Thermax® N990 in Solid Tire Sub-tread

The effects of replacing N660 with N990 on the properties of NR/SBR solid tire sub-tread (also known as cushion) compounds were evaluated in this study. These compounds need to have appropriate dynamic properties to ensure low heat build-up and sufficiently long blow-out times.

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

- **Up to 14% reduction** in mixing power consumption while maintaining filler dispersion rating
- **Up to 15% reduction** in dynamic compression set
- **>75% improvement** in blow-out time
- Maintenance of physical properties such as tensile strength and elongation at break

The solid tire sub-tread compound test formulations are provided in Table 1. The N660 was replaced with N990 at 25%, 50%, and 75% levels at a 2:1 ratio to maintain a Shore A hardness of 80±5. Mooney, MDR, hardness, tensile, compression set, rebound, dynamic properties, and dispersion were collected for each compound. The compounding and testing were performed by Smithers Rapra, Inc. in Akron, OH.

Table 1. Test Formulations

Ingredient	Control	A	B	C
TSR 20	50	50	50	50
SBR 1500	50	50	50	50
N330	55	55	55	55
N660	30	22.5	15	7.5
Thermax® N990	**-**	**15**	**30**	**45**
Naphthenic Process Oil	10	10	10	10
Zinc Oxide	4	4	4	4
Stearic Acid	2	2	2	2
6PPD	1.5	1.5	1.5	1.5
TMQ	1.5	1.5	1.5	1.5
TBBS	0.5	0.5	0.5	0.5
MBTS	0.3	0.3	0.3	0.3
DTDM	1.4	1.4	1.4	1.4
Sulfur	3	3	3	3
Total	**209.2**	**216.7**	**224.2**	**231.7**

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

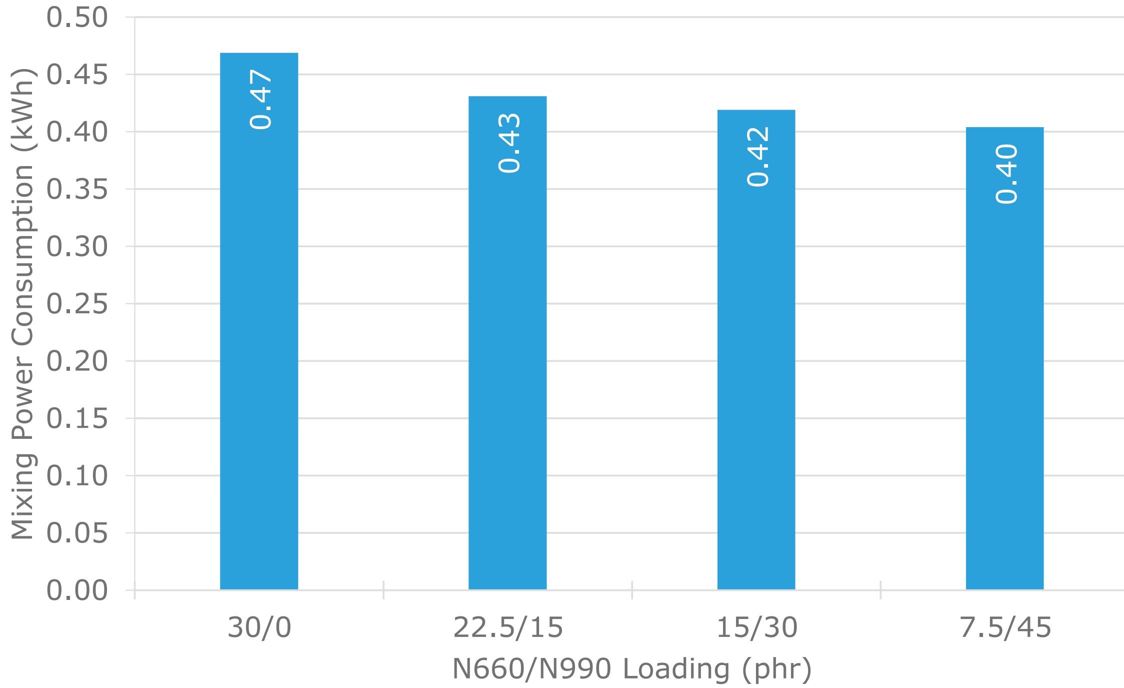

Figure 1. Mixing power consumption for each compound. Mixing power consumption decreased as N990 loading was increased, up to a 14% reduction at 75% replacement level

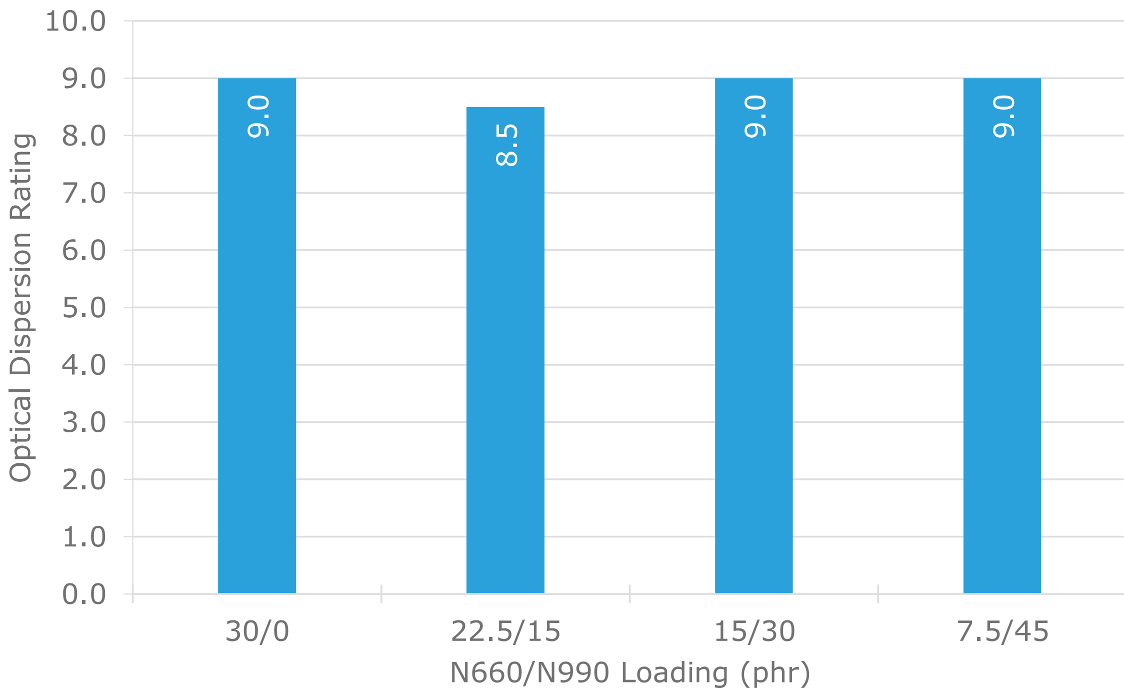

Figure 2. Optical dispersion rating for each compound. Uniform filler dispersion was achieved for all compounds.

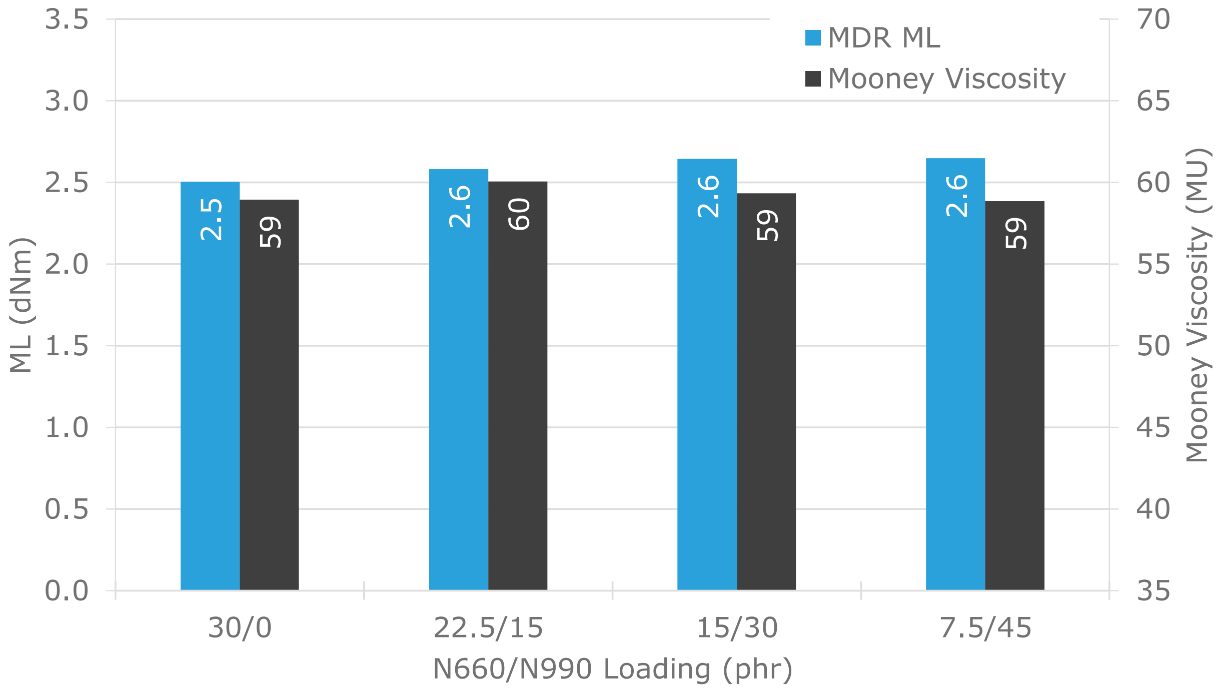

Figure 3. MDR ML (160°C) and Mooney viscosity (100°C) for all compounds. No significant differences in compound viscosity were observed.

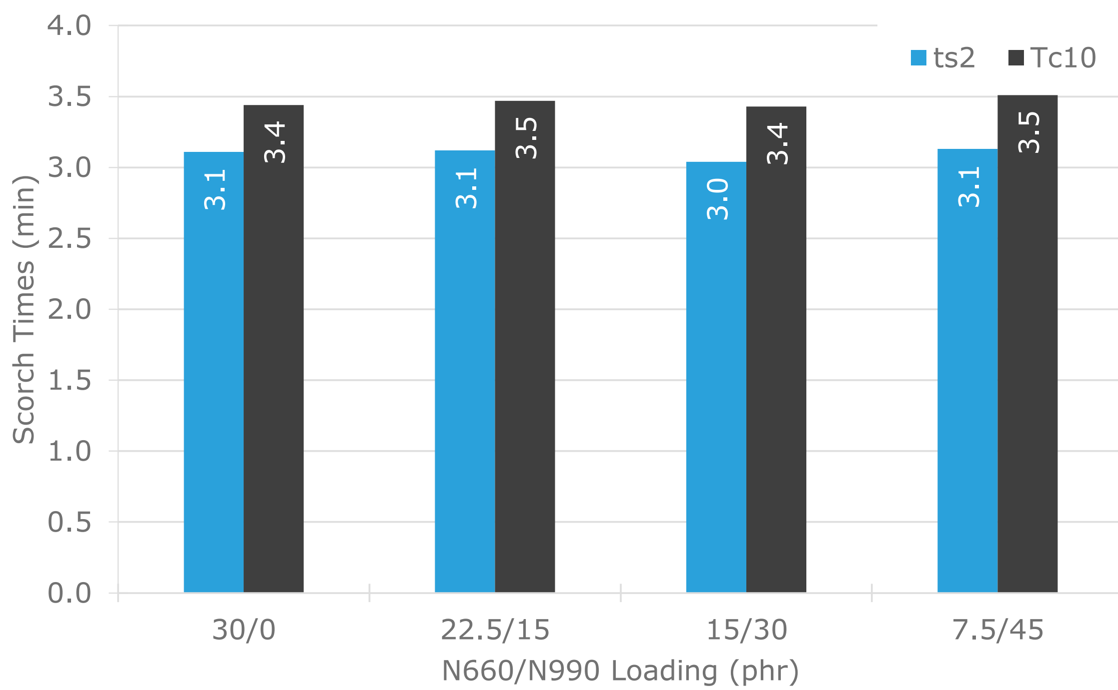

Figure 4. Scorch times, ts2 and Tc10, for all compounds. Scorch times were stable as N990 loading was increased.

1702 Brier Park Crescent N.W., Medicine Hat, AB, Canada, T1C 1T9 Phone 1.403.527.1121 Fax 1.403.529.6093 customer_service@cancarb.com www.cancarb.com

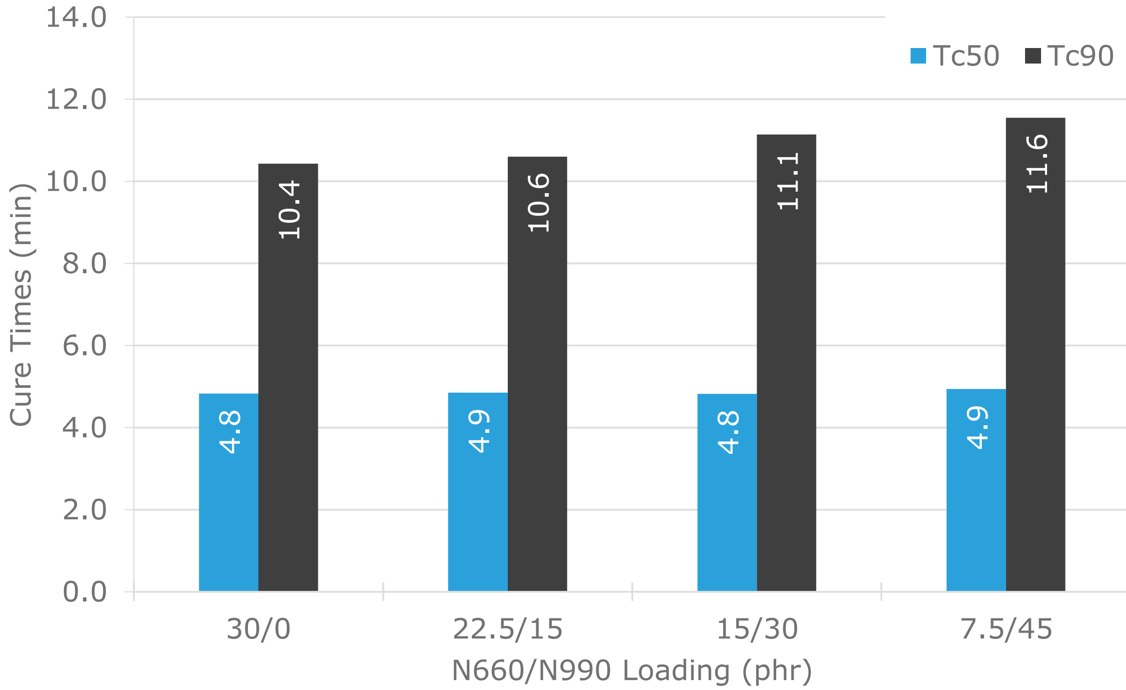

Figure 5. Cure times, Tc50 and Tc90, for all compounds. Cure times tended to increase slightly as N990 loading was increased.

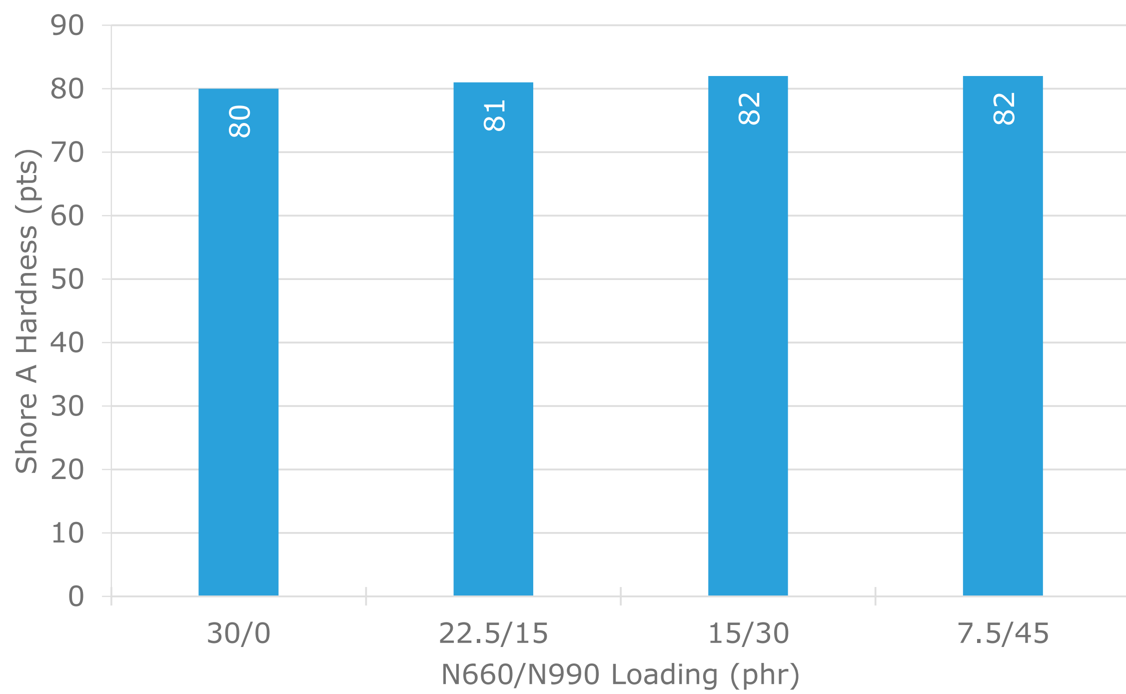

Figure 6. Shore A hardness for all compounds. All compounds were 80±5.

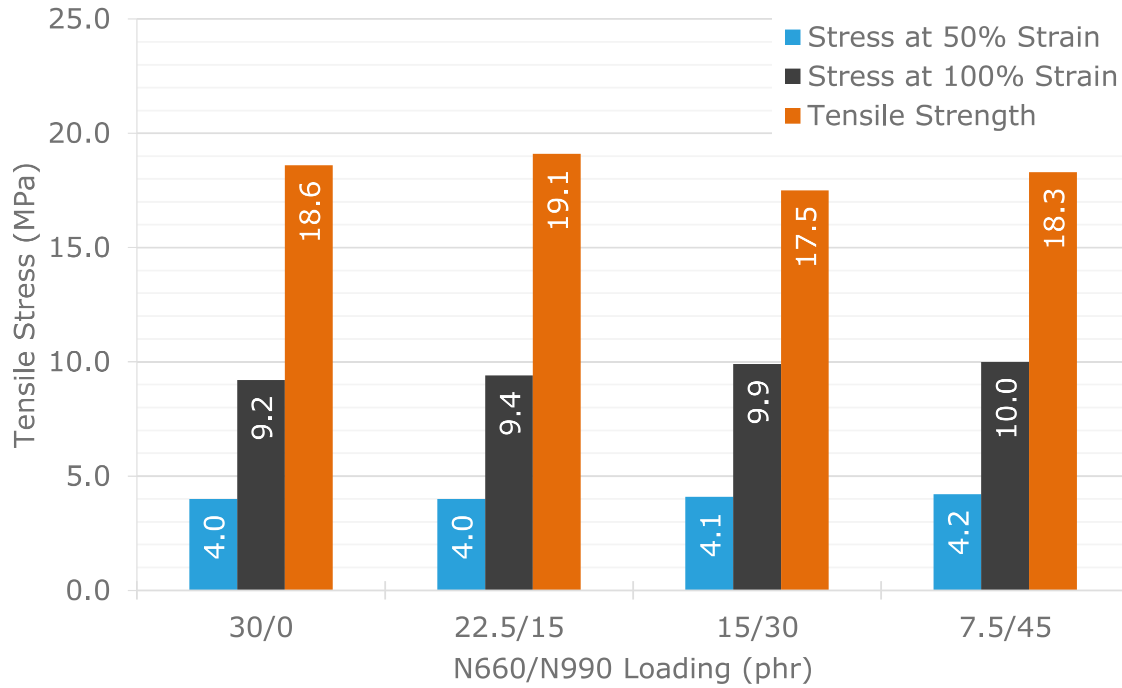

Figure 7. Tensile stress and strength for all compounds. No significant difference in stress at 50% strain was recorded. Stress at 100% strain increased slightly as N990 loading increased. Tensile strength was maintained as N660 was replaced with N990.

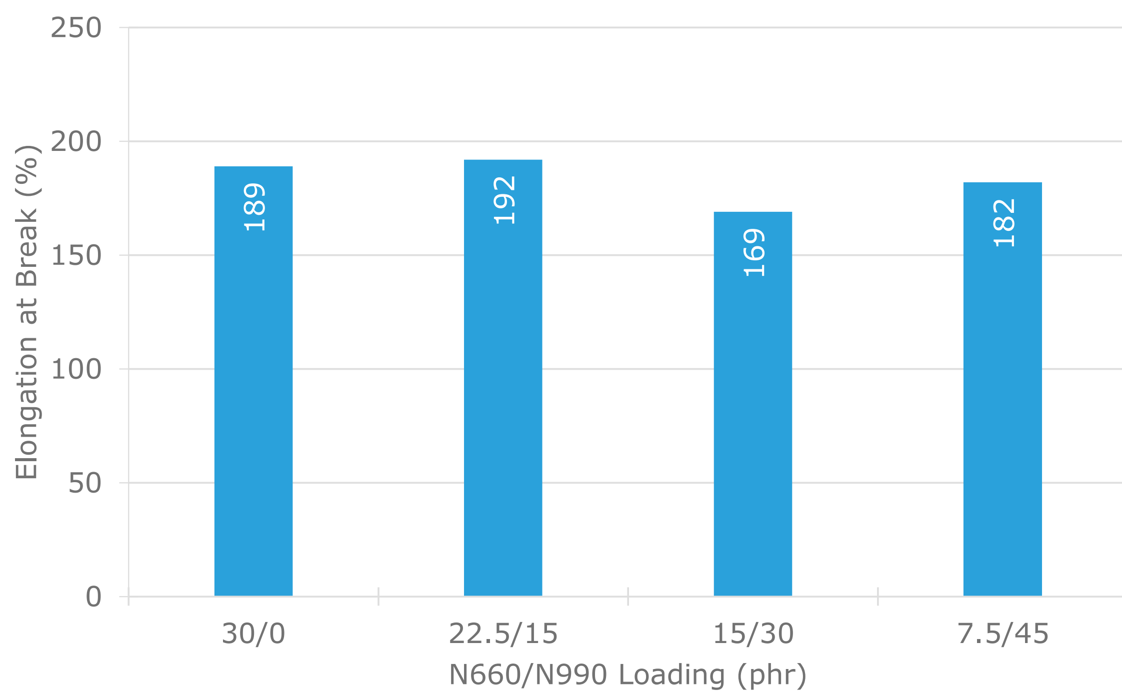

Figure 8. Elongation at break for all compounds. There were no significant differences in elongation.

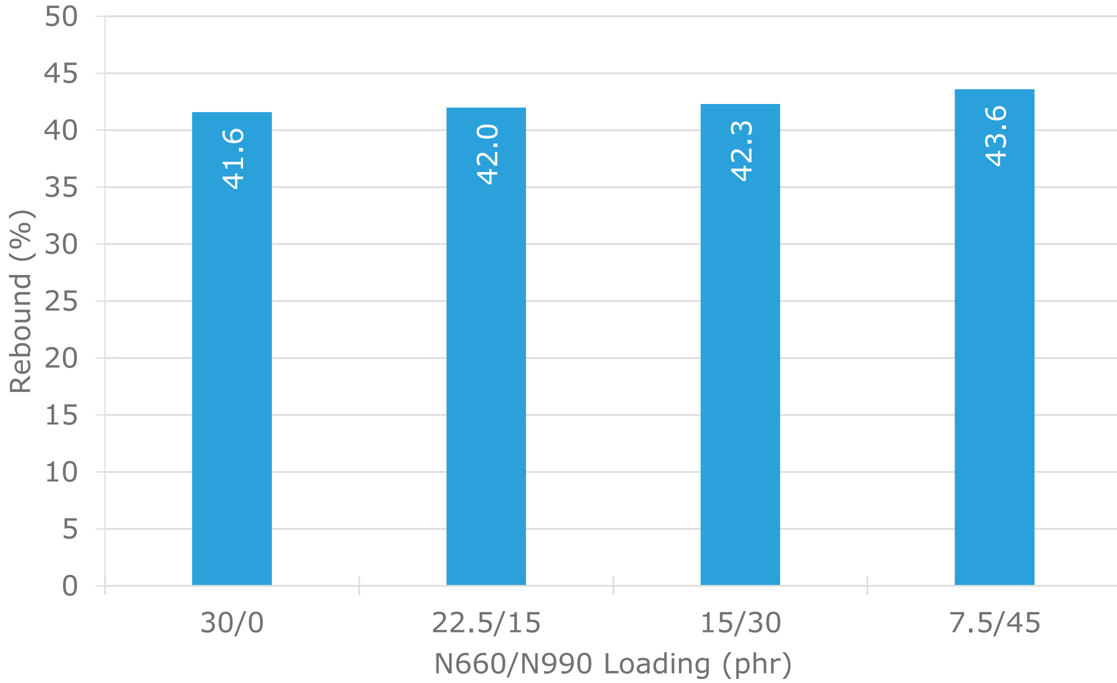

Figure 9. Rebound for all compounds. Rebound tended to increase slightly as N990 loading increased.

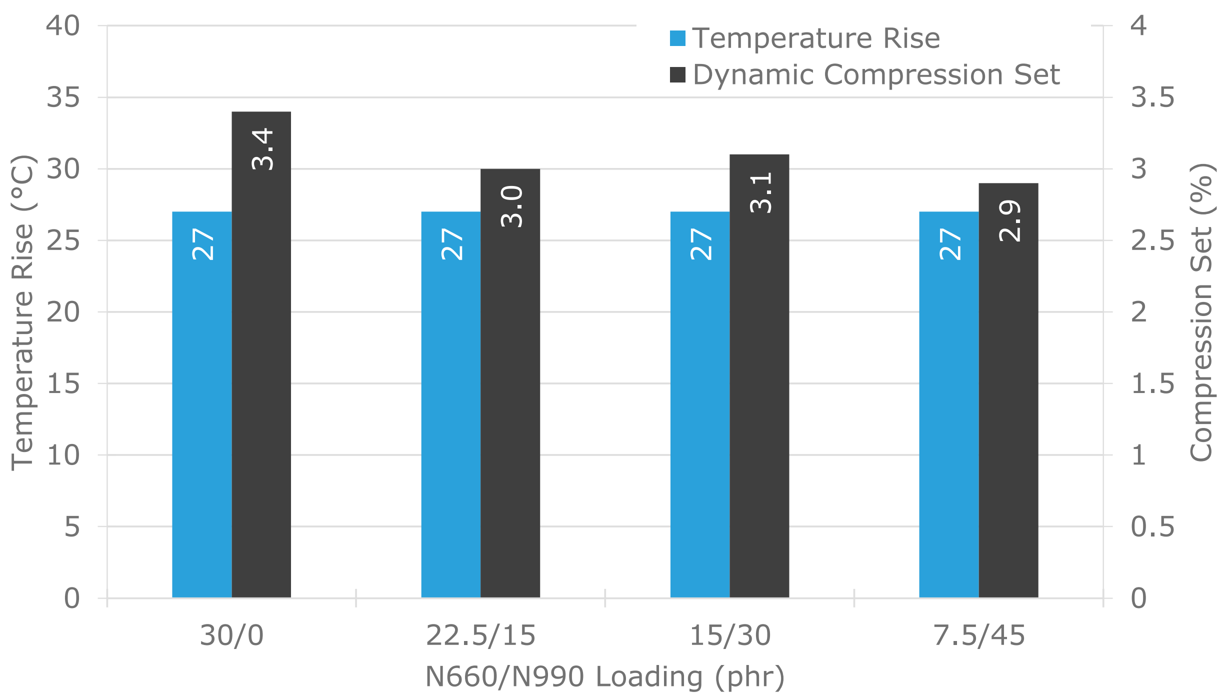

Figure 10. Goodrich flexometer heat build-up results for all compounds. Temperature rise was stable and percent set was reduced after dynamic compression flexing as N990 loading was increased. At the highest replacement level, set was reduced 15%. The heat build-up test used a static load of 55 lbf and a stroke of 0.175 inches.

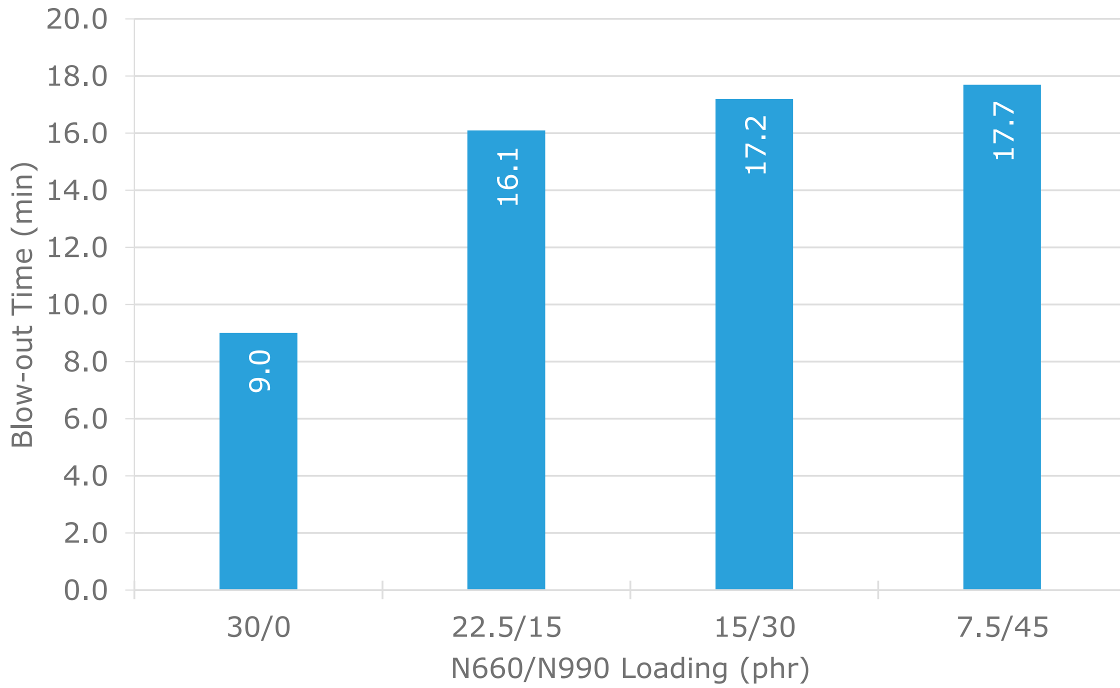

Figure 11. Goodrich flexometer blow-out results for all compounds. Significant increase in blow-out time even at low replacement levels. Blow-out time is nearly doubled at the highest replacement level. The blow-out test used a static load of 110 lbf and a stroke of 0.25 inches.