FKM Automotive Gaskets and Seals

In this study, the effects of replacing N774 with N990 on the properties of FKM (fluoroelastomer) automotive compounds were evaluated. In particular, the impact of higher engine compartment temperatures and more chemically aggressive, lower viscosity oils on the aging properties were investigated using continuous compressive stress relaxation (CCSR). The N774 was replaced at a ratio of 1.7 phr N990:1.0 phr N774 in order to maintain a Shore A hardness of 90. A medium viscosity FKM copolymer with incorporated cure system was chosen to achieve the high levels of hardness.

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

- No significant change in hardness or tensile strength after oven aging 672 hours at 180°C. Only small changes in elongation and modulus were observed at 672 hours and these changes were smallest for compounds with highest loadings of N990.
- No significant change in compression set as N774 is replaced with N990 and total filler loading increases.
- Increase in average counterforce, a measure of the compound's sealing force, during CCSR testing as N774 is replaced with N990. Relaxation behavior versus time was similar between the compounds.
- No significant change in scorch or cure times as N774 is replaced with N990 and total filler loading increases.
- Reduction in viscosity as N774 is replaced with N990. This could provide processing advantages.
- Reduction in cost due to higher filler loading.

The FKM compound test formulations are provided in Table 1. Mooney, MDR, hardness, tensile, compression set, heat-aging, and CCSR properties were collected for each compound. CCSR testing was performed at 180°C in 0W-20 oil. Compounding and testing were performed at Akron Rubber Development Laboratories (ARDL).

Table 1. Test Formulations

Ingredient	Control	A	B	C	D
DAI-EL G-7451*	100	100	100	100	100
Thermax® N990	**-**	**16**	**26**	**36**	**50**
N774	30	21	15	9	-
Calcium Hydroxide	6	6	6	6	6
Magnesium Oxide	3	3	3	3	3
Total	**139**	**146**	**150**	**154**	**159**

*FKM polymer produced by Daikin

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

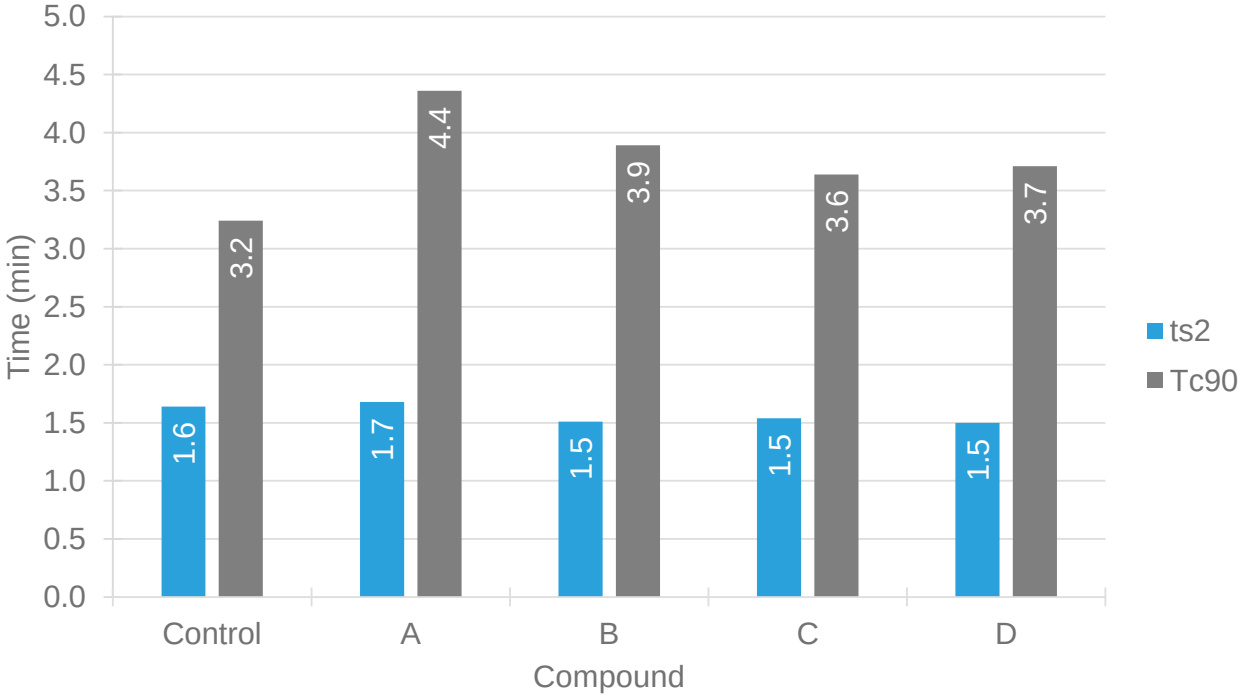

Figure 1. Scorch time, ts2, and cure time, Tc90, from MDR testing at 177°C and 0.5° arc. No significant differences were observed.

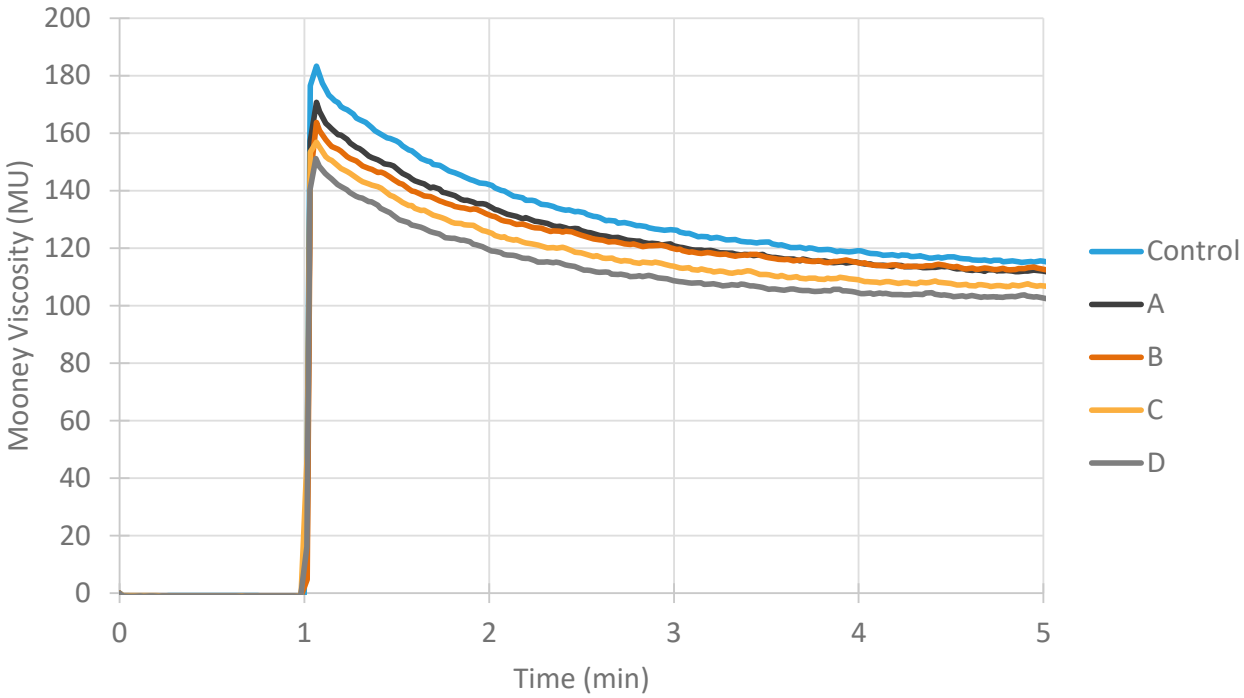

Figure 2. Mooney viscosity curves collected at 121°C with a large rotor. Viscosity decreased as N774 was replaced with N990.

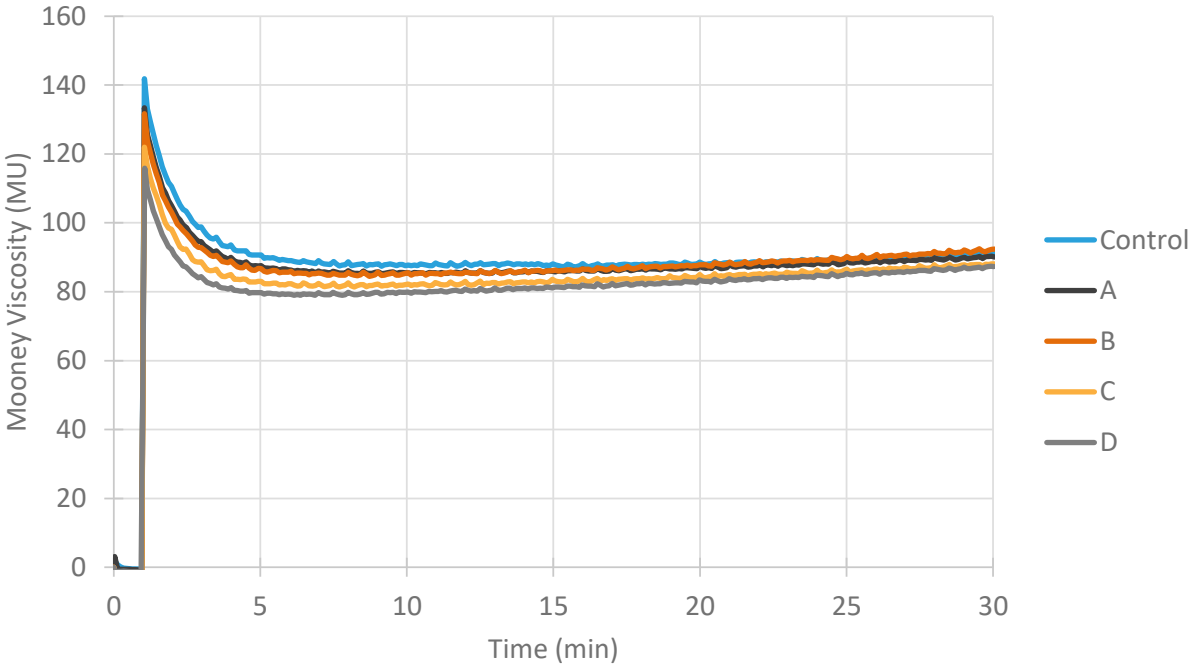

Figure 3. Mooney scorch curves collected at 135°C with a large rotor. Viscosity decreased and scorch time decreased as N774 was replaced with N990.

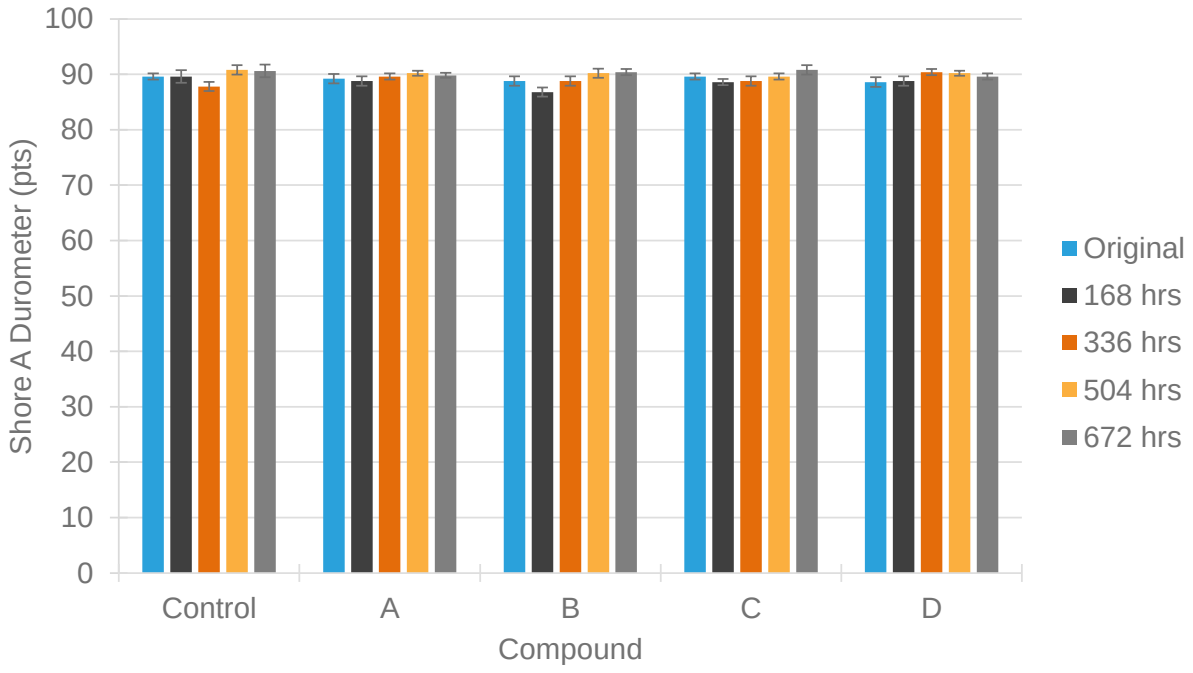

Figure 4. Hardness, original and air oven aged at 180°C, for the compounds. All compounds were within the specification of 90±5 Shore A hardness. No significant change in hardness was observed with aging.

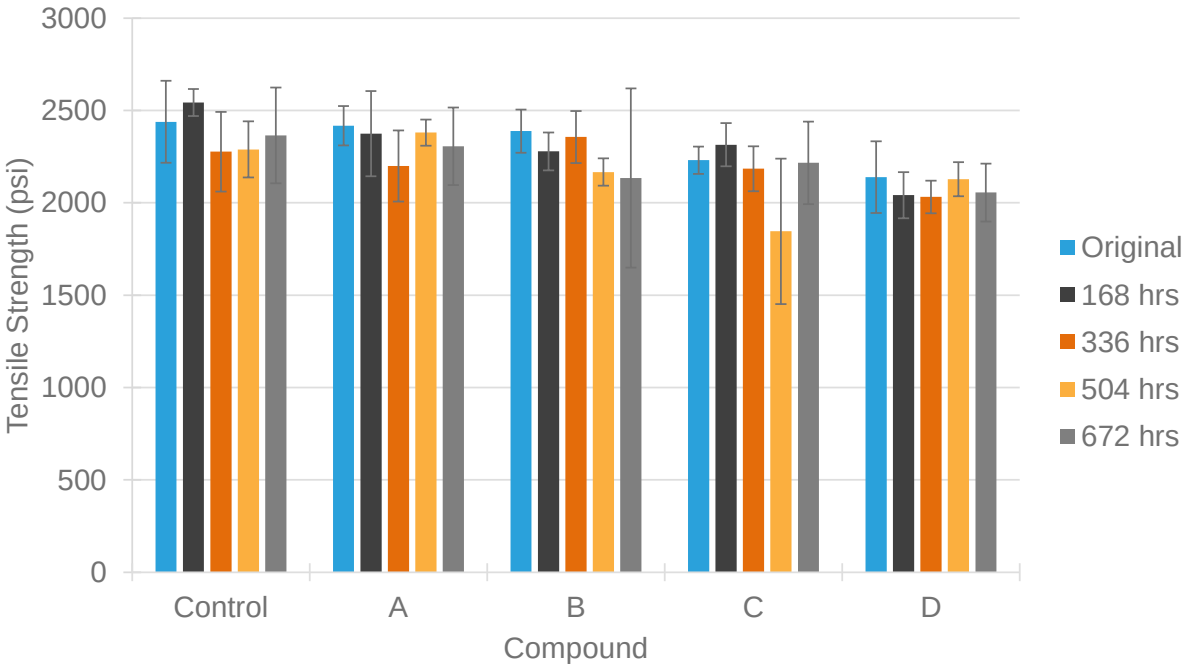

Figure 5. Tensile strength, original and air oven aged at 180°C, collected using Die C dumbbells at a crosshead speed of 20 in/min. Slabs were molded at 177°C for 10 minutes and post cured at 230°C for 24 hours. Tensile strength decreased as N774 was replaced with N990. There were no significant changes in tensile strength after aging.

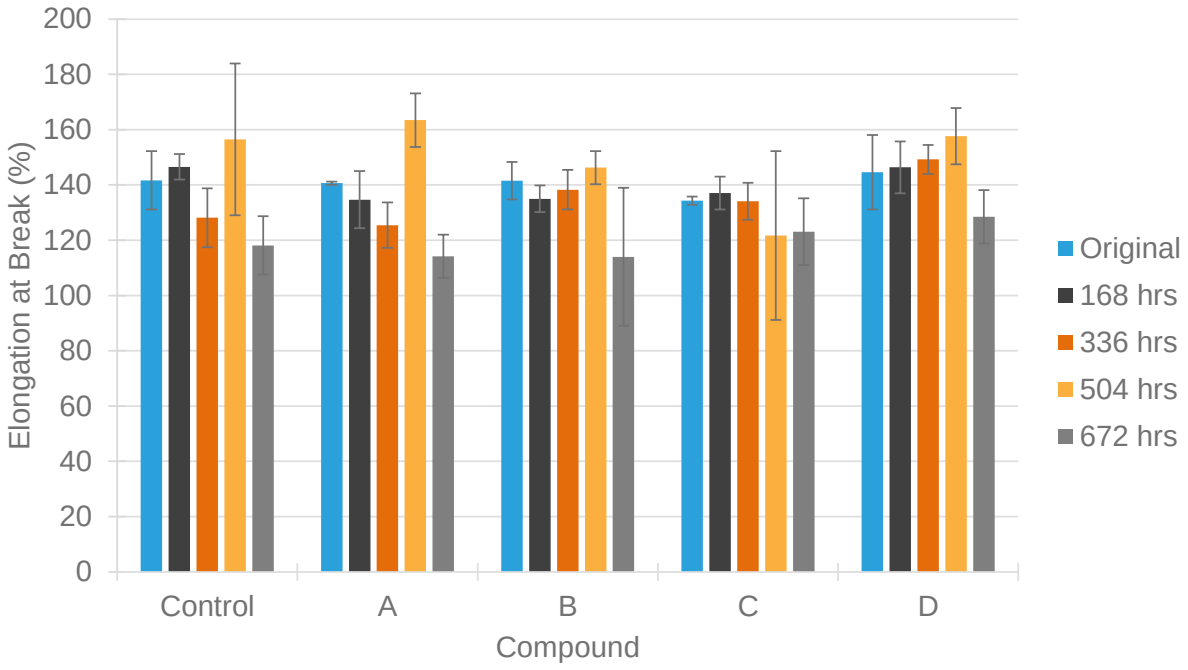

Figure 6. Elongation at break, original and air oven aged at 180°C. No significant change in values as N774 was replaced with N990. Some reduction in elongation was observed after aging 672 hours.

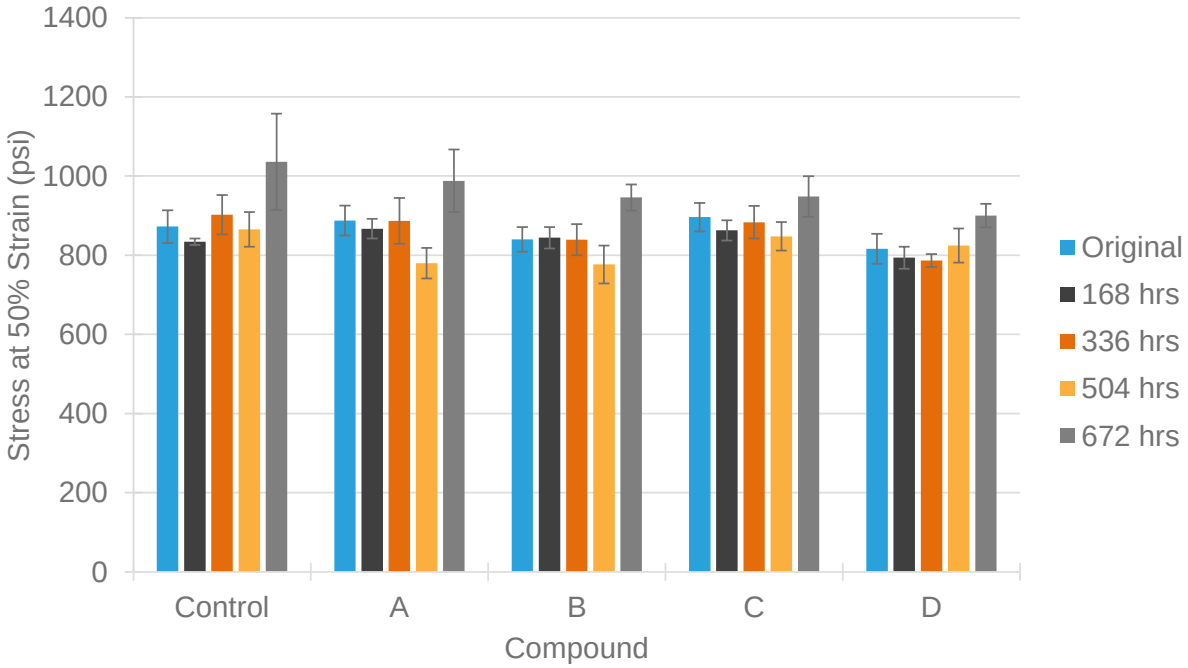

Figure 7. Stress at 50% strain, original and air oven aged at 180°C. No significant change in values as N774 was replaced with N990. Some stiffening was observed after aging 672 hours consistent with the reduction in elongation. The increase in stiffness was highest for the control compound.

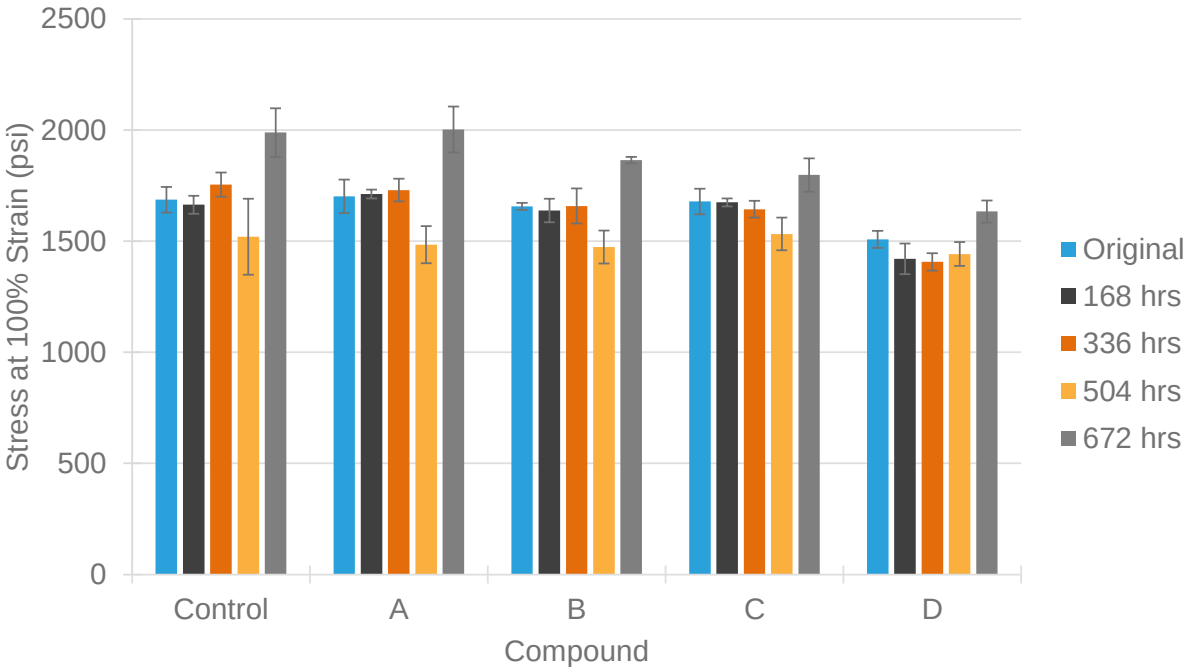

Figure 8. Stress at 100% strain, original and air oven aged at 180°C. No significant change in values as N774 was replaced with N990. Some stiffening was observed after aging 672 hours consistent with the reduction in elongation. The increase in stiffness was highest for the control compound.

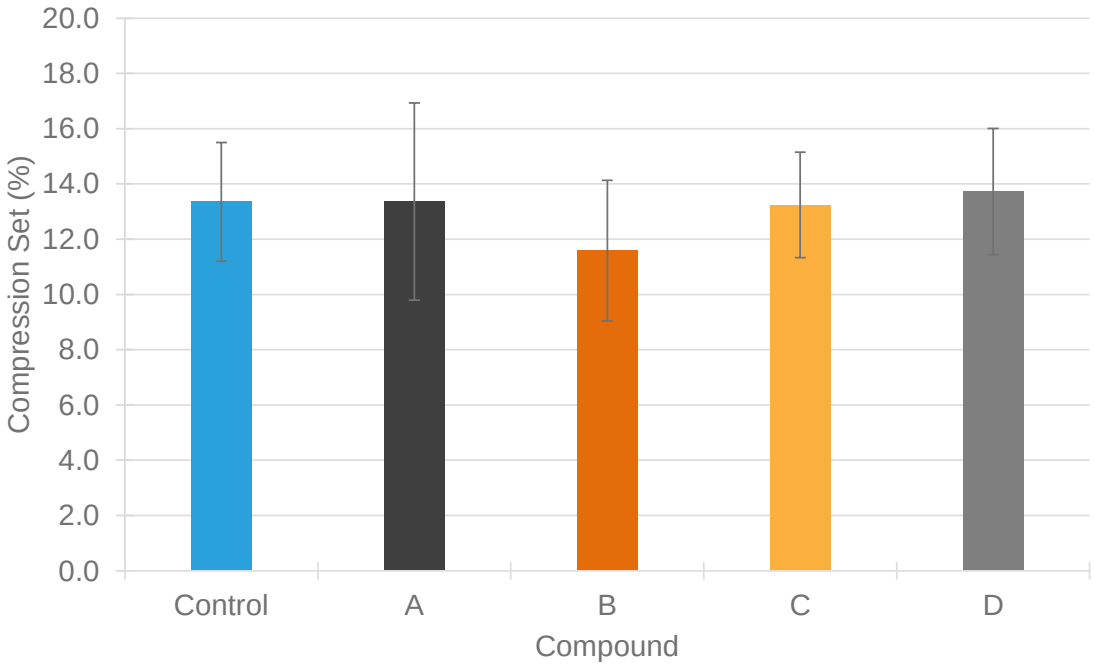

Figure 9. Compression set measured after 30-minute recovery time for buttons aged for 70 hours at 180°C under 25% deflection. Buttons were molded at 177°C for 15 minutes and post cured at 230°C for 24 hours. No significant difference in compression set was observed.

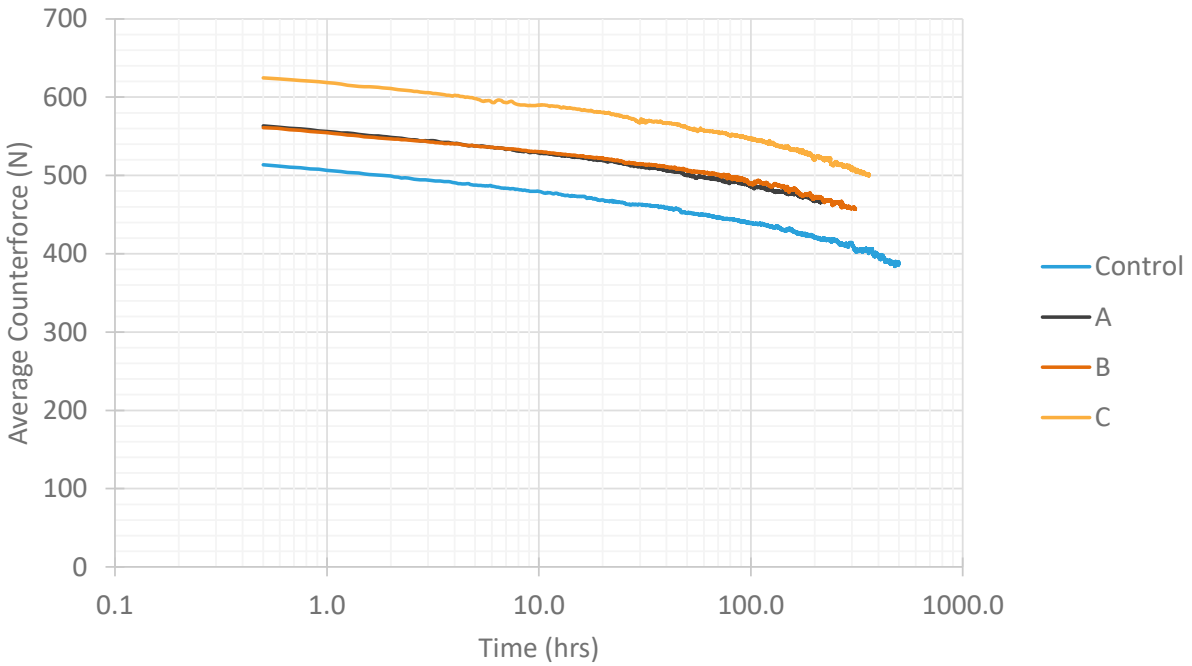

Figure 10. Average counterforce versus time during CCSR testing performed at 180°C in Mobil1 0W-20 fluid. Counterforce was higher as N774 was replaced with N990. Test results for compound D were pending at time of publication.

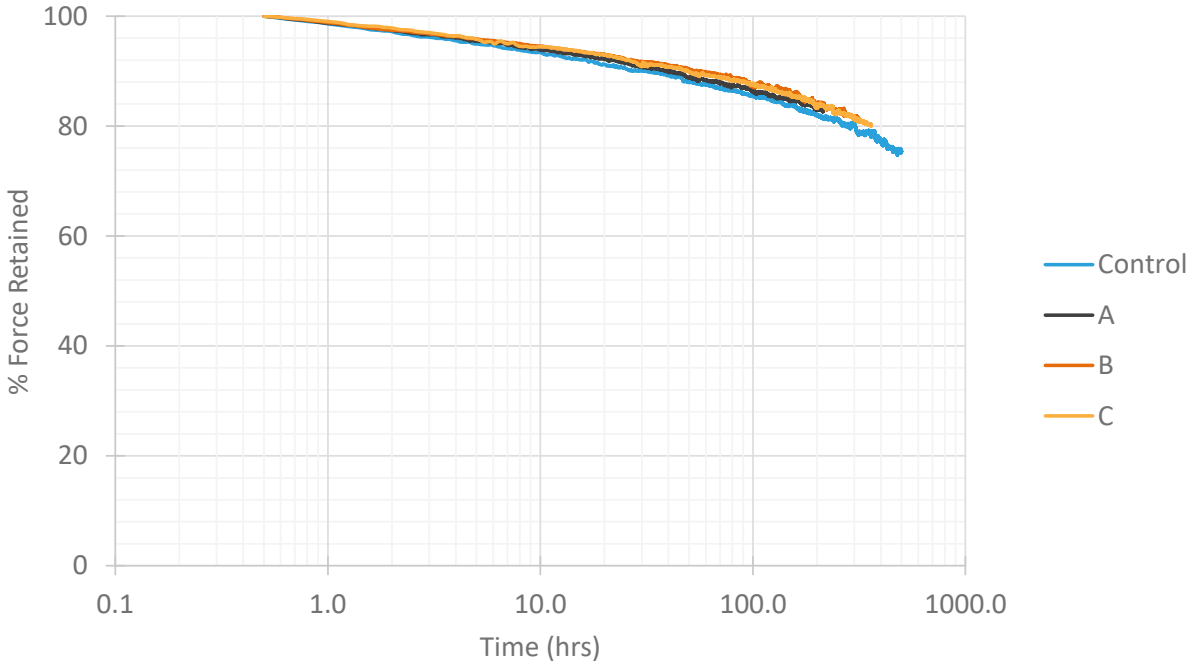

Figure 11. Percent force retained versus time during CCSR testing performed at 180°C in Mobil1 0W-20 fluid. No significant differences in relaxation were observed. Test results for compound D were pending at time of publication.

For more information about this study, please contact customer_service@cancarb.com