TSE INDUSTRIES, INC.
5180 113th Avenue North, Clearwater, Florida 33760 USA
tse-industries.com
(800) 237-7634 | (727) 573-7676

Millathane® 55 and Millathane 55M (Premilled)

Millathane 55 is a sulfur, peroxide or isocyanate curable polyether millable polyurethane rubber used for the production of rubber covered rollers, belting and other molded articles. Millathane 55 gives excellent strength and abrasion resistance properties, especially in sulfur cured compounds, and has very good processing characteristics. Compared to Millathane E34, Millathane 55 gives lower viscosity and higher hardness compounds (especially in sulfur cured compounds).

Product Description

Chemical Composition:	Synthetic rubber based on Ether/MDI polyurethane
Specific Gravity:	Approximately 1.04
Storage stability:	3 years from date of manufacture (stored under dry and cool conditions)

Part Number	Mooney Viscosity ML(1+4)/100º C	Appearance	Package size/carton
M-0055-35 (Virgin)	25 – 45	Pale to dark amber solid bales	38 pounds (17.2 kg)
M-0055M-35 (Premilled)	30 - 40	Pale to dark amber solid sheets	50 pounds (22.7 kg)

Processing

Millathane 55 is processed by techniques which are common to the rubber industry: Compounds can be mixed on an open mill or in an internal mixer. Premilled sheets may be easier for small mill mixing. Molded articles can be produced via compression, transfer or injection molding; calendered sheets can be press- or roto-cured. *See publication TIPS V2-1 for more information on mixing and processing.*

Properties

Vulcanizates based on Millathane 55 can be produced in hardnesses ranging from approximately 50 to 98 Shore A, and offer high strength properties, excellent abrasion resistance, water resistance and good oil resistance. Compounds have low brittle points, but will tend to increase in hardness at low temperatures, due to crystallization. Millathane CM and Millathane E40 are better for resistance to low temperature crystallization.

Applications

A major application of Millathane 55 is in rubber covered rollers, due to its very good processing characteristics, strength properties and abrasion resistance. It is also used in various molded articles and can be used in articles such as belting, industrial wheels, seals, footwear and other applications.

Compounding

Reinforcing Fillers

Reinforcing fillers like N220 or N330 carbon black or precipitated silica increase the mechanical strength of Millathane 55 compounds. Fumed silicas such as Wacker HDK N20 or Cabosil M-5 will give somewhat higher reinforcement than precipitated silicas and will give translucent cured compounds (depending on other ingredients). Silane coupling agents like Silquest A-189 or Si 69 for sulfur cures, or Silquest Y-15866, RC-1, or A172 for peroxide cures, will generally improve the tear strength and set properties of silica-reinforced compounds and are typically used at about 2% of the mineral filler content. Clay, talc and calcium carbonate can also be used as fillers to modify properties and processing, but are less reinforcing than silicas and blacks.

Plasticizers

TP-95 (DBEEA) is a plasticizer that is very compatible with Millathane millable polyurethanes, with compounds containing 25 phr and more usually not showing signs of bleeding or incompatibility. Other plasticizers such as Mediaplast NB-4 and Benzoflex 9-88SG can also be used to plasticize and soften compounds. The antistatic plasticizer Struktol AW-1 can be used to a limited extent, to lower surface resistivity, but may tend to bleed at levels over 10 parts.

Antidegradants

Polyurethanes are generally very resistant to ozone and oxygen attack because of their saturated polymer backbones (like EPDM). Small amounts (0.5-2 phr) of antioxidants like Naugard 445 and Irganox 1010 can provide some benefit to the heat aging characteristics of peroxide-cured Millathane 55 compounds.

Process Aids

Small amounts of process aids are normally used to prevent sticking to processing equipment and to improve flow during molding. For sulfur-cured compounds, the 0.5 phr of zinc stearate used as an activator is usually adequate. For more release, 0.5-2 phr of another process aid such as Struktol WB222 or Vanfre AP-2 can be used. For peroxide cures, 0.2-0.5 phr of stearic acid is used in place of the zinc stearate. A low molecular weight polyethylene like AC617A, added at 1-4 phr, gives good release for calendering and molding.

Curing Agents

The best physical properties and abrasion resistance are achieved with sulfur cures, while the best compression set, heat aging and reversion resistance come from peroxide cures. The sulfur cure system is a combination of MBTS (4 phr), MBT (2 phr), Thanecure® ZM (1 phr) and sulfur (1.5-2.0 phr), along with zinc stearate (0.5 phr), used as an activator.

Peroxide cures can be used for better set and heat aging characteristics. Typical peroxides used are dicumyl peroxide and DBPH, typically used at about 0.6 – 1.2 phr active peroxide (1.5 – 3.0 phr of 40% active). The use of low levels of coagents such as triallyl cyanurate (TAC) and trifunctional methacrylates like SR350 (TMTPMA) increase the crosslink density and improve compression set. Blends of the difunctional methacrylate SR231 (DEGDMA) with the trifunctional methacrylate SR350 are recommended for high hardness compounds, as the blend gives a good balance of strength properties, elongation and set. High crosslink densities, seen with high peroxide and/or coagent levels, will improve compression set but strength properties and elongation may be adversely affected.

Millathane 55 can also be cured with the isocyanate cure system (a combination of Thanecure® T9SF, HQEE, and accelerator), which gives excellent tensile and tear strengths at high hardnesses. Consult TSE for guidance on using this cure system, as there are some significant differences between it and sulfur and peroxide cure systems.

Vulcanization Conditions

Sulfur-cured Millathane 55 compounds are typically molded at temperatures of 150º - 165ºC; higher temperatures can give poor cures due to reversion. Peroxide-cured compounds can be cured from 145°-175ºC, depending on the peroxide, dimensions of the part etc. Isocyanate-cured compounds are typically cured at 120°-135°C.

Rubber covered rollers are often cured in steam or electric autoclaves, under pressure, at 130°-155°C for 1-6 hours (very large rolls for longer times at lower temperatures), depending on the compound and roll geometry. *See publication TIPS V2-4 for additional information on autoclave curing.*

Formulation Examples

61 Shore A Black Molding or Roller Compound, Peroxide Cured

Millathane® 55	100.0
Stearic Acid	0.25
N330 Black	25.0
TP-95	2.0
Struktol WB-222	1.0
Irganox 1010	0.5
SR-350	1.0
DiCup 40C	2.0

Press Cured Properties, Cured 9 min/160ºC		
Hardness Shore A	61	
TSE-100*, psi (MPa)	238	(1.6)
TSE-300, psi (MPa)	1115	(7.7)
Tensile strength, psi (MPa)	2740	(18.9)
Elongation, %	530	
Tear Die C, lb/in (kN/m)	126	(22.1)
Tear Die B, lb/in (kN/m)	278	(48.7)
Bashore Resilience, %	54	
Compression set, 22hr/70ºC, % set	25	
DIN Abrasion, mm³ loss	92	
Heat aging, 70 hr/70°C		
Hardness change, Shore A pts.	+2	
Tensile strength, % change	+21	
Elongation, % change	0	

73 Shore A Non-Black Molding or Roller Compound, Sulfur Cured

Millathane® 55	100.0
Zinc Stearate	0.50
HiSil 243LD	25.0
Silquest A189	0.5
TP-95	3.0
Carbowax 3350	2.0
Struktol WB-222	1.0
AC617A	2.0
MBTS	4.0
MBT	2.0
Thanecure® ZM	1.0
Sulfur, 80% active	2.5

Press Cured Properties, Cured 14 min/160ºC		
Hardness Shore A	73	
TSE-100, psi (MPa)	440	(3.0)
TSE-300, psi (MPa)	1530	(10.6)
Tensile strength, psi (MPa)	3710	(25.6)
Elongation, %	510	
Tear Die C, lb/in (kN/m)	252	(44.1)
Tear Die B, lb/in (kN/m)	297	(86.5)
Bashore Resilience, %	48	
Compression set, 22hr/70ºC, % set	62	
DIN Abrasion, mm³ loss	55	

94 Shore A Non-Black, Isocyanate-Cured Compound

Millathane® 55	100.0
Stearic acid	0.30
Thanecure® T9SF	20.0
HQEE	6.8
Bismate	0.3
Irganox 1076	1.0

Press Cured Properties, Cured 20 min/130ºC		
Hardness Shore A	94	
Hardness Shore D	44	
TSE-100, psi (MPa)	885	(6.1)
TSE-300, psi (MPa)	1175	(8.1)
Tensile strength, psi (MPa)	3990	(27.5)
Elongation, %	660	
Tear Die C, lb/in (kN/m)	337	(59.0)
Tear Die B, lb/in (kN/m)	385	(67.4)
DIN Abrasion, mm³ loss (rotating)	52	

*TSE-XXX= Tensile Stress at XXX Elongation (a.k.a., “Modulus”)

Adhesion to Metal

Millable polyurethanes generally have very good adhesion to metal, and adhesives from several manufacturers give excellent bonding. Below are results of testing done by adhesive manufacturer on bonding a sulfur-cured, silica reinforced Millathane E34 compound to steel (results would be expected to be similar for Millathane 55). All the adhesives shown gave excellent bonding to the Millathane compound.

Adhesive	Adhesion	Failure
Ty-Ply BN[1]	111 lb/in [19.4 N/mm]	Rubber Failure 100%
Chemlok 218[1]	128 lb/in [22.4 N/mm]	Rubber Failure 100%
Cilbond 49SF+Cilcure B[2]	115 lb/in [20.2 N/mm]	Rubber Failure 100%
Thixon 715-1/720:MEK 1:1[3]	106 lb/in [18.6 N/mm]	Rubber Failure 100%

Other adhesives that have been used successfully and/or recommended for use for bonding to metal are:

Megum 15637[3] for bonding to metal.
Chemlok 213[1], Chemlok 218[1] and Chemlok 219[1] for bonding to Aluminum and steel.
Chemlok 250[1] and Thixon[3] 405 for bonding during injection molding.

[1]Lord Corporation, [2]Chemical Innovations Ltd. (CIL), [3]Dow Chemical

Additional Information

Visit our web site (www.tse-industries.com or www.millathane.com) for information on Millathane 55 and other Millathane grades, as well as technical studies, TIPS and SDS documents, and other information. Inquiries can be sent to millathaneinfo@tseind.com.

Ingredients	Description	Supplier/Manufacturer
AC617A	Low molecular weight polyethylene	Honeywell
Benzoflex 9-88SG	Dipropylene glycol dibenzoate	Eastman Chemical
Bismate	Bismuth dimethyldithiocarbamate	Vanderbilt Chemicals
Cabosil M-5	Fumed silica, surface area 200 m²/g	Cabot Corporation
Di-Cup 40C	Dicumyl Peroxide, 40%	Arkema Inc.
HQEE	Hydroquinone bis(2-hydroxyethyl) ether (ground)	Various
Irganox 1010	Antioxidant	Ciba Specialty Chemicals
Mediaplast NB-4	Adipine acid plasticizer	Kettlitz-Chemie
Naugard 445	Antioxidant	Chemtura
Si 69	Silane Coupling Agent	Evonik
Silquest RC-1, A172, A-189, Y-15866	Silane Coupling Agents	Momentive Performance Materials
SR231	Diethyleneglycol Dimethacrylate (DEGDMA)	Sartomer/Arkema
SR350	Trimethylol propane Trimethacrylate (TMPTMA)	Sartomer/Arkema
Struktol AW-1	Antistatic plasticizer	Struktol Corporation
Struktol WB-222	Process aid	Struktol Corporation
Thanecure® T9SF	TDI Dimer	TSE Industries, Inc.
Thanecure® ZM	MBTS/Zinc chloride complex	TSE Industries, Inc.
TP-95	Di (butoxy-ethoxy-ethyl) adipate (DBEEA)	Hallstar
Ultrasil VN3	Precipitated silica	Evonik
Vanfre AP-2	Process aid	Vanderbilt Chemicals
Varox DBPH-50	2,5-Dimethyl-2,5-di(t-butylperoxy)hexane, 50%	Vanderbilt Chemicals
Wacker HDK N20	Fumed silica, surface area 200 m²/g	Wacker Silicones