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Technical Information for Performance Solutions

Millathane® 26 Blends with High Styrene Resin and Liquid Polybutadiene

Millathane 26 is the only millable polyurethane rubber that complies with the FDA regulation 21CFR177.2600 and has found use in various applications involving food contact. As some applications, including rollers and gaskets, require relatively high hardnesses, several formulation ingredients were evaluated to achieve these higher hardnesses.

This report examines compounding of Millathane 26 with Pliolite S6B (a high styrene resin) and Ricon 154 (a polybutadiene resin). These materials, as well as the other ingredients in the formulations shown here, comply with the FDA regulation 21CFR177.2600*.

Topics:

High Styrene Resin (Pliolite S6B) Blends

Pliolite S6B is an emulsion polymerized high styrene resin with a typical styrene/butadiene ratio of 82.5/17.5. It is commonly used to increase hardness and stiffness in rubber compounds that are used for various applications including shoe soles, rollers, etc.

As a means to achieve high hardness Millathane 26 compounds, Pliolite S6B was blended with Millathane 26 in ratios from 100/0 to 70/30 Millathane 26/Pliolite S6B. The non-black, silica reinforced formula is shown below:

Millathane 26	100 – 70
Pliolite S6B	0 – 30
Stearic acid	0.3
Ultrasil VN3	25
TP-95 (DBEEA)	2
Struktol WB222	1
AC 617A	2
Dicumyl peroxide 40%	5

The data, shown in the following two charts, show the following trends:

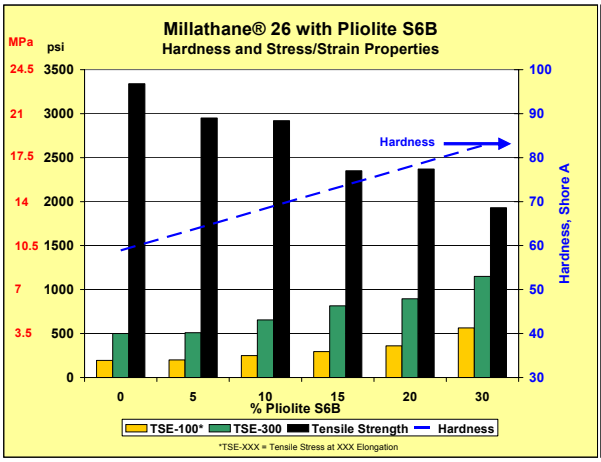
- Hardness and tensile stress (aka, modulus) increased as the level of Pliolite S6B increased. The hardness increased approximately 8 Shore A points per 10 parts Pliolite S6B. The highest hardness of these compounds tested 86 Shore A.
- Tensile strength decreased somewhat with increasing Pliolite S6B, approximately 400 psi (2.7 MPa) per 10 parts Pliolite S6B.
- Abrasion resistance was not affected up to 10 phr Pliolite S6B but was somewhat poorer at higher levels.

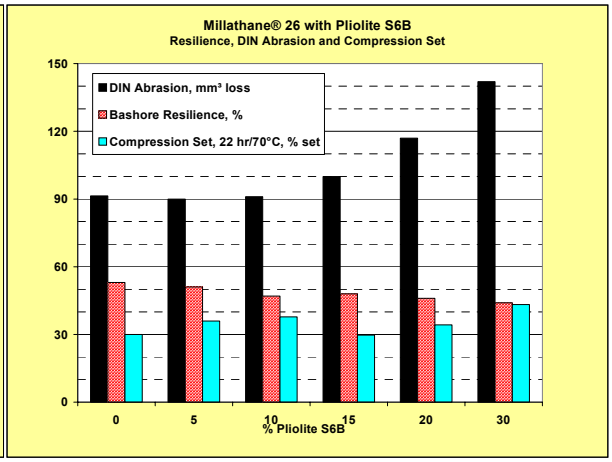
*with information as provided by suppliers of the ingredients, as of November 2009. You should check with the suppliers of your raw materials to confirm that they are (still) FDA-compliant.

The recommendations for the use of our products are based on tests believed to be reliable. However, we do not guarantee the results to be obtained by others under different conditions. Nothing in this literature is intended as a recommendation to use our products so as to infringe on any patent. Millathane® and Thanecure® are registered trademarks of TSE Industries, Inc.

Resilience decreased slightly and compression set increased slightly as the Pliolite S6B level increased.

Other data not shown here indicated that, as the level of Pliolite S6B increased, the viscosity was relatively constant and the tear resistance (both Die C and Die B) was improved.





Liquid Polybutadiene Resin in Millathane® 26

MILLATHANE® FACTOID: *Transparent Millathane® 97 compounds, containing UV stabilizers, showed no signs of crazing or cracking after 29 months outdoors in Clearwater, FL.*

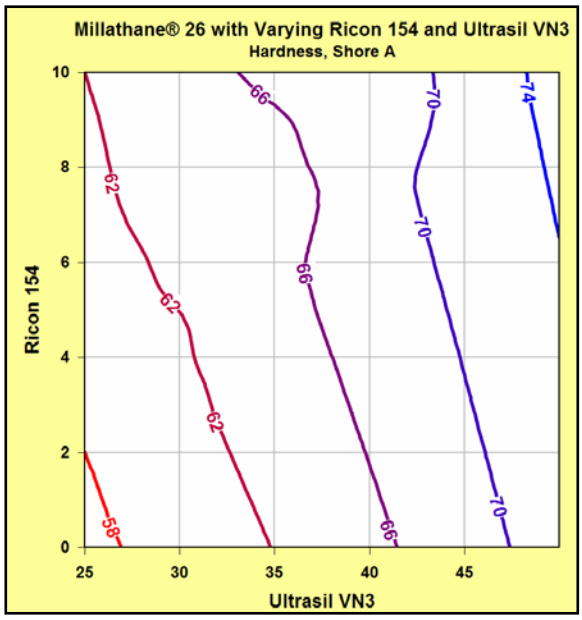
Liquid polybutadiene resins, such as Ricon 154 from Sartomer Company, can be used as vulcanizable coagents in Millathane 26. Ricon 154 is a butadiene homopolymer with 1,2-Vinyl content of 90%. An experimental design was run, varying the precipitated silica (Ultrasil VN3) from 25 to 50 parts while varying the polybutadiene resin (Ricon 154) from 0 to 10 parts.

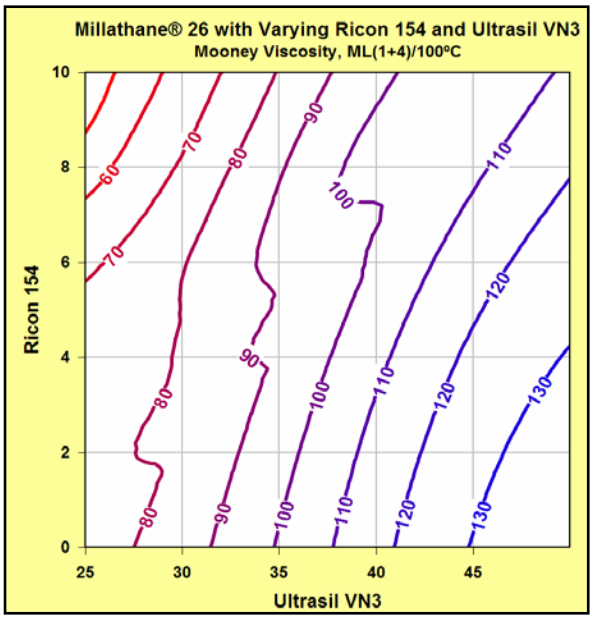
Millathane 26	100
Stearic acid	0.3
Ultrasil VN3	25 – 50
TP-95 (DBEEA)	2
Struktol WB222	1
Ricon 154	0 – 10
Dicumyl peroxide 40%	5

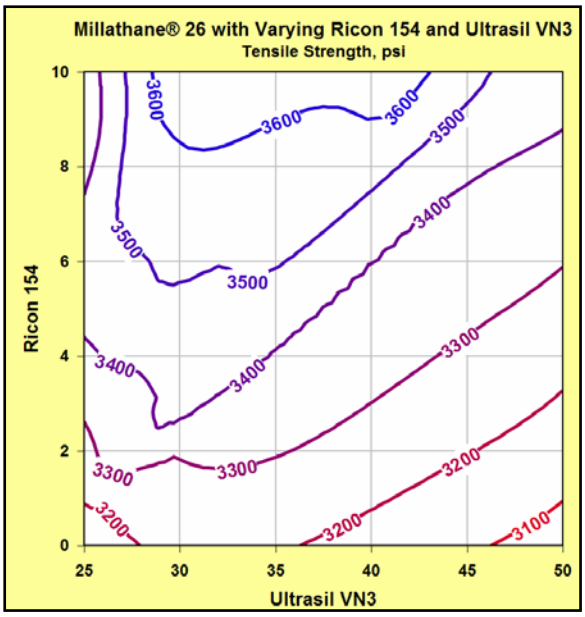
The data, plotted in the contour charts below, show:

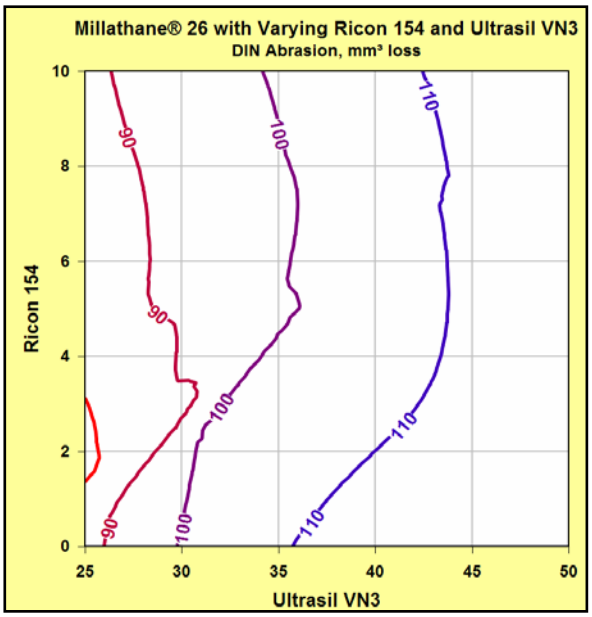
- The **hardness** is primarily affected by the silica level, increasing approximately 4 Shore A points for each 7-8 parts of silica. The polybutadiene resin also increased the hardness, about 4 Shore A points per 10 parts of resin.
- The **compound viscosity** is significantly affected by both the silica and the polybutadiene resin, increasing with increasing silica, and decreasing with increasing polybutadiene resin.
- The **tensile strength** is not significantly affected by either ingredient, with all compounds in this experimental design testing between 3140 and 3650 psi (21.7 to 25.2 MPa) tensile strength.

Abrasion resistance was not significantly affected by the polybutadiene resin levels, but did diminish somewhat as the silica level increased, giving higher DIN abrasion losses.









Summary

High hardness compounds based upon Millathane 26 can be achieved by increasing the silica (or carbon black) level in the compound, although this, by itself, will give tend to give high viscosity compounds. The addition of high styrene resin (Pliolite S6B) or liquid polybutadiene resin (Ricon 154), along with the reinforcing filler, will give better processing (lower viscosity) compounds than just using reinforcing filler to increase hardness.

Although not evaluated yet, the combination of high styrene resin and liquid polybutadiene resin in Millathane 26 compounds may give optimum compounds at moderately high hardnesses. Please contact us for a formulation recommendation for your particular application.

MILLATHANE® FACTOID: *Adding Thanecure® T9 to sulfur or peroxide cured Millathane will increase compound hardness with other properties minimally affected.*

MILLATHANE® FACTOID: *If you're trying to replace CSM (Hypalon®*) in a compound, consider Millathane millable urethanes! Contact us for more information.*

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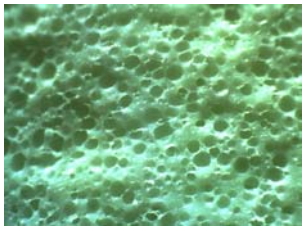
ASK Doctor Millathane®

Dear Dr. Millathane,
I have an application that required a low density urethane material. Can I make sponge or foamed rubber using Millathane millable urethanes?
Dennis Sittie

Hi, Den Sittie,
Yes, you can make expanded/sponge compounds from Millathane millable urethanes, although maybe not in the way you'd expect. The typical method of making sponge compounds is to add a chemical blowing or foaming agent (CBA or CFA) which, when it decomposes during curing, generates nitrogen or carbon dioxide. Unfortunately, these chemicals tend to be difficult to work with in millable urethanes as the chemicals affect the curing of the urethane.

A fairly recent development is the use of expandable microspheres (e.g., Expancel®*) as the expansion agent. These materials are very small polymeric spheres that contain an expandable hydrocarbon gas. Upon heating, the gas, and correspondingly the polymeric sphere, expands in the rubber compound, giving a lower density cured compound.

An example of this technology is a Millathane 97 compound containing 5 parts of Expancel 930DU120. This compound, molded for 4 minutes at 170°C, tested 41 Shore A and 62 Asker C hardness, and had a density of 0.53 g/cc. A micrograph of the sponge is shown below. Please let us know if you have any specific requirements in this area, as we're currently doing some further evaluations of these materials.



Millathane® 97 Sponge (4x)

*Expancel is a trademark of Akzo Nobel, and Hypalon is a trademark of DuPont

Dr. Millathane

If you have any Millathane millable urethane questions you'd like answered, please send an email to millathaneinfo@tse-industries.com.