

Technical Information for Performance Solutions

Peroxide Levels in MILLATHANE® 66

Millathane® 66 is a polyester millable urethane that has excellent abrasion resistance, heat resistance and oil resistance. Millathane 66 is widely used for seals and rollers that require these excellent properties and is easily processed on standard rubber equipment. Millathane 66 is a polyurethane rubber that is peroxide-curable only, and the question oftentimes comes up regarding the optimum level of peroxide to use to optimize a certain property. A study was done in a silica reinforced Millathane 66 compound, comparing the properties of compounds with levels of DBPH-50 from 4 to 8 phr. The formulation is shown below. Testing was done on the compounds per ASTM D2000, and the compounds generally met the requirements of M2BG728.

Formulation

Millathane 66	100
Stearic acid	0.2
Ultrasil VN3	25
Silquest A-172	0.5
TP-95	2
Millstab™ P	2
Struktol WB222	1
SR350	2
Varox DBPH-50	4 to 8

Topics:

- Rheometrics
- Tensile Properties
- Tear Strength
- Compression Set
- Heat, Oil and Toluene Resistance
- Abrasion Resistance
- Compound Properties per ASTM D2000 3BG728 A14 B14 EO14 EO34
- Summary
- ASK Doctor Millathane

Rheometrics

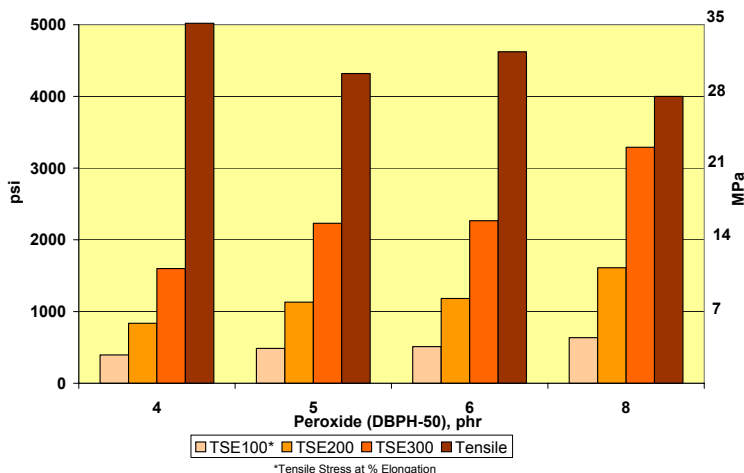
Curemeter data (MDR using a Tech-Pro MDPT), showed the MH values increasing and cure times (tc50 and tc90) decreasing as the peroxide level increases.

Varox DBPH-50	4	5	6	8
MDR at 170°C				
MH, lb-in (dNm)	31.3 (35.4)	35.0 (39.5)	37.4 (42.2)	41.7 (47.1)
t50, minutes	2.3	2.1	1.9	1.7
t90, minutes	6.6	6.4	6.1	5.5

Tensile Properties

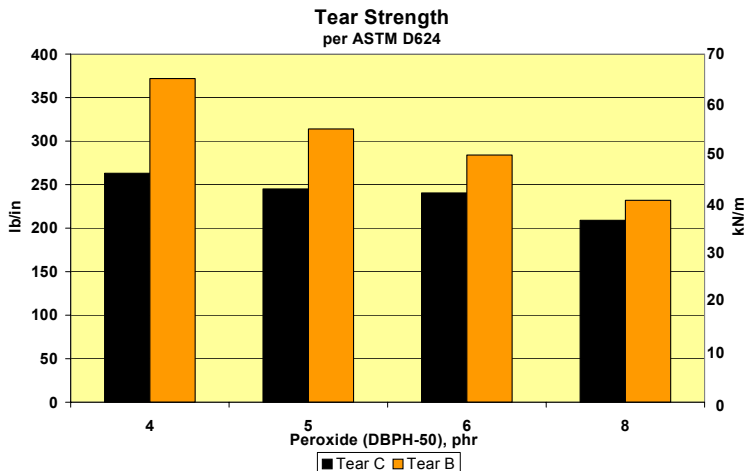
The tensile stress (aka modulus) of the compounds increased as the peroxide level increased, while the tensile strength decreased slightly.

Tensile Stress and Tensile Strength



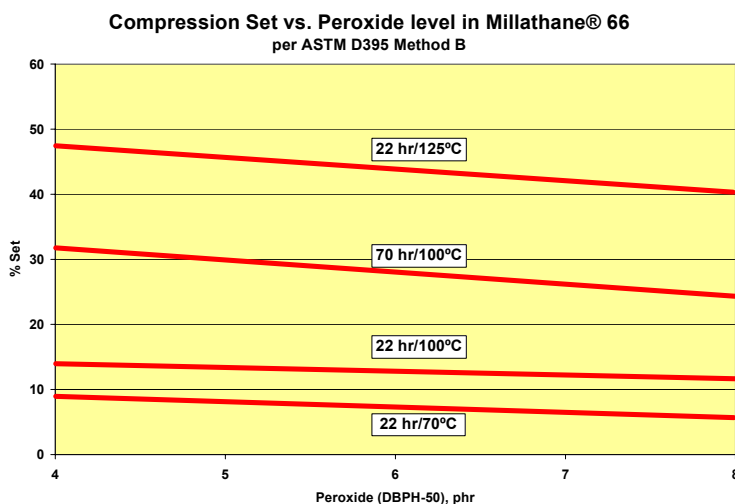
Tear Strength

Tear strength decreased somewhat as the peroxide level increased, slightly for Tear Die C and more significantly for Tear Die B.



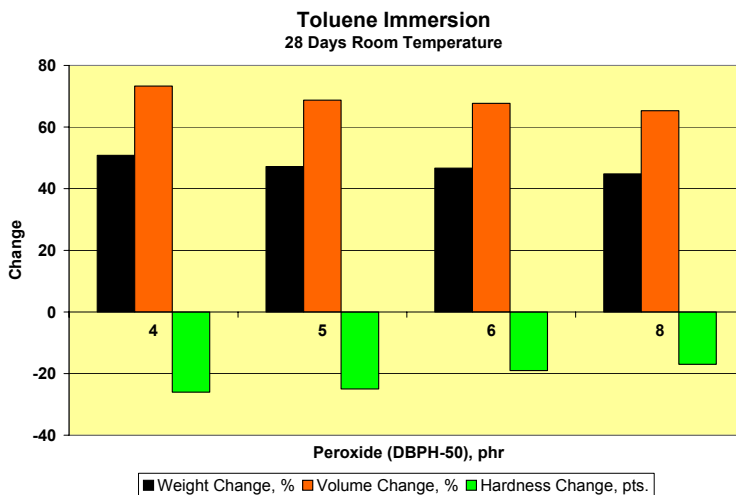
Compression Set

Compression set decreases (improves) as the peroxide level increases, as expected. The effect of peroxide level is more prominent with longer test times and higher temperatures.



Heat, Oil and Toluene Resistance

All the compounds had excellent heat and oil resistance as seen by the data in the table on the following page. Property and volume changes were minimal after 70 hours at 100°C in either IRM 901 or IRM 903 oil, or oven aging. Compounds were also tested for resistance to toluene for 28 days at room temperature (~23°C). The data, in the chart to the right, show less hardness, volume and weight changes as the peroxide level increases.



Abrasion Resistance

All compounds had excellent abrasion resistance, giving between 69 and 88 mm³ loss in the DIN abrasion test (ASTM D5963), with no significant correlation of abrasion resistance with peroxide level.

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FACTOID: To get or offer help on rubber problems, visit the Eng-Tips forum at www.eng-tips.com/threadminder.cfm?pid=335.

MILLATHANE®

FACTOID: Some antimicrobial additives (e.g., fungicides) can adversely affect cured properties in millable urethanes. Contact us for a recommendation if you're considering use of this type of additive.

Compound Properties per ASTM D2000 3BG728 A14 B14 EO14 E034

The properties of the compounds in this study are shown below, comparing them to those of ASTM D2000. The compounds with 4-6 parts of DBPH-50 meet all the requirements of ASTM D2000 3BG728A14B14EO14EO34 and 4BG728A14B14EO14EO34, with the compound with highest peroxide level (8 phr of DBPH-50) being slightly deficient in tensile and elongation for the 28 MPa tensile requirement, although it would easily meet the 17 MPa requirement. Since the 5 and 6 part DBPH-50 compounds are both 75 Shore A, they'd meet the requirements of either 70 ± 5 or 80 ± 5 Shore A hardness, and could be easily be hardened or softened slightly to center the hardness on 70 or 80 Shore A, if necessary.

These compounds would also be expected to pass the requirements of the ASTM D2000 suffixes C12 (ozone resistance) and F17/F19 (low temperature brittleness).

Millathane® 66	100			
Stearic acid	0.2			
Ultrasil VN3	25			
Silquest A-172	0.5			
TP-95	2			
Millstabil™ P	2			
Struktol WB222	1			
SR-350	2			
Varox DBPH-50	4	5	6	8
Total	136.7	137.7	138.7	140.7

Original Properties

Hardness, Shore A	73	75	75	75
Tensile Strength, MPa	34.6	29.8	31.9	27.6*
Elongation, %	535	425	435	335*

*Doesn't meet BG728 but would meet BG717

Oven Aged 70 hr/100°C

Hardness change, points	2	2	3	4
Tensile change, %	-6	4	2	-10
Elongation change, %	-6	-1	-6	-9

Compression Set

22 hr/100°C, % set	16	12	12	13
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IRM 903 Oil Aging 70 hr/100°C

Hardness change, points	1	-1	-1	0
Tensile change, %	-13	-11	-18	-14
Elongation change, %	1	1	-7	6
Volume Change, %	0.1	-0.1	0	-0.3

IRM 901 Oil Aging 70 hr/100°C

Hardness change, points	-4	-5	-4	-1
Tensile change, %	-5	2	-4	-9
Elongation change, %	-3	4	-4	-1
Volume Change, %	-3.2	-3.5	-3.5	-3.7

ASTM D2000 Requirements		
BG Basic	Grade 3	Grade 4
70 ± 5		
28		
400		

BG Basic	A14
± 15	± 5
± 30	± 15
-50 max	-15 max

BG Basic	B14	B14
+50 max	+50 max	+50 max

	EO34	EO34
	-10 to +5	-10 to +5
	-35 max	-35 max
	-40 max	-40 max
+40 max	+16 to +35	0 to +6

EO14	EO14
-7 to +5	-7 to +5
-20 max	-20 max
-40 max	-40 max
-5 to +10	-5 to +5

Summary

Millathane 66 is a polyester millable urethane that gives excellent abrasion resistance, physical properties and oil resistance. The compounds in this study will meet the requirements of ASTM D2000 for BG class materials.

For most applications, peroxide levels of 5-6 parts of DBPH-50 give the best balance of properties. Higher peroxide levels give somewhat better compression set and solvent (toluene) resistance, while lower peroxide levels give better tear strength. Although this study was done with the peroxide DPBH, similar results would be expected with dicumyl peroxide.

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ASK Doctor Millathane®

Dear Dr. Millathane,
I have an application where I need a polyether urethane for resistance to moisture, and need a sulfur cure for the high properties it gives in polyether millable urethane, but I need to improve the heat resistance to meet a specification. Can you help?
Hot, but not ready to trot

Dear Hot,

For better heat resistance in a sulfur cured compound, you can try modifying the cure system to be closer to the “classic” sulfur cure system that was originally developed by DuPont for use with Adiprene CM (now Millathane® CM). The cure system that’s typically used today with millable urethanes is MBTS-4, MBT-2, Thanecure® ZM-1, and sulfur-1.5. The “classic” cure system is similar but has lower levels of MBT (1 phr), Thanecure ZM (0.35 phr) and sulfur (0.75 phr).

The “classic” cure system will give you the following properties vs. the standard cure system (from an evaluation in a Millathane CM compound with N330 black for reinforcement):

- * Longer cure times
- * Lower tensile strength
- * Better heat resistance
- * Poorer abrasion resistance
- * Higher compression set

“Classic” cure versus Standard cure

Test	“Classic” Cure	Standard Cure
Cure time at 160°C, minutes	19	8
Tensile strength, psi (MPa)	4190 (29)	4790 (33)
Tensile, Hot Air 70 hr/100°C, % change	-2	-38
Elongation, Hot Air 70 hr/100°C, % change	-26	-53
DIN abrasion, mm ³ loss	76	55
Compression set, 22hr/70°C	52	43

Also, the classic cure system gave poorer cured samples when cured at higher temperatures than the standard cure system, giving somewhat dimpled surfaces when cured at temperatures higher than 150°C.

So, for heat resistance improvement in sulfur cures, try the “classic” cure system but be aware that longer cure times at lower cure temperatures may be necessary. Other properties, as seen in the table above, may be slightly lower than expected.

Dr. Millathane

If you have any Millathane millable urethane questions you’d like answered, please send an email to millathaneinfo@tse-industries.com.