



Comparison of Millathane® E34 vs. Competitive Urethane U50

This study compares Millathane® E34 to a competitive polyether grade U50 to assist the compounder in choosing the best millable urethane for the application and required properties. While these two polyether urethanes differ only slightly in their chemical base composition, variations in their performance are found.

FORMULATION

The two polymers were compared in a silica filled 75-80 Shore A non-black compound. A modification of the Millathane® E34 compound was evaluated to try to improve abrasion resistance and compression set. It should be noted that while this study uses a sulfur crosslinking system, both polymers are capable of being cured with peroxides. Peroxide cures of polyether urethanes generally give better set properties, but mechanical strength properties (such as tensile and tear strength) are generally inferior to sulfur cures.

Polymer (at 100 parts)	U50	Millathane® E34	
Zinc Stearate	0.5	0.5	0.5
Ultrasil VN3	40	40	40
Silquest A-189	0.8	0.8	1.6
Carbowax 3350	2	2	2
TP-95 (DBEEA)	3	3	3
Struktol WB222	1	1	1
AC 617A Polyethylene	2	2	2
MBTS	4.0	4.0	4.0
MBT	2.0	2.0	2.0
Thanecure® ZM	1.0	1.0	1.0
Methyl Zimate	0.8	0.8	--
Sulfur	2.0	2.0	2.0
Total	159.1	159.1	159.1

	U50	Millathane® E34	Millathane® E34 – Mod.
Mooney Viscosity (Polymer) ML (1+4)/100°C	34	35	
Mooney Viscosity (Compound) ML (1+4)/100°C	68	61	94

	U50	Millathane® E34	Millathane® E34 – Mod.
MDR, 45'/140°C			
ML, lb-in / dNm	2.2 / 2.5	2.7 / 3.0	2.7 / 3.1
MH, lb-in / dNm	26.4 / 29.9	26.6 / 30.1	21.8 / 24.6
ts1, minutes	1.6	2.9	4.8
t90, minutes	29.9	27.2	23.1
MDR, 20'/160°C			
ML, lb-in / dNm	3.8 / 4.2	3.8 / 4.3	3.4 / 3.8
MH, lb-in / dNm	28.1 / 31.8	24.1 / 27.3	25.6 / 29.0
ts1, minutes	0.9	1.6	1.0
t90, minutes	8.4	7.6	8.7

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Comparison of Millathane® E34 vs. Competitive Urethane U50 (cont.)

PHYSICAL PROPERTIES (140°C Cures)

As the table below shows, the Millathane® E34 and the modified compounds gave higher tensile strength and abrasion resistance compared to the competitive polymer. The Millathane E34-Modified compound, which incorporated a higher level of silane coupling agent and omitted Methyl Zimate, showed improved Tear Die C and compression set.

Samples Cured at 140°C	U50	Millathane® E34	Millathane® E34 – Mod.
Cure Time, Mins. at 140°C	30	26	25
Hardness Shore A	80	75	75
TSE-100*, psi / MPa	565 / 3.9	455 / 3.1	510 / 3.5
TSE-200*, psi / MPa	1170 / 8.1	1030 / 7.1	1230 / 8.5
TSE-300*, psi / MPa	1920 / 13.2	1760 / 12.1	2210 / 15.2
Tensile Strength, psi / MPa	4390 / 30.3	4740 / 32.7	4740 / 32.7
Elongation, %	560	580	505
Tear, Die B, lb-in / kN/m	463 / 81.0	499 / 87.3	416 / 72.8
Tear, Die C, lb-in / kN/m	325 / 56.9	329 / 57.6	345 / 60.4
Bashore Resilience, %	42	47	48
DIN Abrasion, mm ³ loss	74	62	58
Compression Set, %			
24 hr, 70°C	85	85	64
22 hr, Room Temp. (23°C)	19	17	13

*TSE-xxx = Tensile Stress at xxx% Elongation

PHYSICAL PROPERTIES (160°C Cures)

This table shows the Millathane® E34 compound giving generally comparable properties to the competitive polymer, except for improved abrasion resistance. The modified compound gave the highest tensile strength, and the best abrasion resistance and compression set properties.

Samples Cured at 160°C	U50	Millathane® E34	Millathane® E34 – Mod.
Cure Time, Mins. at 160°C	8	26	9
Hardness Shore A	80	75	75
TSE-100*, psi / MPa	485 / 3.3	395 / 2.7	490 / 3.4
TSE-200*, psi / MPa	945 / 6.5	815 / 5.6	1110 / 7.7
TSE-300*, psi / MPa	1510 / 10.4	1390 / 9.6	1960 / 13.5
Tensile Strength, psi / MPa	4470 / 30.8	4370 / 30.1	4760 / 32.8
Elongation, %	650	660	550
Tear, Die B, lb-in / kN/m	472 / 82.6	473 / 82.8	423 / 74.0
Tear, Die C, lb-in / kN/m	316 / 55.3	305 / 53.4	324 / 56.7
Bashore Resilience, %	35	39	40
DIN Abrasion, mm ³ loss	72	66	56
Compression Set, %			
24 hr, 70°C	88	91	71
22 hr, Room Temp. (23°C)	40	43	29

*TSE-xxx = Tensile Stress at xxx% Elongation



Comparison of Millathane® E34 vs. Competitive Urethane U50 (cont.)

TYPICAL POLYMER PROPERTIES

Chemical Type	Polyether Polyurethane	
Color	Pale Amber to Dark	
Physical Form	Solid Bale or Milled Sheets	
Packaging	Solid Bale 38 lb (17.2 kg) carton	Premilled Sheets 50 lb. (22.7 kg) carton
Odor	Faint, Characteristic	
Specific Gravity	1.04	
Mooney Viscosity, ML(1+4)/100°C	35 - 65 (50 +/- 10 Typical)	
Storage Stability	2 Years Under Dry and Cool Conditions	

TYPICAL END USES

Printing Rollers	Copier Rollers / Copier Stops	Drive Belts
Radar Dome Covers	Dust Covers	Conveyor Belts
Footwear Outsoles	Cable Jackets	Aircraft Fasteners

SUMMARY

Overall Millathane® E34 compared very favorably to the competitive urethane U50. The Millathane® E34 compound had:

- Slightly faster cure rate, which may be a benefit in shorter cure cycles
- Slightly lower hardness (within test variability). If necessary adding a few extra parts of silica will equalize the hardness and result in a less expensive compound.
- Slightly higher tensile strength
- Better abrasion resistance
- Other properties were similar

The slightly modified Millathane® E34 compound, with higher silane coupling agent, had improved tear resistance, improved abrasion resistance, and improved compression set versus the control Millathane® E34 and the U50.

RECOMMENDATIONS

Customers should evaluate Millathane® E34 in any compound that currently uses U50 for improved properties. Applications requiring high abrasion resistance, ozone resistance, fuel and oil resistance, outstanding hydrolytic stability and improved processing could benefit.