EPDM Engine Mount

In this study, the effects of replacing N550 with Thermax® N990 on the properties of EPDM engine mounts were evaluated. While natural rubber is often used in anti-vibration applications, EPDM has been adopted in situations requiring higher heat, oil, and ozone resistance. The low surface area and structure of Thermax® N990 allow rubber to maintain its inherent elastomeric properties, even at high loadings. The result is compounds with lower hysteresis as compared to compounds loaded with furnace black grades.

The benefits of Thermax® N990 found in the study were:

- **Up to 10% reduction** in compound viscosity
- Increase in scorch safety
- Improvement in heat aged tensile and tear strength
- **Up to 60% increased** room temperature metal adhesion
- Good compression set, rebound, and dynamic properties

The EPDM compound test formulations are provided in Table 1. The N550 was replaced at a ratio of 1.0 phr N550:2.4 phr Thermax® N990 to maintain a Shore A hardness of approximately 50. Mooney, ODR, hardness, tensile, tear, compression set, rebound, heat aging, dynamic and adhesion properties were collected for each compound. Compound preparation, mixing, and analysis were performed at BFGoodrich Laboratory in Brecksville, Ohio. Dynamic testing was performed at Experimental Services Inc. in Akron, Ohio. Adhesion testing was performed by Lord Corporation.

Table 1. Test Formulations

Ingredient	Control	1	2	3	4
EPDM DE304	175	175	175	175	175
Thermax® N990	**-**	**28**	**52**	**100**	**147**
N550	62	50	40	20	-
Sunpar 2280	5	5	5	5	5
Stearic Acid	1.5	1.5	1.5	1.5	1.5
TEA	0.6	0.6	0.6	0.6	0.6
Zinc Oxide	5	5	5	5	5
S-80	0.3	0.3	0.3	0.3	0.3
Perkadox 14/40	9	9	9	9	9
Total	**258.4**	**274.4**	**288.4**	**316.4**	**343.4**

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

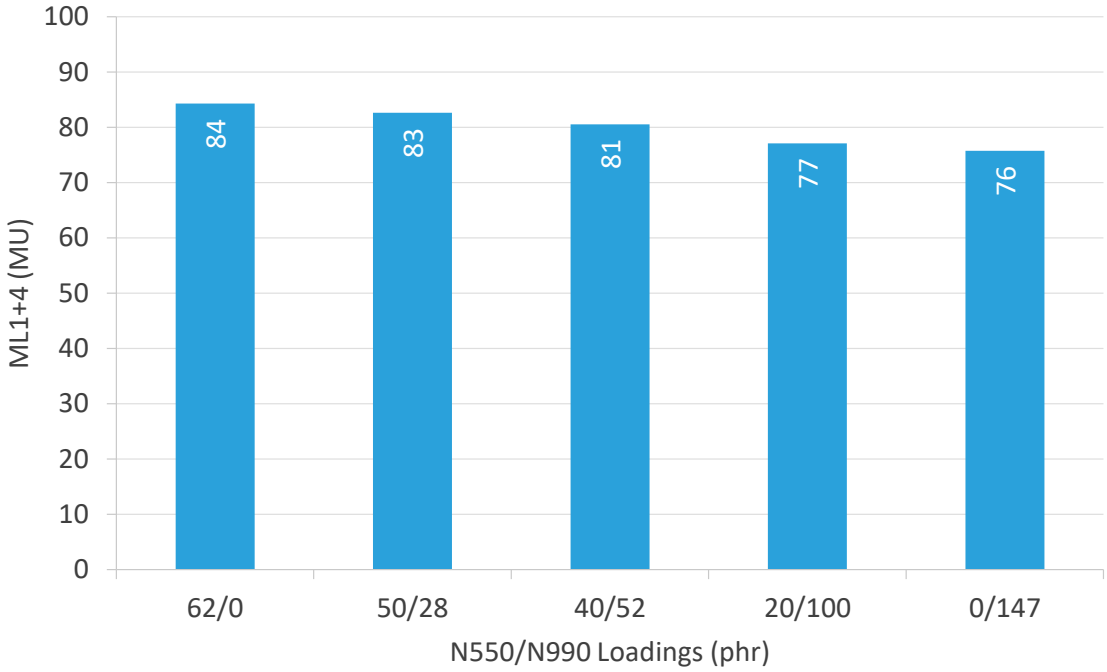

Figure 1. Mooney viscosity, ML1+4, at 100°C for the compounds. Viscosity tended to decrease as N550 was replaced with N990.

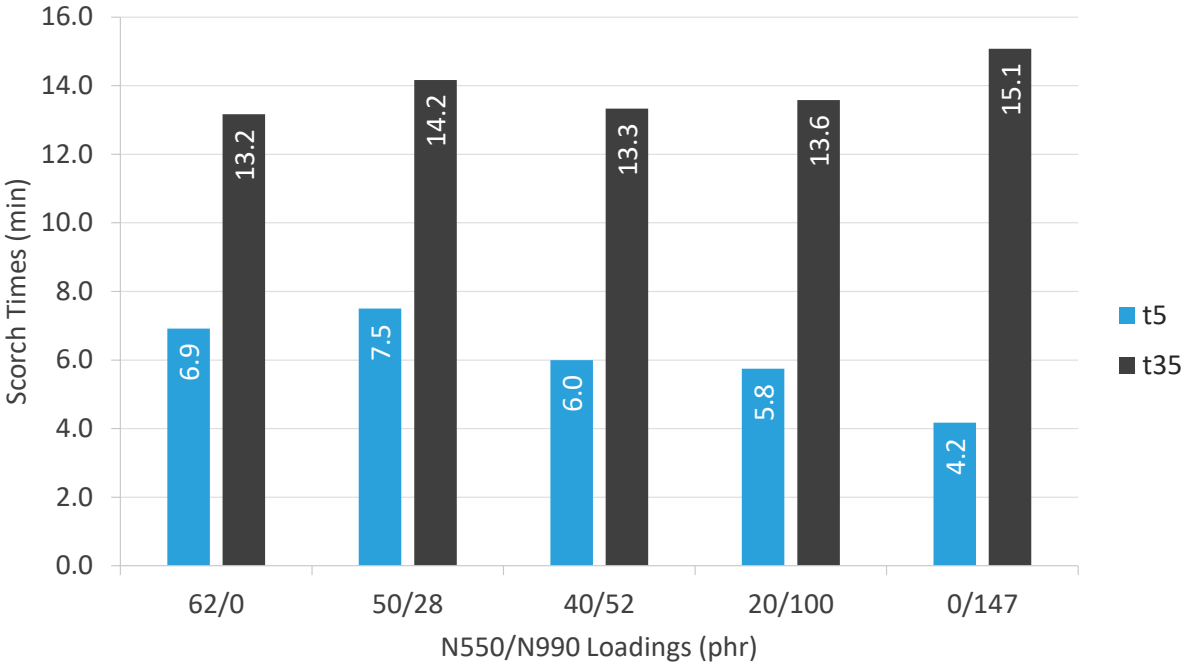

Figure 2. Mooney scorch times, t_5 and t_{35}, at 140°C for the compounds. The t_5 scorch time tended to decrease as N550 was replaced with N990. The t_{35} scorch time tended to increase as N550 was replaced with N990.

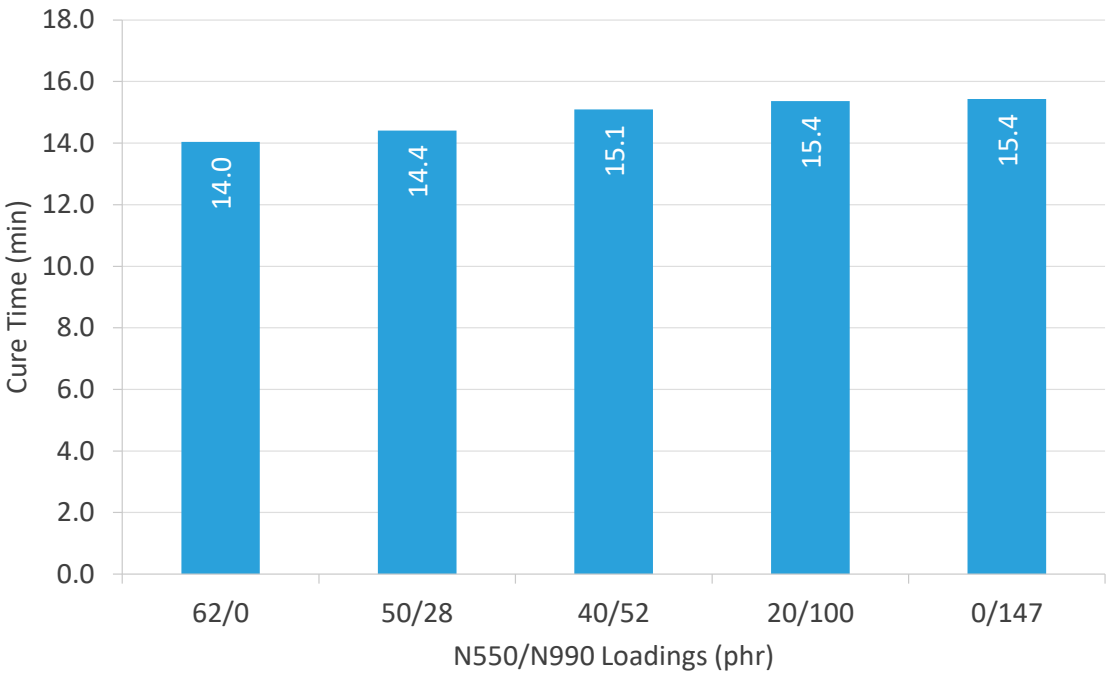

Figure 3. ODR cure time, Tc95, at 175°C and 1° arc for the compounds. Cure time increased slightly as N990 replaced N550.

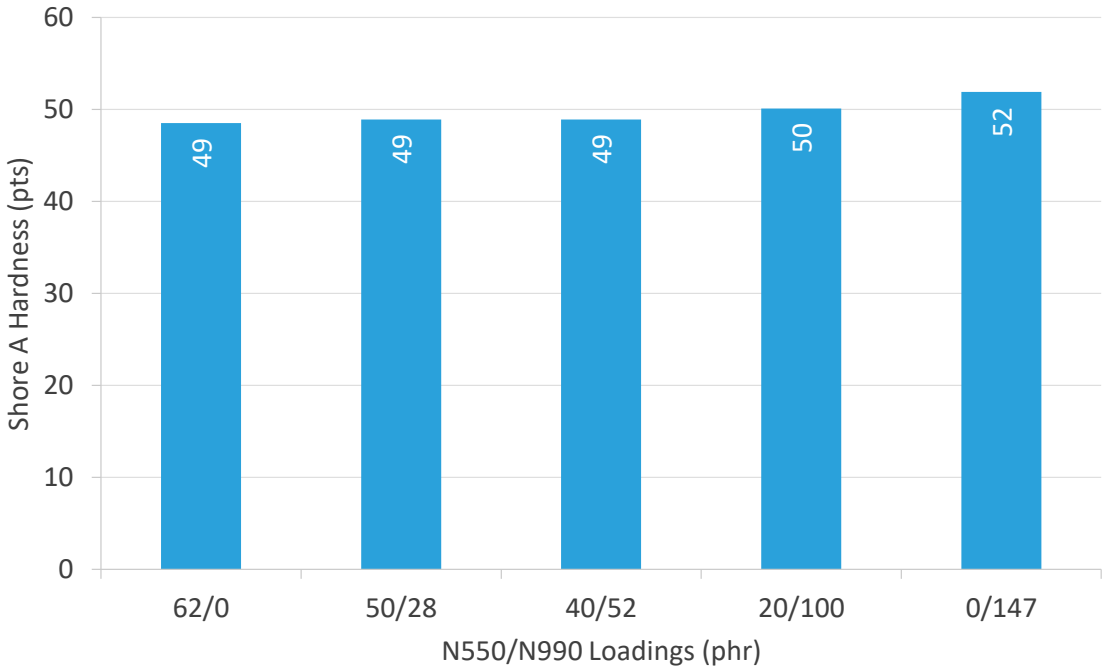

Figure 4. Shore A hardness for the compounds. All compounds fell within 50±5 specification.

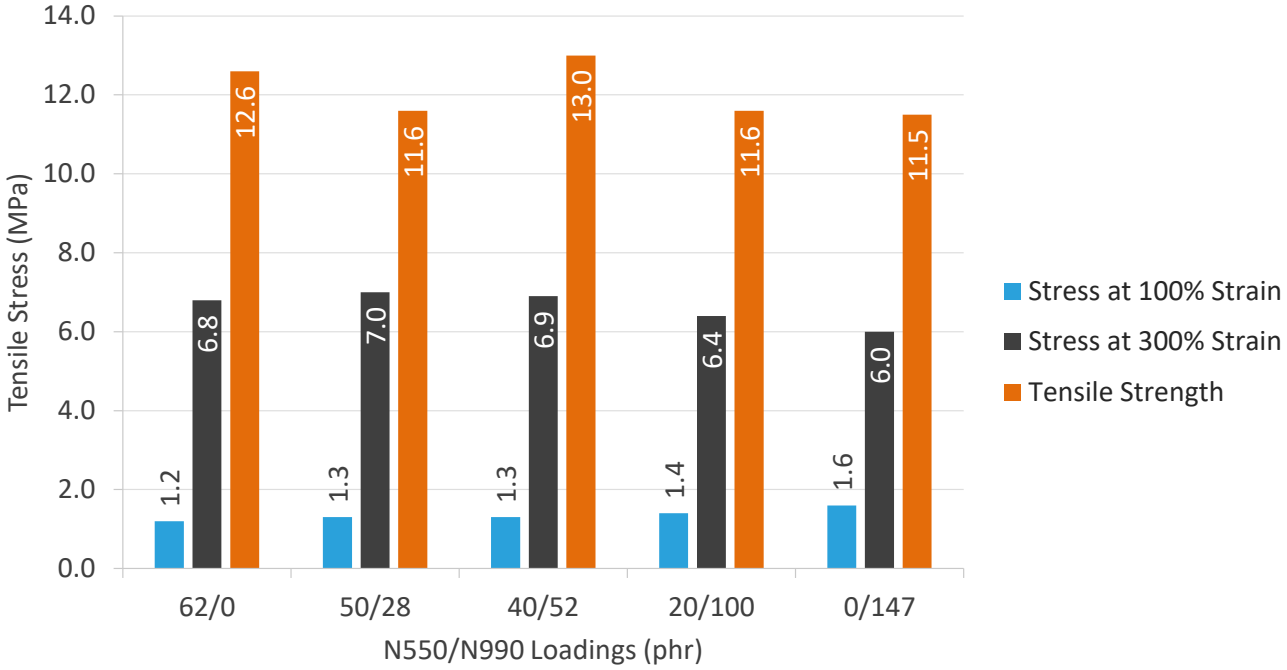

Figure 5. Tensile modulus and strength for the compounds. As N550 was replaced with Thermax® N990, the 100% modulus increased, the 300% modulus decreased, and the tensile strength showed no significant change.

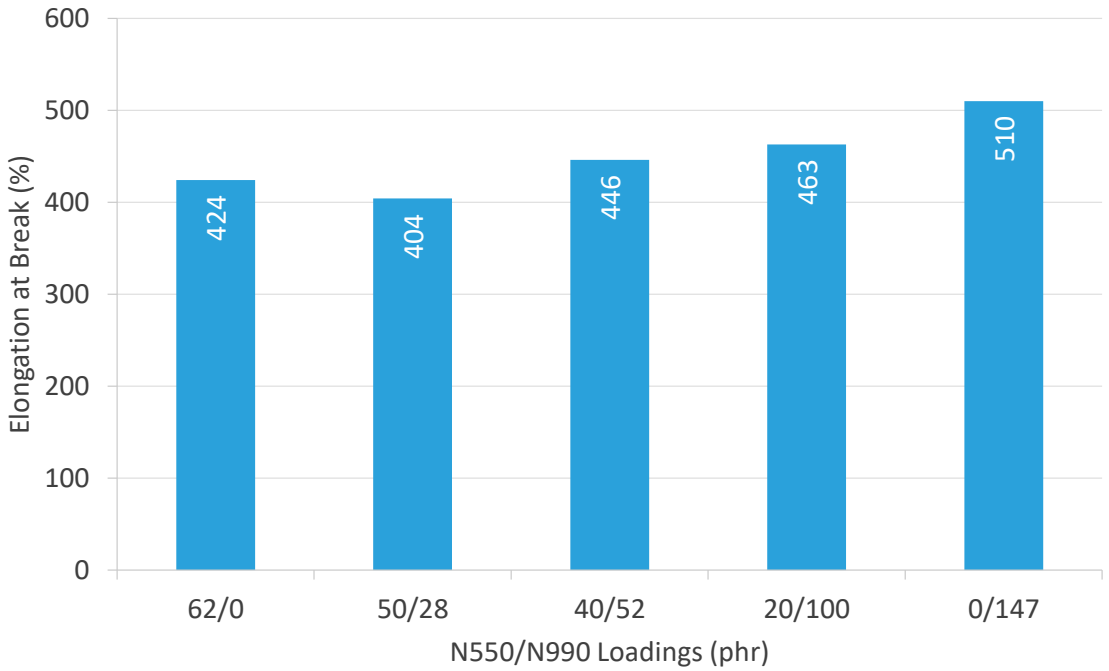

Figure 6. Elongation at break for the compounds. Elongation tended to increase as N990 replaced N550.

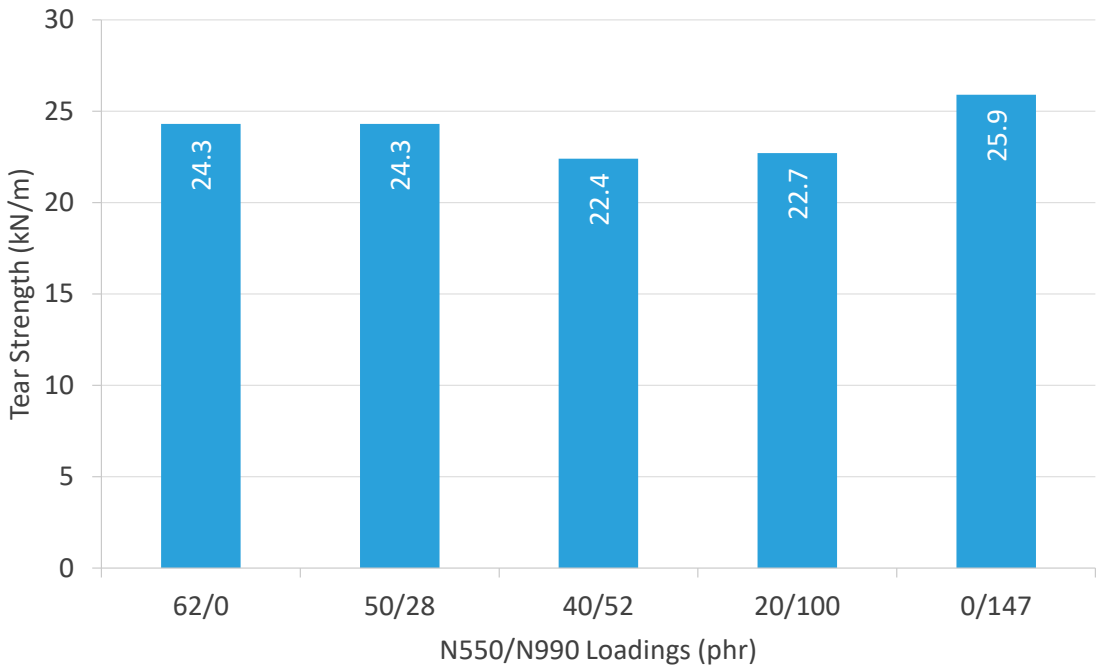

Figure 7. Die C tear strength for the compounds. No significant difference in tear strength was observed.

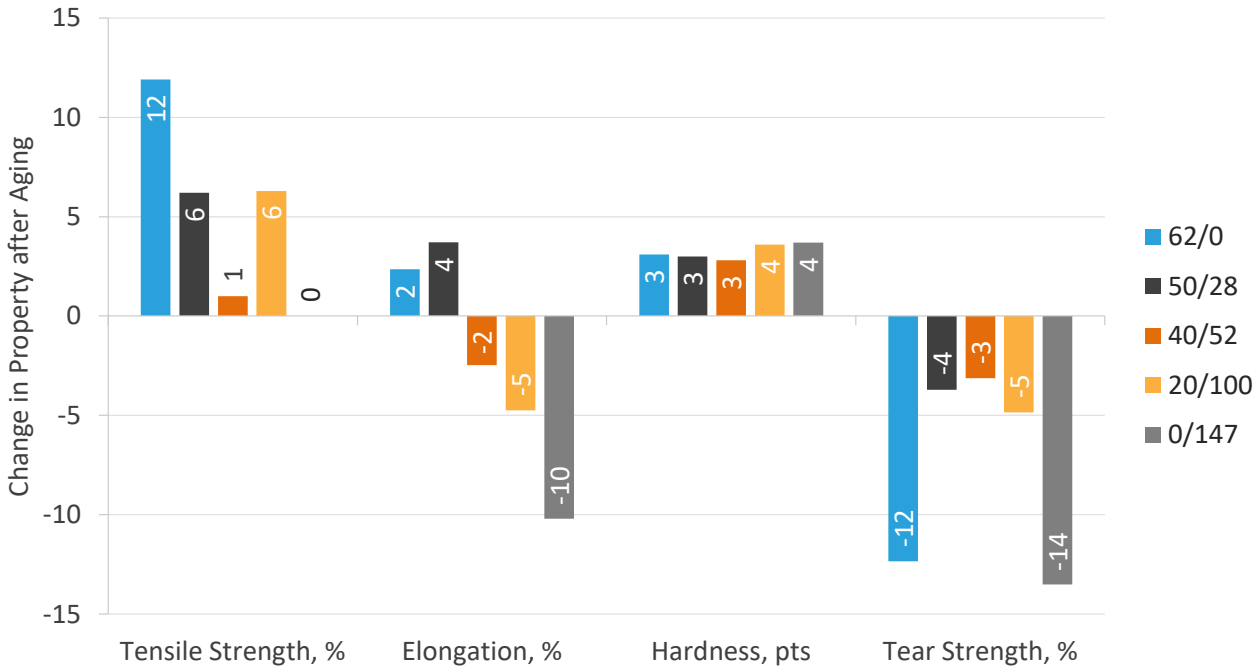

Figure 8. Change in properties after aging 28 days at 120°C. All compounds displayed good heat aging properties.

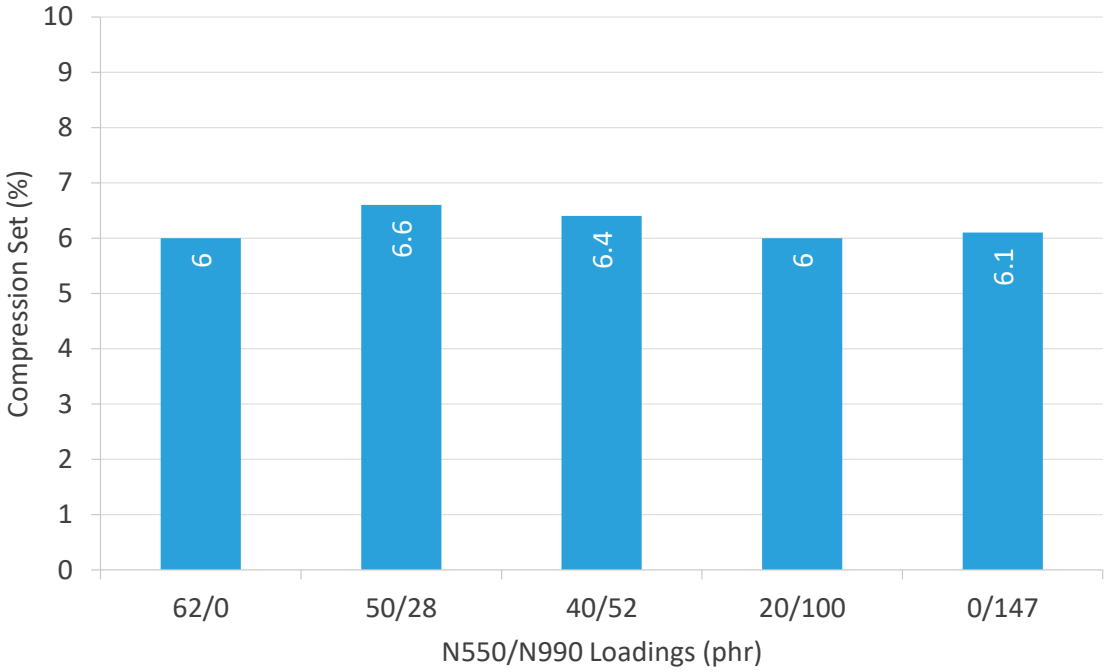

Figure 9. Compression set after 24 hours at 120°C for the compounds. No significant differences in compression set were observed.

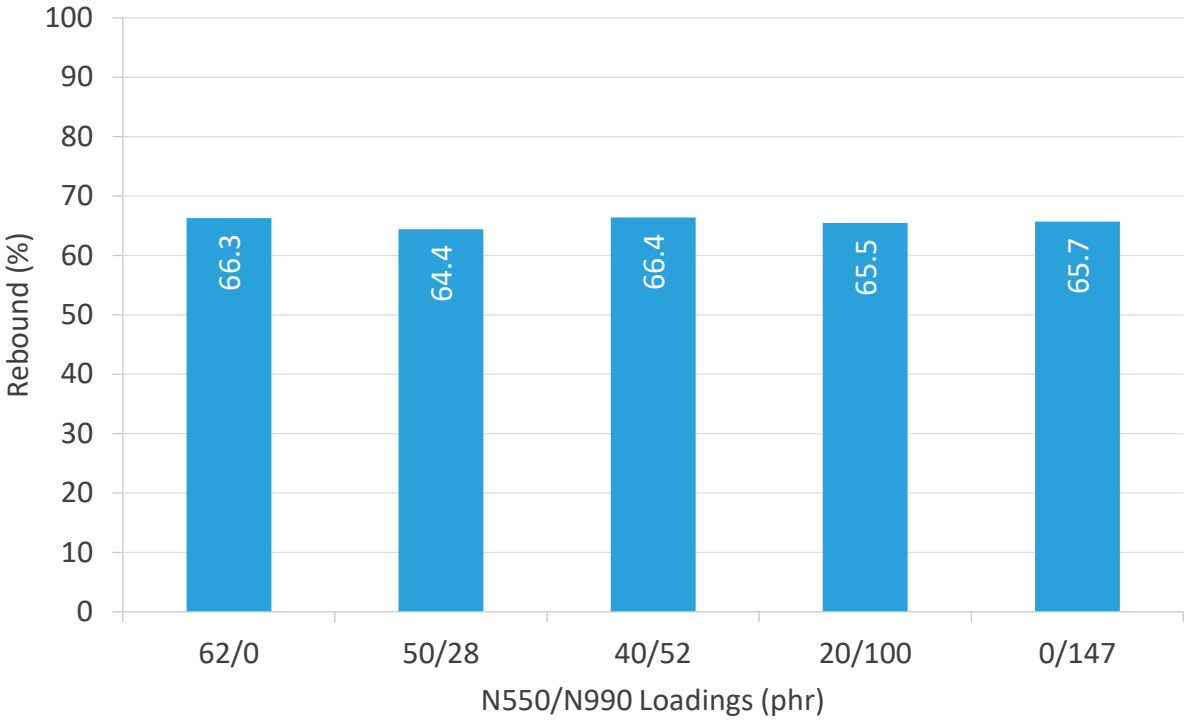

Figure 10. Rebound for the compounds. No significant differences were observed.

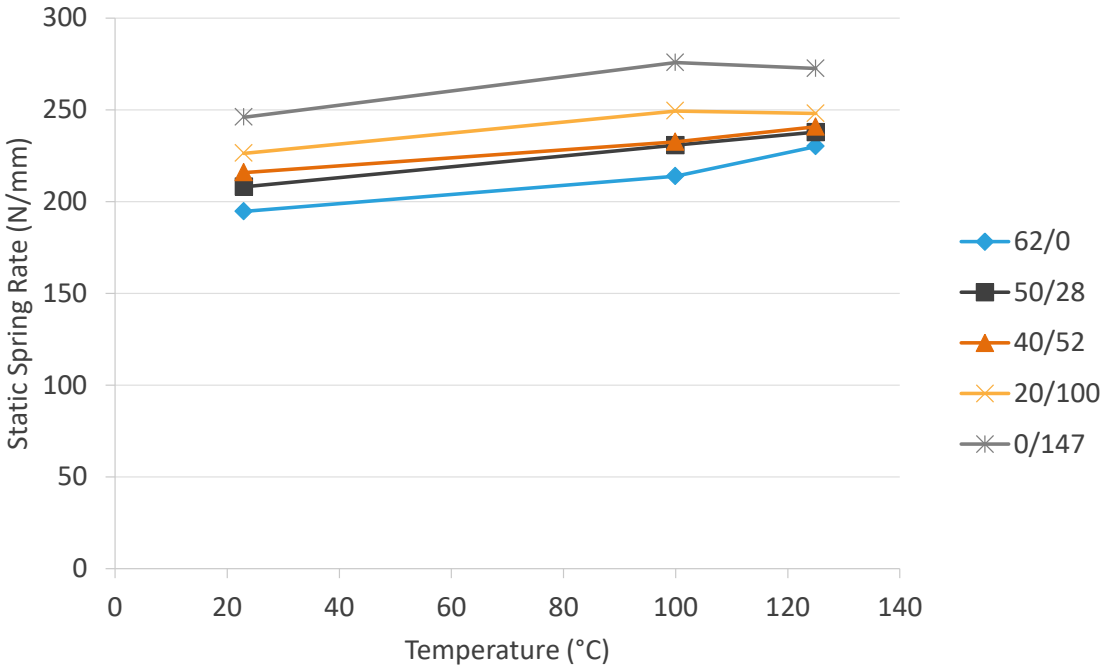

Figure 11. Static spring rate versus temperature for the compounds. Static spring rate tended to increase as N990 replaced N550.

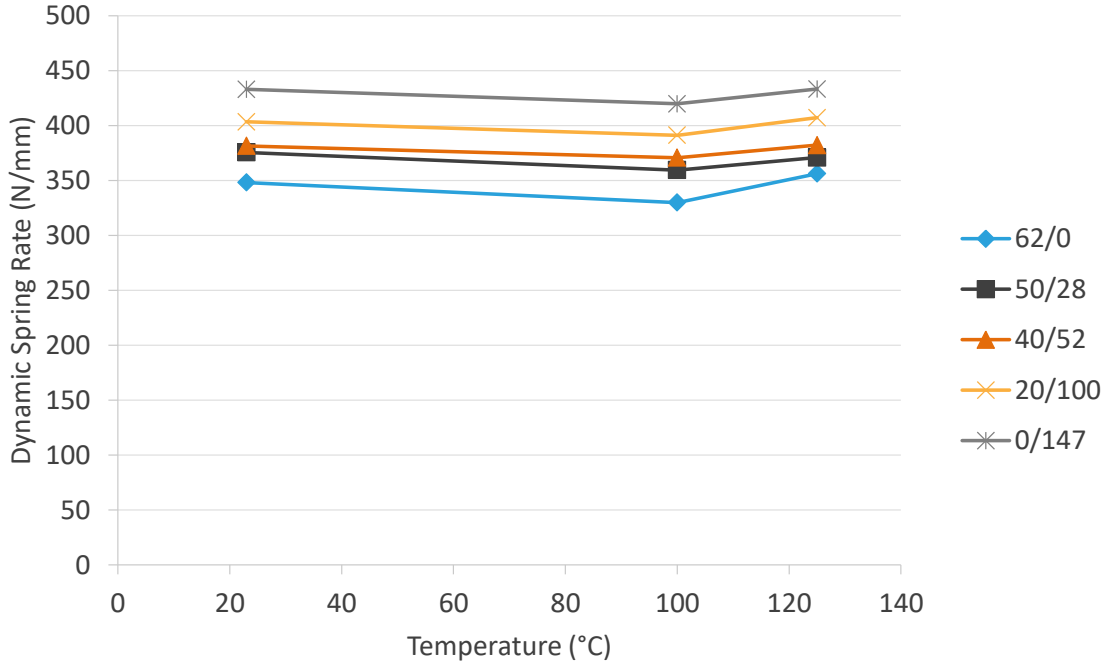

Figure 12. Dynamic spring rate versus temperature for the compounds. Dynamic spring rate tended to increase as N990 replaced N550.

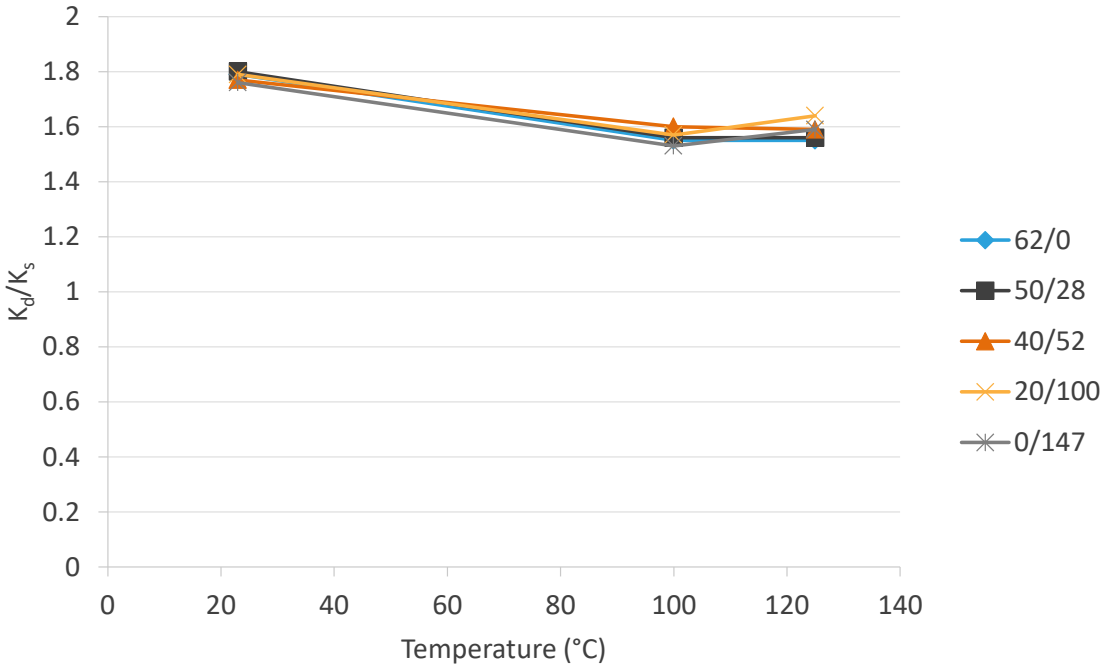

Figure 13. Spring rate ratios versus temperature for the compounds. No significant differences were observed.

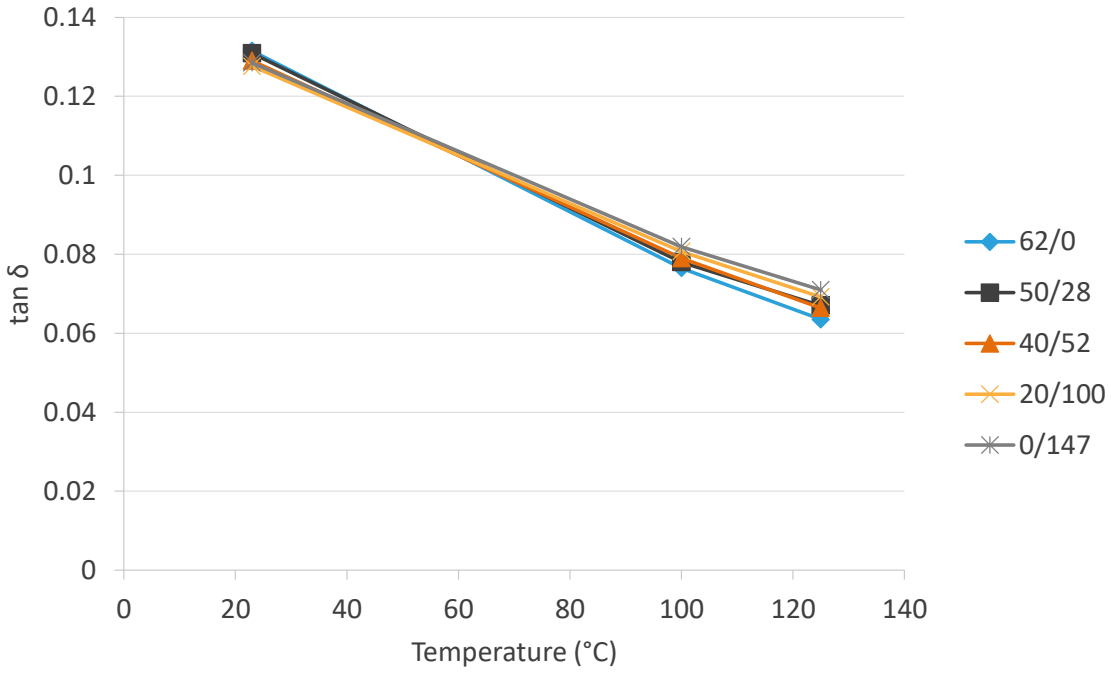

Figure 14. Tan δ versus temperature for the compounds. At elevated temperatures, tan δ tended to increase slightly as N990 replaced N550.

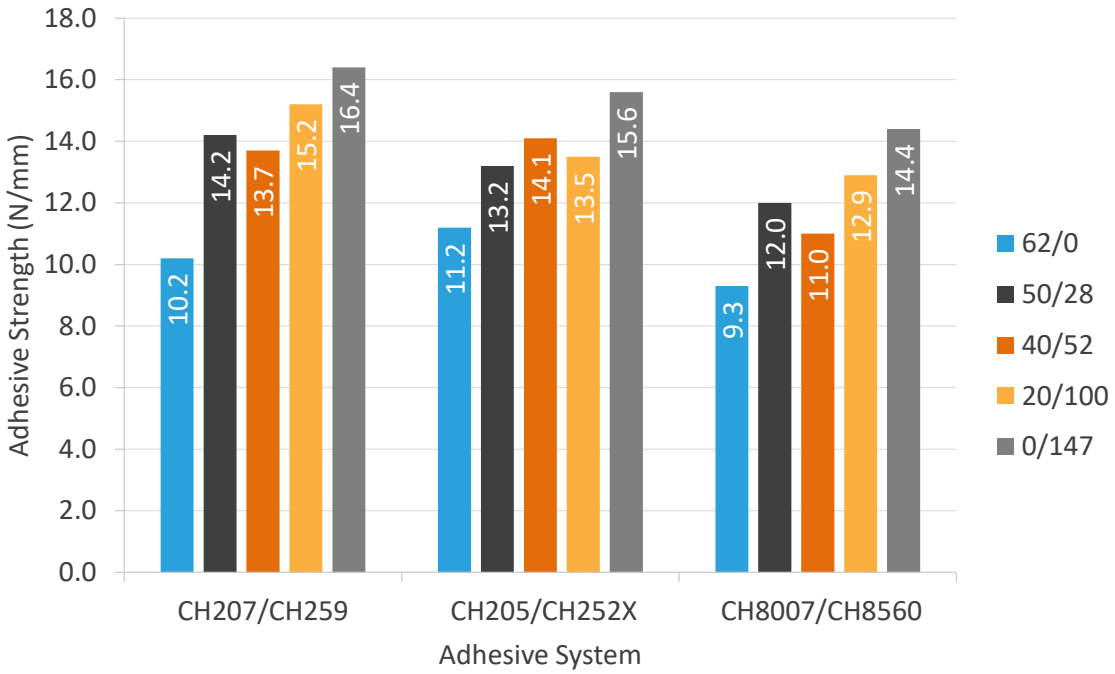

Figure 15. Adhesive strength to zinc phosphatized steel at room temperature for the compound. Adhesive strength tended to increase as N990 replaced N550.

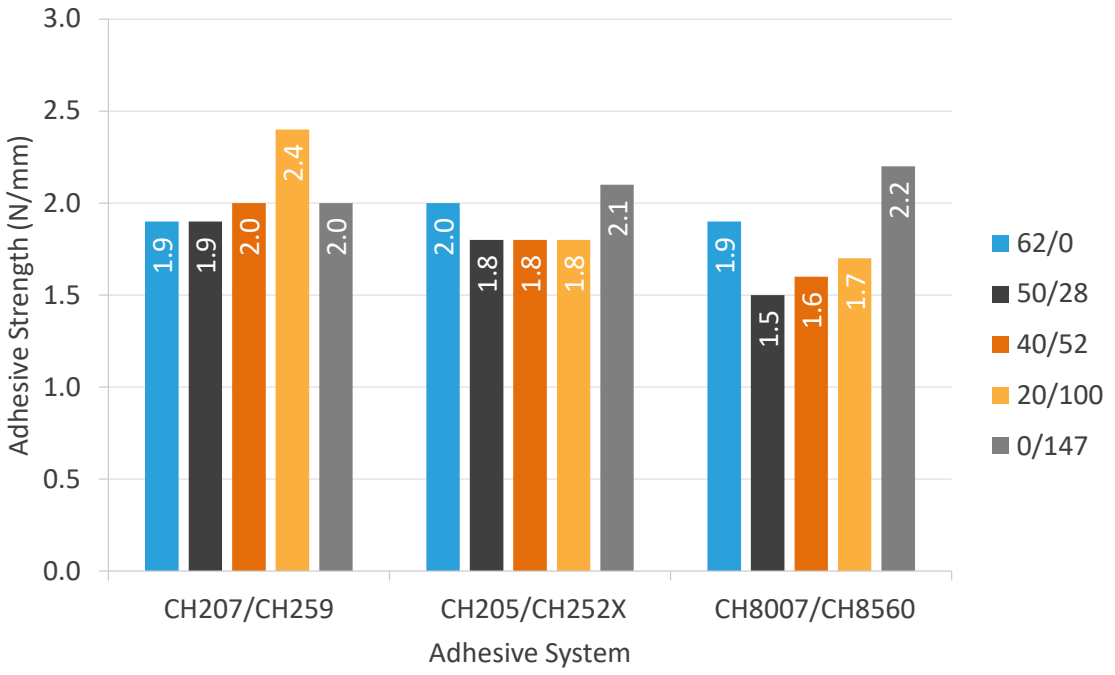

Figure 16. Adhesive strength to zinc phosphatized steel at 120°C for the compounds. No significant differences were observed.