

EOEC BASELINE ANALYSIS

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Performance you can rely on.



Summary



- Only statistical significance is considered in this document, no consideration of practical significance of lab differences is made.
- For all parameters (Hardness, Tensile Strength and Elongation), there are labs whose result means are statistically significantly different.
- The elastomer ranking of the mean Hardness and Tensile Strength for one lab differed relative to that of the other four labs.



Data and Analysis

- The purpose of this study is to determine if Instron measurements differ by lab without the confounding effect of differing bath designs.
- Experiment design
 - Developed and facilitated by Mike Birke.
 - Samples of two elastomers were supplied to and tested by five different labs (IAR, ISP, Lubrizol, SwRI and Valvoline).
 - Hardness, Tensile Strength and Elongation were measured for each elastomer sample (fresh – not processed in water bath) at each lab.
- For this document, the labs are identified by a randomly assigned code of K through O. If desired, each lab can request their lab code.
- Analyses for each parameter or measurement type include the follow components:
 - A plot by Lab and Elastomer for visual comparison
 - A table including the means and standard deviations for each lab
 - Regression analysis:
 - Combining the results of both elastomers with factors of Lab, Elastomer and Lab x Elastomer.
 - Separate analysis for each elastomer utilizing Tukey HSD procedure for determining which labs have means which differ from each other.
- **Analyses are only concerned with statistical significance. No discussion of practical significance of differences among labs is made.**



HARDNESS

TENSILE STRENGTH

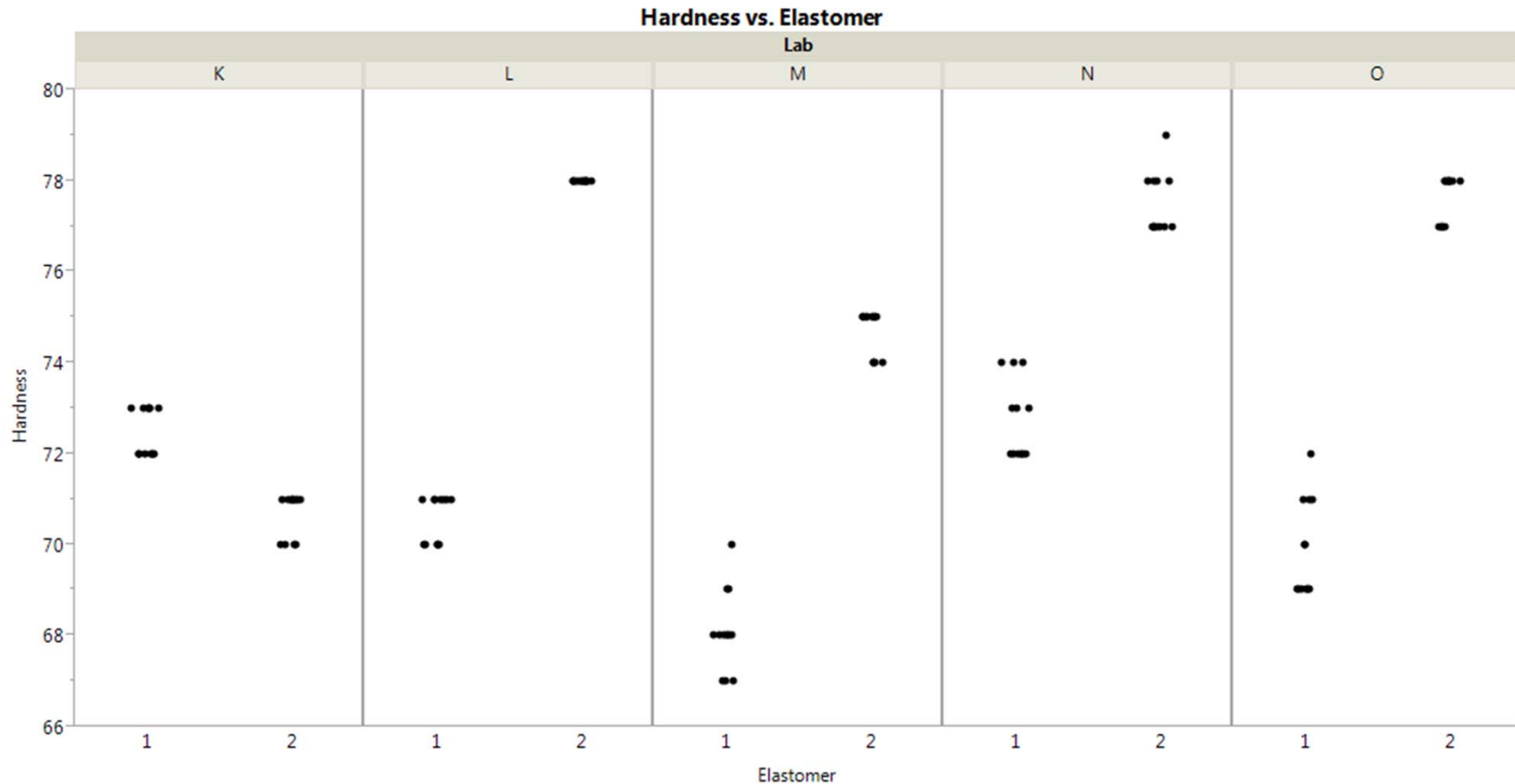
ELONGATION



HARDNESS



Hardness Plot



- All labs, except Lab K, show a similar difference in Hardness for Elastomers 1 and 2.
- For each elastomer, there is obvious lack of overlap among the labs.



Hardness Summary Statistics

Hardness Summary Table

Lab	Sample Size		Mean			Pooled Std. Dev.
	Elastomer 1	Elastomer 2	Elastomer 1	Elastomer 2	Difference	
K	12	12	73	71	-2	0.51
L	12	12	71	78	7	0.36
M	12	12	68	75	7	0.73
N	12	12	73	78	5	0.78
O	12	12	70	78	8	0.84

- The range of Hardness means for Elastomers 1 and 2 are 5 and 7, respectively.
- Again, Lab K's difference between the mean Hardness of the two elastomers stands out relative to that of the others.



Hardness Regression Analysis

- Combining the results from both elastomers:
 - The Lab effect is strongly statistically significant.
 - The Elastomer × Lab effect is also strongly statistically significant, largely due to the reversal of lab K means for the two elastomers.
- Analyzing the results from each elastomer separately:
 - Labs are statistically significantly different.
 - For both elastomers, Lab N is in Level Code group 1.
 - Lab K has Level Code 1 for Elastomer 1 and Level Code 2 for Elastomer 3.

Hardness Effect Test

Factor	DF	p-Value
Elastomer	1	<.0001
Lab	4	<.0001
Elastomer*Lab	4	<.0001

Hardness Least Square Means

Elastomer	Lab	Level Code	LS Mean
1	N	1	73
	K	1	73
	L	2	71
	O	2	70
	M	3	68
2	L	1	78
	O	1	78
	N	1	78
	M	2	75
	K	3	71

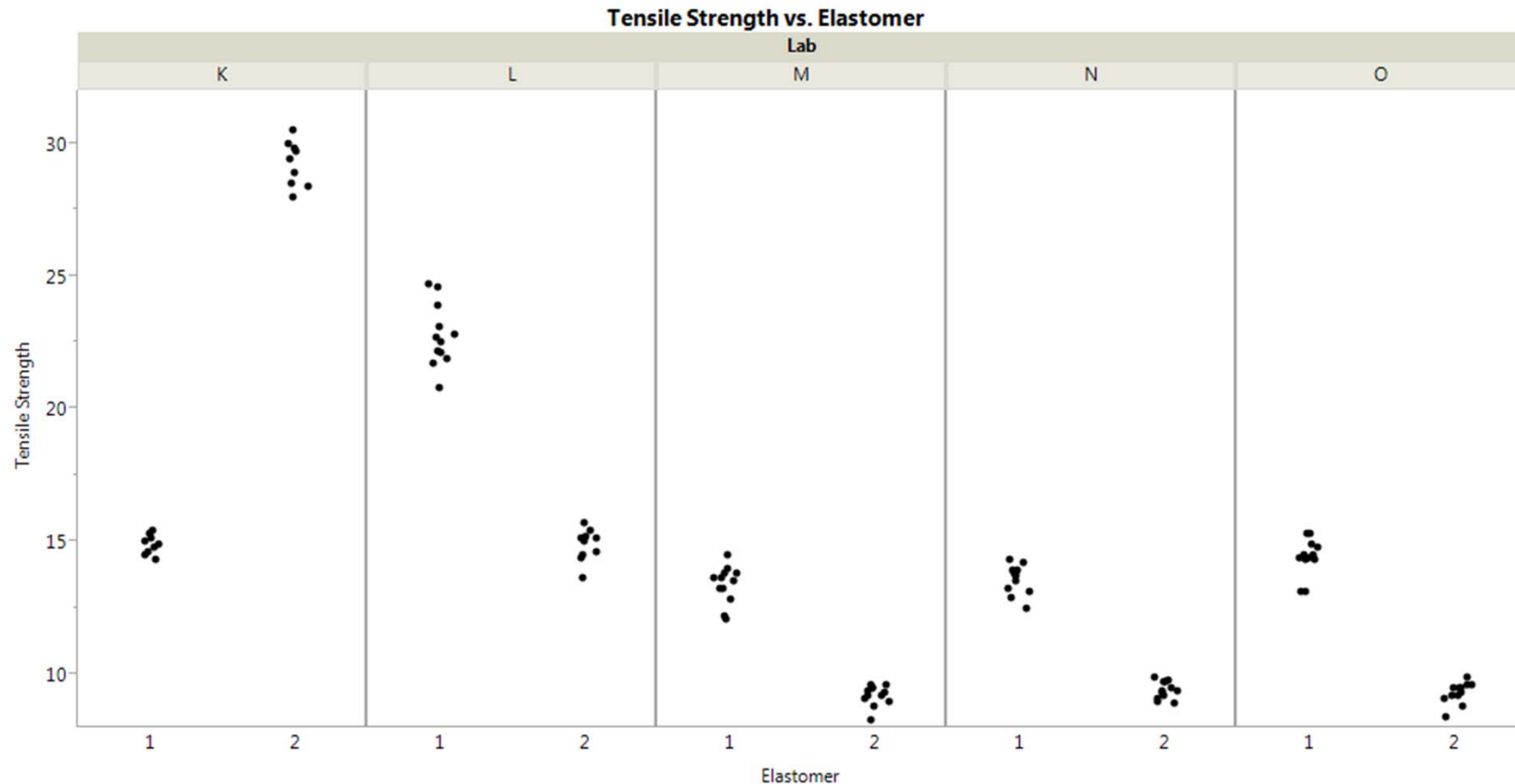
Labs not connected by the same Level Code are statistically significantly different.



TENSILE STRENGTH



Tensile Strength Plot



- Relative to the other labs, there is a lack of overlap of the Lab L results for both elastomers and likewise with Elastomer 2 for Lab K.
- For each lab, other than Lab K, Elastomer 1 has the higher mean Tensile Strength.



Tensile Strength Summary Statistics

Tensile Strength Summary Table

Lab	Sample Size		Mean				Pooled Std. Dev.
	Elastomer 1	Elastomer 2	Elastomer 1	Elastomer 2	Difference	% Change	
K	9	9	14.9	29.2	-14.4	-97	0.65
L	12	10	22.8	14.9	7.9	35	0.96
M	12	12	13.4	9.2	4.1	31	0.57
N	12	12	13.6	9.4	4.2	31	0.45
O	12	12	14.4	9.3	5.1	35	0.57

- For each lab except K, % Change is similar though the Lab L elastomer means are quite different from the other labs.



Tensile Strength Regression Analysis

- Combining the results from both elastomers:
 - The Lab effect is strongly statistically significant.
 - The Elastomer \times Lab effect is also strongly statistically significant, largely due to the reversal of Lab K means for the two elastomers.
- Analyzing the results from each elastomer separately:
 - Labs are statistically significantly different.
 - For both elastomers, Labs M and N are in Level Code group 3.
 - For both elastomers, Labs K and L are in Level Code groups 1 and 2.

Tensile Strength Effect Test

Factor	DF	p-Value
Elastomer	1	<.0001
Lab	4	<.0001
Elastomer*Lab	4	<.0001

Tensile Strength Least Square Means

Elastomer	Lab	Level Code	LS Mean
1	L	1	22.7
	K	2	14.9
	O	2	14.4
	N	3	13.6
	M	3	13.3
2	K	1	29.2
	L	2	14.8
	N	3	9.4
	O	3	9.3
	M	3	9.2

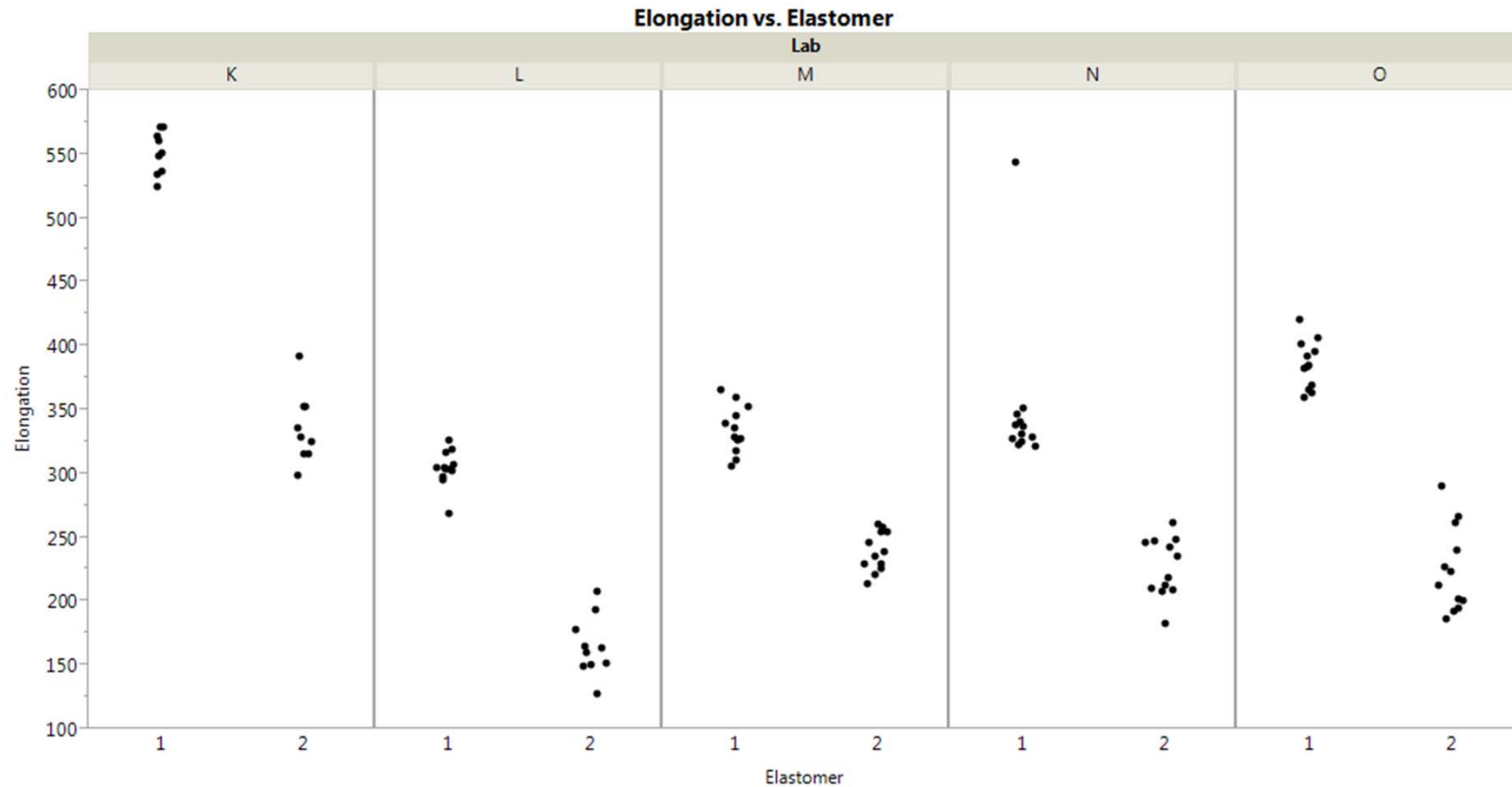
Labs not connected by the same Level Code are statistically significantly different.



ELONGATION



Elongation Plot



- One of the Lab N Elongation results is an outlier for Elastomer 1.
- For all labs, the mean Elongation for Elastomer 1 is greater than that for Elastomer 2.
- For each elastomer, there is a lack of overlap for the labs.

Elongation Summary Statistics



Elongation Summary Table

Lab	Sample Size		Mean				Pooled Std. Dev.
	Elastomer 1	Elastomer 2	Elastomer 1	Elastomer 2	Difference	% Change	
K	9	9	551	335	217	39.3	22.9
L	12	10	304	165	139	45.9	18.9
M	12	12	334	239	96	28.6	17.2
N	12	12	351	227	124	35.4	46.5
O	12	12	385	225	161	41.7	27.2

- The difference in means for the Elongation of Elastomer 1 and 2 for the labs ranges from 96 to 217 but the range of % Change is 28.6 to 45.9%.



Elongation Regression Analysis

- Combining the data for both elastomers, the Elastomer, Lab and their interaction effects are statistically significant.
- Analyzing the results from each elastomer separately:
 - Labs are statistically significantly different.
 - For both elastomers, Lab K has the highest elongation and Lab L the lowest.

Elongation Effect Test

Factor	DF	p-Value
Elastomer	1	<.0001
Lab	4	<.0001
Elastomer*Lab	4	<.0001

Elongation Least Square Means

Elastomer	Lab	Level Code	LS Mean
1	K	1	551
	O	2	385
	N	3	347
	M	3	334
	L	4	304
2	K	1	334
	M	2	238
	N	2	225
	O	2	222
	L	3	163

Labs not connected by the same Level Code are statistically significantly different.



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