



Millathane® 66 Compounds for High Heat Resistance

Millable polyurethane rubber is not known for its high heat resistance, typically being used at temperatures less than 100°C. For applications that need non-continuous exposure to temperatures up to 150°C, 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 150°C.

This report evaluates the heat aging and compression set of an 88 Shore A Millathane® 66 compound, which was initiated at the request of a customer who was interested in producing rollers that would be used at temperatures up to 140°C. The compound, shown below, uses Millathane® 66 Premilled containing 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.

| 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)/100°C | 36 | 35 |
| MDR, 20'/170°C | | |
| ML, lb-in (dNm) | 0.9 (1.0) | 1.3 (1.5) |
| MH, lb-in (dNm) | 52.9 (59.8) | 61.0 (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 (MPa) | 1680 (11.6) | 2260 (15.6) |
| Tensile Strength, psi (MPa) | 3350 (23.1) | 3550 (23.1) |
| Elongation, % | 185 | 155 |
| Tear, Die C, lb/in (kN/m) | 162 (28.4) | 122 (21.4) |
| Bashore Resilience % | 41 | 41 |
| DIN Abrasion, mm ³ loss | 107 | 128 |

*TSE-xxx=Tensile Stress at xxx% Elongation

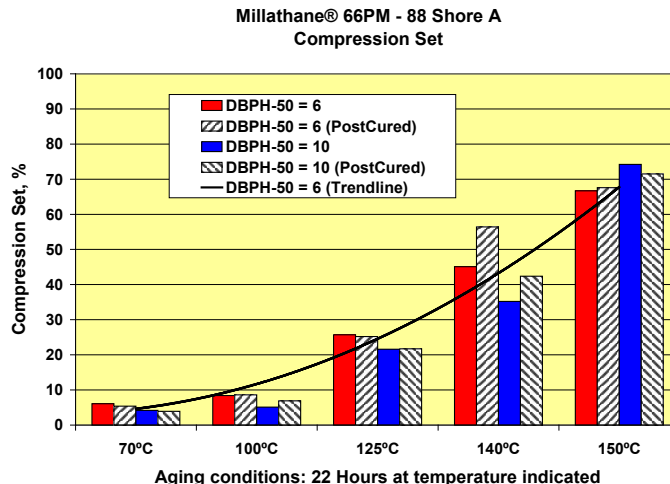
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Millathane® 66 Compounds for High Heat Resistance (cont.)

COMPRESSION SET PROPERTIES

Compression set, tested by ASTM D395 Method B, showed very good results at temperature up to 140°C. The higher peroxide level was beneficial to the set for all temperatures except for the highest temperature, 150°C. 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 125°C did not provide any benefit to compression set.



HEAT AGING CHARACTERISTICS

The data below shows excellent retention of properties after heat aging up to 150°C. 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 / 70°C | 70 hr / 100°C | 70 hr / 125°C | 70 hr / 140°C | 70 hr / 150°C |
|-----------------------------|-------------|--------------|---------------|---------------|---------------|---------------|
| Hardness, Shore A (Change) | 88 (-) | 87 (-1) | 89 (+1) | 87 (-2) | 86 (-2) | 88 (0) |
| Tensile Strength, psi (MPa) | 3350 (23.1) | 3360 (23.2) | 3360 (23.2) | 3640 (25.1) | 2820 (19.4) | 2980 (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 / 70°C | 70 hr / 100°C | 70 hr / 125°C | 70 hr / 140°C | 70 hr / 150°C |
|-----------------------------|-------------|--------------|---------------|---------------|---------------|---------------|
| Hardness, Shore A (Change) | 88 (-) | 88 (0) | 88 (0) | 88 (0) | 88 (0) | 88 (0) |
| Tensile Strength, psi (MPa) | 3550 (24.5) | 3920 (27.0) | 4120 (28.4) | 2370 (16.3) | 2750 (19.0) | 3190 (22.0) |
| % Change | — | +10 | +16 | -33 | -23 | -10 |
| Elongation, % | 155 | 165 | 170 | 90 | 100 | 150 |
| % Change | — | +6 | +10 | -42 | -35 | -3 |

SUMMARY

The Millathane® 66 compounds evaluated in this study have very good compression set and heat aging characteristics up to 140°C. 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. Post curing the samples did not show any benefit to the set characteristics of these compounds. 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