



Interaction of Abrasion and Oil Resistance of Sealant Materials

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FlexPackCon® 2017



Background

- Packages for holding abrasive and oily food products often require a combination of abrasion and oil resistance.



- Current laboratory abrasion test methods ^[2]:
 - ISO 1518, Ford BN 108-13, ASTM 7027 ^[3,4], Taber linear abrasion test^[5], etc.
 - Use standard lab environment
 - Do not correlate with commercial experience.
- Need better understanding of the interactions of abrasion and oil resistance of sealant materials for optimal package design.

Objectives

1. Develop a laboratory abrasion test method

- better mimic oily and abrasive environments
- provide quantitative comparisons of sealants

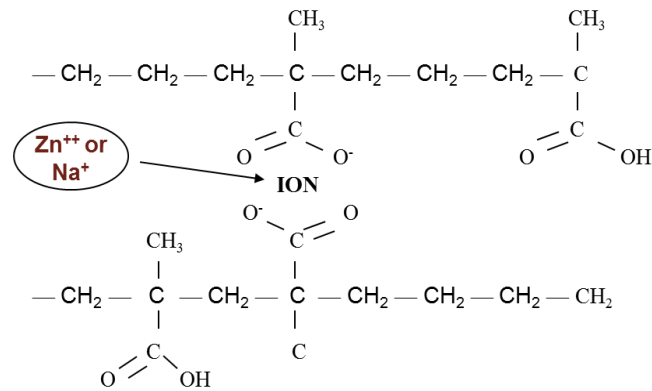
2. Investigate the interaction of abrasion resistance and oil resistance of sealant materials.

Sealant Materials

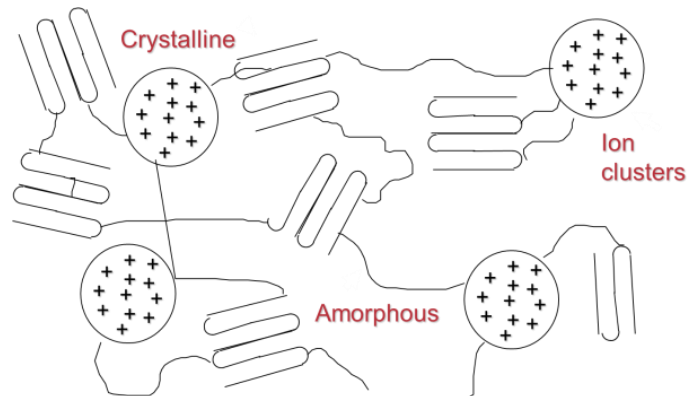
- Polyolefin sealants swell in presence of oil
- Low density (crystallinity) versions of PE usually have poor oil resistance - not well suited as sealants where oil and abrasion are present.
- Ionomer Sealants have both low seal initiation temperature and outstanding oil resistance.

Ionomer Sealants

Ionomers are ethylene-acid copolymers partially neutralized with metal salts.



The ionic associations form melt-reversible crosslinks and organize into clusters.



Unique balance of properties:

- Abrasion and scratch resistance
- Oil and grease resistance
- Chemical resistance
- High gloss and transparency
- Toughness and impact resistance
- Melt strength for ease of processing

Typical uses:

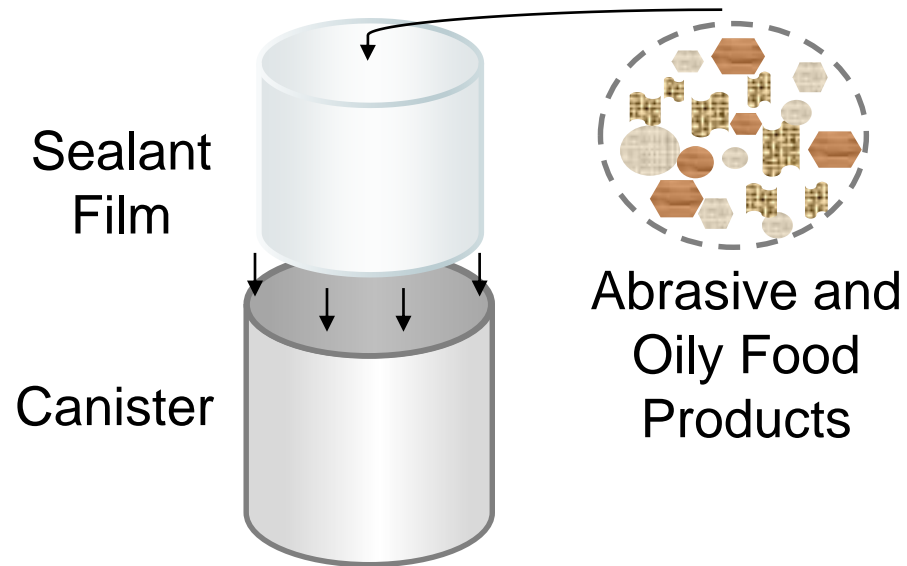
- Flexible packaging sealant
- Golf ball covers and mantles
- Perfume caps with glass-like clarity
- Flooring
- Protective layers for composites

Objective 1:

Develop a laboratory abrasion test method that can:

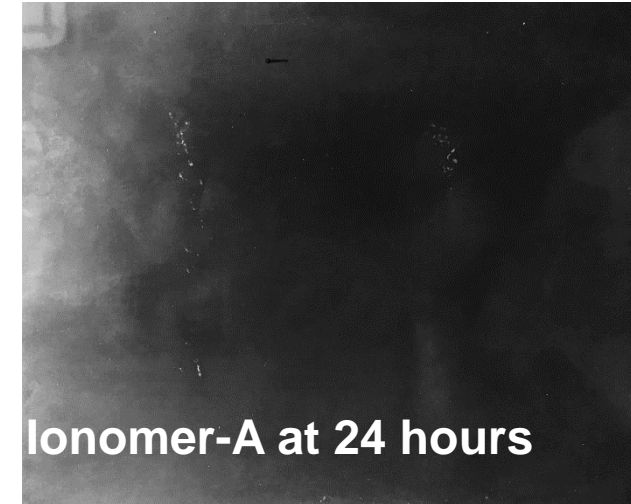
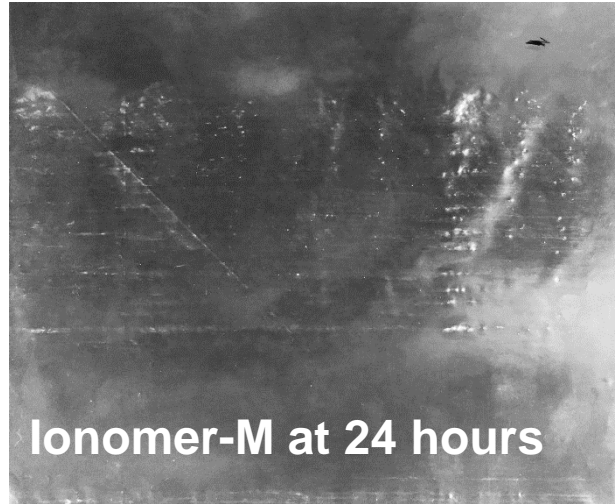
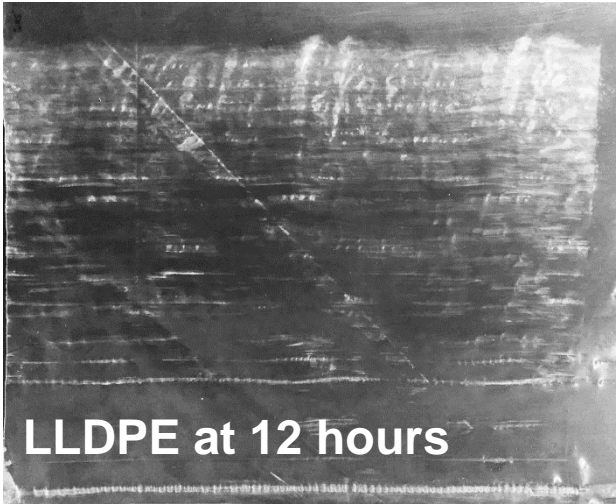
- better mimic the oily and abrasive environments found in many snack food packages.
- provide quantitative comparisons of different sealant resins for optimizing package design.

Shaker Table Abrasion Test

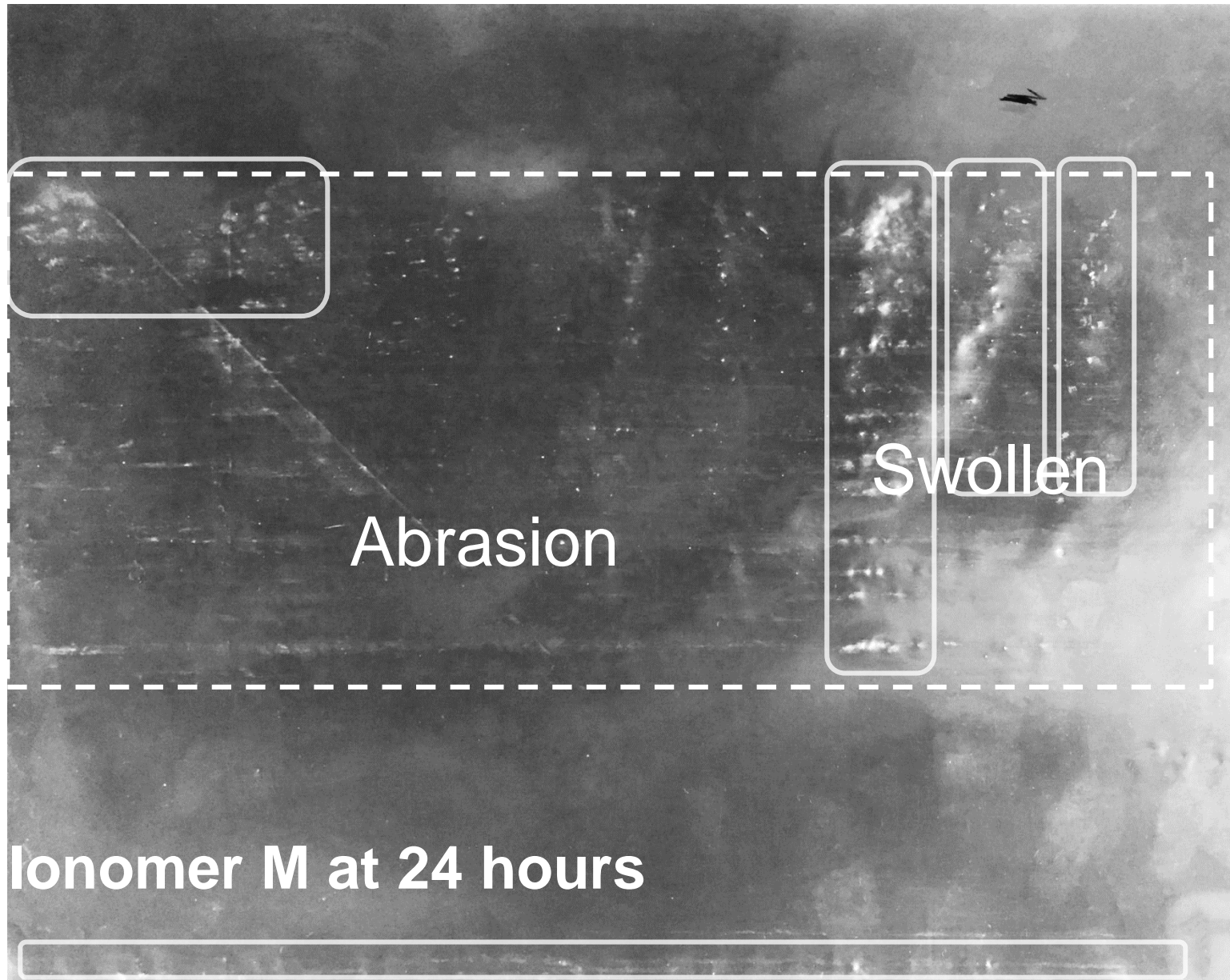


- 50- μm monolayer film samples.
- There were five specimens for each material.
- Tested in the shaker at 27°C and 150 RPM for 24 hours.

Test Validation



- Ionomer-M is an ionomer grade with good abrasion and oil resistance
- Ionomer-A is an ionomer grade with excellent performance in abrasion and oil resistance.
- Shaking time was increased from 12hrs to 24hrs to see more swelling due to oil absorption.



Example of abraded areas and swollen areas on a film after the Shaker Table Abrasion Test.

Rating Systems

Abrasion & Scratch Resistance Rating

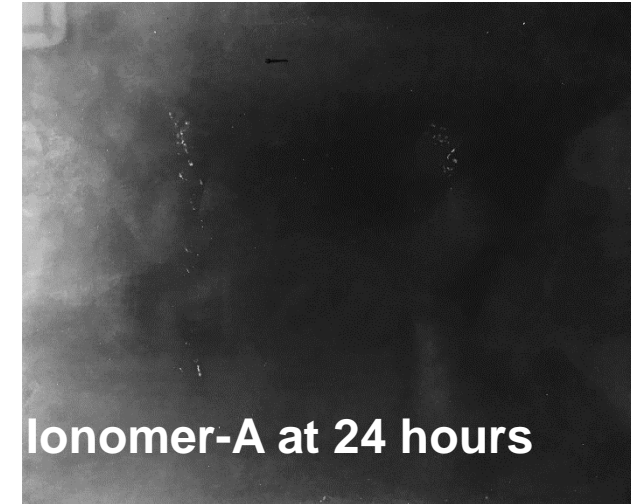
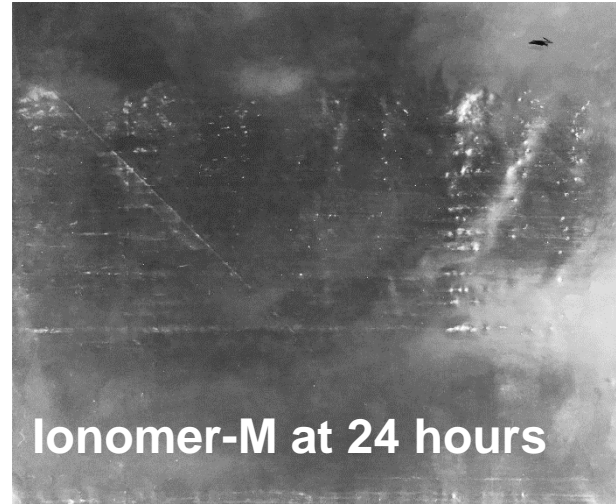
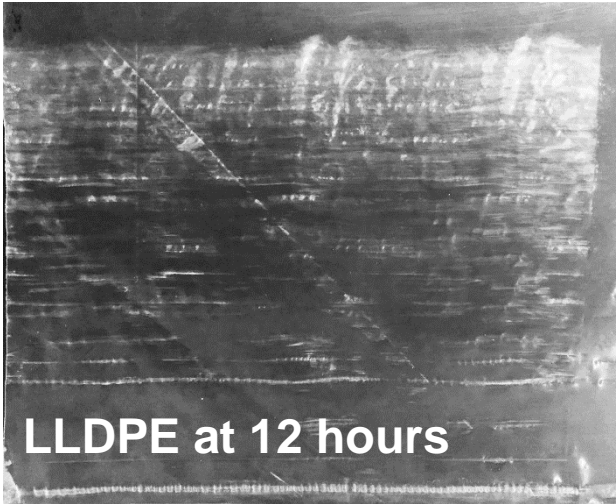
	%Area Affected							
Abrasion + Scratch	>80%	80%-50%	50-35%	35-25%	25-15%	15-5%	<5%	<1%
Rating A	1	3	5	6	7	8	9	10
Final Rating	mA							

Severity of Abrasion + Scratch	Very Low	Low	Medium	High	Very High
Multiplier, m	0.95	0.75	0.55	0.35	0.15

Grease Resistance Rating

	Area Affected								
Swollen + Deep Cut	$\geq 50\%$	50%-35%	35-25%	25-10%	10-5%	5-2%	2%-1%	1-0.3%	<0.3%
Rating B	0	1	3	5	6	7	8	9	10

Example Results



Abrasion & Scratch Resistance Rating:

$$m = 30\% VH + 40\% H + 30\% M = 0.35$$

$$A = 1 (> 80\%),$$

$$mA = 0.35$$

$$m = 40\% L + 60\% M = 0.63$$

$$A = 3 (80 - 50\%),$$

$$mA = 1.89$$

$$m = 0.75 (L),$$

$$A = 9 (5 - 1\%),$$

$$mA = 6.75$$

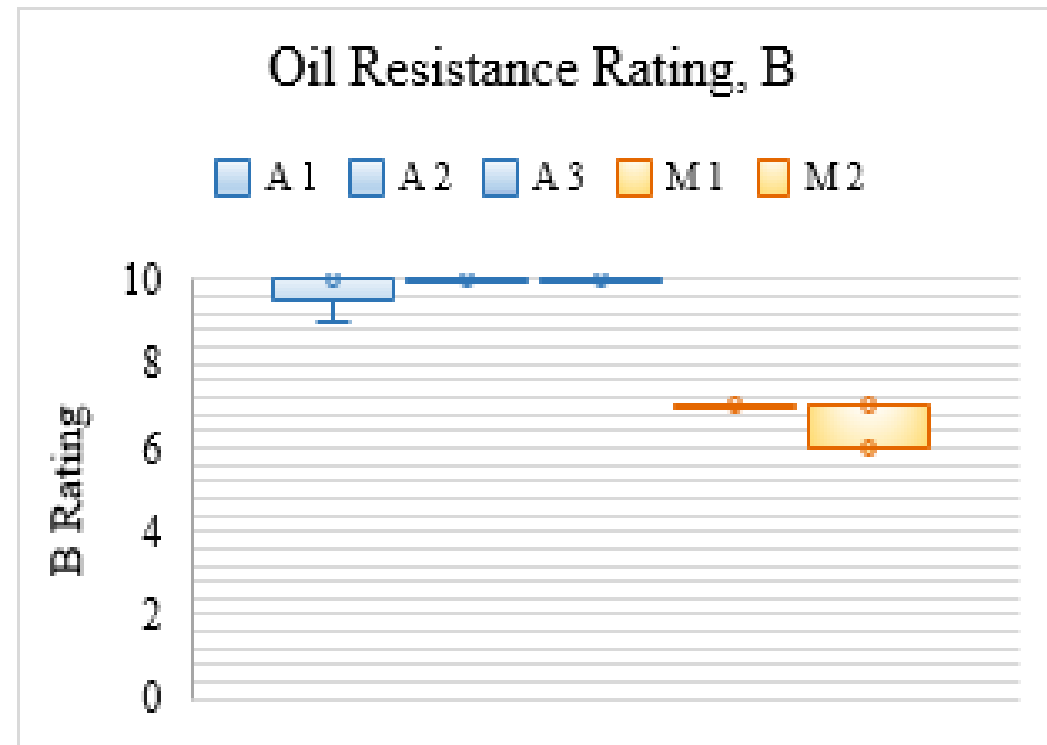
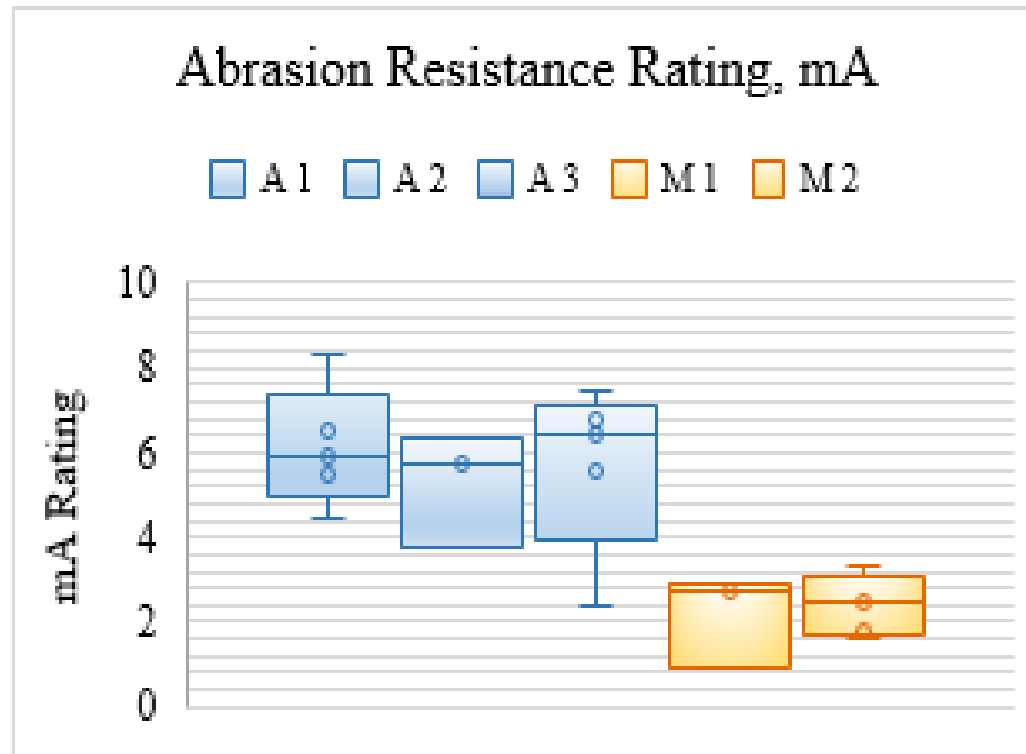
Grease Resistance Rating:

$$B = 0 (> 50\%)$$

$$B = 5 (25 - 10\%)$$

$$B = 10 (< 0.3\%)$$

Reproducibility



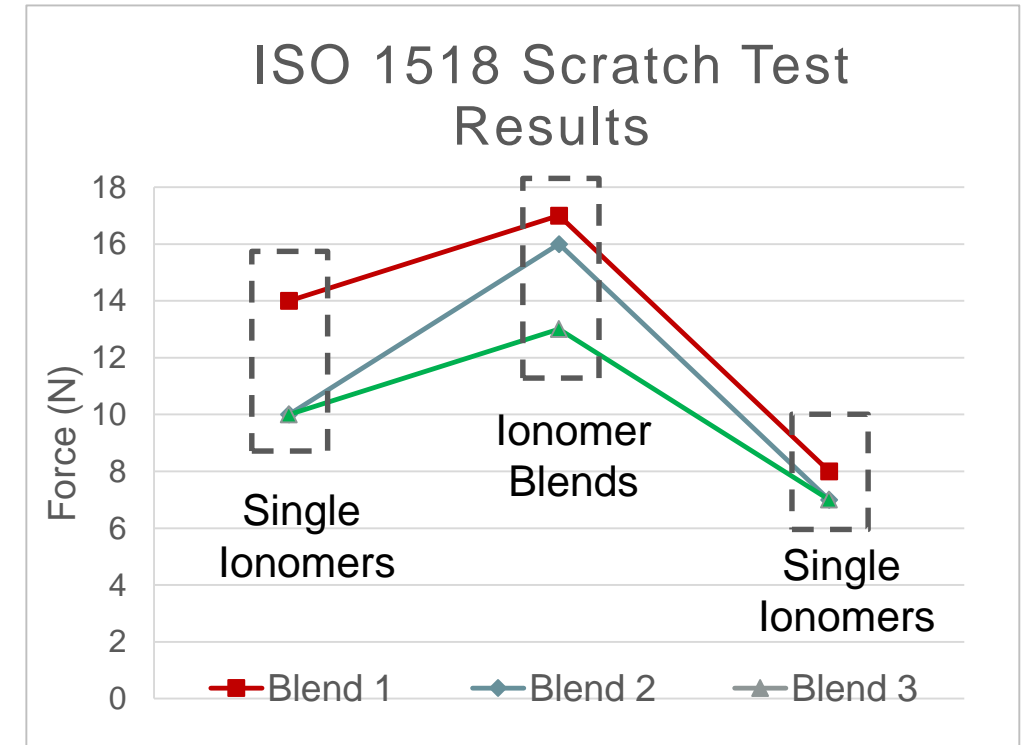
Test validation results

Objective 2:

Investigate the interaction of abrasion resistance and oil resistance of sealant materials.

Ionomer blends give better abrasion resistance?

- Combinations of certain ionomers may bring synergistic improvements in abuse resistance^[7].
- Will the blends keep the improved abrasion resistance in an oily environment?



Scratch resistance of three groups of ionomer blends

Experimental Design

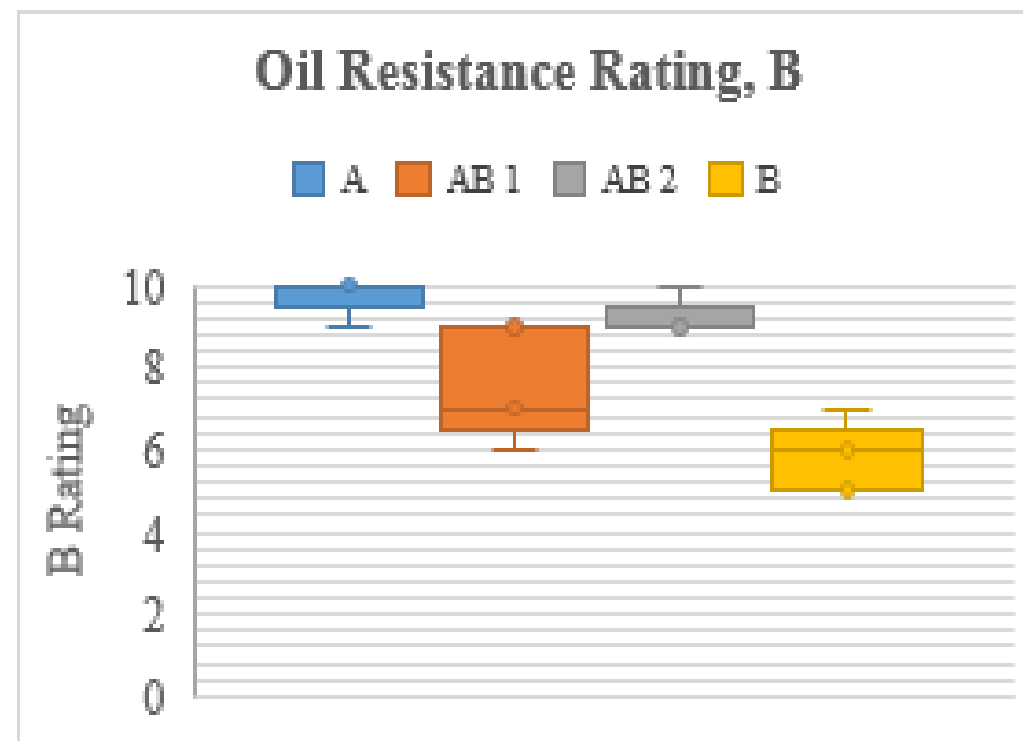
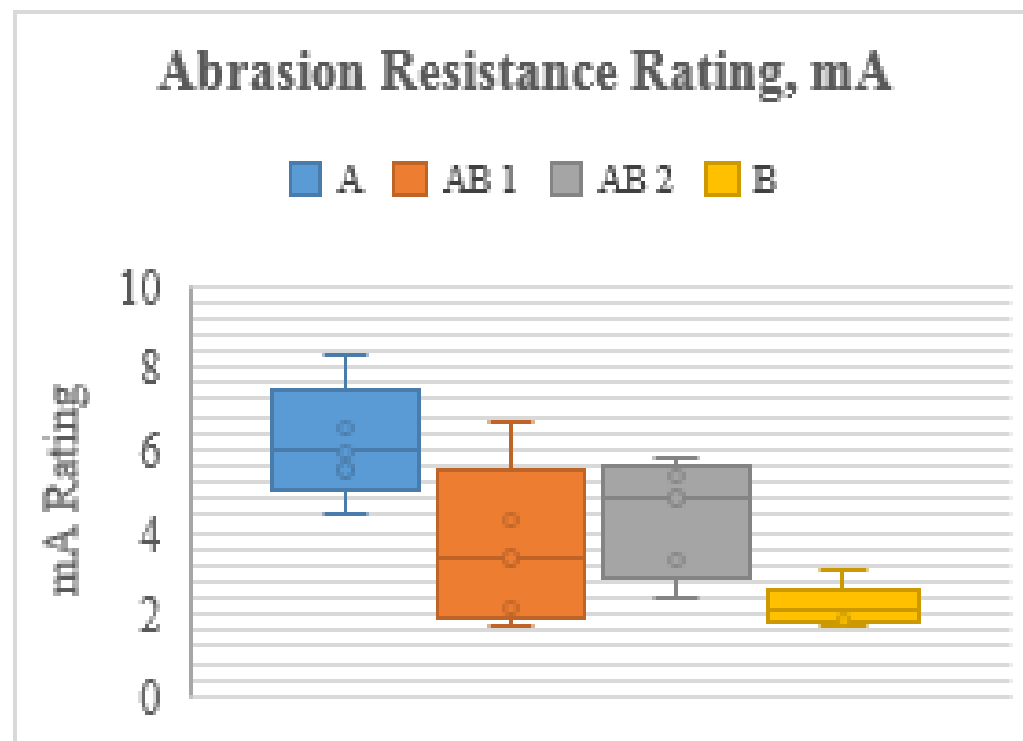
Ionomers used in study

	% Acid	%Neutrali zation	MI (g/10min)
A	High	Medium	2.5
B	High	Medium	5
C	High	Medium	5.2
D	High	Medium	3.9
E	High	High	1.2
F	High	High	0.7
G	High	High	0.9

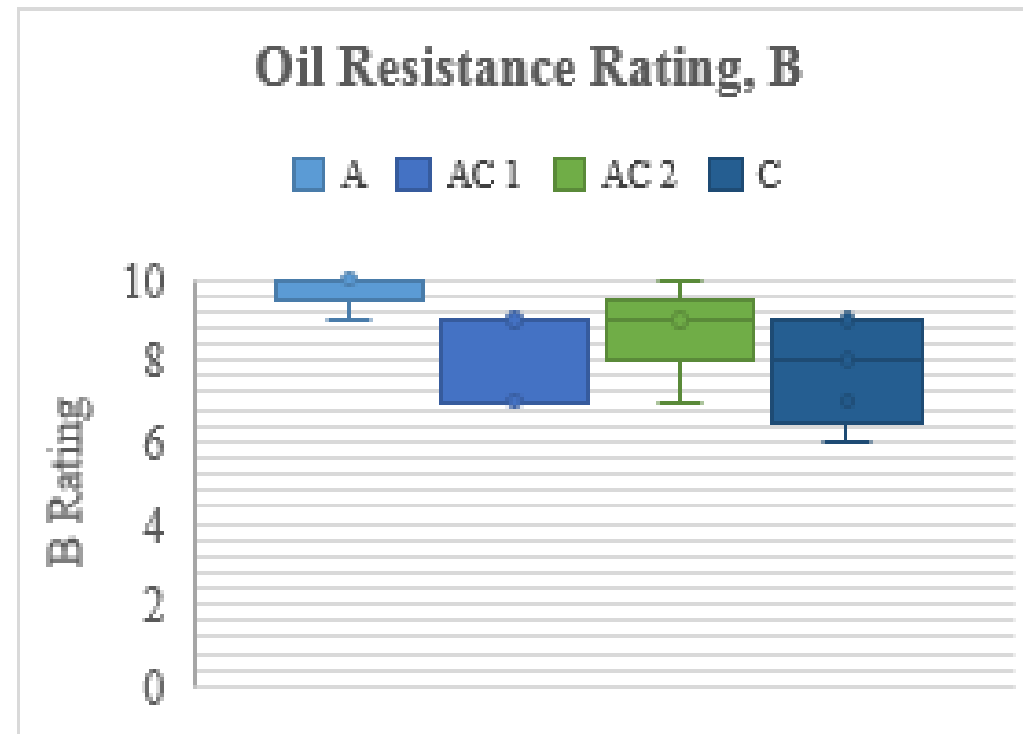
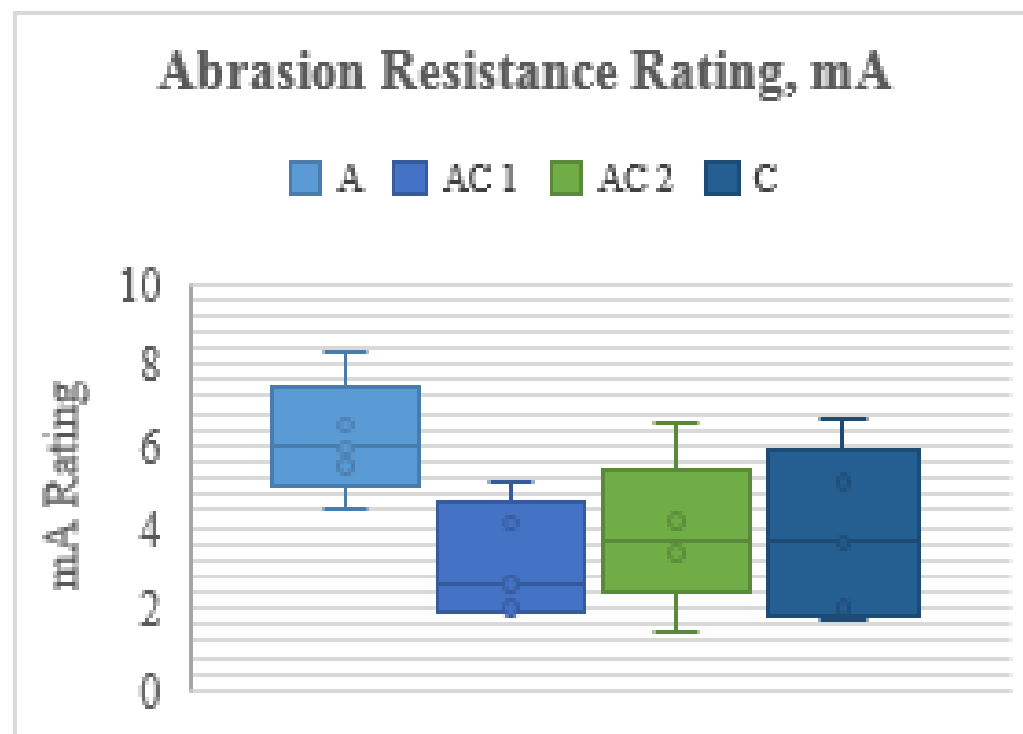
Blends used in study

Ionomers		Blends	
		Ratio 1	Ratio 2
A	B	AB 1	AB 2
A	C	AC 1	AC 2
A	D	AD 1	AD 2
A	E	-	AE 2
F	G	-	F/G 2

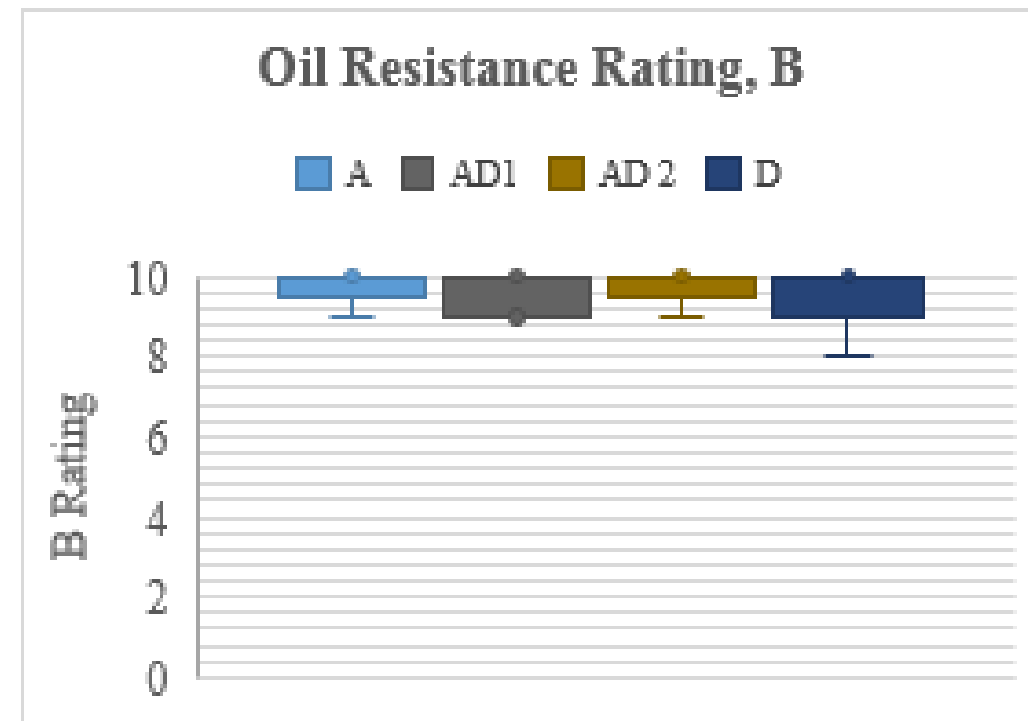
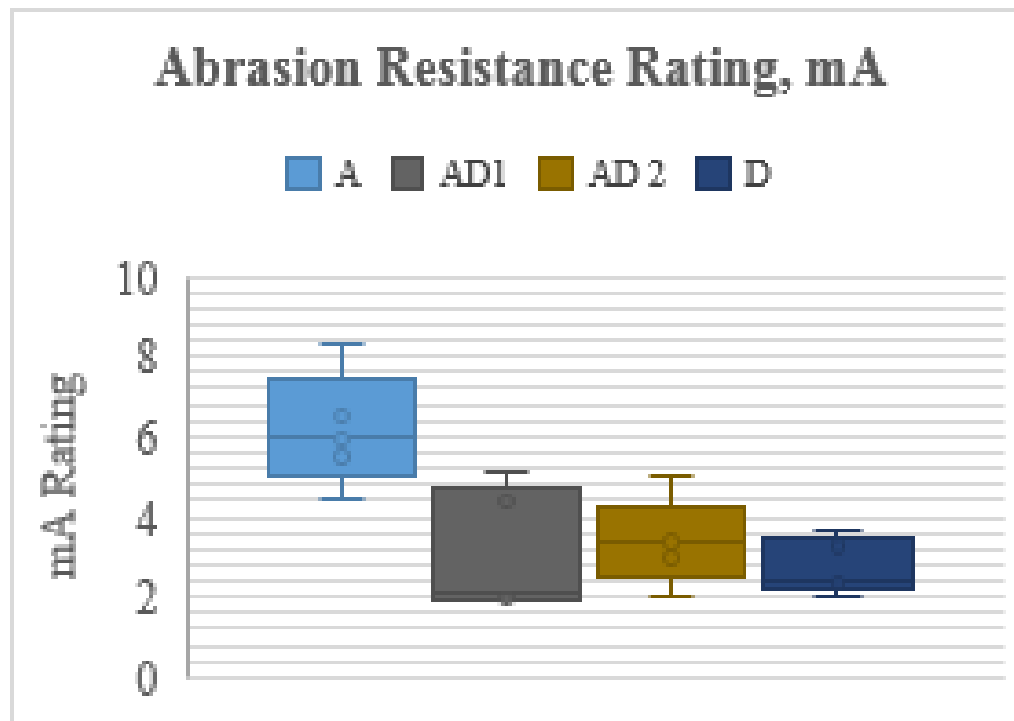
Results and Discussion



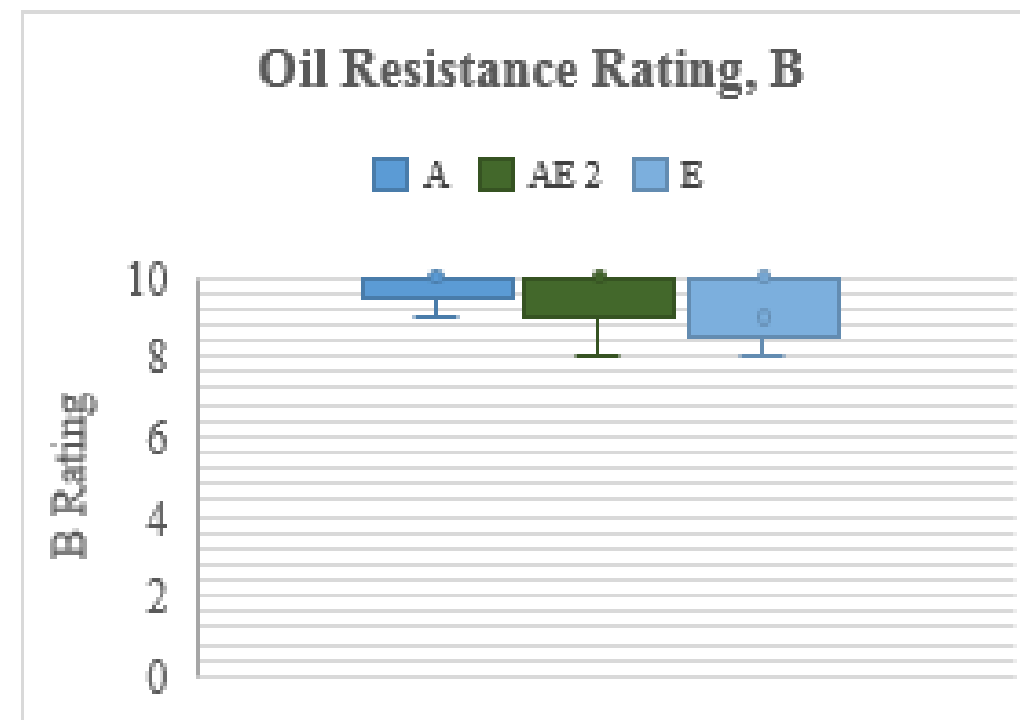
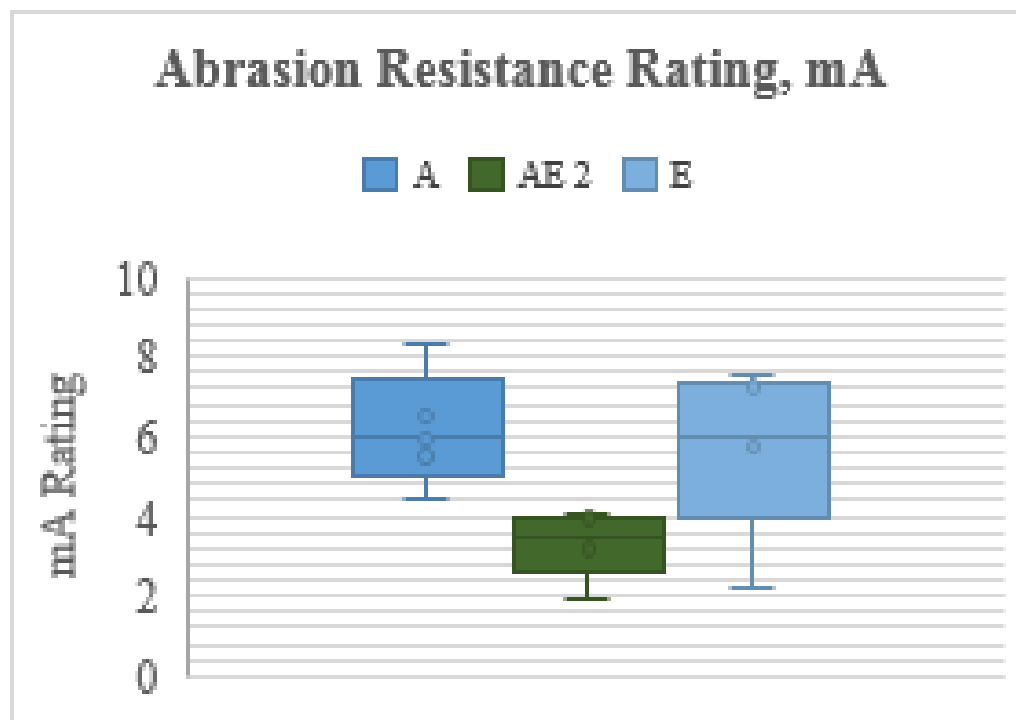
Results and Discussion



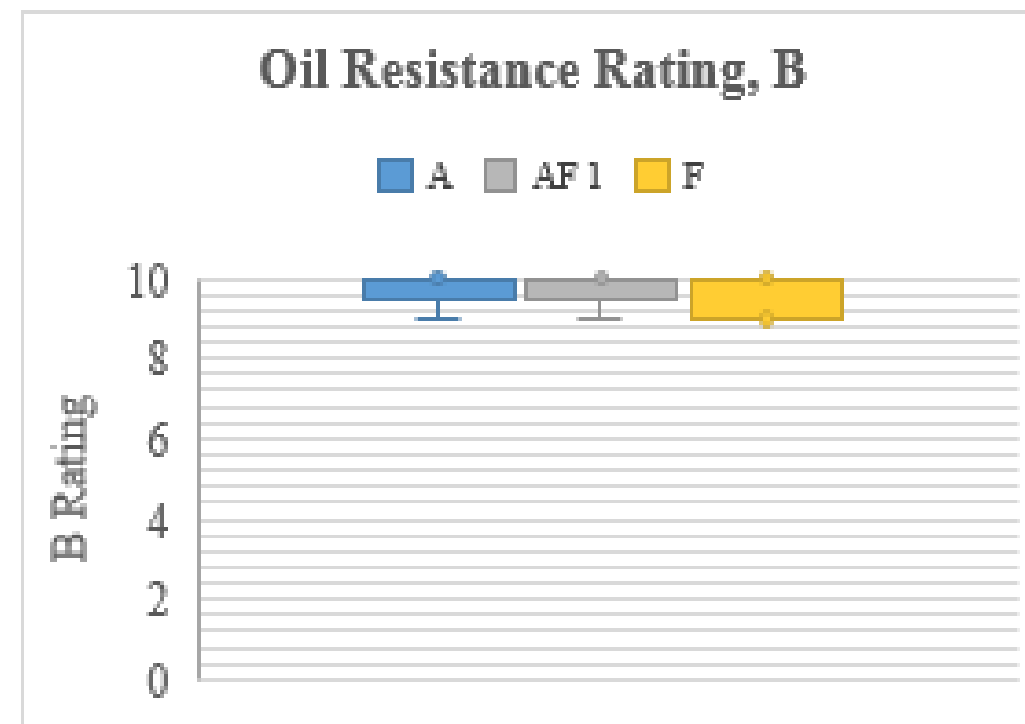
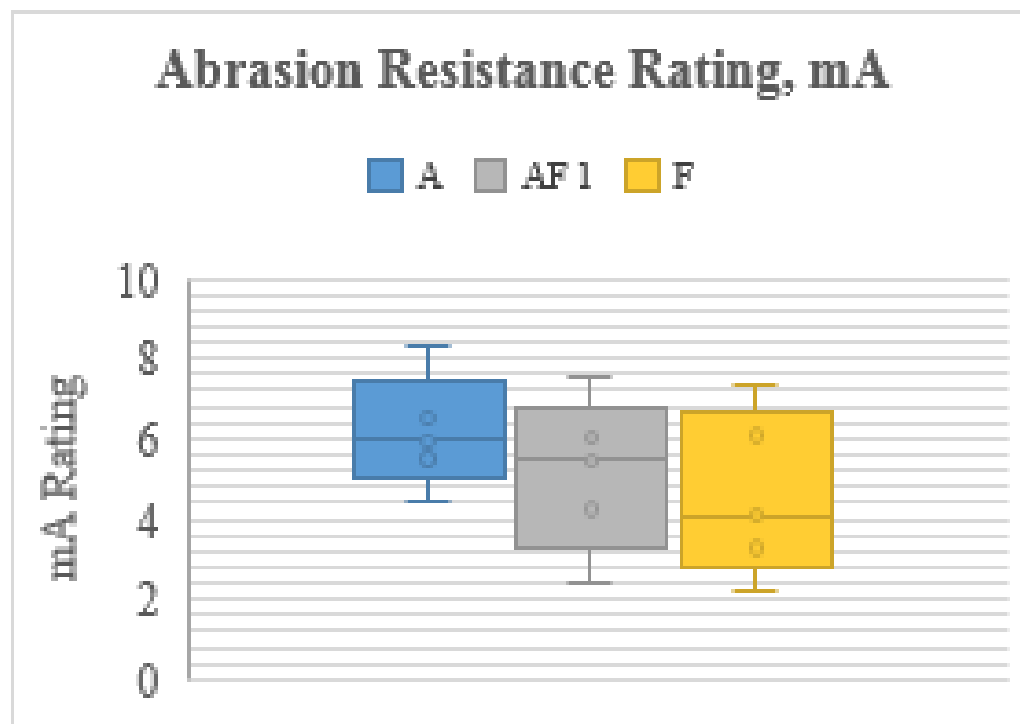
Results and Discussion



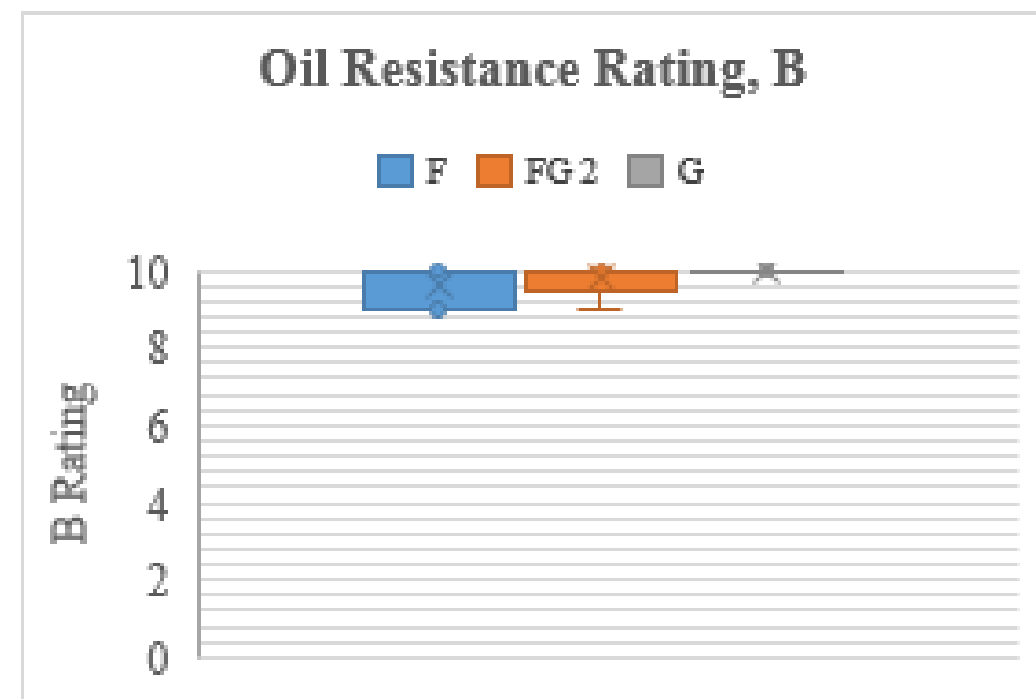
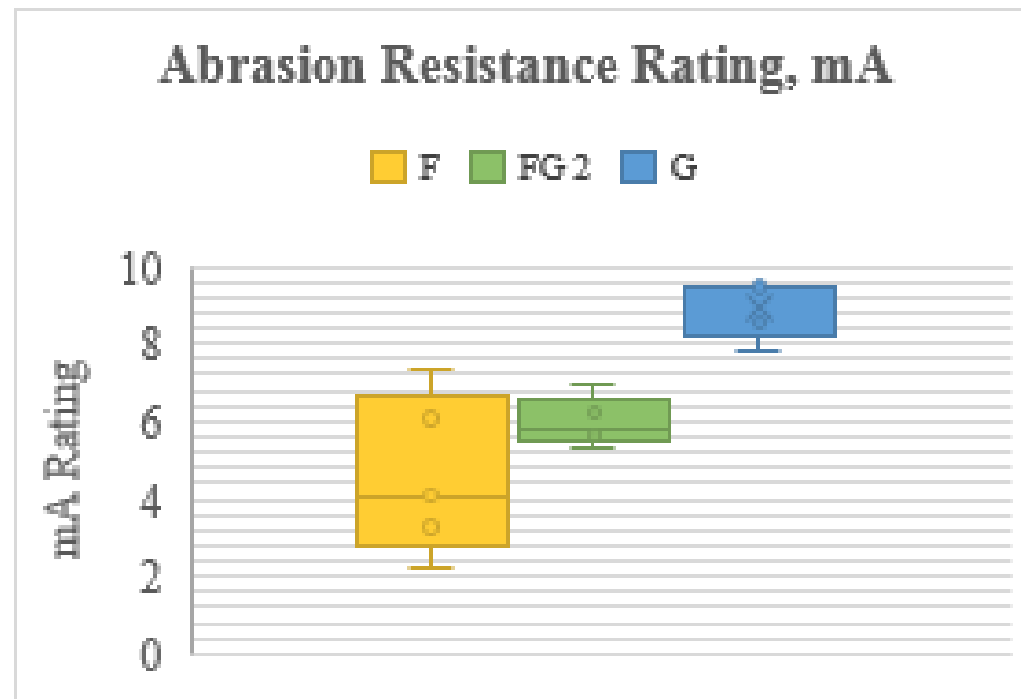
Results and Discussion



Results and Discussion



Results and Discussion



Conclusion

- A laboratory shaker table abrasion test was developed
 - Uses actual product
 - Allows testing in oily environment
 - Correlates with commercial experience
- The test was validated to be consistent and repeatable.
- In an abrasive and oily environment, advanced abrasion resistance of a sealant material can be comprised by weaker oil resistance.

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Questions?

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