

# Technical Information for Performance Solutions

## MILLATHANE® POLYURETHANE RUBBER - Premilled versus Virgin

Most Millathane polyurethane grades are available in two forms: Virgin, in 38 (17.2 kg) or 45 (20.4 kg) pound bales, and Premilled sheets, in 50 pound (22.7 kg) cartons. There are several advantages for Millathane customers to use Premilled sheets.

### Topics:

- Premilled Millathane
- Physical Properties Comparison
- Premilled Millathane Stability
- Abrasion Resistance
- Pictures

- **Ease of mixing on two roll mills**

Premilled Millathane sheets facilitate mixing compared to solid bales which have no previous rubber breakdown, especially on smaller-sized mills.

- **Range of Mooney viscosity is  $\pm 5$  points for most products**

Starting out with a narrow defined Mooney viscosity range helps ensure a consistent mixed compound viscosity.

- **Premilled polyester grades contain 1.5 phr of hydrolytic stabilizer (Millstab™ P)**

For polyester urethanes, it's *very important* to include at least a nominal amount of hydrolysis stabilizer in the compound, to provide some protection against ambient moisture or water exposure. Using Premilled polyester grades, which have the stabilizer incorporated into the polymer, makes it easy to incorporate 1.5 phr of stabilizer into the compound. The stabilizer in premilled polyester grades would also improve the polymer's storage stability.

**Table 1: Millathane® Premilled Grades**

Product	Part Number	Mooney Viscosity ML (1+4)/100°C	Note
Millathane 26	M-0026M-40	35 – 45	FDA Polyether
Millathane E34	M-0034M-40	35 – 45	Polyether
	M-0034M-45	40 – 50	Polyether
	M-0034M-50	45 – 55	Polyether
Millathane E40	M-0040M-45	35 – 55	Polyether
Millathane CM	M-00CM-30	30 – 35 MS(1+10)	Polyether
	M-00CM-40	35 – 45 MS(1+10)	Polyether
	M-00CM-45	40 – 50 MS(1+10)	Polyether
	M-00CM-55	50 – 60 MS(1+10)	Polyether
Millathane 97	M-0097M-45	40 – 50	Polyether
	M-0097M-60	50 – 70	Polyether
Millathane 76	M-0076M-30	25 – 35	Stabilized polyester
	M-0076M-40	35 – 45	Stabilized polyester
	M-0076M-50	45 – 55	Stabilized polyester
Millathane 66	M-0066M-45	40 – 50	Stabilized polyester
	M-0066M-55	50 – 60	Stabilized polyester
Millathane 5004	M-5004-M	50 – 70	Stabilized polyester
Millathane HT	M-00HTM-50*	50 – 65	Stabilized polyester

\*Made to order

### MILLATHANE®

#### FACTOID:

TSE will have a booth at the Rubber Division ACS meeting in Nashville, TN Oct. 14-16, 2014 Stop in to say Hi!

## Physical Properties Comparison

Test formulations for comparing Virgin and Premilled Millathane have 20 phr N-330 black, process aids and curatives. The scope of this testing was to compare Premilled Millathane against Virgin Millathane in both sulfur and peroxide cure recipes for differences in stress-strain properties and abrasion resistance. Table 2 lists the formulation ingredients used to develop physical property test data in Table 3.

**Table 2: Test Formulations Millathane Virgin versus Premilled**

SULFUR FORMULATION	phr	PEROXIDE FORMULATION	phr
Millathane Virgin	100.0	Millathane Virgin	100.0
Millathane Premilled*	101.5	Millathane Premilled*	101.5
Zinc Stearate	0.5	Stearic Acid	0.5
Process Aid - wax	1.0	Triallylcyanoate	0.5
N-330 Black	20.0	N-330 black	20.0
DBEEA plasticizer	5.0	Process Aid - wax	1.0
MBTS	4.0	DBEEA plasticizer	5.0
MBT	2.0	40% dicumylperoxide	2.5
Thanecure® ZM	1.0		
Sulfur	1.5		
<b>TOTAL</b>	<b>135.0</b>	<b>TOTAL</b>	<b>129.5</b>

\* polyester grades contain 1.5 phr Millstab™ P

Millathane® 76 is a sulfur or peroxide curable polyester polyurethane rubber. Millstab™ P, a carbodiimide hydrolytic stabilizer, is added to the Premilled version. From the rheometer (ODR) data, we find a delay in cure caused by the addition of stabilizer to Millathane 76 Premilled. Stress strain results of Premilled versus Virgin are clearly within experimental error for tensile, elongation and hardness. Tear strengths are comparable as well as abrasion resistance and compression set values. See Table 3 for test results.

**Table 3: Physical Properties Millathane® 76 Virgin & Premilled**

TEST DATA	Millathane 76 Sulfur		Millathane 76 Peroxide	
	Virgin	Premilled	Virgin	Premilled
ODR°C	155	155	160	160
Ts2, min.	1.7	2.6	2.9	3.3
T90, min.	7.1	9.6	17.6	18.6
Cure time/temp.	7'/155°C	10'/155°C	18'/160°C	19'/160°C
Hardness, Shore A	65	63	55	54
TSE-100*, psi	550	531	226	243
MPa	3.8	3.7	1.6	1.7
TSE-200, psi	1248	1218	720	797
MPa	8.6	8.4	5.0	5.5
TSE-300, psi	2134	2068	1508	1599
MPa	14.7	14.3	10.4	11.0
Tensile Strength, psi	4708	4291	2525	2383
MPa	32.5	29.6	17.4	16.4
Elongation, %	524	510	425	397
Tear, Die C, lb/in	264	243	104	108
kN/m	46.2	42.5	18.5	18.9
Bashore resilience, %	20	18	24	23
DIN abrasion, mm <sup>3</sup> loss	83	71	55	56
Compression Set, %				
22 hr/70°C	42	49		
22 hr/100°C			72	70

\*TSE-xxx = tensile stress at xxx% elongation

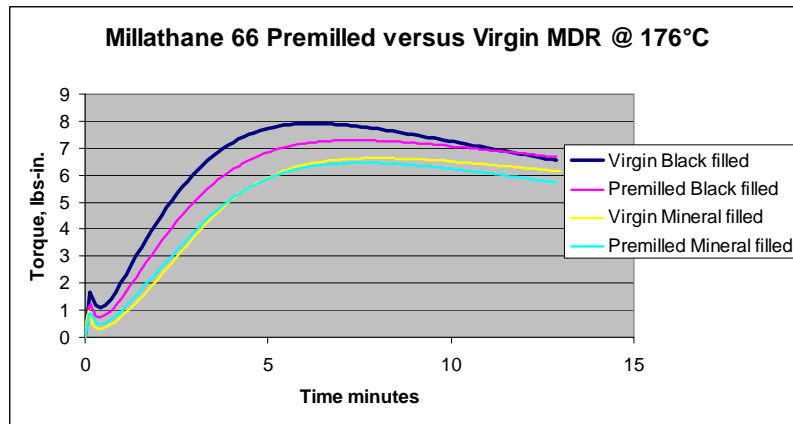
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# Premilled Millathane® Stability

Premilled Millathane polyester grades contain carbodiimide hydrolytic stabilizer which improves shelf life, resists hydrolysis in cured parts and there is some indication of improved reversion resistance.

In the study done with Millathane 66, a polyester polyurethane rubber, we compared Virgin against Premilled in both a black filled and mineral filled compounds. In both cases, there is a slight improvement in reversion resistance as indicated in Figure 1 which compares the cure curves using a moving die rheometer.

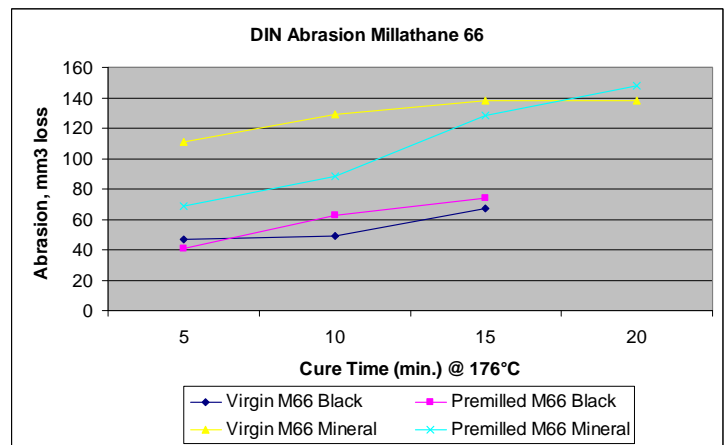
**Figure 1: Reversion Resistance Premilled Millathane 66**



# Abrasion Resistance

Abrasion resistance testing showed comparable DIN Abrasion in clay-filled compounds for Virgin vs. Premilled Millathane 66, but in black-filled compounds the Premilled Millathane 66 gave improved abrasion resistance over typical and extended cure times. This may be due to the stabilizing effect of the carbodiimide included in Premilled Millathane 66. See data below.

**Figure 2: Improved Abrasion Resistance Premilled Millathane® 66**



**Table 4: Test Recipe Millathane® 66 Virgin and Premilled**

Ingredients	A	B	C	D
Millathane 66 Virgin	100		100	
Millathane 66 Premilled		101.5		101.5
Stearic Acid	0.3	0.3	0.3	0.3
N-330 black	30	30		
Process aid	0.5	0.5	0.5	0.5
Hard Clay			40	40
Co-Agent	3	3	3	3
40% Dicumyl peroxide	5	5	5	5
<b>Total</b>	<b>138.8</b>	<b>140.3</b>	<b>148.8</b>	<b>150.3</b>
Ref: XP4427				

### TSE INDUSTRIES

4370 112th Terrace North  
Clearwater, FL , USA 33762-4902

Toll Free: 800-237-7634  
Phone: 727-573-7676  
Fax: 727-572-0487  
E-mail: millathaneinfo@tse-industries.com



[www.tse-industries.com](http://www.tse-industries.com)



An ISO 9001:2008  
Certified Company

*We are here to serve you:*

Tom Jablonowski, *Technical Service Manager*  
Nina Manee, *Sales & Marketing Representative*  
Massimo Cerboni, *Global Business Director*

tom.jablonowski@tse-industries.com  
nina.manee@tse-industries.com  
massimo.cerboni@tse-industries.com

**FIGURE 1: PREMILLED MILLATHANE® E34**



**FIGURE 2: PREMILLED MILLATHANE 76 MILLED SHEETS**



**FIGURE 3: PACKAGING MILLATHANE 76 PREMILLED SHEETS**



**FIGURE 4: STANDARD SKID VIRGIN MILLATHANE 76**