



Millathane® 66 and Millathane 66M (Premilled)*

Millathane 66 is a peroxide-curable millable polyurethane rubber for the production of oil, fuel and chemical resistant parts which require excellent low and high temperature performance and high mechanical strength. As is typical of polyurethanes, it also has excellent abrasion resistance.

Product Description

Chemical Composition:	Synthetic rubber based on ester/MDI polyurethane
Specific Gravity:	Approximately 1.19
Storage stability:	2 years from date of manufacture (stored under dry and cool conditions)

Part Number	Mooney Viscosity ML(1+4)/100° C	Appearance	Package size/carton
M-0066-50 (Virgin)	40 - 65	Pale to dark amber solid bales	45 pounds (20.4 kg)
M-0066M-45 (Premilled*)	40 - 50	Pale to dark amber solid sheets	50 pounds (22.7 kg)
M-0066M-55 (Premilled*)	50 - 60	Pale to dark amber solid sheets	50 pounds (22.7 kg)

*Premilled - Contains 1.5 phr of polymeric carbodiimide hydrolysis stabilizer

Processing

Millathane 66 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. *See our publication TIPS V2-1 for typical mixing procedures.*

Molded articles can be produced via compression, transfer or injection molding, at temperatures dependent on the peroxide type (typically from 140°-180°C). Injection molding Millathane 66 provides very short cycle times, excellent flow and demolding and shows negligible mold fouling. Due to the peroxide vulcanization and its chemical base, Millathane 66 can not be cured in direct contact with open steam or hot air, and, hence, for applications like hose, its use is limited to inner liners. Calendered sheets can be press-cured or rotocured.

Properties

Vulcanizates based on Millathane 66 can be produced in hardnesses of 45 to 95+ Shore A and offer excellent strength properties and abrasion resistance. Millathane 66 compounds have excellent low temperature properties with brittle points as low as -57°C (or even lower) with very good resistance to low temperature stiffening. Millathane 66 vulcanizates also show very good heat resistance, low compression set, and low gas permeability.

Applications

The good balance of excellent properties of Millathane 66 makes it a perfect choice for seals, gaskets, O-rings, membranes, CV-boots, dust covers, mounts and bearings for the automotive industry and for many other hydraulic or pneumatic applications. It is also widely used for the production of rollers and flippers for office machines and drive belts for audio and video equipment.



Compounding

Reinforcing Fillers

Reinforcing fillers like N330 carbon black or precipitated silica increase the mechanical strength of Millathane 66 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 RC-1, A171 or A172 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

Plasticizers such as TP-95, Medioplast NB-4 and Benzoflex 9-88SG can be used to plasticize and soften compounds. The antistatic plasticizer Struktol AW-1 can be used to a limited extent, but may tend to bleed at levels over 10 parts.

Process Aids

Small amounts of process aids are normally used to prevent sticking to processing equipment and to improve flow during molding. Generally, about 0.2 phr of stearic acid is used along with 0.5-2 phr of another process aid such as Struktol WB222 or Vanfre AP-2. A low molecular weight polyethylene like AC617A, added at 1-4 phr, gives good release for calendaring and molding.

Stabilizers/Antidegradants

Compounds should include at least a small amount (1-2 phr) of a carbodiimide hydrolysis stabilizer such as Millstab™ P** to protect the polyester urethane from the effects of water and ambient moisture. This stabilizer also has a positive influence on the heat aging properties. Using Premilled Millathane 66, which contains 1.5 phr of Millstab P, is recommended. Higher levels of hydrolysis stabilizer, up to 5 phr, will provide improved, longer term hydrolysis resistance. Antioxidants are not normally needed for most applications, but Naugard 445 at 0.5-1.0 phr can improve heat aging and Irganox 1010/Tinuvin 328/Tinuvin 765 at 0.3-0.5 phr each can be of some benefit in improving color stability.

Curing Agents: Peroxides and Coagents

Typical peroxides used are dicumyl peroxide and DBPH (2,5-dimethyl-2,5-di (t-butylperoxy) hexane), typically used at about 2-3 phr active peroxide (5-8 phr of 40% active). The use of coagents such as triallyl cyanurate (TAC) and trifunctional methacrylates like SR350 (TMTDMA) increase the crosslink density and improve compression set. Liquid methacrylates also function as a non-extractable plasticizers. For high hardness compounds, blends of trifunctional and difunctional methacrylates (e.g. SR231 (DEGDMA)) give a good balance of tensile strength, elongation and good processing.

A study looking at peroxide (DBPH-50) levels in a silica reinforced Millathane 66 compound (see formula and charts below) showed that as the peroxide level increased:

- The hardness increased very slightly
- The tensile stress (“modulus”) increased
- The tensile strength, elongation and tear strength decreased slightly
- The compression set improved, more significantly at higher temperatures
- The solvent (toluene) resistance improved
- Heat aging, oil aging and abrasion resistance were not significantly affected (these properties were excellent for all compounds).

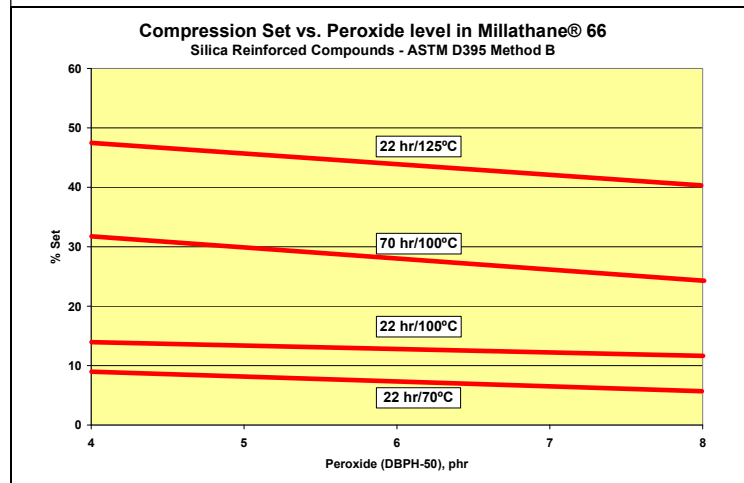
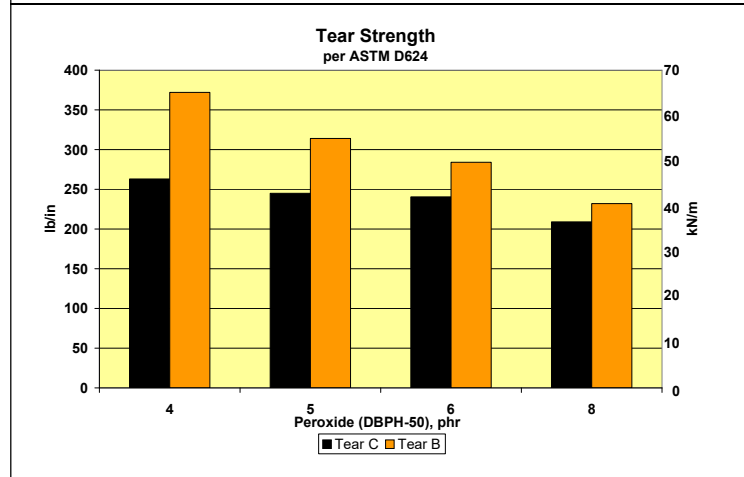
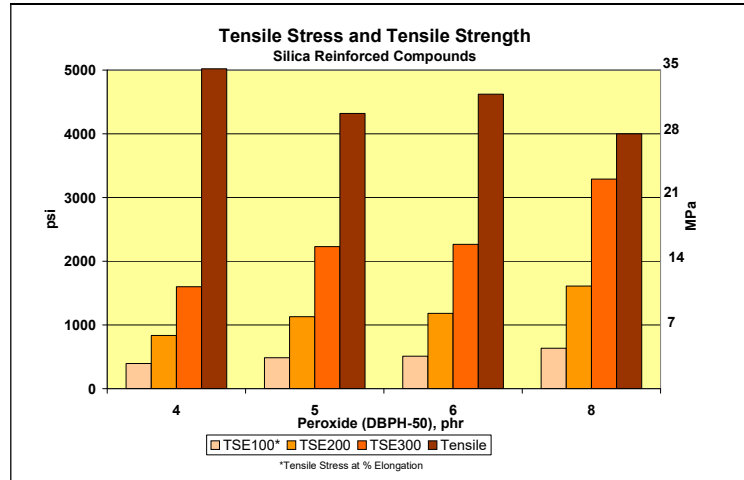


Millathane® 66 Peroxide Level Study

Formulation

Millathane 66	100
Stearic acid	0.2
Ultrasil VN3	25
Silquest A-172	0.5
TP-95 (DBEEA)	2
Millstab P	2
Struktol WB222	1
SR-350 (TMPTMA)	2
Varox DBPH-50	4 - 8

These compounds met the requirements of ASTM D2000 M3BG728 A14 B14 EO14 and EO34 (except for the 8 phr DBPH-50 compound which was very slightly deficient in tensile and elongation). They would probably also meet suffixes C12 (ozone resistance) and F17/F19 (low temperature brittleness).





Vulcanization Conditions

Compounds based on Millathane 66 are vulcanized at temperatures of 140° - 180°C, depending on the peroxide, dimensions of the part etc. Injection molded parts with a wall thickness of less than 2 mm can be vulcanized in approximately one minute at 170° - 180°C mold temperature.

66 Shore A Black Molding Compound

(meets ASTM D2000 M2BG728A14B14C12EA14EO34)

Millathane® 66	100.0	Press Cured Properties, Cured 15 min/160°C	
Stearic acid	0.20	Hardness Shore A	66
Millstab™ P**	3.0	TSE-100, psi (MPa)	245 (1.7)
N 330 black	20.0	TSE-300, psi (MPa)	990 (6.8)
DBEEA (TP-95)	2.0	Tensile strength, psi (MPa)	4600 (31.7)
Struktol WB-222	1.0	Elongation, %	675
Di-Cup 40 C	5.0	Tear Die C, lb/in (kN/m)	264 (46.2)
		DIN Abrasion, mm ³ loss	90
		Compression set, 22hr/70°C, % set	17
		Compression set, 22hr/100°C, % set	31
		Compression set, 22hr/125°C, % set	45

Heat Aging, 70 hr/125°C

Hardness/Tensile/Elongation changes +1/+2%/-1%

IRM 903 Oil Aging, 70 Hr/100°C

Hardness/Tensile/Elongation changes -8/-13%/+1%
Volume Change, % +4.3

Ingredients	Description	Supplier/Manufacturer
AC617A	Low molecular weight polyethylene	Honeywell
Benzoflex 9-88SG	Dipropylene glycol dibenzoate	Eastman Chemical
Cabosil M-5	Fumed silica, surface area 200 m ² /g	Cabot Corporation
Di-Cup 40C	Dicumyl Peroxide, 40%	Arkema Inc.
Irganox 1010	Antioxidant	Ciba Specialty Chemicals
Mediaplast NB-4	Adipine acid plasticizer	Kettlitz-Chemie
Millstab P	Polymeric carbodiimide hydrolysis stabilizer	TSE Industries
Naugard 445	Antioxidant	Chemtura
Silquest RC-1, A172, A171	Silane Coupling Agents	Momentive Performance Materials
SR231	Diethyleneglycol Dimethacrylate (DEGDMA)	Sartomer/Cray Valley
SR350	Trimethylol propane Trimethacrylate (TMPTMA)	Sartomer/Cray Valley
Struktol AW-1	Antistatic plasticizer	Struktol Corporation
Struktol WB-222	Process aid	Struktol Corporation
Tinuvin 328, 765	UV stabilizers	Ciba Specialty Chemicals
TP-95	Di (butoxy-ethoxy-ethyl) adipate (DBEEA)	Rohm and Haas
Ultrasil VN3	Precipitated silica	Degussa
Vanfre AP-2	Process aid	R. T. Vanderbilt
Varox DBPH-50	2,5-Dimethyl-2,5-di(t-butylperoxy)hexane, 50%	R. T. Vanderbilt
Wacker HDK N20	Fumed silica, surface area 200 m ² /g	Wacker Silicones

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