CR Automotive Hose Cover

In this study, the effects of replacing N550 with N990 on the properties of a CR automotive hose cover compound were evaluated. The compound needs to have good heat, oil, and ozone resistance as well as excellent abrasion resistance and extrudability.

The benefits of N990 found in the study were:

- **Significant reduction in compound viscosity**, up to 30% at 50% replacement
- **Increase in scorch time**, up to 25% at 50% replacement
- **Decrease in compression set**, as much as 17%
- **Reduction in compound cost** due to higher filler loading
- **Dispersion, ozone resistance, and extrusion quality were excellent** for all compounds
- Tensile strength and elongation at break maintained before and after aging

The CR compound test formulations are provided in Table 1. Mooney, MDR, RPA, hardness, tensile, compression set, abrasion, heat aging, and fluid aging properties were collected and reported for each compound. Compounding and testing were performed at ACE Products and Consulting. The N550 was replaced at a ratio of 2 phr N990:1 phr N550 in order to maintain a Shore A hardness of approximately 75.

Table 1. Test Formulations

Ingredient	Control	1	2	3	4
Neoprene W	100	100	100	100	100
Thermax® N990	**-**	**7.5**	**46**	**81**	**115**
N550	115	110	92	75	58
Zinc Oxide	4	4	4	4	4
Stearic Acid	1	1	1	1	1
Sundex 790	40	40	40	40	40
CIS-4	15	15	15	15	15
Vanwax H	2	2	2	2	2
Scorchguard O	5	5	5	5	5
Wingstay 100AZ	1	1	1	1	1
Octamine	3	3	3	3	3
Innovox 95	10	10	10	10	10
Sulfur	0.7	0.7	0.7	0.7	0.7
TMTD	0.5	0.5	0.5	0.5	0.5
Vulkacit CRV	1.25	1.25	1.25	1.25	1.25
Total	**298.5**	**301.0**	**321.5**	**338.7**	**356.0**

Detailed compound test results are provided in the figures on the following pages.

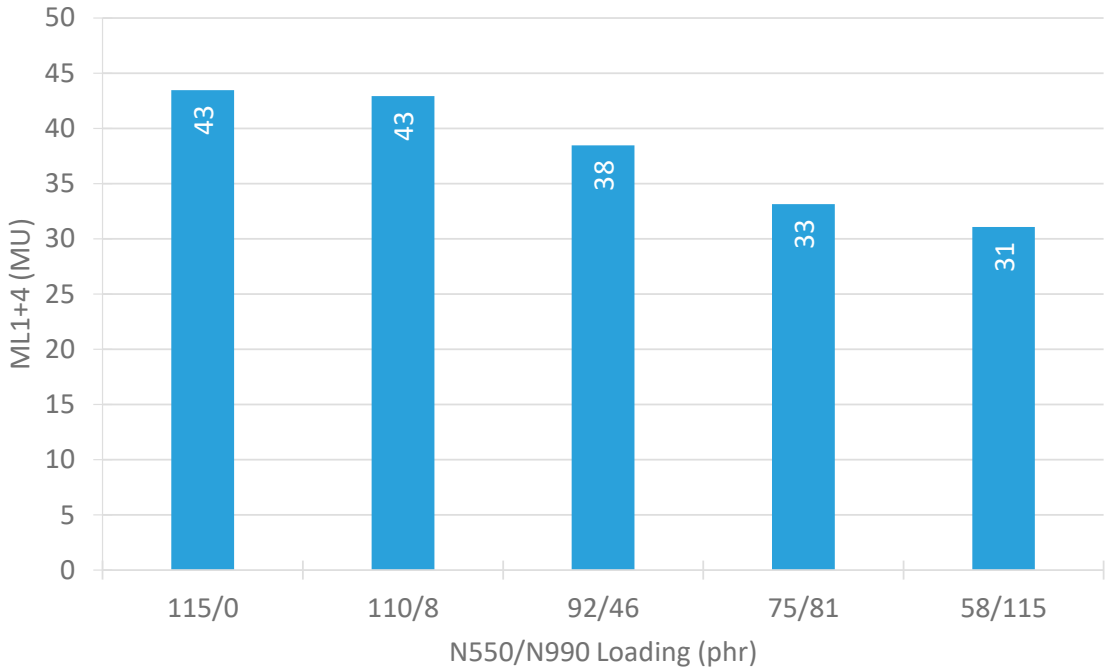

Figure 1. Mooney viscosity, ML1+4, at 100°C for the compounds. Viscosity tended to decrease significantly as N550 was replaced with N990.

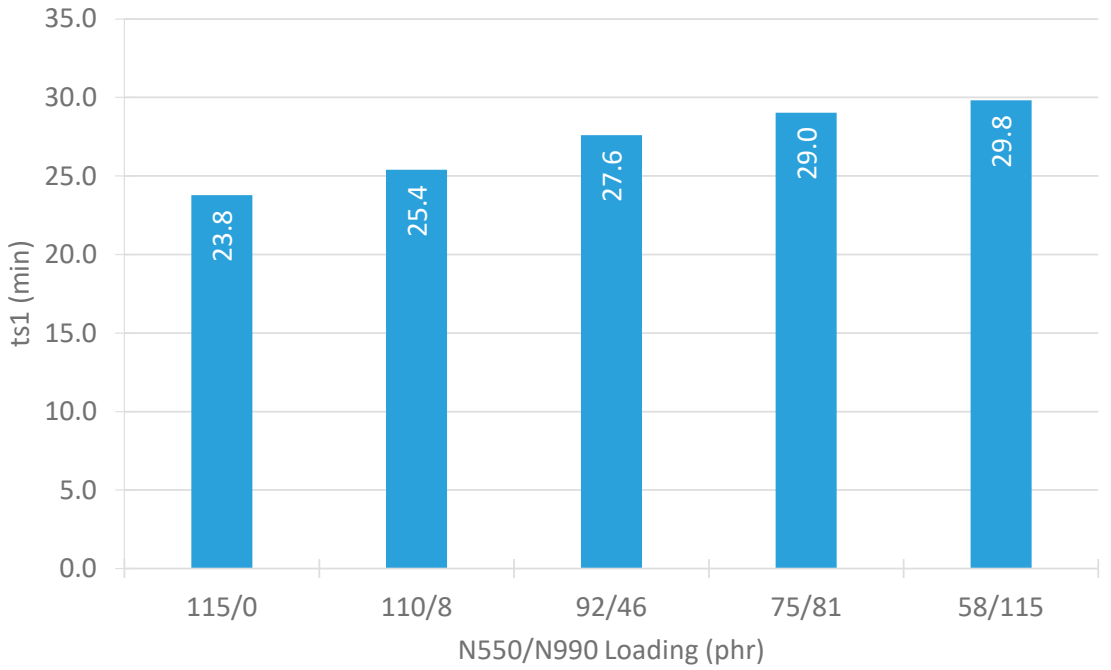

Figure 2. Mooney scorch time, ts1, at 125°C for the compounds. Scorch time tended to increase as N550 was replaced with N990.

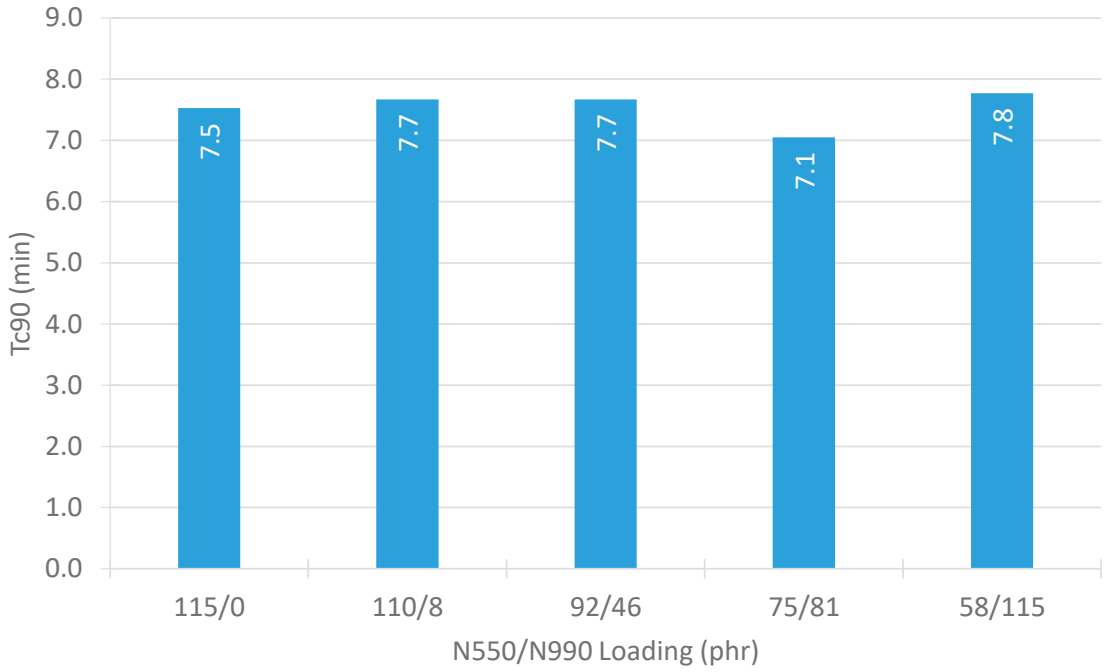

Figure 3. MDR cure time, Tc90, at 180°C for the compounds. No significant difference in cure times was observed.

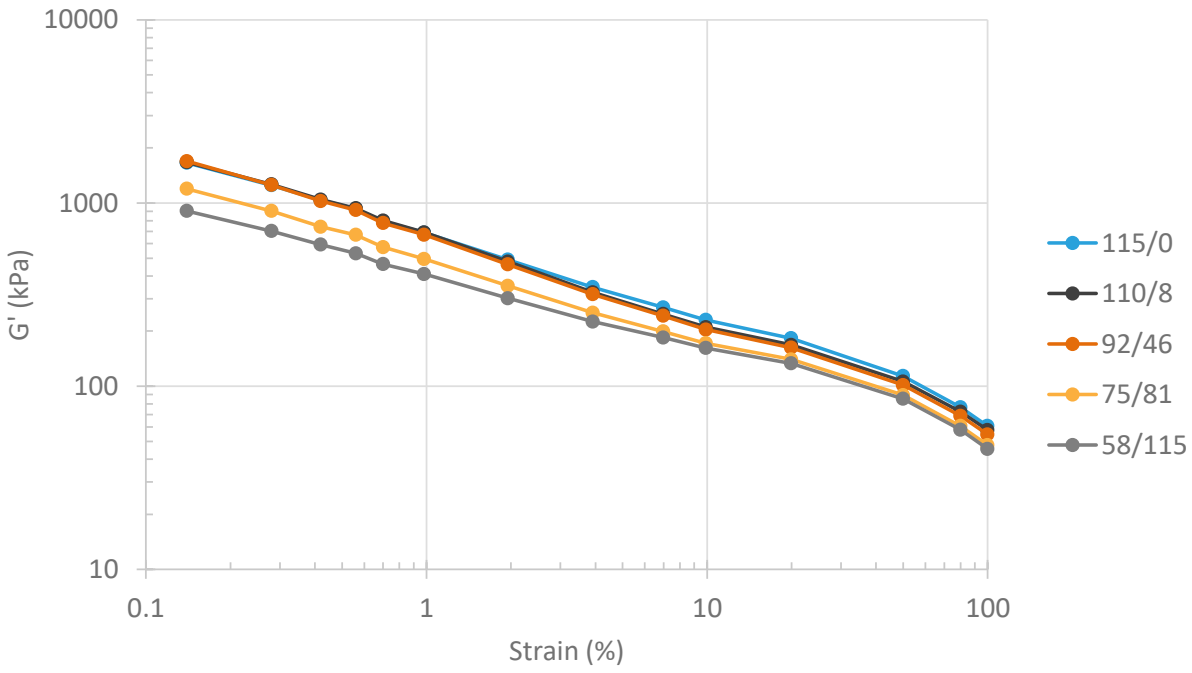

Figure 4. Payne Effect, G' versus strain amplitude, at 70°C and 1 Hz for the compounds. Small strain modulus was reduced ~45% and medium strain modulus was reduced ~25% as N550 was replaced with N990.

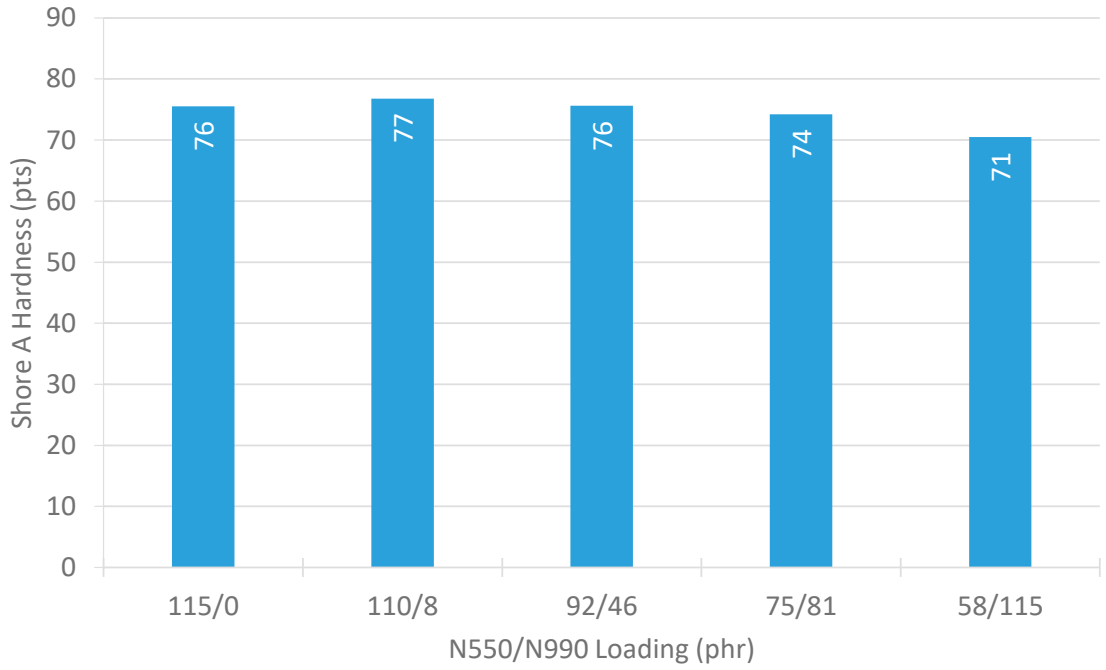

Figure 5. Shore A hardness for the compounds. All compounds fell within 75±5 specification.

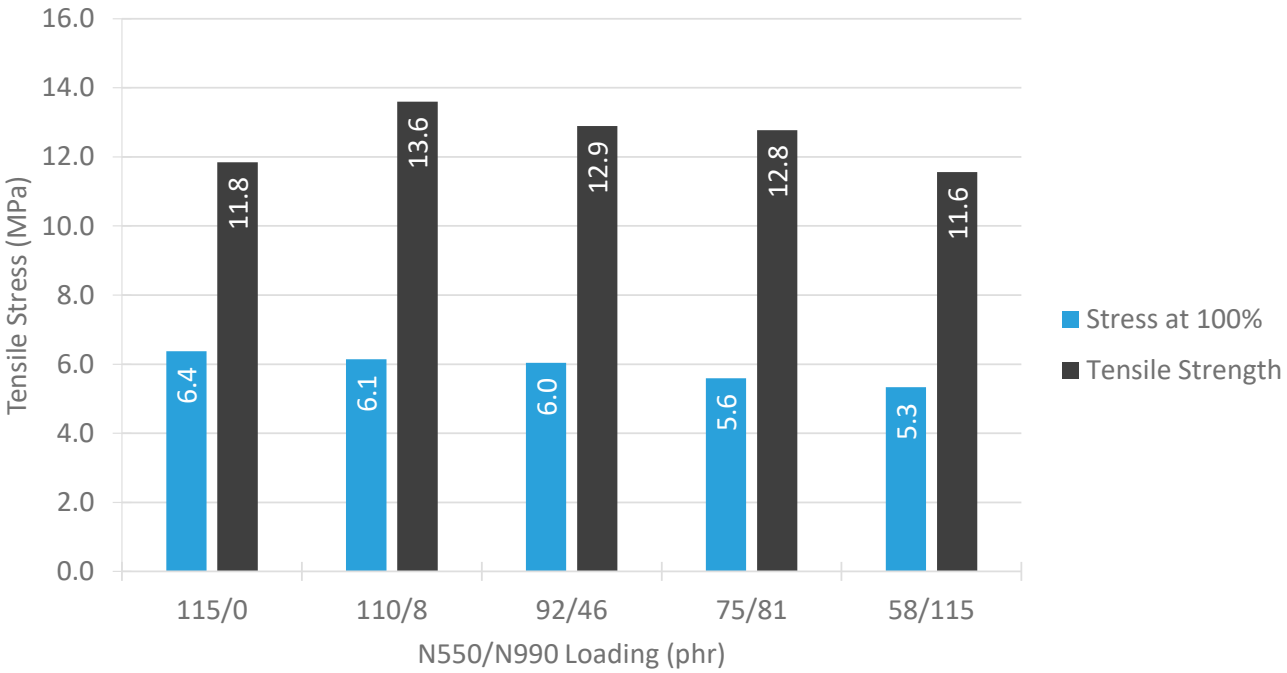

Figure 6. Tensile modulus and strength for the compounds. As N550 was replaced with N990, the 100% modulus tended to decrease. The tensile strength was maintained or slightly higher for the compounds with N990.

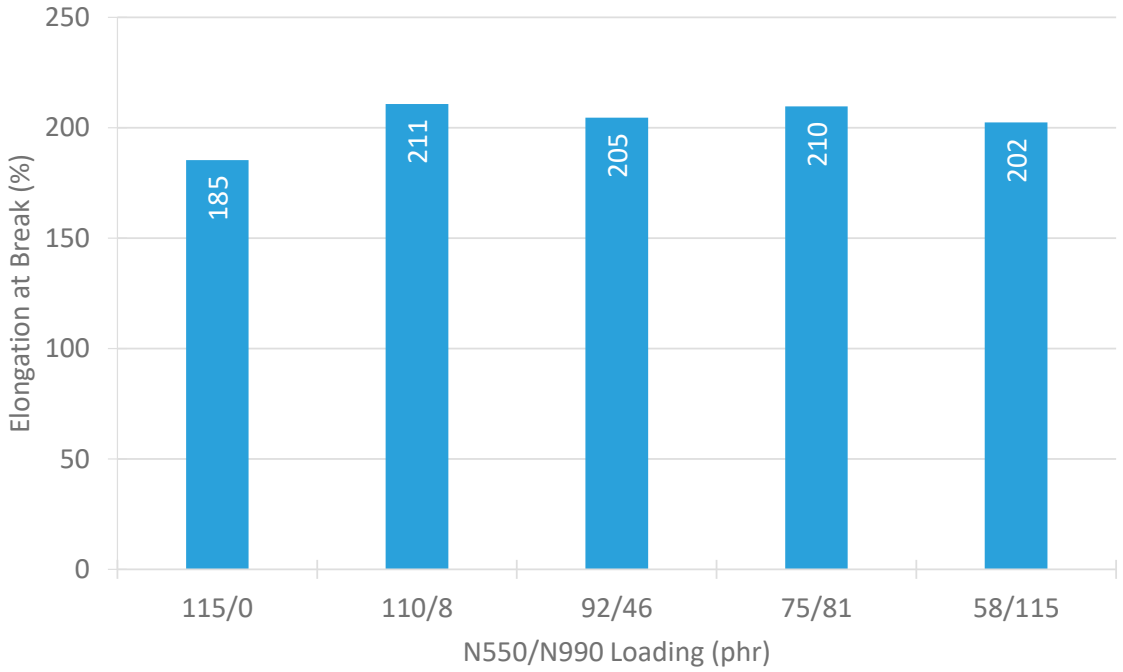

Figure 7. Elongation at break for the compounds. Elongation tended to be higher as N550 was replaced with N990.

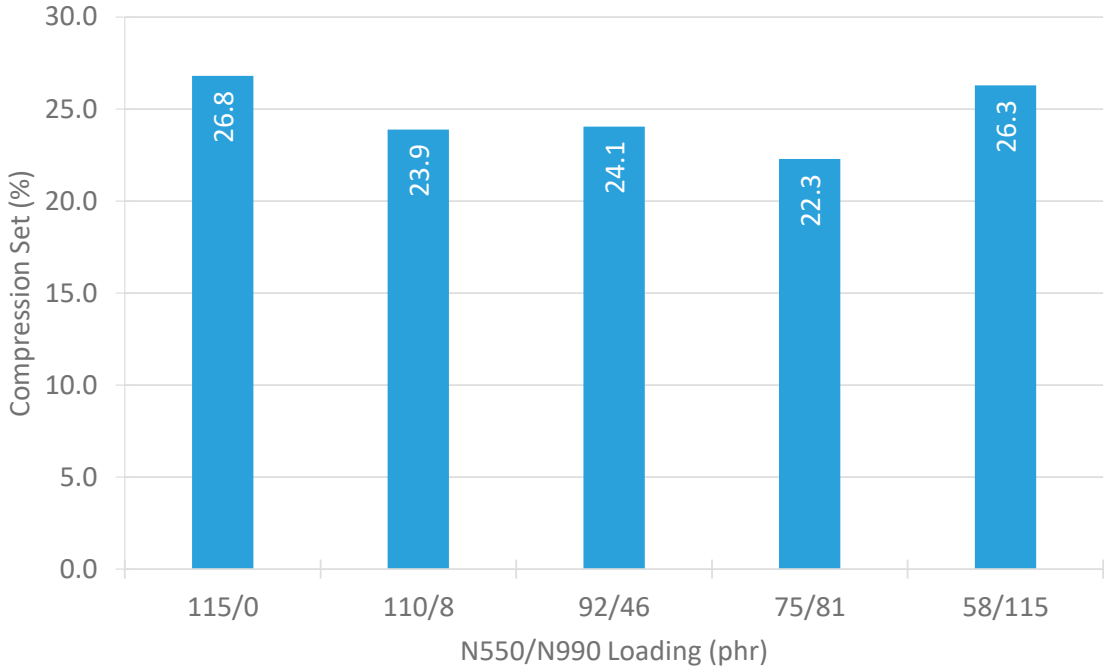

Figure 8. Compression set for the compounds after 22 hours at 100°C. A reduction in compression set was observed as N550 was replaced with N990.

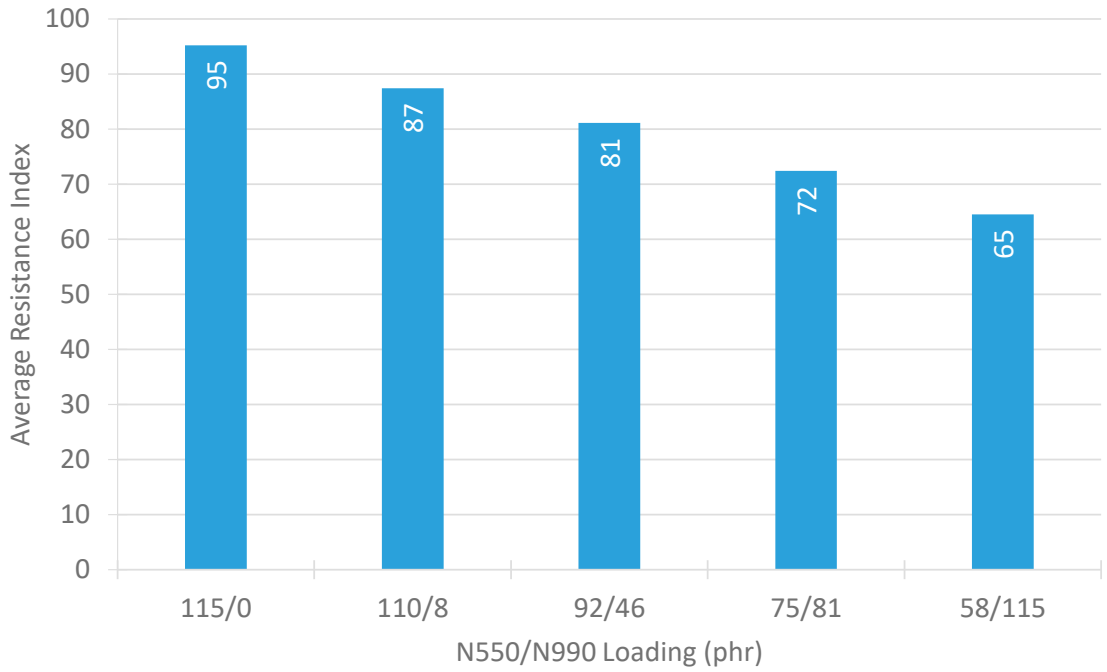

Figure 9. DIN abrasion average resistance index for the compounds. Abrasion resistance tended to decrease as N550 was replaced with N990. At a 50% replacement level, abrasion resistance decreased 33%.

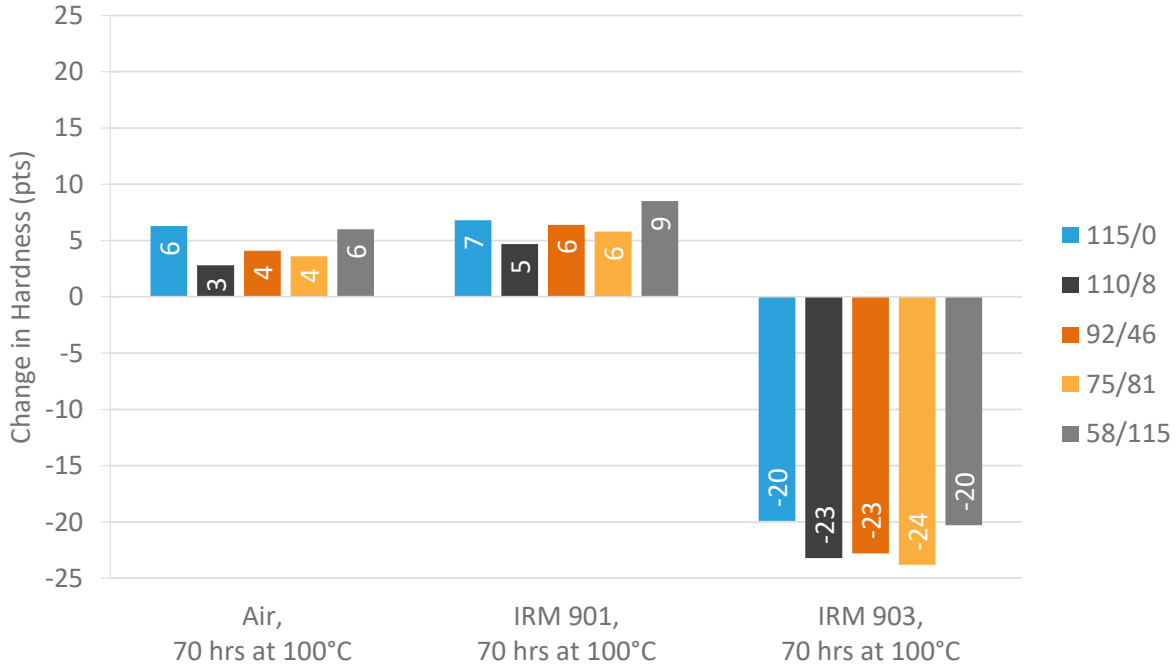

Figure 10. Change in hardness after aging performed in air and oil. There were no significant differences observed. IRM 901 is a paraffinic oil and IRM 903 is a naphthenic oil. The compounds struggled in IRM 903 with a hardness change of greater than ±15 points.

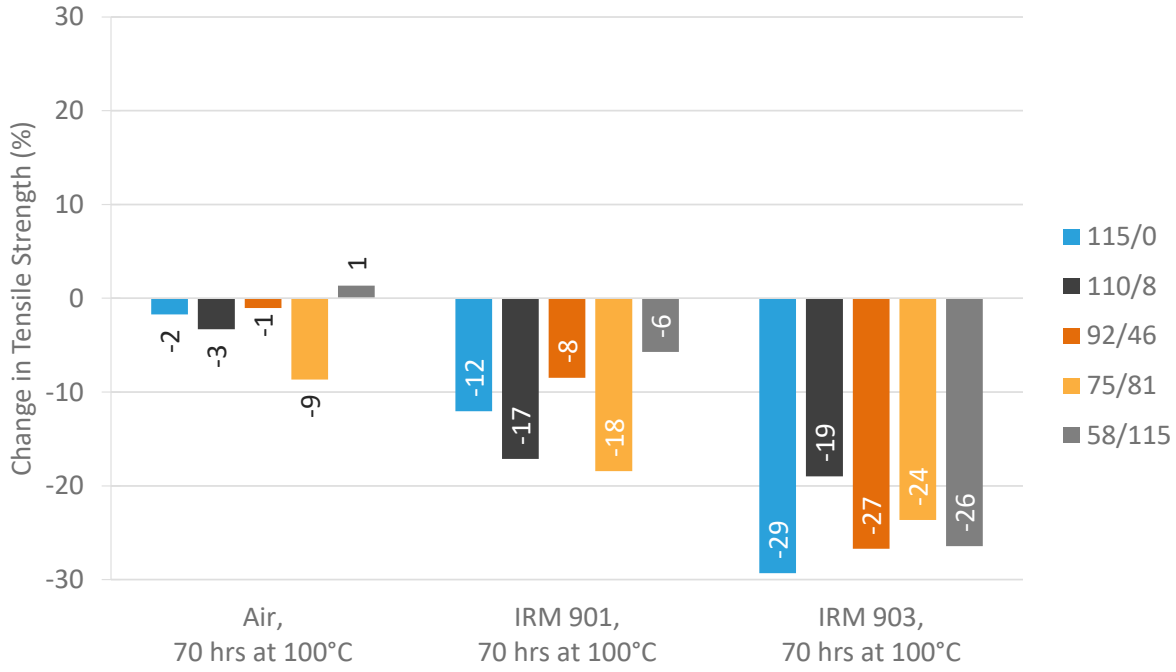

Figure 11. Change in tensile strength after aging performed in air and oil. No significant trends were observed.

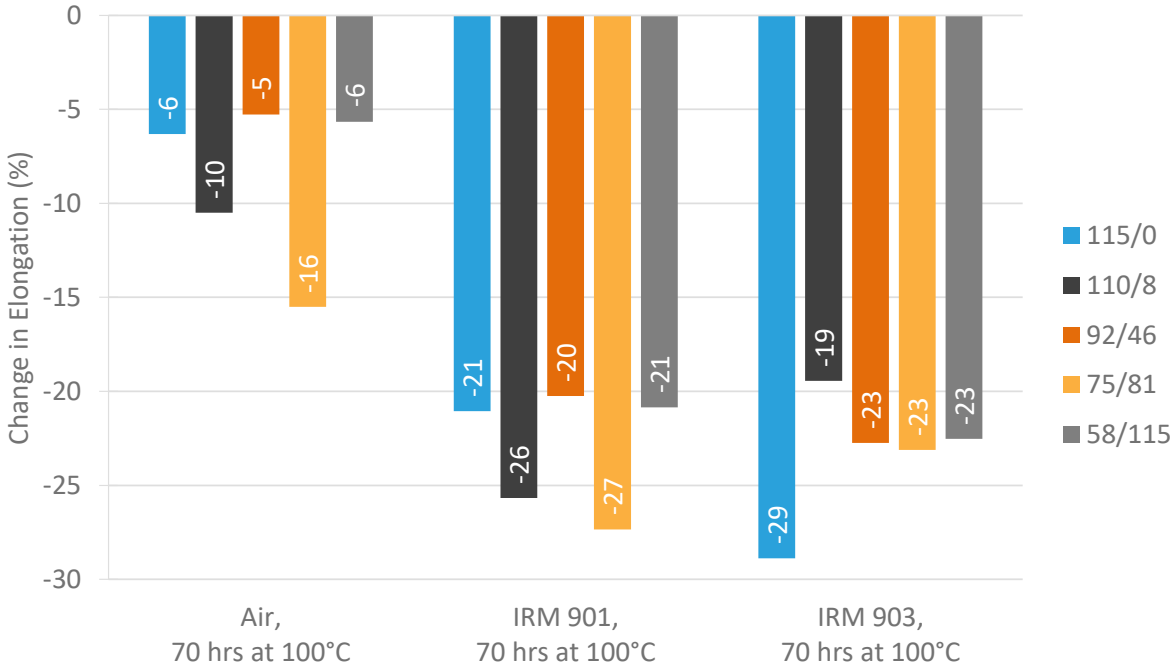

Figure 12. Change in elongation after aging performed in air and oil. Performance in IRM 903 was improved over control compound.

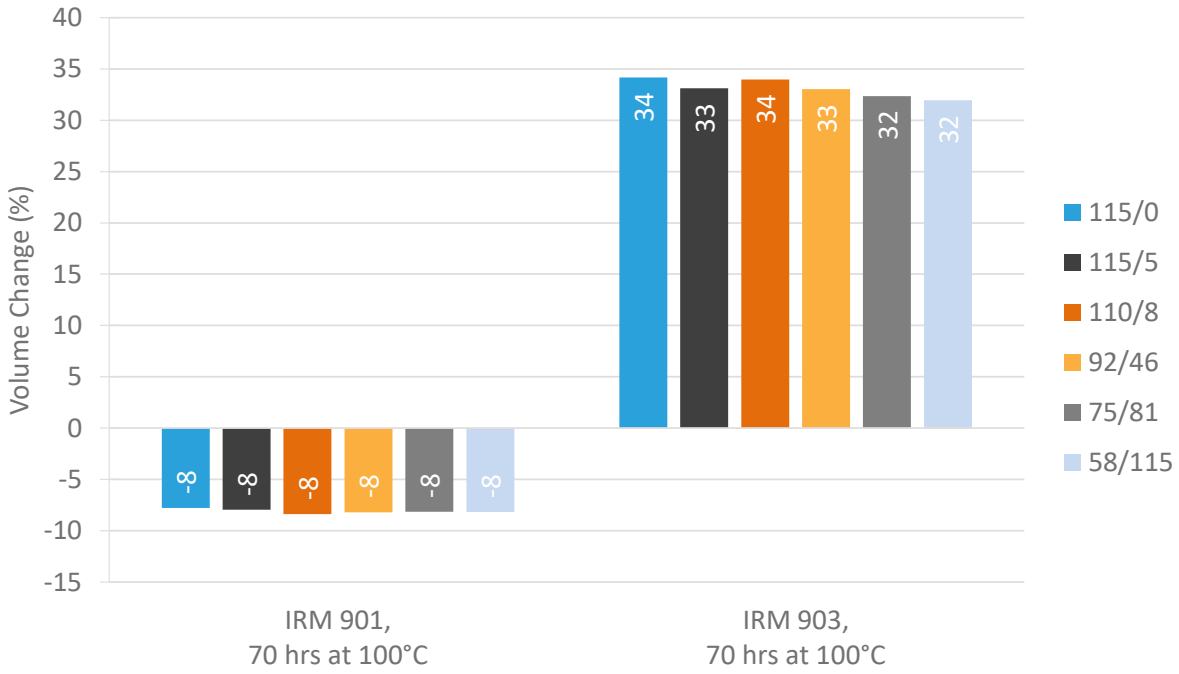

Figure 13. Volume swell after aging in oil for 70 hours at 100°C. No significant differences were observed in IRM 901. A slight trend of decreasing volume swell with increasing N990 loading was observed in IRM 903.