



### Choosing the Right Millathane® Polyester Urethanes Grade

TSE Industries currently provides five grades of polyester millable polyurethanes, each being developed for different end use applications. This study compares these five polyester millable urethanes to better assist the compounder in choosing the best millable urethane having the required properties for the application.

GRADES EVALUATED	
Millathane® 76	General purpose, sulfur and peroxide curable
Millathane® 5004	Excellent heat and oil resistance; peroxide curable only
Millathane® 66	Excellent processing, heat and oil resistance; peroxide curable only
Millathane® HT	Excellent hydrolytic stability and low temperature flexibility; sulfur and peroxide curable
Millathane® 28	Excellent resistance to gas permeability combined with low temperature flexibility; peroxide curable only

TYPICAL APPLICATIONS	
Millathane® 76	used in automotive vibration damping applications such as door and trunk stoppers because of its low resilience and consistent modulus upon aging
Millathane® 5004	excellent tear strength which enables de-molding of parts having complex design with low scrap
Millathane® 66	used in business machine applications where low temperature properties, combined with excellent abrasion resistance, are required for small rollers and drive belts
Millathane® HT	used in business machine applications where low temperature properties, combined with excellent abrasion resistance, are required for small rollers and drive belts
Millathane® 28	excellent permeability resistance combined with low temperature properties for automotive and industrial pneumatic seals and gaskets

### FORMULATION

The same general formulation was used for all compounds, with the only variable being the peroxide (DiCup 40C) level, as each polymer requires different peroxide levels to achieve optimum properties. Two peroxide levels were evaluated for each polymer. The compounds with the peroxide level that gave similar stress at 100% elongation (100% modulus) are shown to compare the polymers on an equal basis. Data comparing the two peroxide levels is shown on page 3.

Millathane Urethane	100.0
Stearic Acid	0.2
N330 Black	25.0
DBEEA (TP-95)	2.0
Struktol WB-222	1.0
Stabaxol P	2.0
DiCup 40C	Variable

### PHYSICAL PROPERTIES

As the table below shows, Millathane® 66 and Millathane® 28 gave the highest tensile strength, while Millathane® 5004 gave the highest tear strength.

Millathane® Grade	76	5004	66	HT	28
DiCup 40 Level	2	4	6	1	6
Hardness, Shore A	65	70	67	69	65
TSE-100*, psi / MPa	310 / 2.1	390 / 2.7	300 / 2.1	270 / 1.9	300 / 2.1
TSE-300*, psi / MPa	1840 / 12.7	1770 / 12.2	1300 / 9.0	1430 / 9.9	1600 / 11.0
Tensile Strength, psi / MPa	3840 / 26.5	3910 / 27.0	4560 / 31.4	3260 / 22.5	4800 / 33.1
Elongation, %	465	565	625	485	570
Tear, Die C lb/in / kN/m	199 / 34.8	304 / 53.2	258 / 45.2	172 / 30.1	250 / 43.8

\*TSE-XXX = tensile Stress at XXX% elongation



### Choosing the Right Millathane® Polyester Urethanes Grade (cont.)

#### HEAT AGING

Heat aging at both 100°C and 125°C showed very good results for all the compounds, with Millathane® HT having somewhat higher change of elongation after aging than the other Millathane® grades.

Millathane® Grade	76	5004	66	HT	28
DiCup 40 Level	2	4	6	1	6
<b>Oven Aging 70 hr / 100° C</b>					
Hardness Change, pts.	2	5	3	6	5
Tensile Strength Change, %	10	11	7	3	-11
Elongation Change, %	1	-2	1	-16	4
<b>Oven Aging 70 hr / 125° C</b>					
Hardness Change, pts.	4	3	5	3	1
Tensile Strength Change, %	-7	12	5	5	-1
Elongation Change, %	-15	-12	-10	-38	-4

#### FLUID AGING

The IRM 903 oil aging showed good results for all the compounds, with Millathane® 5004, 66, and 28 giving slightly better overall retention of properties. The boiling water immersion test showed the best retention of properties with Millathane® HT, 66, and 5004. All compounds had two parts of the hydrolysis stabilizer Stabaxol P added to the formulations. The Toluene immersion test showed the best resistance to swelling by Millathane® 28, while Millathane® 28, 76, and 5004 had the lowest hardness changes.

Millathane® Grade	76	5004	66	HT	28
DiCup 40 Level	2	4	6	1	6
<b>IRM 903 Oil Aging 70 hr / 100° C</b>					
Hardness Change, pts.	-7	-5	-7	-6	-8
Tensile Strength Change, %	-23	4	-9	-5	-1
Elongation Change, %	-13	-5	-6	-30	-3
<b>Water Aging 70 hr / 100° C</b>					
Hardness Change, pts.	-15	-8	-9	-4	-8
Tensile Strength Change, %	-42	-19	-26	-17	-44
Elongation Change, %	39	19	1	-25	9
Volume Change, %	7	2	3	2	4
<b>Toluene Aging, 7 Days / 23° C</b>					
Hardness Change, pts.	-13	-13	-20	-20	-15
Volume Change, %	58	61	61	60	48

*The recommendations for 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®, Crystal® and Thanecure® are registered trademarks of TSE Industries, Inc.*



### Choosing the Right Millathane® Polyester Urethanes Grade (cont.)

#### OTHER TESTS

Compounds based upon Millathane® 76 and HT gave lower resilience (rebound) than the other polyester urethanes. Millathane® 5004, 28 and 66 had the best abrasion resistance, while Millathane® HT, 66, and 5004 had the lowest brittle point. Compression set resistance was best for Millathane® 28, 76, and 66.

Millathane® Grade	76	5004	66	HT	28
DiCup 40 Level	2	4	6	1	6
Bashore Resilience, %	25	43	50	23	44
DIN Abrasion, mm <sup>3</sup>	115	70	55	86	66
Low Temperature Brittle Point, °C	-35	-55	-57	-59	-45
Compression Set, %					
22 hr / 70° C	7	13	11	10	7
22 hr / 100° C	24	40	24	35	24
22 hr / 125° C	39	67	39	52	33

#### EFFECT OF PEROXIDE LEVEL

Generally, higher peroxide levels give higher stress at elongation (modulus) values, better abrasion resistance, lower compression set, and better fluid resistance. The charts below illustrate the effect of peroxide level on several of these properties.

