Sequence IX
Oil Aging Data Review

Statistics Group

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Executive Summary

- Significant differences between test Laboratories for KV100 and KV40 parameters
  - KV40, KV100, Oxidation, and Nitration tends to be higher for Lab A as compared to the other 2 labs (B & G).
  - Significant differences could be due to engines as compared to test labs (lab and engine factors are confounded)
- Significant differences in TBN, TGA, Mg, and Ca - for Oils A and B
- With Laboratory and Aged Oil terms in the model, no outliers were identified in the data set

Sequence IX Test Oils – Results from Aging Tests

- All Analytical Measurements were performed at the same test lab
- Total Number of Tests = 6
- Number of Labs = 3
  - A, B, and G
- Number of Aged Oils = 2
  - Oils A and B

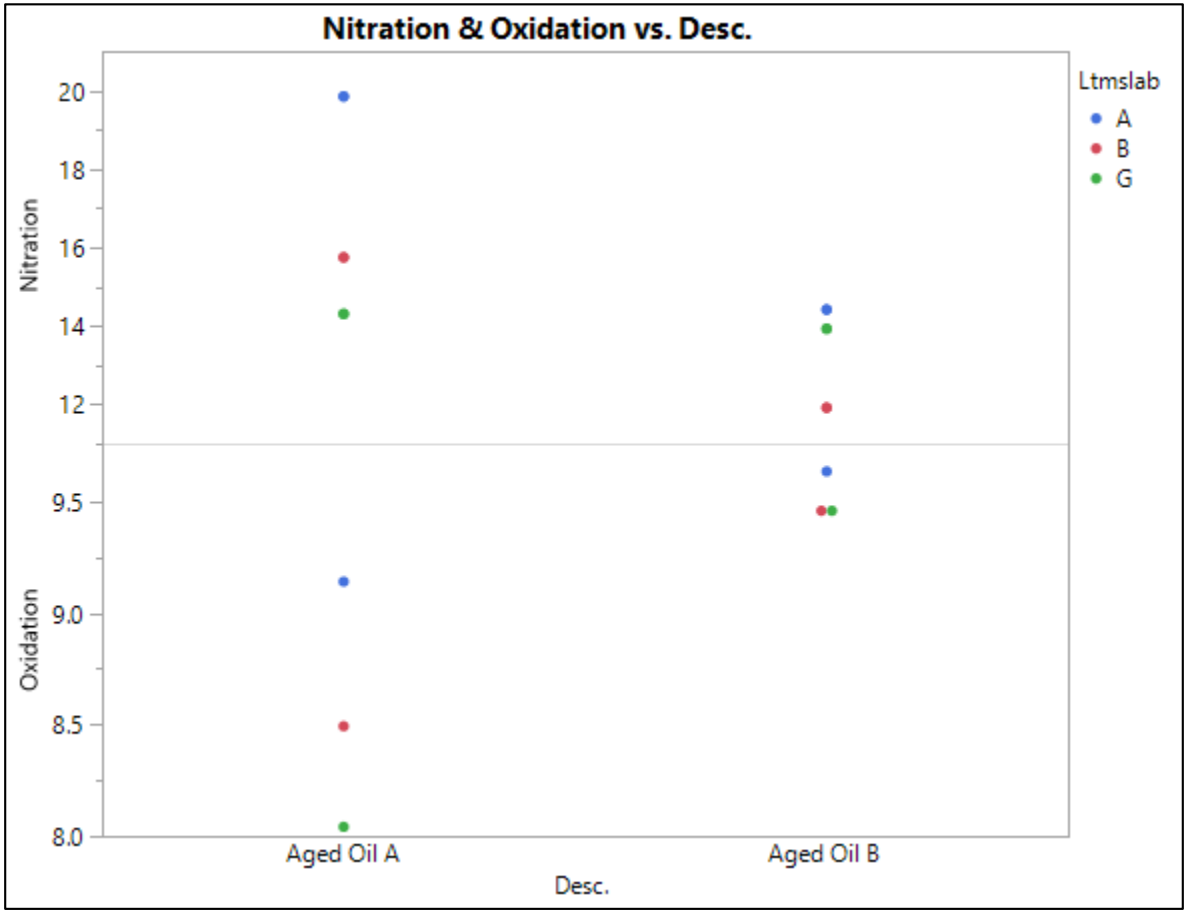
Used Oil Data Summary:

Obs	Oil Code	Lab Code	Ltmslab	Oil	Oil Type	Ag	Al	B	Ba	Ca	Cr	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	Pb	Si	Sn	Ti	V	Zn	Nitration
1	OS366228C		G	A	Aged	0	1	44	1	1431	0	16	7	2	795	1	1	2	0	727	0	78	0	0	0	807	14.31
2	OS366229C		G	B	Aged	0	1	31	0	1993	0	12	8	7	8	0	746	4	0	667	0	152	1	0	0	744	13.93
3	OS366228C	OS612905, 16-09,C,015	B	A	Aged	0	1	50	1	1441	0	11	8	3	779	1	0	0	0	704	0	21	1	0	0	752	15.75
4	OS366229C	OS612997	B	B	Aged	0	1	38	0	1977	0	21	6	2	6	1	748	1	0	675	0	25	1	0	0	750	11.92
5	OS366228C	LO-396288	A	A	Aged	0	1	35	0	1442	0	13	6	2	812	0	1	9	0	729	0	40	0	0	0	816	19.85
6	OS366229C	LO-396289	A	B	Aged	0	1	45	1	2008	0	15	8	1	6	0	749	2	0	718	0	44	1	0	0	800	14.42

Fresh Oil Data Summary:

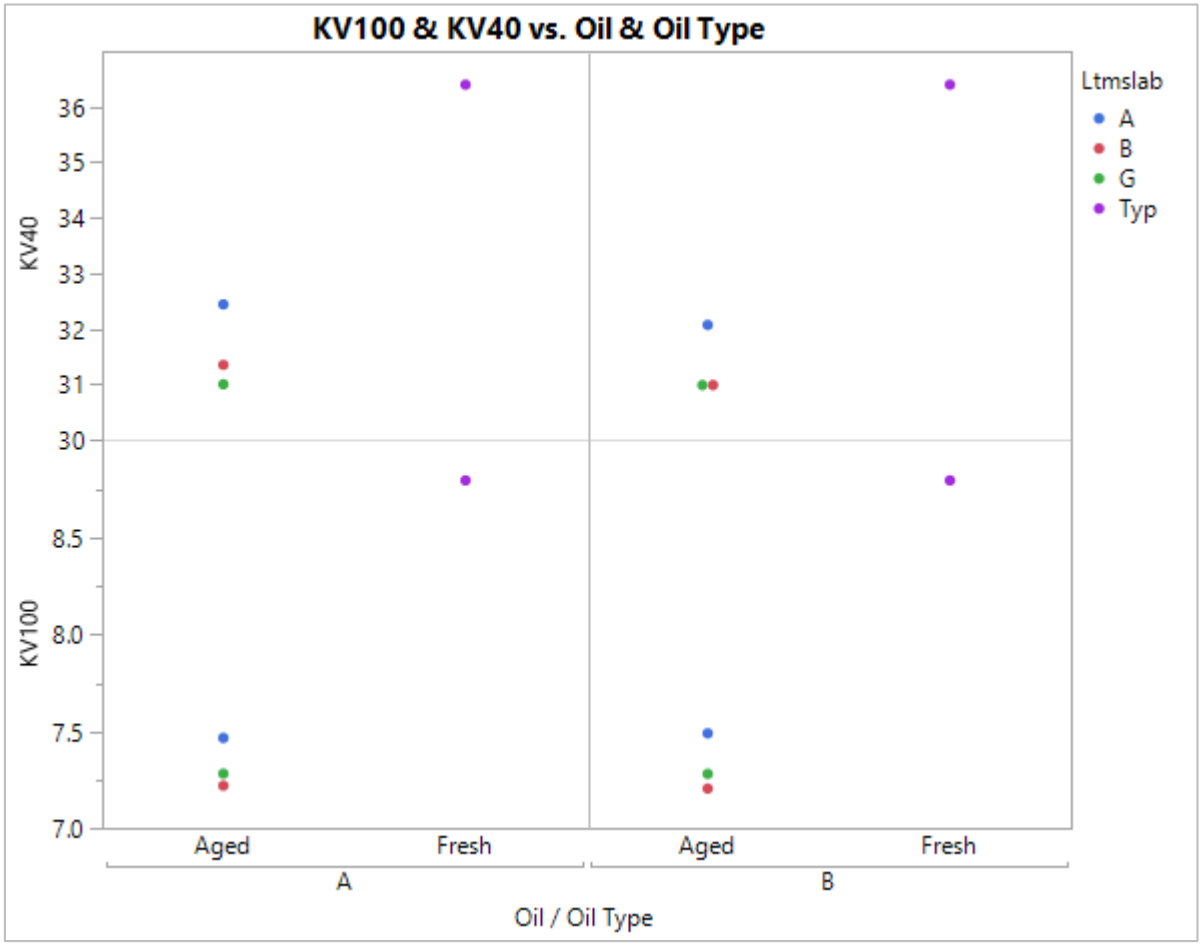
Oil	Oil Code	D2270 KV at 40C (cSt)	KV at 100C (cSt)	D4683 HTHS (cP)	D5293 CCS at -35C (cP)	D2896 TBN (mg KOH/g)	D4739 TBN (Buffer) (mg KOH/g)	TBN (Inflection) (mg KOH/g)	D664 TAN (Buffer) (mg KOH/g)	TAN (Inflection) (mg KOH/g)	Elemental Analysis B (ppm)	Ca (ppm)	Mg (ppm)	Mo (ppm)	Phos (ppm)	Sulfur (ppm)
A	OS366228C	36.4	8.8	2.6	3291	9.4	7.2	7.6	2.74	2.69	216	1304	863	0	756	2796
B	OS366229C	36.4	8.8	2.7	3420	7.3	5.4	5.6	3.97	2.79	236	1948	0	776	766	3661

Nitration & Oxidation



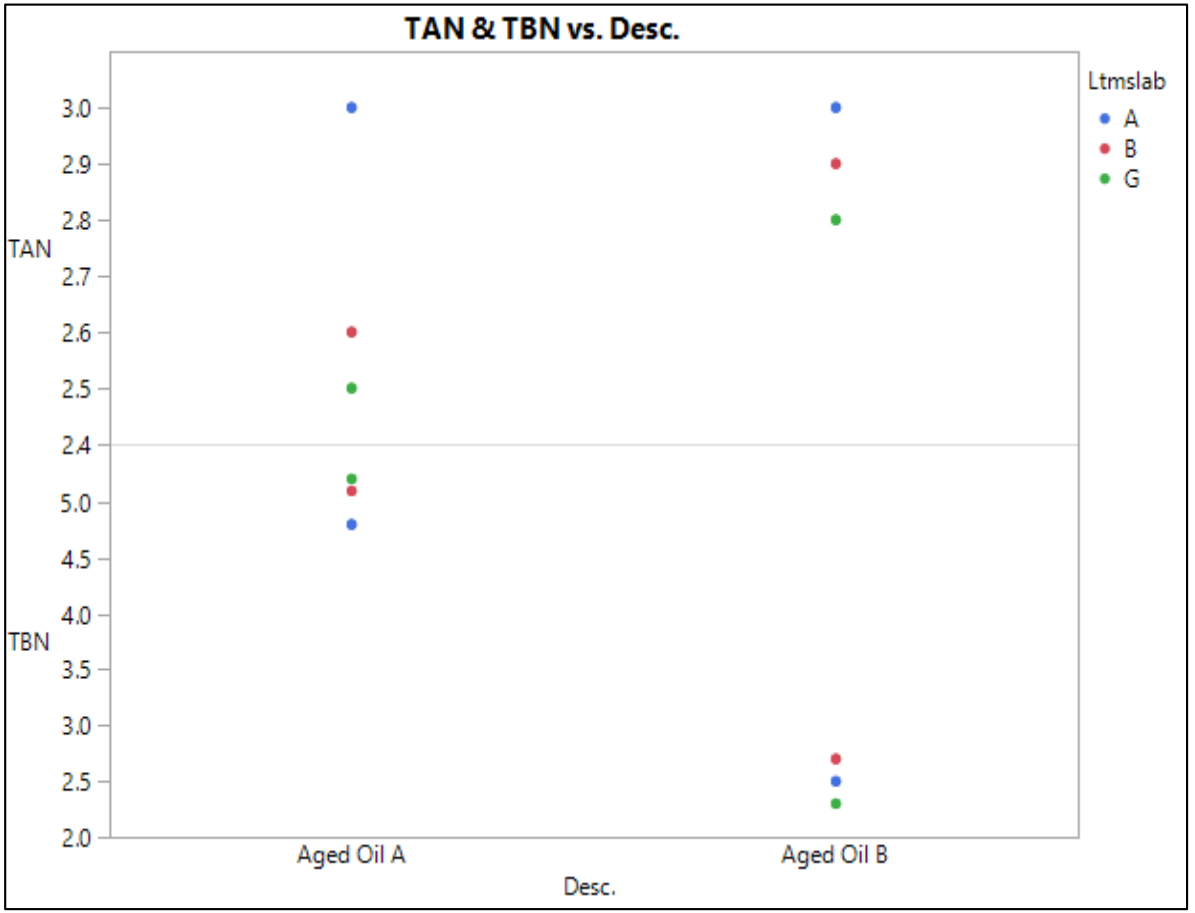
Desc.	Mean(Nitration)	Std Dev(Nitration)	Mean(Oxidation)	Std Dev(Oxidation)
Aged Oil A	16.64	2.87	8.56	0.55
Aged Oil B	13.42	1.32	9.52	0.10

Kinematic Viscosity



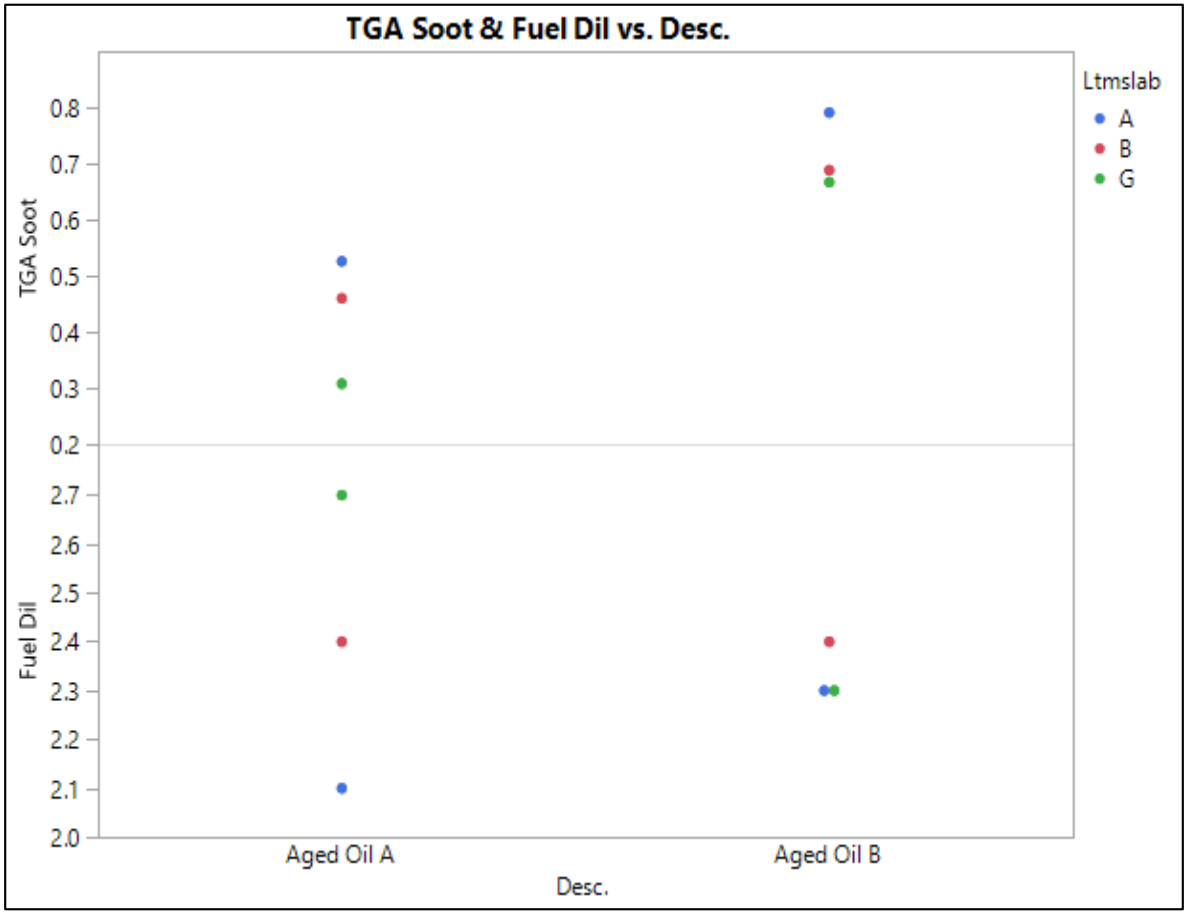
Desc.	Mean(KV100)	Std Dev(KV100)	Mean(KV40)	Std Dev(KV40)
Aged Oil A	7.32	0.13	31.60	0.75
Aged Oil B	7.33	0.15	31.35	0.63

TAN & TBN



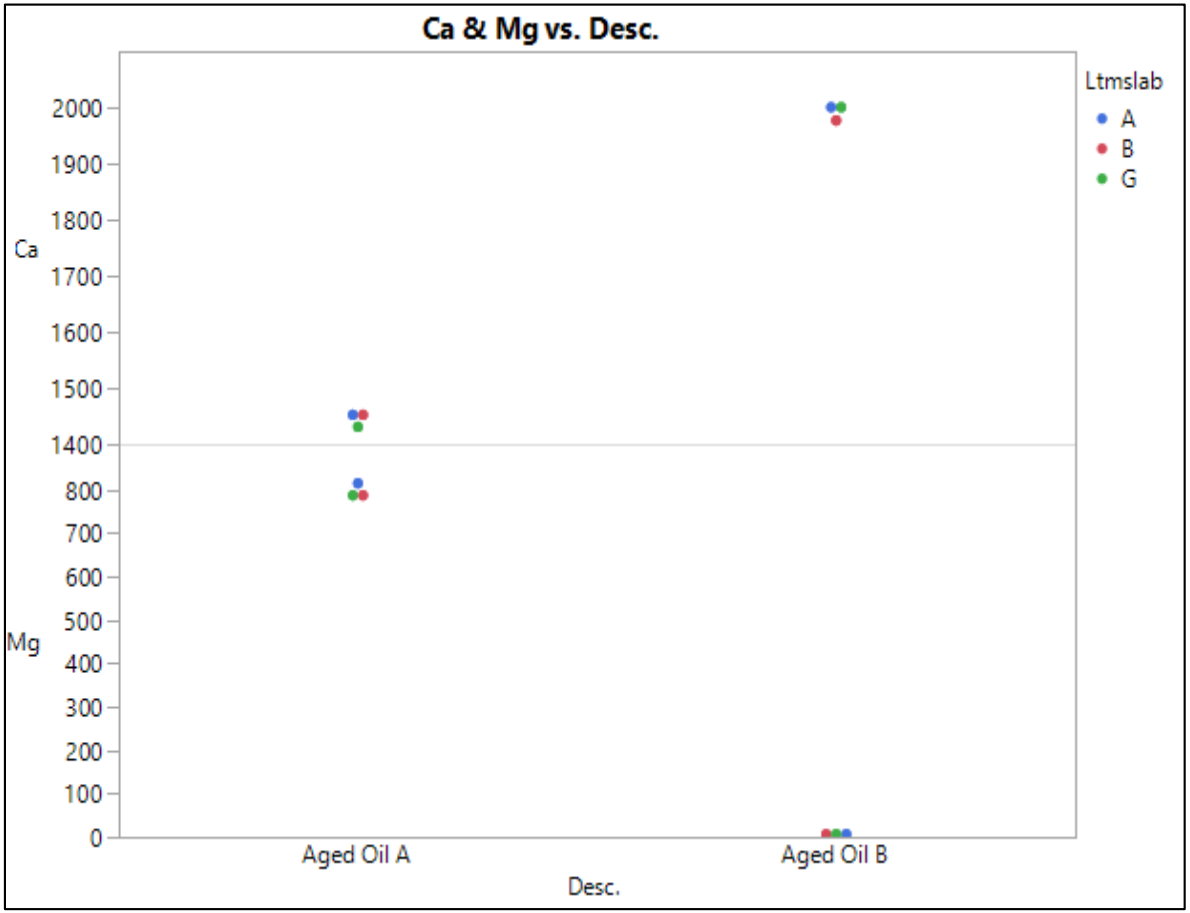
Desc.	Mean(TAN)	Std Dev(TAN)	Mean(TBN)	Std Dev(TBN)
Aged Oil A	2.70	0.26	5.03	0.21
Aged Oil B	2.90	0.10	2.50	0.20

TGA Soot & Fuel Dilution



Desc.	Mean(TGA Soot)	Std Dev(TGA Soot)	Mean(Fuel Dil)	Std Dev(Fuel Dil)
Aged Oil A	0.43	0.11	2.40	0.30
Aged Oil B	0.72	0.07	2.33	0.06

Ca & Mg



Desc.	Mean(Ca)	Std Dev(Ca)	Mean(Mg)	Std Dev(Mg)
Aged Oil A	1438.00	6.08	795.33	16.50
Aged Oil B	1992.67	15.50	6.67	1.15

Model Regression Summary

	P-values									
Model Term	TAN	TBN	Nitration	Oxidation	KV100	KV40	TGA	Fuel Dil	Mg	Ca
Laboratory {A, B, G}	0.1875	0.62	0.3325	0.3425	0.0049	0.0309	0.1364	0.5	0.5012	0.4784
Aged Oil {A, B}	0.1835	0.0053	0.1638	0.0703	0.7007	0.2171	0.0186	0.7418	0.0001	0.0003

Statistically Significant (p-values $\leq$ 0.05)

- Significant differences between test Laboratories for KV100 and KV40 parameters
- Significant differences in TBN, TGA, Mg, and Ca - for Oils A and B
- With Laboratory and Aged Oil terms in the model, no outliers were identified in the data set