

### Millathane® Polyurethane Rubber: Premilled Versus Virgin

Millathane® polyurethane rubbers have excellent abrasion resistance as well as oil and fuel resistance along with low temperature flexibility. These properties make Millathane® polymers well suited for many applications in automotive, business machines, agriculture and industrial applications.

#### PREMILLED MILLATHANE®

Many of Millathane® polyurethane rubbers are available in two forms:

- Virgin - 38 (17.2 kg) or 45 (20.4 kg) pound bale
- Premilled - available in sheets packaged 50 lbs. per carton.

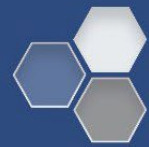
There are several advantages for Millathane customers to use premilled sheets:

- Ease of mixing on two roll mills
- Range of Mooney viscosity is  $\pm 5$  points for most products
- Premilled polyesters contain hydrolytic stabilizer
- Premilled package is 50 lbs. (22.7 kg) net weight

For customers mixing on two roll mills, Premilled Millathane® facilitates mixing compared to solid bales which have no previous rubber breakdown. Starting out with a narrowly defined Mooney viscosity range ensures a consistent mixed compound viscosity. Table 1: Millathane® Premilled products lists the various grades and their respective Mooney viscosity range.

**TABLE 1: MILLATHANE® PREMILLED PRODUCTS**

Product	Part Number	Mooney Viscosity ML 1+4@100°C	Note
Millathane® 76	M-0076M-30	25 to 35	Stabilized Polyester
	M-0076M-40	35 to 45	Stabilized Polyester
	M-0076M-50	45 to 55	Stabilized Polyester
Millathane® E34	M-0034M-40	35 to 45	Polyether
	M-0034M-45	40 to 50	Polyether
	M-0034M-50	45 to 55	Polyether
Millathane® 66	M-0066M-45	38 to 52	Stabilized Polyester
	M-0066M-50	43 to 57	Stabilized Polyester
Millathane® 26	M-0026M-40	35 to 45	FDA Polyether
Millathane® 28	M-0028M-50	45 to 58 ML5+4	Stabilized Polyester
Millathane® CM	M-00CM-30	30 – 35 MS1+10	Polyether
	M-00CM-40	35 – 45 MS1+10	Polyether
	M-00CM-45	40 – 50 MS1+10	Polyether
	M-00CM-55	50 – 60 MS1+10	Polyether
Millathane® 97	M-0097M-60	50 to 70	Polyether



### Millathane® Polyurethane Rubber: Premilled Versus Virgin (cont.)

#### 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 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	Triallylcyanurate	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>

\* polyesters will contain 1.5 phr polycarbodiimide

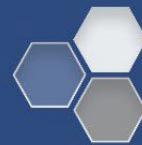
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Millathane® 76 is a sulfur or peroxide curable polyester polyurethane rubber. A carbodiimide hydrolytic stabilizer is added to the premilled version. From the rheometer (ODR) data, we find a delay in cure caused by the addition of stabilizer to Millathane®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

**TABLE 3: PHYSICAL PROPERTIES OF MILLATHANE 76 VIRGIN AND PREMILLED**

TEST DATA	Millathane® 76 Sulfur		Millathane® 76 Peroxide	
	Virgin	Premilled	Virgin	Premilled
ODR°C	155	155	160	160
Ts2	1.7	2.6	2.9	3.3
T90	7.1	9.6	17.6	18.6
Cure, min.@ °C	7'@155	10'@155	18'@160	19'@160
Hardness, Shore A	65	63	55	54
TSE-100*, psi / MPa	550 / 3.8	531 / 3.7	226 / 1.6	243 / 1.7
TSE-200, psi / MPa	1248 / 8.6	1218 / 8.4	720 / 5.0	797 / 5.5
TSE-300, psi / MPa	2134 / 14.7	2068 / 14.3	1508 / 10.4	1599 / 11.0
Tensile Strength, psi / MPa	4708 / 32.5	4291 / 29.6	2525 / 17.4	2383 / 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
<i>*TSE-xxx = tensile stress at xxx % elongation</i>				
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

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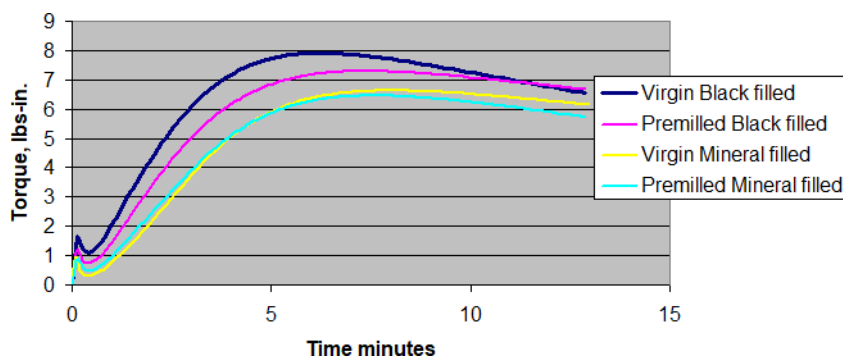
### Millathane® Polyurethane Rubber: Premilled Versus Virgin (cont.)

#### PREMILLED MILLATHANE® STABILITY

Premilled Millathane® polyester grades contain carbodiimide hydrolytic stabilizer which improves shelf life, resists hydrolysis in cured parts and we have 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**

Millathane® 66 Premilled vs. Virgin MDR @ 176°C

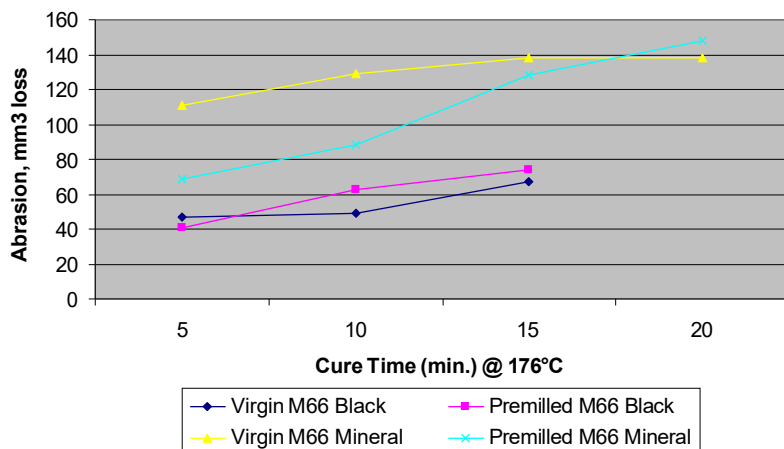


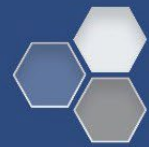
#### ABRASION RESISTANCE

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. Millathane® 66 mineral filled as can be seen in Figure 2: Improved Abrasion Resistance of Premilled Millathane® 66.

**FIGURE 2: IMPROVED ABRASION RESISTANCE PREMILLED MILLATHANE® 66**

DIN Abrasion Millathane® 66





### Millathane® Polyurethane Rubber: Premilled Versus Virgin (cont.)

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% Dicumylperoxide	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



Premilled Millathane® E34



Premilled Millathane® 76 Milled Sheets



Packaging Millathane® 76 Premilled Sheets



Standard Skid Virgin Millathane® 76