT IN TEMPERATURE ITERATION B

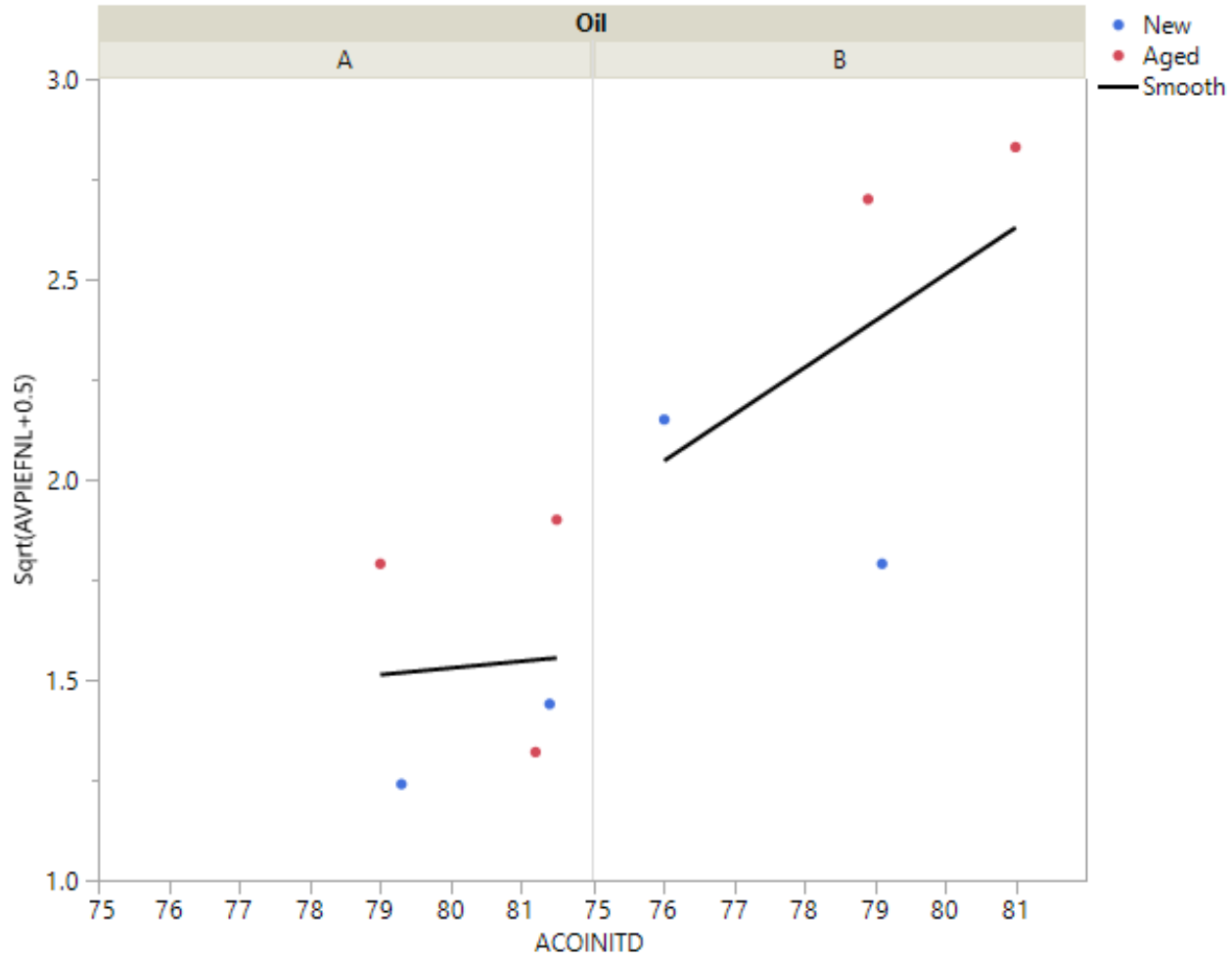
Graph Builder



AVERGE COOLANT IN TEMPERATURE ITERATION C

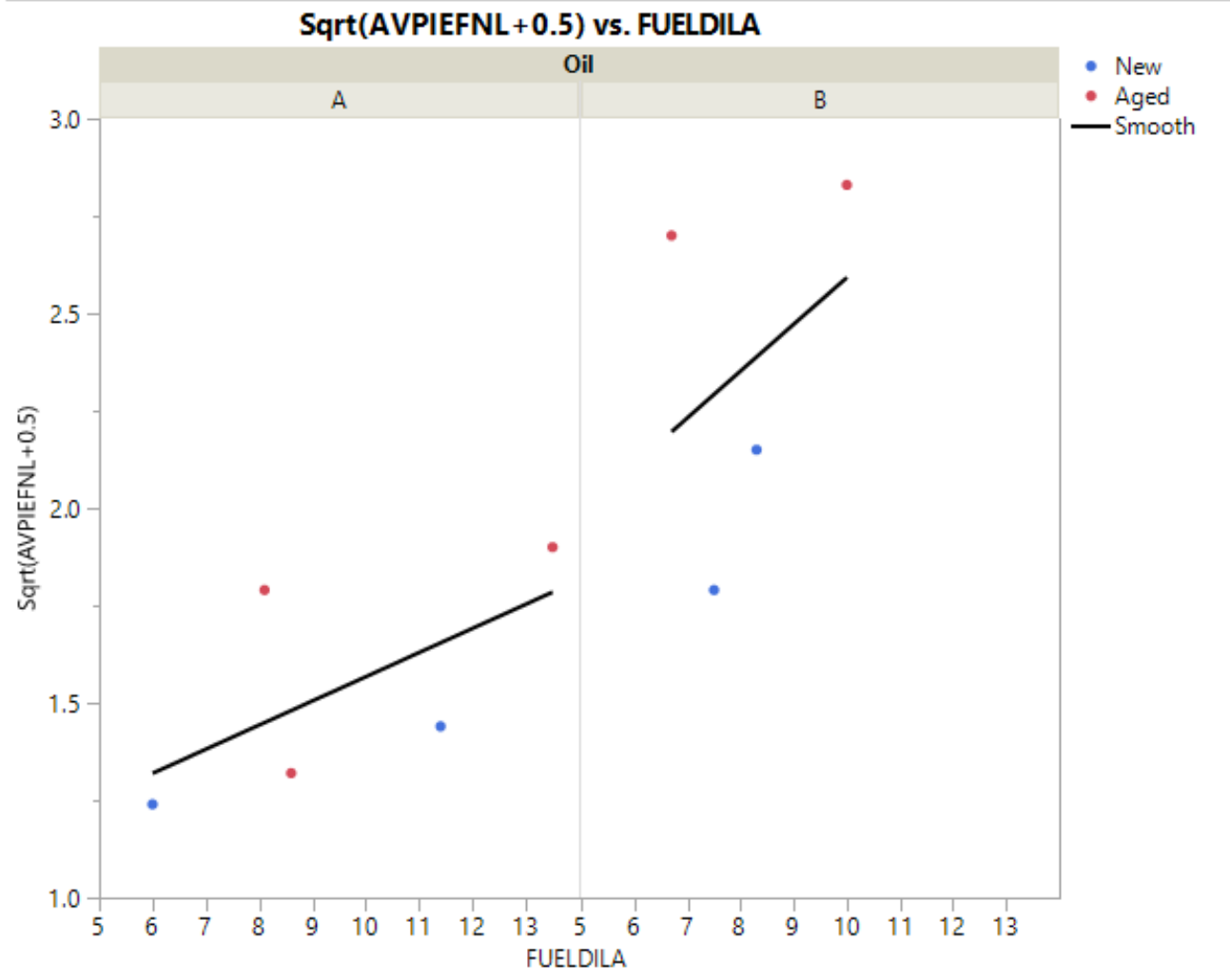
Graph Builder

Sqrt(AVPIEFNL+0.5) vs. ACOINITD



AVERGE COOLANT IN TEMPERATURE ITERATION D

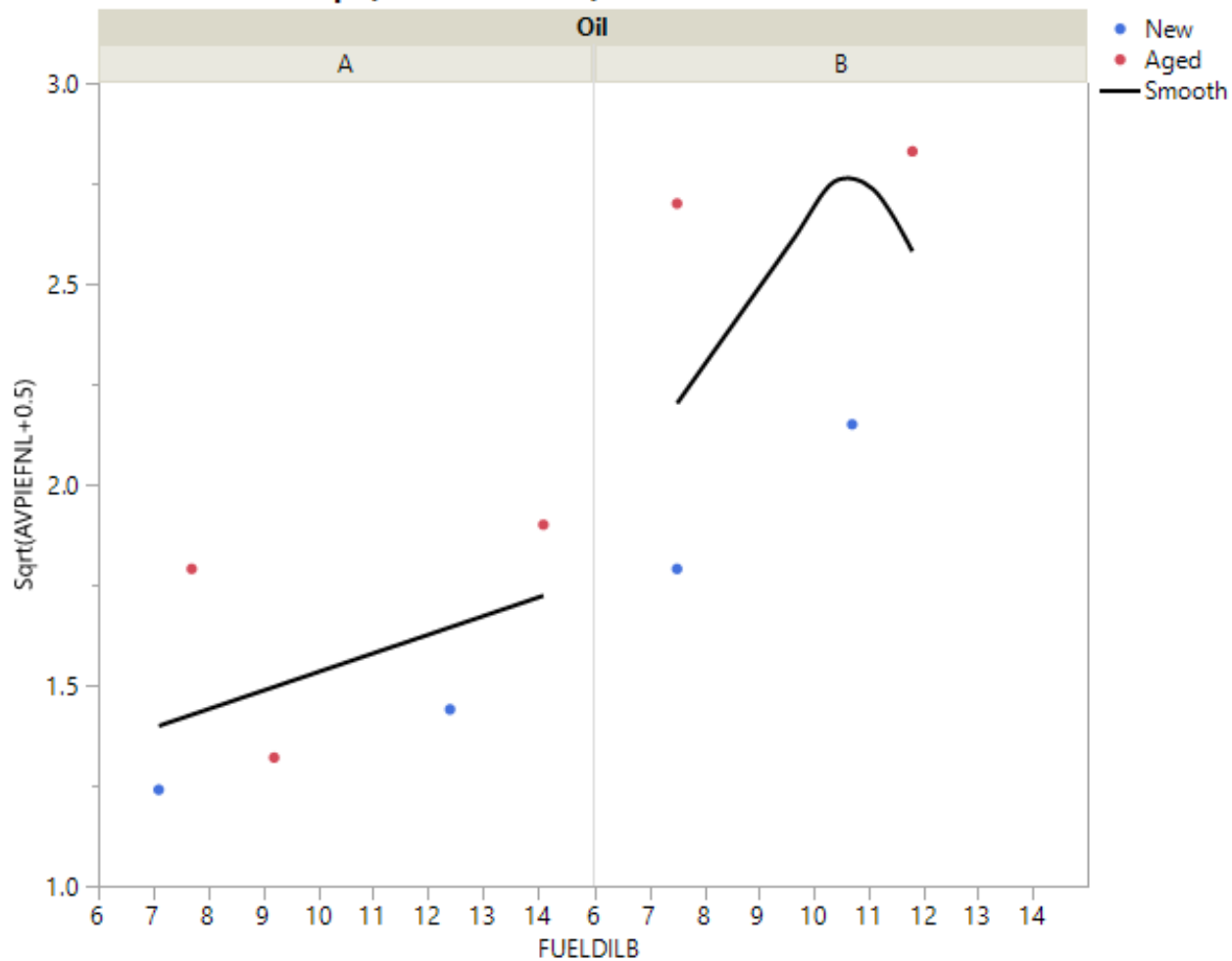
Graph Builder



FUEL DILUTION BY GC, ITERATION A

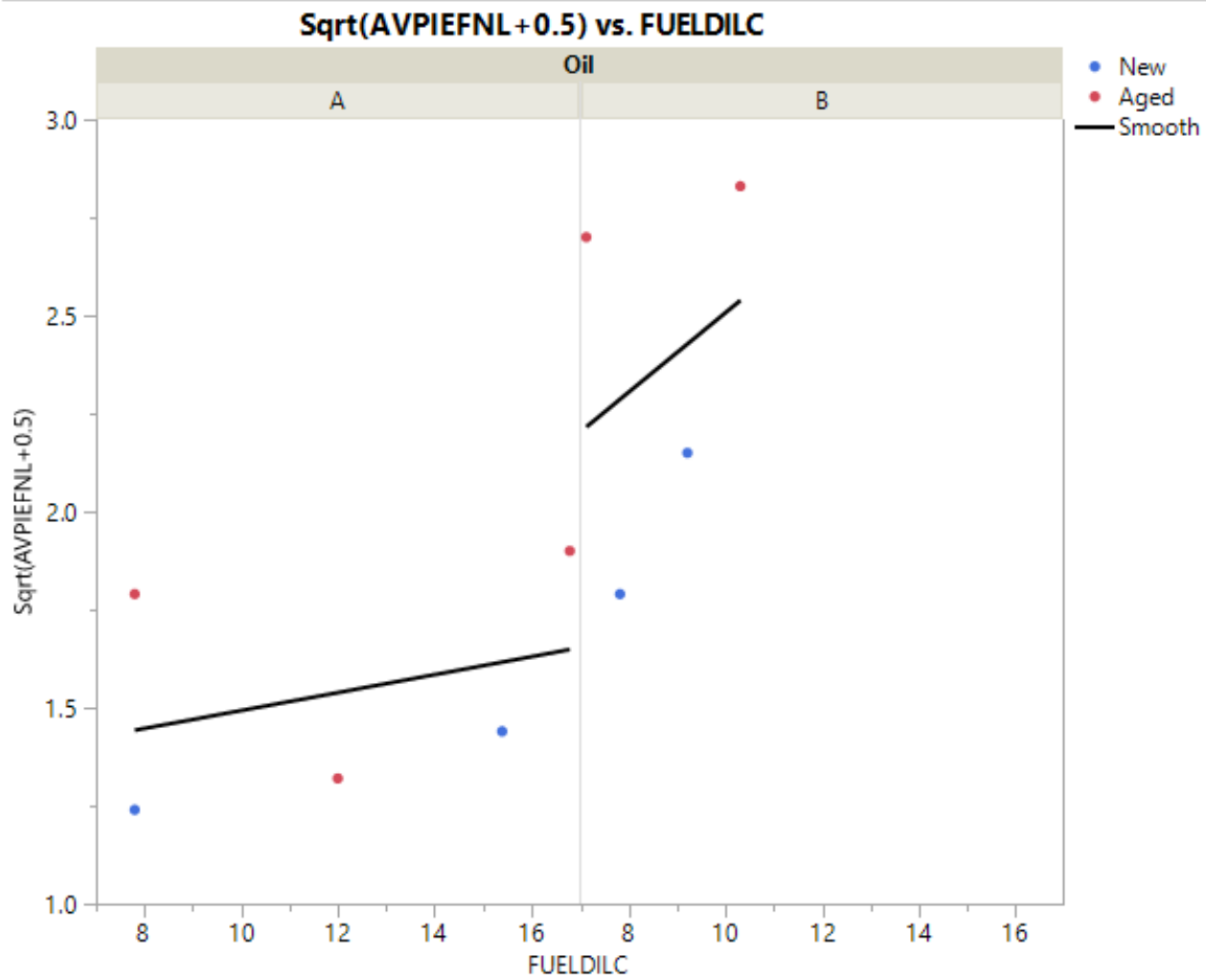
Graph Builder

Sqrt(AVPIEFNL + 0.5) vs. FUELDILB



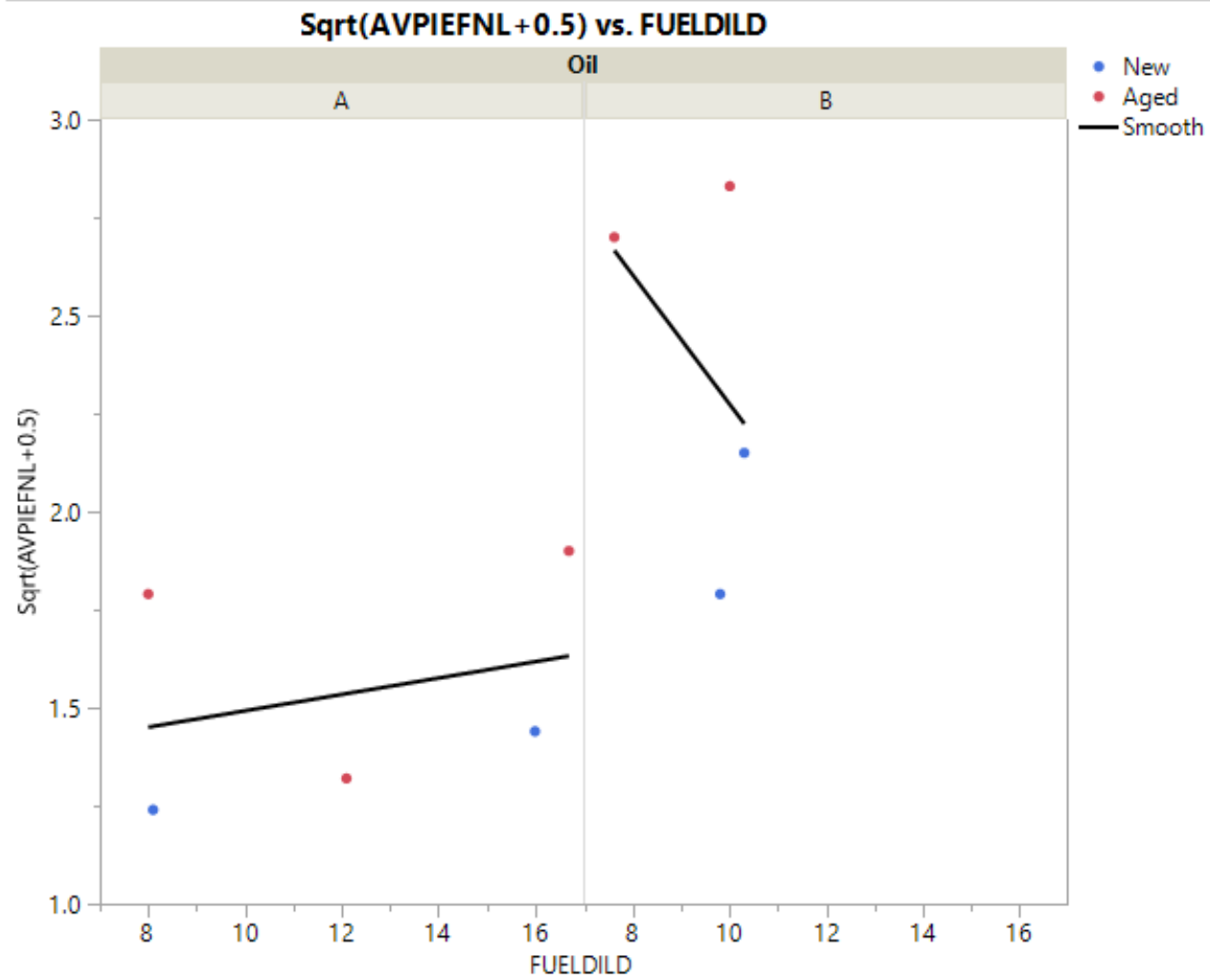
FUEL DILUTION BY GC, ITERATION B

Graph Builder



FUEL DILUTION BY GC, ITERATION C

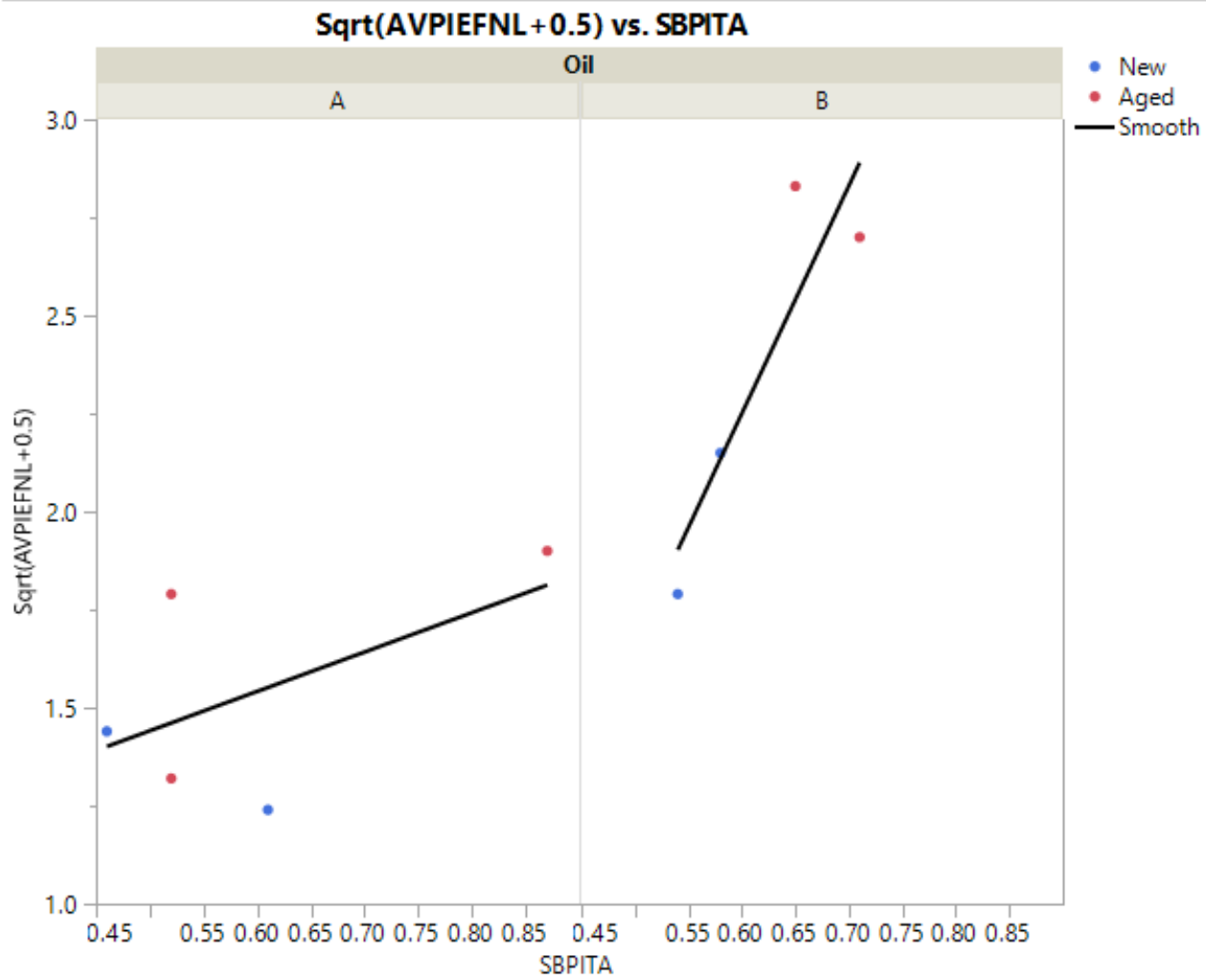
Graph Builder



FUEL DILUTION BY GC, ITERATION D

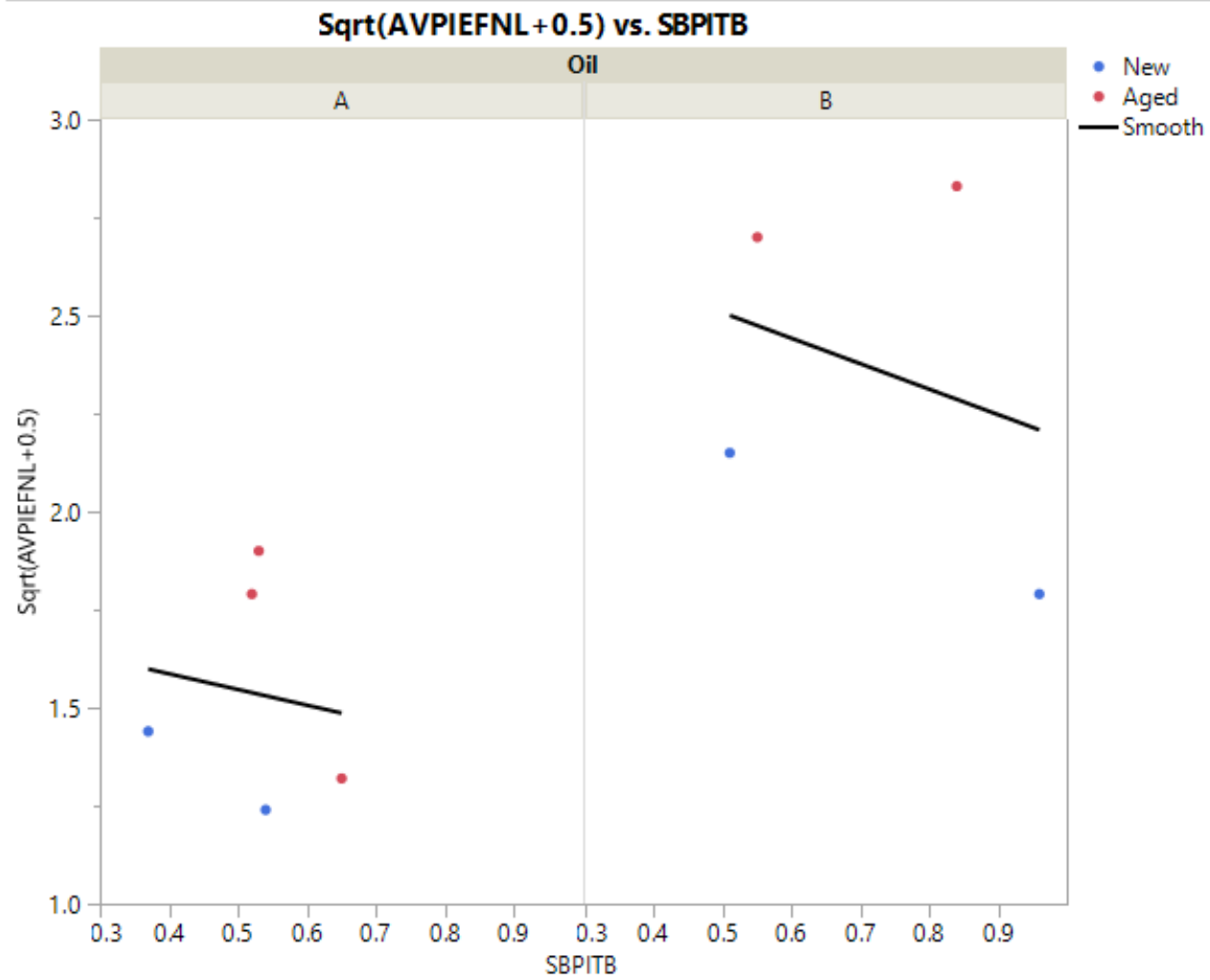


Graph Builder

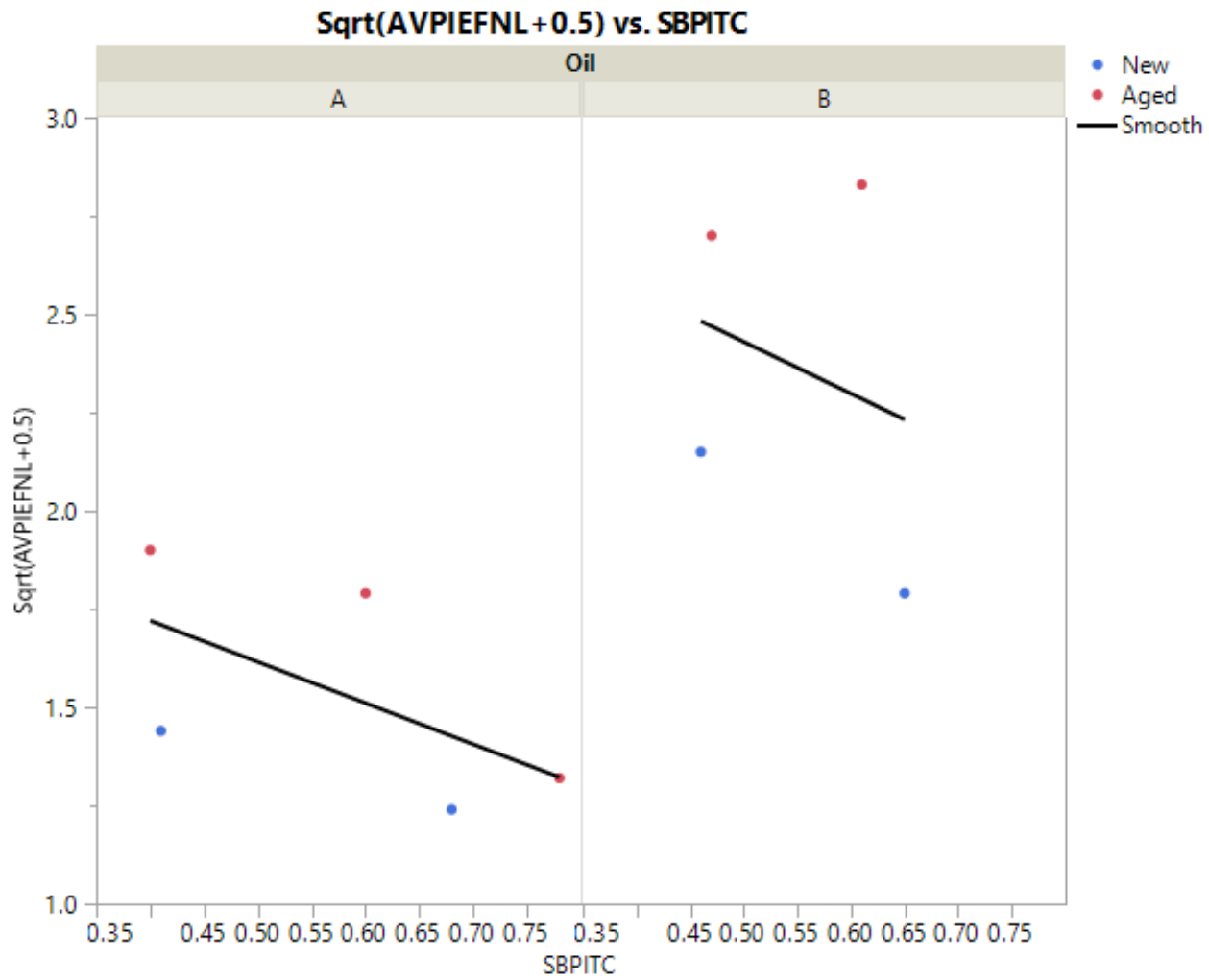


STANDARD DEVIATION BOOST PRESSURE ITERATION A

Graph Builder

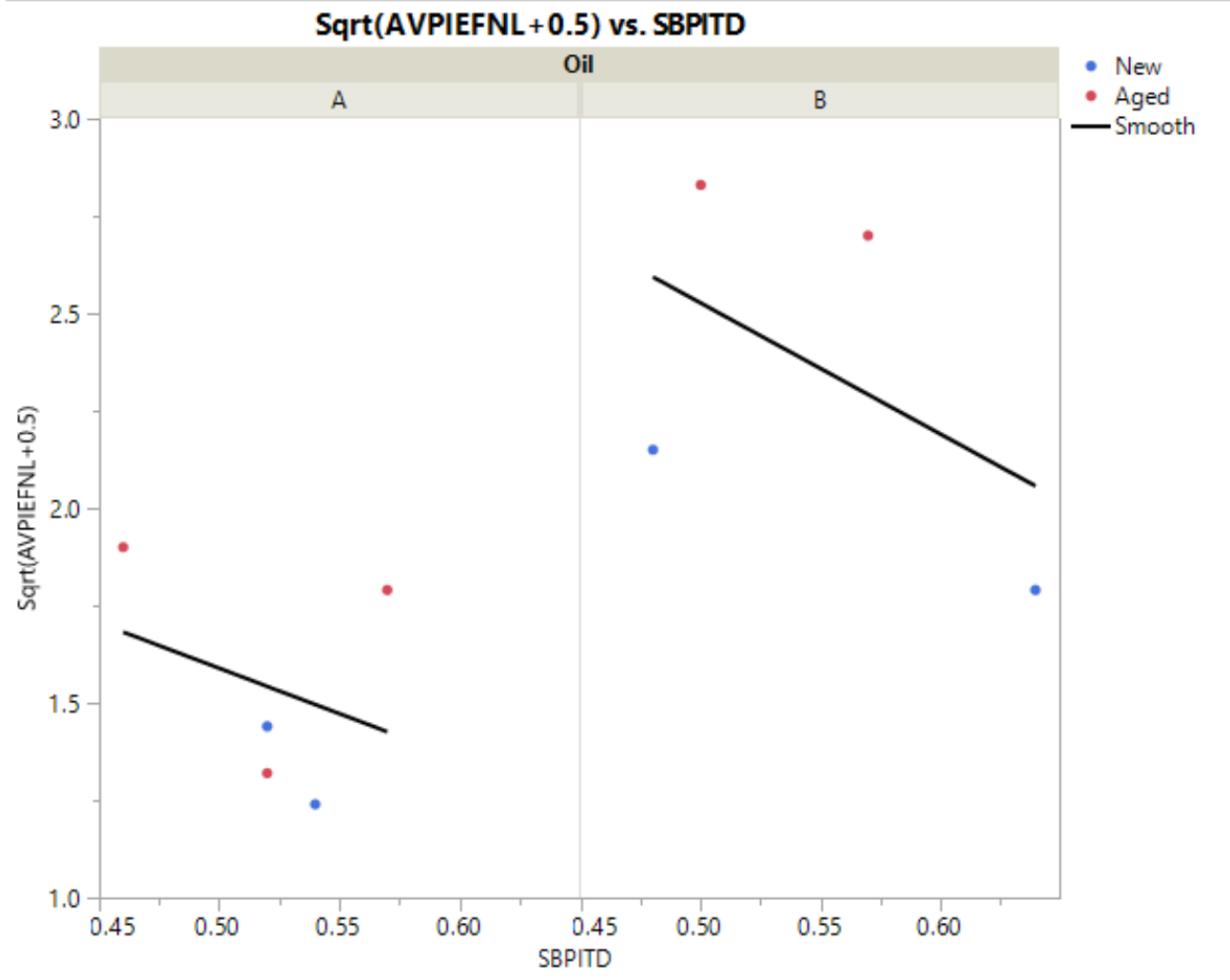


Graph Builder



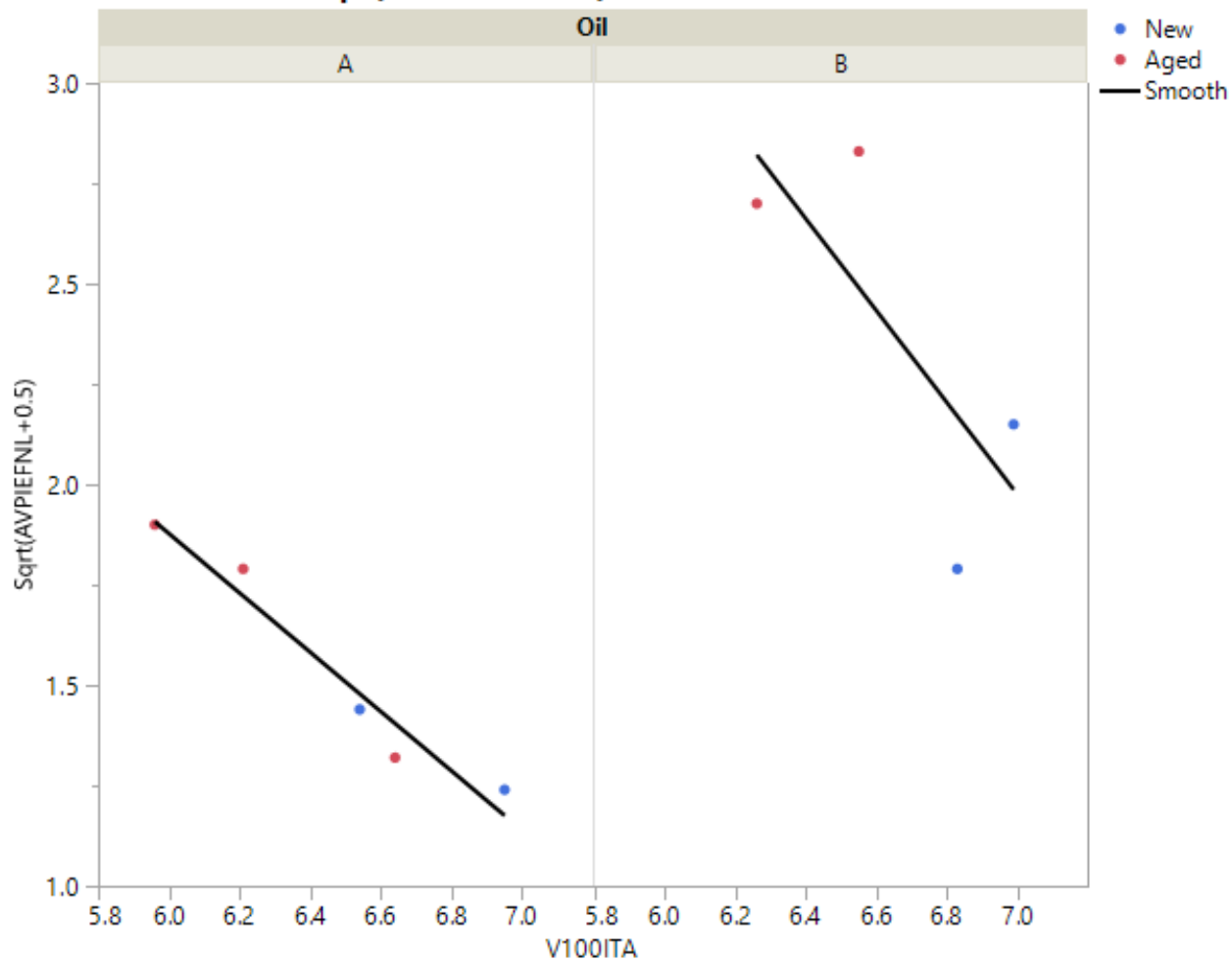
STANDARD DEVIATION BOOST PRESSURE ITERATION C

Graph Builder



Graph Builder

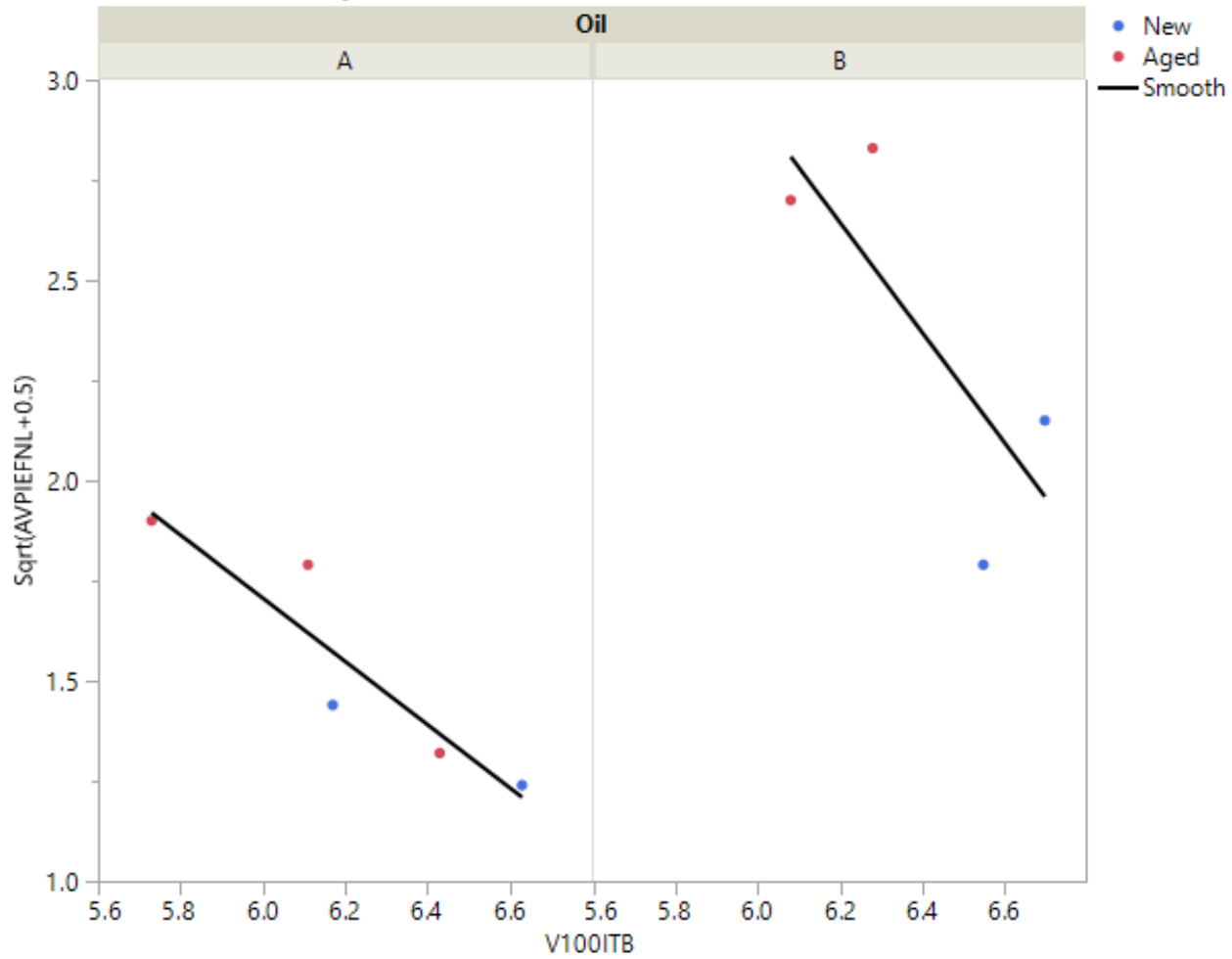
Sqrt(AVPIEFNL+0.5) vs. V100ITA



D445 VISCOSITY @ 100 DEG C END OF ITERATION A

Graph Builder

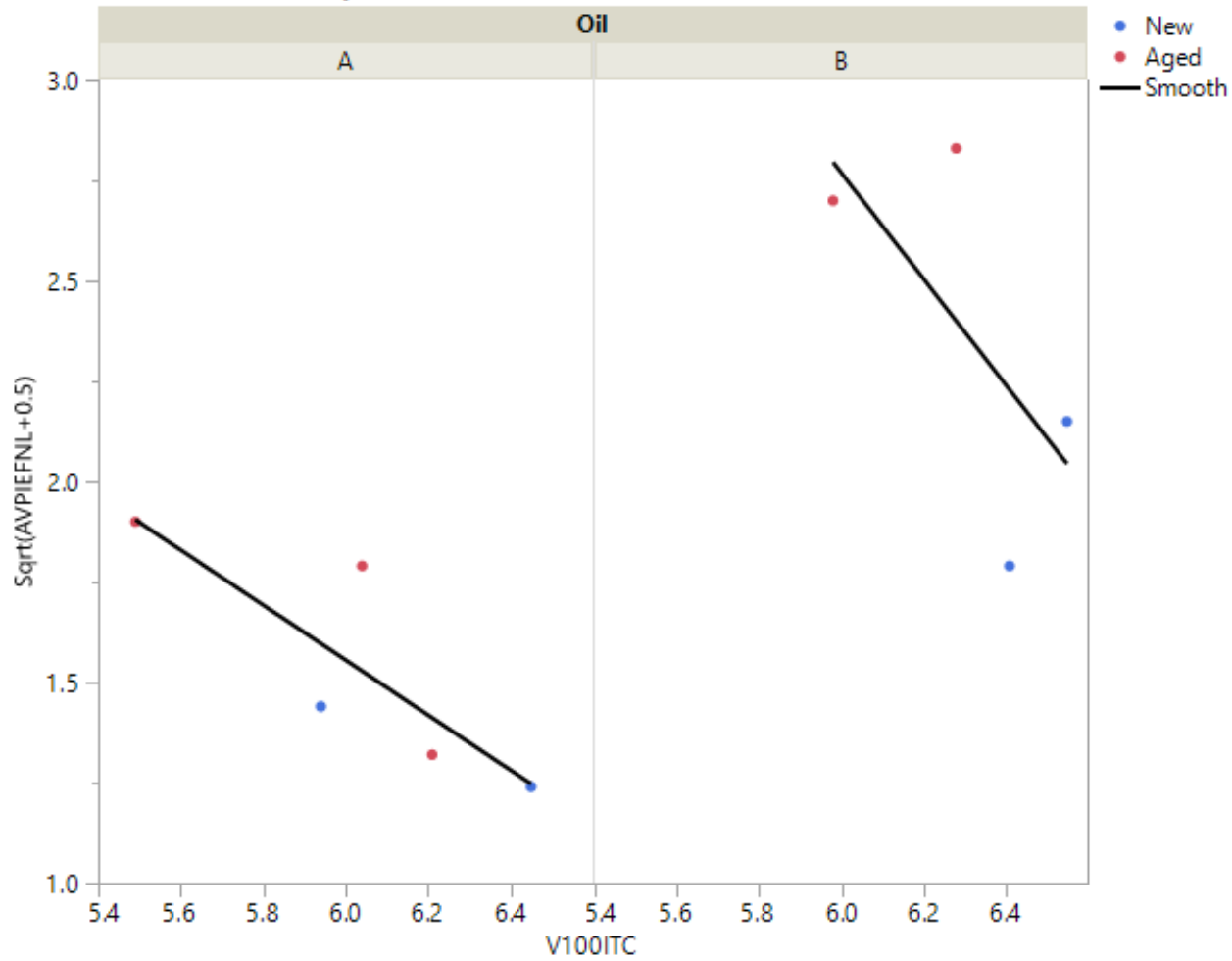
Sqrt(AVPIEFNL + 0.5) vs. V100ITB



D445 VISCOSITY @ 100 DEG C END OF ITERATION B

Graph Builder

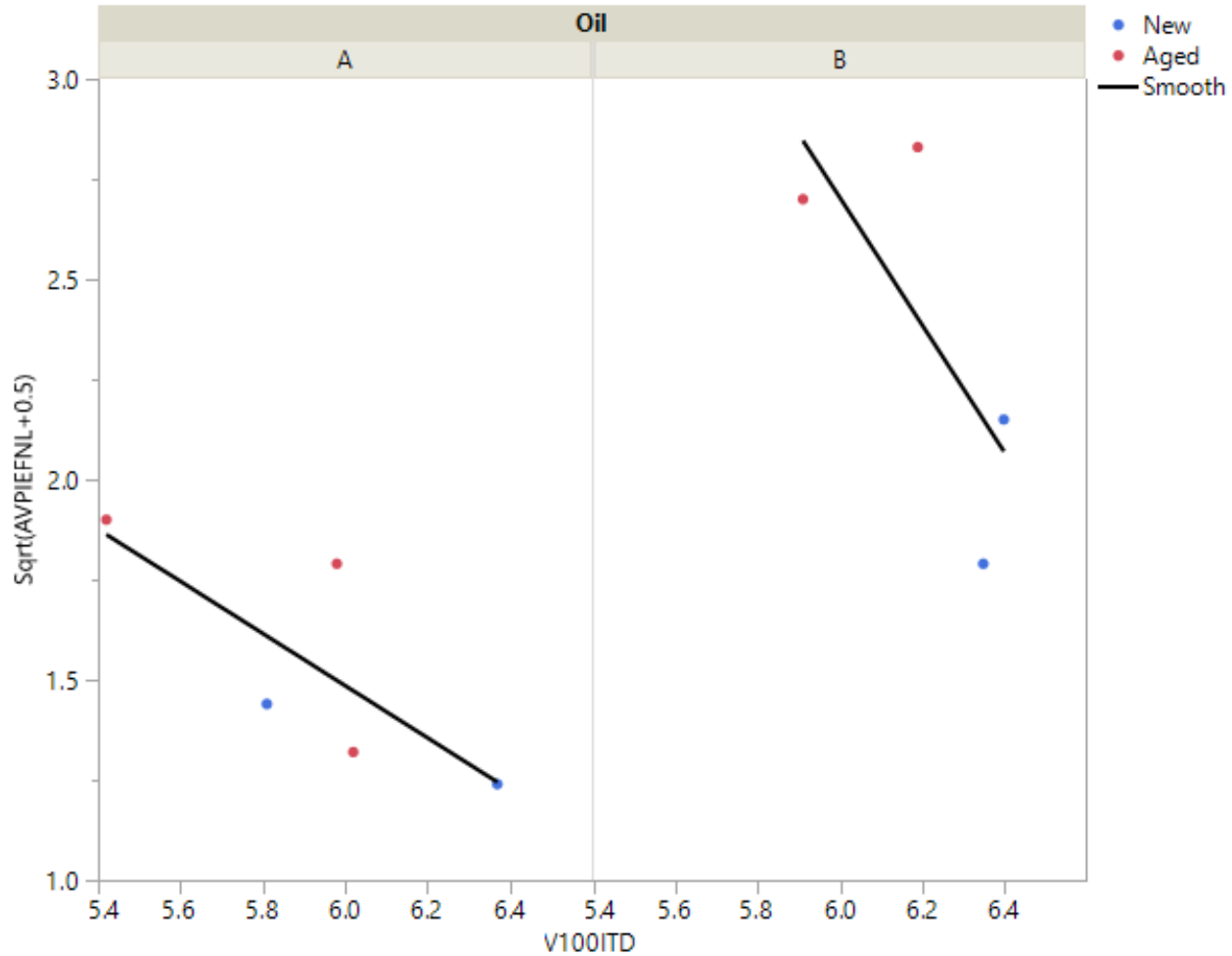
Sqrt(AVPIEFNL + 0.5) vs. V100ITC



D445 VISCOSITY @ 100 DEG C END OF ITERATION C

Graph Builder

Sqrt(AVPIEFNL+0.5) vs. V100ITD



D445 VISCOSITY @ 100 DEG C END OF ITERATION D



Graph Builder

Sqrt(AVPIEFNL + 0.5) vs. V100NEW

