Thermax® Effects on Silicone DCBP Cure Systems

It is well known that carbon black can interfere with the cure mechanisms of silicone rubber. Typically, the surface functional groups are an issue for a DCBP (bis(2,4-dichlorobenzoyl) peroxide) cure system. Due to the relatively low surface area of Thermax® N990, it was theorized that it could be used in conjunction with DCBP cure systems at pigment loading levels (0-3 phr) without any negative effects. In order to investigate this hypothesis, Thermax® N990, Thermax® Ultra Pure N990UP, and a low color grade of furnace black were evaluated in a DCBP cured compound. The N990UP has very low levels of contaminants with similar surface area and structure as regular N990.

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

- N990 can be used with only a modest effect on crosslink density up to 1 phr
  - For comparison, 1 phr N990 resulted in 10% decrease in MH while 1 phr furnace grade resulted in 65% decrease in MH
- No difference in performance was observed between N990 and N990UP
- Cure system stability was acceptable during 28 days of ambient temperature storage whereas furnace grade compound failed to cure when tested at 7 days

The DCBP cure formulations are provided in Table 1. The relevant carbon black properties can be found in Table 2. On the following pages, the effect of the carbon black addition on cure properties and cure stability over time at ambient temperature are shown. The compounding and testing were performed by NovationSi in Barberton, OH.

Table 1. DCBP Cure Formulations

Ingredient	Control	1	2	3	4	5
65 Duro Base	100	100	100	100	100	100
DCBP	1.2	1.2	1.2	1.2	1.2	1.2
N990	-	1	3	-	-	-
N990UP	-	-	-	1	3	-
Monarch® 120	-	-	-	-	-	1
Total	**101.2**	**102.2**	**104.2**	**102.2**	**104.2**	**102.2**

Table 2. Carbon Black Properties

Parameter	Units	N990	N990UP	Monarch® 120
Nitrogen Surface Area (NSA), typical	m^2/g	9	9	30
Oil Absorption Number (OAN), typical	$cm^3/100g$	40	40	70

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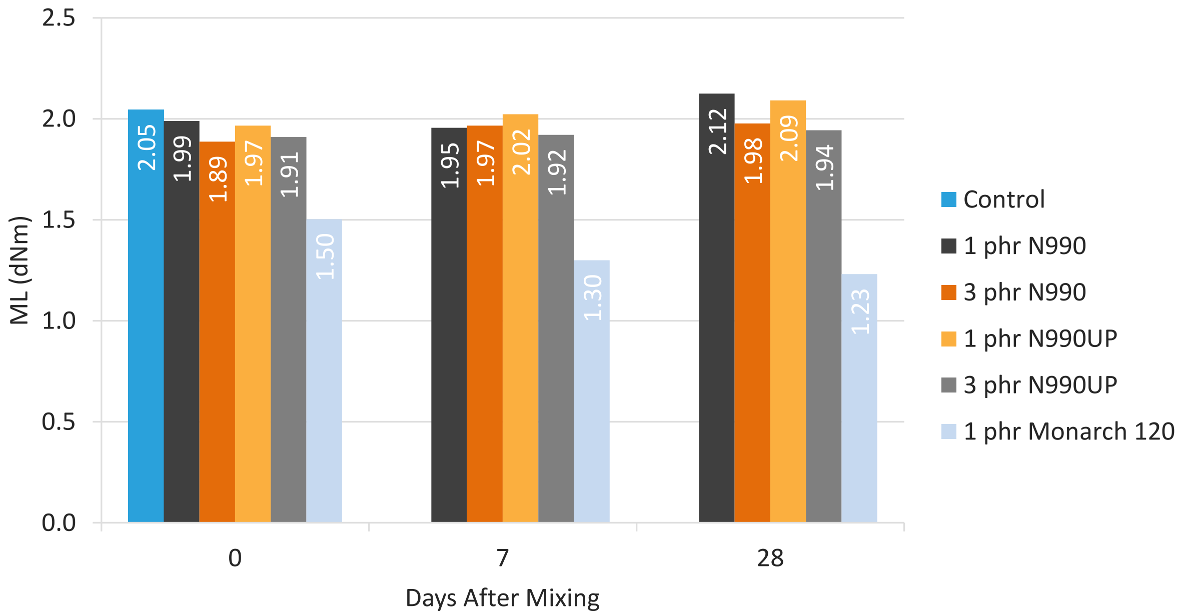

Figure 1. Minimum torque, ML, measured with MDR at 121°C and 1° arc for the DCBP cured compounds. The ML for compounds containing N990 was equivalent to the control and remained stable over time. The ML for the furnace black containing compound was immediately lower and continued to drop during storage.

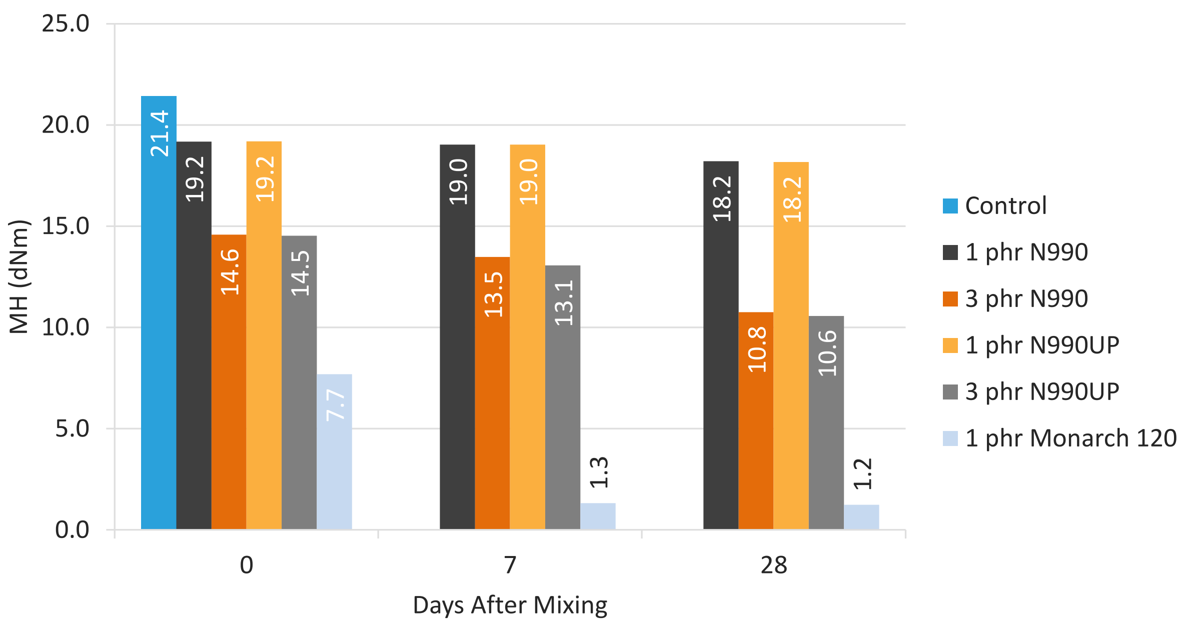

Figure 2. Maximum torque, MH, measured with MDR at 121°C and 1° arc for the DCBP cured compounds. The immediate MH decreased for all compounds. The magnitude of reduction in increasing order was: 1 phr N990 < 3 phr N990 < 1 phr furnace grade. During storage, the decrease in MH was more significant for the compounds with a higher loading of N990. The cure for the furnace grade flat lined during the storage period, meaning no crosslinking occurred.

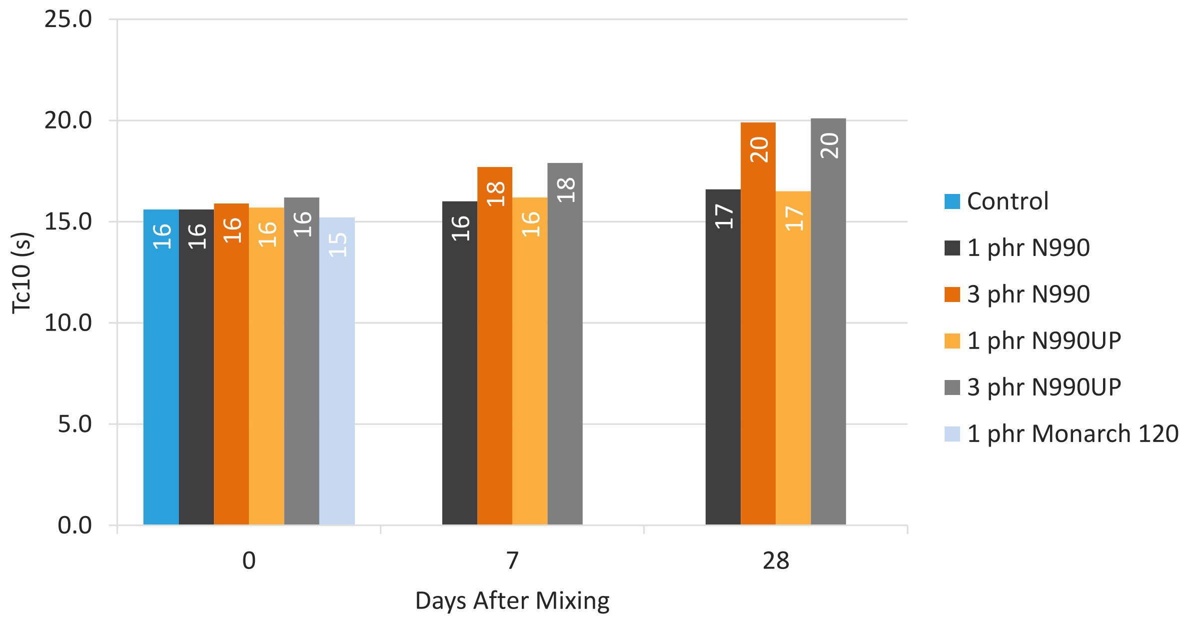

Figure 3. Scorch time, Tc10, measured with MDR at 121°C and 1° arc for the DCBP cured compounds. The scorch time tended to lengthen during the storage period with 3 phr N990 experiencing a larger increase than 1 phr N990. The furnace black compound did not cure at all after storage.

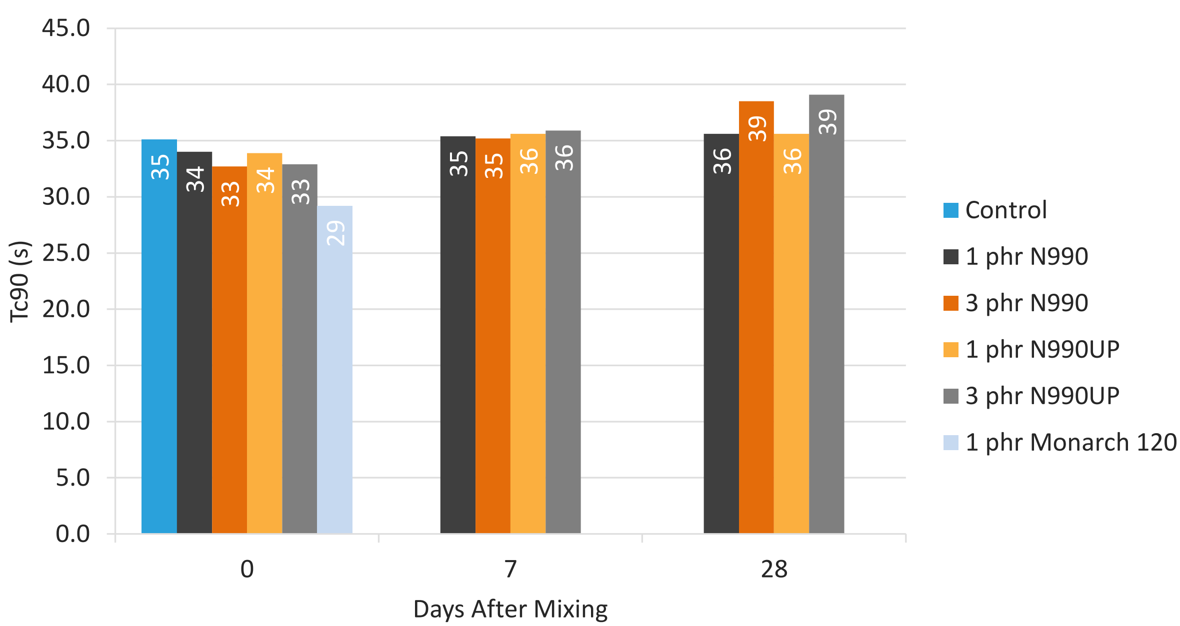

Figure 4. Cure time, Tc90, measured with MDR at 121°C and 1° arc for the DCBP cured compounds. Immediate cure time tended to be slightly lower than the control. During storage, the cure time tended to lengthen slightly. The furnace black compound did not cure at all after storage.