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Technical Information for Performance Solutions

Millathane® 66 Compounds for High Heat Resistance

Millable polyurethane rubber is not particularly known for its high heat resistance, typically being used at temperatures less than 100ºC. For applications that need non-continuous exposure to temperatures up to 150ºC, peroxide cured polyester millable urethanes such as Millathane 66, Millathane 5004 and Millathane 28 can have good retention of properties at moderately high temperatures, approaching 150ºC.

This report evaluates the heat aging and compression set of an 88 Shore A Millathane 66 compound, this work initiated at the request of a customer who was interested in producing rollers that would be used at temperatures up to 140ºC. The compound, shown below, uses Millathane 66 Premilled which contains 1.5 parts of Millstab™ P, a polymeric carbodiimide hydrolysis stabilizer, which also is beneficial to heat aging properties. Two levels of peroxide were evaluated, as higher levels of peroxide generally give better (lower) set values.

Topics:

Formulation

Millathane® 66 Premilled	101.5
Stearic acid	0.2
N550	20.0
N330	20.0
TP-95 (DBEEA)	4.0
Struktol WB222	1.0
AC 617A	1.0
SR 350 (TMPTMA)	20.0
Varox DBPH-50	6, 10

Ingredient Information

DBEEA is available from Rohm & Haas as TP-95 and from C.P. Hall as Plasthall 226. AC617A is low melting polyethylene from Honeywell. TMPTMA is available from Sartomer as SR350 and from other suppliers. Varox DBPH-50 is available from R.T. Vanderbilt.

Original Properties

These compounds exhibited excellent tensile strengths and good elongations for these high hardness compounds.

	DBPH-50 = 6	DBPH-50 = 10
Mooney Viscosity, ML(1+4)/100ºC	36	35

MDR, 20'/170ºC		
ML, lb-in	0.9	1.3
dNm	1.0	1.5
MH, lb-in	52.9	61.0
dNm	59.8	69.0
ts1, minutes	0.2	0.2
t90, minutes	5.9	6.1

Press Cure, 6 minutes at 170°C

Hardness, Shore A	88	88
TSE-100*, psi	1680	2260
MPa	11.6	15.6
Tensile Strength, psi	3350	3550
MPa	23.1	24.5
Elongation, %	185	155
Tear, Die C, lb/in	162	122
kN/m	28.4	21.4

*TSE-xxx=Tensile Stress at xxx% Elongation

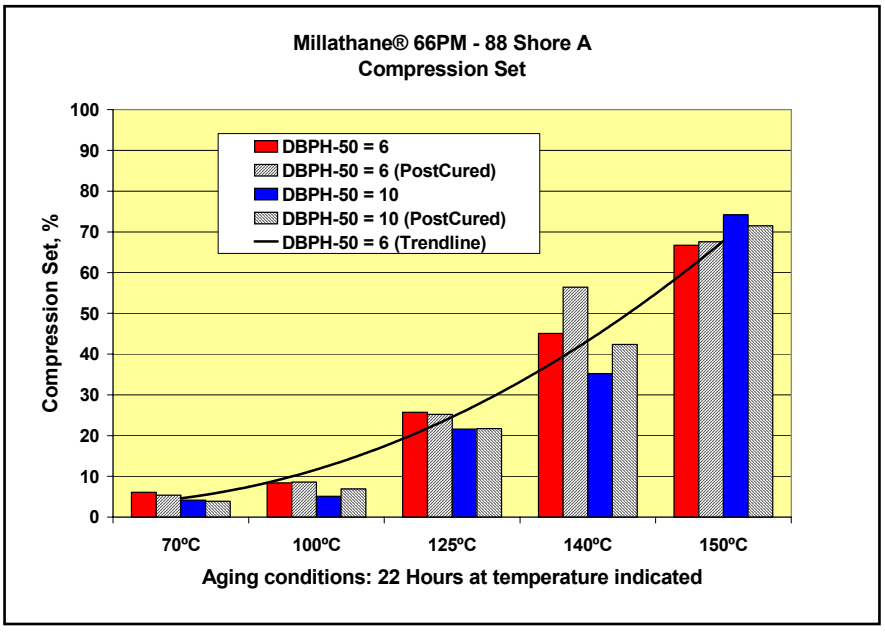
Bashore Resilience %	41	41
DIN Abrasion, mm³ loss	107	128

MILLATHANE® ***FACTOID:*** *A new video has been produced demonstrating internal mixer and mill mixing, as well as testing, of a Millathane E34 compound. Call us if you'd like a copy.*

Compression Set Properties

Compression set, tested by ASTM D395 Method B, showed very good results at temperature up to 140ºC. The higher peroxide level was beneficial to the set for all temperatures except for the highest temperature, 150ºC. Both compounds easily met the compression set requirements of ASTM D2000 BG (and CE and CH) materials.

Giving the compounds a post cure of 2 hour at 125ºC did not provide any benefit to compression set.



Heat Aging Characteristics

The data below shows excellent retention of properties after heat aging up to 150ºC. There didn't seem to be any significant difference in heat aging characteristics between compounds with the two different peroxide levels.

Heat Aging Properties for Compound A (DBPH-50 = 6)

	Original	70 hr/ 70ºC	70 hr/ 100ºC	70 hr/ 125ºC	70 hr/ 140ºC	70 hr/ 150ºC
Hardness, Shore A	88	87	89	87	86	88
Change	—	-1	+1	-1	-2	0
Tensile Strength, psi	3350	3360	3360	3640	2820	2980
MPa	23.1	23.2	23.2	25.1	19.4	20.6
% Change	—	0	0	+9	-16	-11
Elongation, %	185	185	180	190	130	145
% Change	—	0	-3	+3	-30	-22

Heat Aging Properties for Compound B (DBPH-50 = 10)

	Original	70 hr/ 70ºC	70 hr/ 100ºC	70 hr/ 125ºC	70 hr/ 140ºC	70 hr/ 150ºC
Hardness, Shore A	88	88	88	88	88	88
Change	—	0	0	0	0	0
Tensile Strength, psi	3550	3920	4120	2370	2750	3190
MPa	24.5	27.0	28.4	16.3	19.0	22.0
% Change	—	+10	+16	-33	-23	-10
Elongation, %	155	165	170	90	100	150
% Change	—	+6	+10	-42	-35	-3

MILLATHANE® FACTOID: *The Rubber World Magazine web site (www.rubberworld.com) has a much improved technical forum that can be used to get answers to your rubber questions.*

Summary

The Millathane® 66 compounds evaluated in this study have very good compression set and heat aging characteristics up to 140ºC. The compound with the higher level of peroxide (10 parts of DBPH-50 vs. 6 parts of DBPH-50) gave somewhat better (lower) compression set at these temperatures. Postcuring the samples did not show any benefit to the set characteristics of these compounds. The effect of higher peroxide levels on Millathane 66 compounds was also seen in TIPS V5-1 (available on the Millathane Technical Information page* of our web site).

Compounds such as those in this study find use in applications such as rollers and gaskets where heat resistance, along with abrasion, oil and ozone resistance, is required

* http://www.tse-industries.com/MillathaneTech.asp

MILLATHANE® FACTOID: *TSE's web site has a new page, "What Is Millable Polyurethane", that provides some basic information on Millathane millable urethanes.*

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ASK Doctor Millathane®

Dear Dr. Millathane,
I've developed a high hardness Millathane® E34 compound (about 90 Shore A) that meets the customer's specification except for low elongation. How can I improve the elongation in this peroxide-cured compound?
"Spec" O'Lowe

Dear SOL,
Good question! There are several things that will improve elongation in your compound. First, check your peroxide level; you may be getting too "tight" of a cure by higher than optimum levels of peroxide. If your peroxide (DCP-40, for example) level is 3 phr or higher, reduce this to 2-2.5 phr, which is about optimum for Millathane E34. This should increase elongation and may also improve tensile strength.

Second, if you're only using TMPTMA (e.g., SR350 from Sartomer) as a co-agent with the peroxide, that may also be giving too tight of a cure and thus limiting elongation. Try replacing a portion of the TMPTMA with about 50% more DEGDMA (e.g., SR231). For example, if your compound contains 16 parts of TMPTMA try replacing 6 parts of it with about 9 parts of DEGDMA, giving 10 of TMPTMA plus 9 of DEGDMA. This should give about the same hardness but improve the elongation.

Also, if your compound uses 100% carbon black for reinforcement, try replacing a portion of it with a mineral filler such as precipitated silica (e.g., Ultrasil VN3 or HiSil 233) at about the same level.

One last note: polyester millable urethanes, such as Millathane 66, will typically give higher elongation and better properties at high hardnesses with peroxide cures than polyether urethanes like Millathane E34. For example, we've developed several Millathane 66 compounds with 90+ Shore A and 400+ elongation. Please let us know if you need a formula recommendation.

Dr. Millathane

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