

# Technical Information for Performance Solutions

## Special points of interest:

- Crystallization of Millable Urethanes
- Process Aids
- Mill Mixing
- Internal Mixing
- Brabender (Small Internal Mixer) Mixing
- Polymer Breakdown
- Calendering
- Extrusion
- Crystal® 2000-Slab DIP/  
Anti-stick Agent

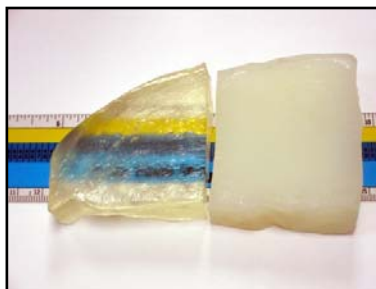
## PROCESSING OF MILLATHANE® MILLABLE URETHANES

Millathane millable urethanes are processed on conventional rubber equipment, including mills, internal mixers, calenders and extruders. Because of their unique composition, the processing of millable urethanes is optimized when the following suggestions are followed.

### Crystallization of Millable Urethanes

Millable urethanes can undergo crystallization when stored for long periods at room temperature or for shorter periods when stored below room temperature. Polymers that are crystallized become hard and milky in color compared to the usual softer, transparent or translucent material. The crystallization is completely reversible and millable urethane polymers can be decrystallized by warming, in a conventional or microwave oven, at 70°-100°C (158°-212°F) until the polymer returns to its original color. Mixing crystallized, or partially crystallized, rubber can damage equipment or result in poor polymer dispersion.

The picture below shows Millathane E34's typical appearance on the left, and crystallized Millathane E34 on the right.



### Bale Wrap / Plastic Liners

The plastic wrap or bags that Millathane millable polyurethanes are wrapped in are not inclusion bags and must be removed before mixing.



## Process Aids

Millable urethanes can tend to show sticking to mixer surfaces, especially when low Mooney viscosity polymers are used and mixing equipment is warm or hot. This can be alleviated by incorporating a small amount (0.5-2.0 parts) of a process aid into the compound. For sulfur cures, 0.5 part of zinc stearate is generally used and it acts both as a cure activator and a process/release agent. For peroxide cures, stearic acid is usually added at 0.25 – 0.5 parts. An additional process aid such as Struktol WB222, Aflux 54, Vanfre AP-2, or AC617A (low melt polyethylene) can also be added at 0.5-2 part levels.

## Mill Mixing

For mill mixing of Millathane® millable urethane compounds, it's best to start with a cool mill and to keep the water (or other cooling medium) on to prevent sticking. Process aids should be added at the beginning of the mix, with the polymer, and blended well before adding fillers. Half the filler should then be added, with the most reinforcing filler added first. After blending, the remaining filler and any plasticizer or other ingredients should be added. If the batch temperature is below 100°C (212°F), curatives can be added; otherwise sheet off the stock and add after the stock cools.

### **MILLATHANE® FACTOID:**

*For static conductive compounds, sulfur cures of Millathane® millable urethanes give lower electrical resistance (better conductivity) than peroxide cures. For example, Millathane CM when sulfur cured gave volume resistivity of  $2 \times 10^{10}$  while a peroxide cure gave  $3 \times 10^{11}$  ohm-cm.*



## Internal Mixing

Full cooling is generally used, to prevent sticking, and a slow mixing speed (20-25 RPM) is usually used. A typical procedure is as follows:

- 0' Add polymer and process aids
- 1' Add ½ filler
- 3'-5' Add remaining filler, plasticizer, and other ingredients
- 5'-7' Dump 100°-125°C (212°-257°F)

When the amp meter or stock temperature has leveled off, the batch is ready to dump. Another indicator of time to dump is the characteristic “slurping” sound of a good mix. Add curatives to cooled stock on mill or in a second pass.

If sticking occurs, try reducing the batch size, reducing the ram pressure and/or mixing speed, or adding a process aid. Zinc stearate should NOT be used for a slab dip; Crystal® 2000, talc or clay solutions can be used. Stock should be cool and dry before stacking.

## Brabender (Small Internal Mixer) Mixing

Because of the toughness of urethane polymers, normal mixing procedures in Brabender mixers sometimes result in broken shear pins. It's best to undersize the batch by 10-20%, and to cut the rubber into small pieces and/or warm the rubber, in a conventional or microwave oven, before adding it to the mixer.

## Polymer Breakdown

Generally, millable urethanes polymers can be reduced in viscosity by a breakdown step, either as a separate step or as an initial part of the mixing process. This may be desirable for improved transfer or injection molding of urethane compounds. Breakdown should be done with a process aid to avoid sticking, and is more efficient when done at moderate-to-high temperatures (70°-100°C; 158°-212°F). Cured properties are generally not affected by the breakdown step.

## Calendering

For the best calendering of millable urethane compounds:

- \* Ply up thin sheets of 0.5-1.0 mm (0.020-0.040 in.) to make thicker sheets
- \* Cool stock before wrapping in liner
- \* Higher temperatures will give better sheet smoothness, as will differential roll speeds
- \* Use moderate temperatures:
 

Stock	60°-90°C (140°-194°F)
Top Roll	90°-105°C (194°-221°F)
Middle Roll	110°-120°C (230°-249°F)
Bottom Roll	60°-90°C (140°-194°F)

## Extrusion

Millable urethanes can be extruded to make preforms for molding operations. Because urethanes have poor high temperature green strength, they are not suitable for continuous cure processes which operate at, or generate, high temperatures.

For the best extrusion characteristics,

- \* Use compounds with good scorch safety
- \* Avoid excessive heat to prevent softening and sticking
- \* Use fine particle blacks and silicas
- \* Generally, cold screw, cool barrel, and warm-hot heat and die work best.

Typical temperatures used are:

Screw	20°-30°C (68°-86°F)
Barrel	60°-70°C (140°-158°F)
Head	75°-90°C (167°-194°F)
Die	85°-100°C (185°-212°F)

### *MILLATHANE® FACTOID:*

*The compression set of sulfur-cured Millathane® millable urethanes can be improved by post curing 3-4 hours at 121°C (250°F). For example, a non-black sulfur-cured Millathane 76 compound had 75% compression set (22 hr/100°C test), but 45% set after a 3 hr/121°C post cure.*

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**Crystal® 2000 - Slab DIP / Anti-stick Agent**

Crystal® 2000 (a product of Franklynn Industries) is an effective anti-stick agent for mixed stock or mold preforms. A one-part Crystal 2000 to three part water solution is recommended to prevent uncured rubber slabs or preforms from sticking to themselves. Crystal 2000 is transparent and will not discolor white or colored stocks.