

Vulcanizing Natural and Synthetic Rubbers

Di-Cup® dicumyl peroxide and Vul-Cup® peroxide [a,a'-bis(tert-butylperoxy)diisopropylbenzene] are effective vulcanizing agents for natural rubber (NR), polyisoprene rubber (IR), polybutadiene rubber (BR), and styrene-butadiene rubber (SBR). These peroxides are low in cost, safe to handle, and produce vulcanizates with better heat resistance and lower compression set than sulfur-accelerator systems.

The compounds in this bulletin were vulcanized with Di-Cup® 40KE dicumyl peroxides and Vul-Cup® 40KE peroxide. Other forms of Di-Cup® and Vul-Cup® can be used with similar results.

Peroxide vs. Sulfur Cure

Unsaturated elastomers cured with Di-Cup® dicumyl peroxide or Vul-Cup® peroxide exhibit better elevated-temperature performance than the same compounds cured with a sulfur-accelerator system. Table I, page 2, shows this comparison. The level of Di-Cup® was determined to give approximately the same state of cure as the sulfur-accelerator stock.

Formulating with Peroxide

The following basic formulation is suggested as a starting point in developing a new compound. If an existing formulation is to be modified to include a peroxide, remove all ingredients associated with the previous cure system and add Di-Cup® dicumyl peroxide or Vul-Cup® peroxide as indicated.

Formulation	Parts by Weight	
NR, IR, BR, or SBR	100	
Filler	Variable	
Zinc oxide	5.0	
Antioxidant	1.0	
Peroxide	(See Below)	
	Di-Cup® 40KE	Vul-Cup® 40KE
For NR, IR, SBR	2.5-5.0 phr	1.5-3.0 phr
For BR	1.2-2.5 phr	0.75-1.5 phr

Typical results using this formulation are shown in Table II. All compounds contain 50 phr HAF black and can be cured as follows:

Peroxide	Elastomers			
	NR	IR	BR	SBR
Di-Cup® 40KE, phr	4.0	3.2	1.2	2.4
Vul-Cup® 40KE, phr	2.5	2.0	0.75	1.5
Conditions				
Di-Cup 40KE	25 min. at 330°F (166°C)			
Vul-Cup 40KE	25 min. at 340°F (171°C)			

Table I - Property Comparison - Peroxide vs. Sulfur-Cured SBR

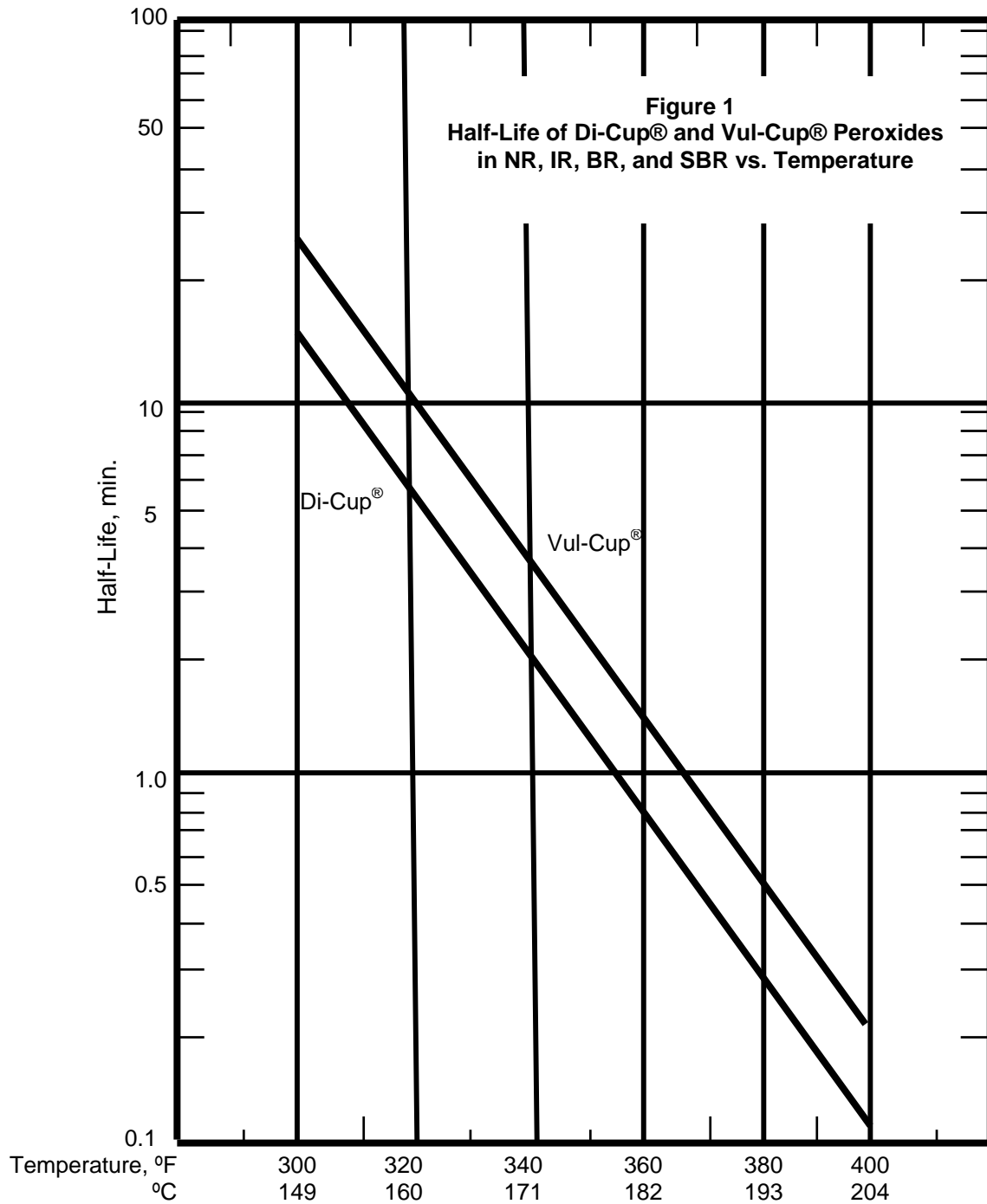
	<u>Sulfur</u>	<u>Peroxide</u>
SBR 1500	100	100
HAF black	50	50
Zinc oxide	5.0	5.0
Stearic acid	1.0	1.0
Octamine®	1.0	1.0
Circosol® 4240	13	13
Santocure® NS	1.0	---
Sulfur	1.8	---
Di-Cup® 40KE	---	3.2
Cure time, min.	45	25
Cure temperature, °F (°C)	300 (149)	330 (166)
<u>Unaged Properties</u>		
300% modulus, psi (Mpa)	1,430 (9.9)	1,325 (9.1)
Tensile strength, psi (Mpa)	3,450 (23.8)	2,820 (19.4)
Elongation, %	585	480
Shore A hardness, points	55	48
<u>Air-Oven-Aging, 48 hrs. at 212°F (100°C)</u>		
300% modulus, psi (Mpa)	2,785 (19.2)	1,250 (8.6)
Tensile strength, psi (Mpa)	2,785 (19.2)	2,200 (15.2)
Elongation, %	300	440
Shore A hardness, points	64	47

Table II - Comparison of Peroxide-Cured Unsaturated Elastomers

	<u>NR</u>	<u>IR</u>	<u>BR</u>	<u>SBR</u>
Unaged Properties				
100% modulus, psi (Mpa)	300 (2.1)	190 (1.3)	300 (2.1)	270 (1.9)
200% modulus, psi (Mpa)	1,320 (9.1)	580 (4.0)	740 (5.1)	950 (6.6)
Tensile strength, psi (Mpa)	2,860 (19.7)	2,540 (17.5)	1,110 (7.7)	2,975 (20.5)
Elongation, %	300	450	270	360
Shore A hardness, points	58	52	57	63
<u>Air-Oven-Aging, 70 hrs. at 212°F (100°C)</u>				
100% modulus, psi (Mpa)	225 (1.6)	155 (1.1)	335 (2.3)	390 (2.7)
200% modulus, psi (Mpa)	750 (5.2)	465 (3.2)	790 (5.4)	1,200 (8.3)
Tensile strength, psi (Mpa)	1,625 (11.2)	2,160 (14.9)	1,100 (7.6)	2,780 (19.2)
Elongation, %	500	270	320	
Shore A hardness, points	45	45	55	61
<u>Compression set, %</u>				
70 hrs. at 212°F (100°C)	12.0	18.5	30.0	31.0

Cure Time

The cure curves of unsaturated elastomers with Di-Cup® dicumyl peroxide and Vul-Cup® peroxide follow the normal peroxide curing pattern and are related to the peroxide decomposition rate. Figure 1 contains the plots of Di-Cup® and Vul-Cup® peroxide half-life vs. temperature.



For additional information, or to place an order or sample request, call 1.800.331.7654

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