



Millathane® HT Polyester Millable Urethane

Millathane HT is a sulfur or peroxide curable polyester millable polyurethane rubber, used in many applications because of its excellent resistance to abrasion and ozone, high temperature properties and unique frictional characteristics.

Millathane HT is available only in Premilled form. The Premilled polymer contains 1.5 phr of Millstab™ P, a polymeric carbodiimide hydrolysis stabilizer. The incorporated hydrolysis stabilizer provides protection to the polymer, to mixed compounds and to the finished product.

Product Description

Chemical Composition:	Synthetic rubber based on ester/aliphatic diisocyanate
Specific Gravity:	Approximately 1.12
Storage stability:	1 year from date of manufacture (stored under dry and cool conditions)

Part Number	Mooney Viscosity ML(1+4)/100° C	Appearance	Package size/carton
M-00HTM-50 (Premilled*)	50-65	Pale to dark amber sheets	50 pounds (22.7 kg)

*-Contains 1.5 phr of carbodiimide hydrolysis stabilizer (Millstab™ P)

Processing

Millathane HT is processed by techniques which are common to the rubber industry. Compounds can be mixed on open mills or in internal mixers. Very often a compound can be mixed in one step including the vulcanization chemicals. Molded articles can be produced via compression, transfer or injection molding. Injection molding Millathane HT, mostly done with peroxide cures, provides very short cycle times, excellent flow and demolding and shows negligible mold fouling. Most compounds can be calendered for fabrication of rubber covered rollers or conveyor belting, or calendered sheets can be press cured or rotocured.

Properties

Vulcanizates based on Millathane HT can be produced in hardnesses ranging from approximately 55 to 95 Shore A, and offer excellent strength properties abrasion resistance and oil resistance. Sulfur cured Millathane HT compounds have higher strength properties than Peroxide cured, however the latest one give improved compression set and heat aging properties.

Applications

The excellent balance of properties especially frictional characteristic, makes Millathane HT a perfect choice for various rubber parts including belts, rollers and gaskets.

Compounding

Reinforcing Fillers

Reinforcing fillers like N330 carbon black or precipitated silica increase the mechanical strength of Millathane HT 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). Clay, talc and calcium carbonate can also be used as fillers to modify properties and processing, but are less reinforcing than silicas and blacks. Silane coupling agents like Silquest A189 and Si69 (in sulfur cures) and Silquest Y-15866, RC-1, or A172 (in peroxide cures) will improve the tear strength and set properties of mineral filled/reinforced compound and are recommended to be added at about 2% of the mineral filler content.

Plasticizers

TP-95 (DBEEA) is a plasticizer that is very compatible with Millathane HT, with compounds containing 20 phr and more usually not showing signs of bleeding or incompatibility. Other plasticizers such as Medioplast NB-5 and Benzoflex 9-88SG can also be used to plasticize and soften compounds. Coumarone indene resins such as Cumar P10 and Cumar P25 can be used to plasticize sulfur-cured compounds and improve uncured tack, although high levels (>20 phr) may give tacky cured surfaces. 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. Vulcanized vegetable oils (factices) are often used in soft compounds to assist with plasticizer incorporation. Sulfur-free factice like Akrofax 758 is good for sulfur or peroxide cures; sulfur-containing factices can be used in sulfur cures only. White factices should not be used, as they retard the cure.

Stabilizers/Antidegradants

Millathane HT, being a polyester polyurethane, is prone to the effect of hydrolysis, where water can attack the polyester linkage of the polymer chain. This effect is accelerated by higher temperatures or acidic conditions. The inclusion of a small amount of hydrolysis stabilizer such as Millstab™ P (1.5 phr) in the Premilled material greatly inhibits the effect of hydrolysis. Additional amounts of Millstab P can also be added (up to 5 phr total) if improved or longer protection is needed.

Small amounts (0.5-2 phr) of antioxidants like Naugard 445 and Irganox 1010 or 1076 may provide some benefit to the heat aging characteristics of Millathane HT 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 zinc stearate. A low molecular weight polyethylene like AC617A, added at 1-4 phr, gives good release for calendaring and molding. Process aids are best added at the very beginning of the mix cycle, to prevent sticking to mills and mixing equipment.

Curing Agents: Sulfur and Peroxide Cures

The best physical properties and abrasion resistance are achieved with sulfur cures, while the best compression set, heat aging and reversion resistance comes 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. Sulfur dispersions, typically with about 20% process oil, are often used for optimal sulfur dispersion.

Peroxide cures can be used for better set and heat aging characteristics. Typical peroxides used are dicumyl peroxide and DBPH, typically used at about 0.3 – 3 phr active peroxide (0.75 – 1.25 phr of 40% active DiCup and 1-6 phr DBPH-50). 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 methacrylates SR231 (DEGDMA) or SR297 (BGDMA) 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.

Vulcanization Conditions

Sulfur-cured compounds are typically molded at temperatures of 150° - 165°C; higher temperatures can give poor cures due to reversion. Peroxide-cured compound can be cured from 160°-175°C, depending on the peroxide, dimensions of the part etc. Rubber covered rollers can be vulcanized in hot air (electric) or steam autoclaves, but it is extremely critical to completely protect the compound from direct contact with steam and to not over-cure the rollers. Autoclave temperatures can range from 130°-150°C, with times dependent on roller size. Millathane HT cannot be cured in direct contact with open steam or hot air, and, hence, for applications like hose, its use is usually limited to inner liners. Calendered sheets can be press-cured, Rotocured, or cured in autoclaves (calendered into fabric liners, and then protected against steam contact).

Formulation Examples

85 Shore A Non-Black HT Molding Compound

XP-8219-F		Press Cured Properties, Cured 21 min/160°C	
Millathane® HT Premilled	101.50	Hardness Shore A	85
Stearic acid	0.25	TSE-100*, psi (MPa)	580 (4.0)
Wacker HDK N20	35.00	TSE-300*, psi (MPa)	1510 (10.4)
Silquest RC-1	0.70	Tensile strength, psi (MPa)	2770 (19.1)
DBEEA (TP-95)	5.00	Elongation, %	475
Struktol WB-222	0.50	Tear Die C, lb/in (kN/m)	233 (40.8)
SR517	5.00	Tear Die B, lb/in (kN/m)	351 (61.4)
SR231 (DEGDMA)	3.00	DIN Abrasion, mm ³ loss	121
DiCup 40C	0.75	Compression set, 22hr/70°C, % set	39
		Heat Aging, 24 hr/150°C	
		Hardness/Tensile/Elongation changes	+2/+22%/-18%
		IRM 903 Oil Aging, 24 hr/70°C	
		Hardness/Tensile/Elongation changes	0/+3%/+1%
		Volume Change, %	+0.5

*TSE-xxx is Tensile Stress at xxx% elongation ("modulus")

60 Shore A Black Millathane HT Compound

XP-7505-B		Press Cured Properties, Cured 15 min/160°C	
Millathane® HT Premilled	101.50	Hardness Shore A	60
Stearic acid	0.20	TSE-100*, psi (MPa)	180
N330 Black	25.00	TSE-300*, psi (MPa)	695 (4.8)
TOTM (plasticizer)	2.00	Tensile strength, psi (MPa)	2425 (16.7)
Struktol WB222	1.00	Elongation, %	575
Naugard 445	2.00	Tear Die C, lb/in (kN/m)	164 (28.7)
TAC	0.50	DIN Abrasion, mm ³ loss	150
DiCup 40C	1.25	Compression set, 22hr/70°C, %set	26
		Bashore Resilience, %	24

**74 Shore A Black HT Molding Compound**

XP-6616-E1		Press Cured Properties, Cured 21 min/160°C	
Millathane® HT Premilled	101.50	Hardness Shore A	74
Zinc Stearate	0.50	TSE-100*, psi (MPa)	420 (2.9)
N330 Black	25.00	TSE-300*, psi (MPa)	1525 (10.5)
DBEEA(TP-95)	2.00	Tensile strength, psi (MPa)	3220 (22.2)
Struktol WB 222	1.00	Elongation, %	485
Millstab P	0.50	Tear Die C, lb/in (kN/m)	202 (35.4)
MBTS	4.00	Tear Die B, lb/in (kN/m)	390 (68.3)
MBT	2.00	DIN Abrasion, mm ³ loss	119
Thanecure Zm	1.00	Compression set, 22hr/70°C, % set	60
Sulfur	1.50	Heat Aging, 70 hr/100°C	
		Hardness/Tensile/Elongation changes	+3/-5%/-43%
		IRM 903 Oil Aging, 70 hr/100°C	
		Hardness/Tensile/Elongation changes	1/-10%/-28%
		Volume Change, %	+6.0

*TSE-xxx is Tensile Stress at xxx% elongation ("modulus")

Contact:

For further information or compound recommendations, visit our web site at www.millathane.com or email us at millathaneinfo@tseind.com.

Ingredients	Description	Supplier/Manufacturer
AC617A	Low molecular weight polyethylene	Honeywell
Akrofax 758	Sulfur-less vulcanized vegetable oil (factice)	Akrochem
Benzoflex 9-88SG	Dipropylene glycol dibenzoate	Eastman Chemical
Cabosil M-5	Fumed silica, surface area 200 m ² /g	Cabot Corporation
DBEEA (TP-95)	Di (butoxy-ethoxy-ethyl) adipate	Hallstar
Di-Cup 40C	Dicumyl Peroxide, 40%	Arkema Inc.
Irganox 1010	Antioxidant	BASF
Mediaplast NB-5	Adipic acid plasticizer (phthalate-free)	Kettlitz-Chemie
Millstab P**	Polymeric carbodiimide hydrolysis stabilizer	TSE Industries
Naugard 445	Antioxidant	Addivant
Si69	Silane Coupling Agent	Evonik
Silquest A189, A172, RC1	Silane Coupling Agents	Momentive Performance Materials
SR231, SR297, SR350	Liquid methacrylate coagents	Sartomer
Struktol AW-1	Antistatic plasticizer	Struktol Corporation
Struktol WB-222	Process aid	Struktol Corporation
Thanecure ZM	MBTS/Zinc chloride complex	TSE Industries
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 m ² /g	Wacker Silicones

**Millstab P is sold, primarily in the USA, by TSE Industries. Other similar products, available worldwide, are Stabaxol P from Rhein Chemie and Stabilizer 2000/9000 from Raschig