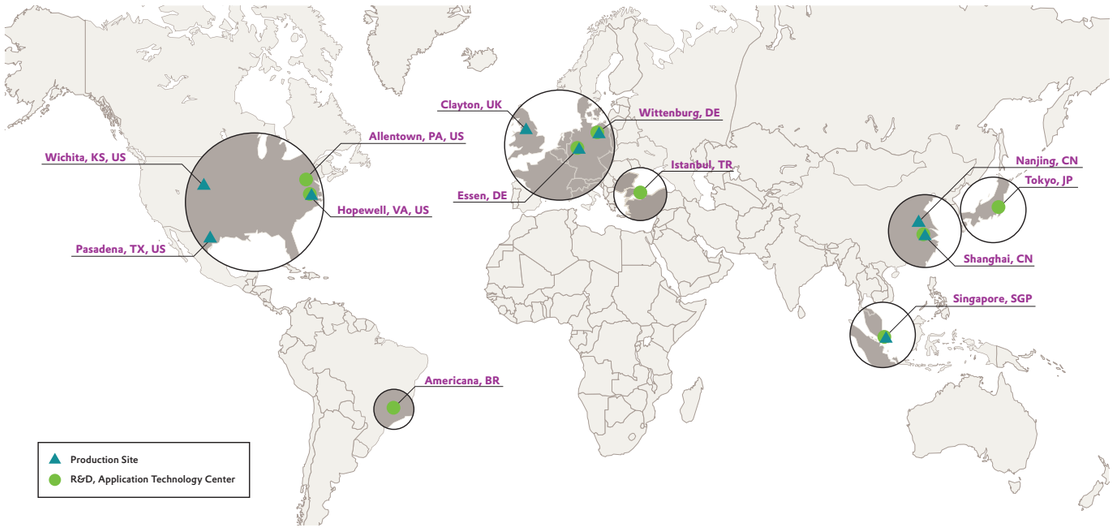
ADDITIVES FOR POLYURETHANE CASE APPLICATIONS – AMERICAS

CATALYSTS, CURATIVES, PERFORMANCE ADDITIVES, SURFACTANTS & RELEASE AGENTS

EVONIK
Leading Beyond Chemistry

Contents

EVONIK – YOUR PARTNER FOR POLYURETHANE CASE APPLICATIONS



Polyurethane is a versatile material that is ideally suited for a wide range of CASE (Coatings, Adhesives, Sealants, and Elastomers) applications. As a leading innovator and additive supplier to the polyurethane industry, Evonik offers a wide array of advanced technologies to include into the formulators' toolbox.

Our solutions enable you to optimize performance by controlling reaction profile and pot life, shortening return to service time, improving surface appearance and adhesion, as well as helping to enhance the physical properties of the final product.

As a dedicated partner, Evonik works extensively on developing new products with the focus to provide innovative solutions and to support transitioning to higher sustainability in formulations. Our extensive product portfolio includes Catalysts (amine and metal), Surfactants (silicone and organic), Release Agents, Performance Additives, and Curatives.

Building on our deep understanding of polyurethane chemistry and with manufacturing sites and laboratories across the globe, we are well positioned to meet your current and future development needs with tailored made solutions.

SPECIALTY CATALYSTS – HIGH PERFORMANCE

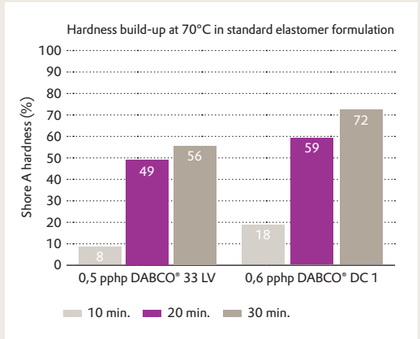
Catalyst solutions from our high-performance range combine the typical benefits of metal- and amine-based catalysts. They allow for extended front-end delay while preserving an efficient back-end cure profile and short tack-free times. These catalysts help formulators to reduce exposure and handling of toxic metal catalysts in production, such as dibutyltin.

DABCO® DC 1 is a delayed-action catalyst for use in all castable (foamed and high density) polyurethane systems. It has a reactivity similar to standard amine catalysts such as DABCO® 33 LV while also providing a more efficient hardness build-up. DABCO® DC 2 shows a higher reactivity compared to DABCO® DC 1 with shorter pot life and faster return-to-service time. For application sensitive to VOC's emissions or staining issue, DABCO® DC 5 LE offers similar benefits to DABCO® DC 2 with a lower emission profile.

POLYCAT® SA 20 exhibits a similar front-end reactivity as DABCO® DC 1, while meeting low emission requirements and providing an option that does not contain dibutyltin. For situations that require both tin-free and low emission solutions, we offer POLYCAT® SA 5 as a high-performance delayed-action catalyst.

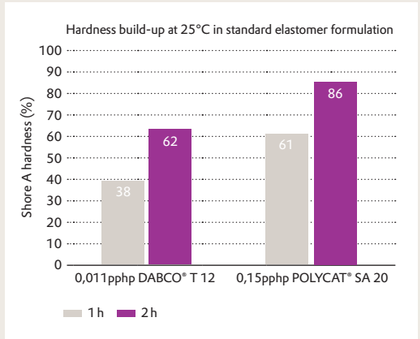
DABCO® DC 1, DABCO® DC 2, and POLYCAT® SA 5 are highly efficient and can be used at low levels as co-catalysts in existing formulations to help increase the cure speed of the system without affecting the front-end of the reaction, while maintaining working life.

DABCO® DC 1 vs DABCO® 33 LV



Adjusted to similar pot life times

POLYCAT® SA 20 vs DABCO® T 12



Adjusted to similar pot life times

SPECIALTY CATALYSTS – THERMOLATENT

Traditional polyurethane catalysts accelerate a polyol-isocyanate reaction at ambient conditions. However, when a delayed reaction profile is preferred, we offer the POLYCAT® SA series.

These catalysts are activated by the natural exotherm generated during the formation of polyurethane or by using an external heat source, speeding up the cure time.

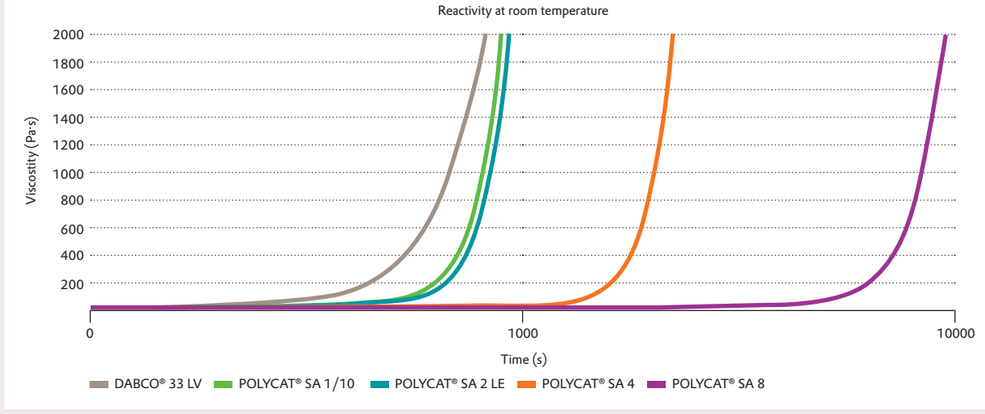
POLYCAT® SA catalysts cure at different temperatures (as shown in the illustration below). By choosing the right catalyst you can tailor a delayed reaction profile to optimize your process and formulation.

20–25 °C	35–50 °C	50–70 °C	>70 °C
POLYCAT® SA 5 Room temperature activation	**POLYCAT® SA 1/10** Excellent back-end cure Extended pot life	**POLYCAT® SA 4** Excellent back-end cure Extended pot life Fast demould time	**POLYCAT® SA 8** Excellent front-end delay
POLYCAT® SA 20 Excellent back-end cure Low Emission	**POLYCAT® SA 2 LE** Low Emission		

The graphic below depicts the delayed action performance at ambient conditions of POLYCAT® SA 1/10, POLYCAT® SA 2 LE, POLYCAT® SA 4 and POLYCAT® SA 8.

POLYCAT® SA 1/10 and POLYCAT® SA 2 LE have a more subtle delay. Due to its unique composition, POLYCAT® SA 2 LE can also be utilized to help reduce amine emissions. POLYCAT® SA 8 provides the longest delay as this catalyst activates at the highest de-blocking temperature. Additionally, the POLYCAT® SA series catalysts can be combined with other catalysts in our portfolio to optimize material properties and cure profile behavior.

Viscosity profiles in a standard aromatic elastomer formulation



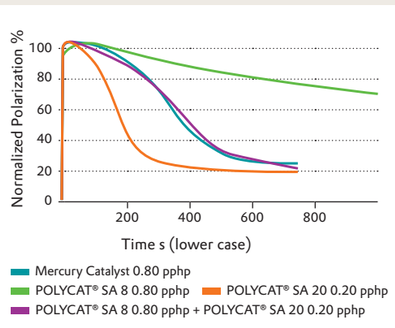
MERCURY ALTERNATIVE CATALYSTS

To address cure profile and snap cure requirements, we recommend working with a combination of POLYCAT® SA 20 and POLYCAT® SA 8. This approach allows formulators to fine-tune the front-end and back-end cure profiles to meet the desired processing conditions, while offering a sustainable alternative to Mercury and other toxic catalysts. In the example shown below, a 20/80 ratio blend of POLYCAT® SA 20 and POLYCAT® SA 8 shows an excellent back-end cure and pot life balance similar to that offered by a traditional mercury catalyst. To learn more about this tailored approach, please contact your local sales representative.

Shore a hardness

	10 MINUTES	24 HOURS
Mercury Catalysts (0.8 pphp)	<10	72
POLYCAT® SA 8 (0.8 pphp) POLYCAT® SA 20 (0.2 pphp)	15	72

Reactivity comparison between mercury and POLYCAT® SA catalysts



TYPICAL COMBINATIONS:

- POLYCAT® SA 8 : POLYCAT® SA 20 (0.8 : 0.2 pphp)
- POLYCAT® SA 8 : POLYCAT® SA 5 (0.8 : 0.2 pphp)

Catalyst ratios may need to be optimized to achieve desired curing profile and pot life for a specific formulation.

	FRONT-END DELAY	BACK-END CURE
POLYCAT® SA 8	X	
POLYCAT® SA 5		X
POLYCAT® SA 20		X

SPECIALTY CATALYSTS – HIGH SUSTAINABILITY

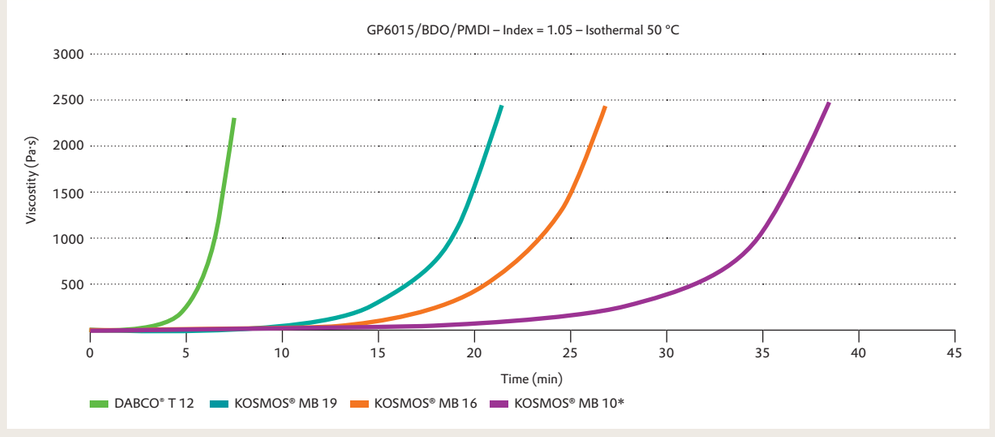
Organotin catalysts, like Dibutyl Tin Dilaurate (DBTL) and Dioctyl Tin Dilaurate (DOTL), are constantly under regulatory threat and have special labeling requirements when being used around the world. With these challenges, formulators need to be aware and ready with suitable alternatives.

At Evonik, sustainability is the central element behind our purpose "Leading Beyond Chemistry" and we are committed to providing innovative solutions that help to make our lives more sustainable, healthier, and more comfortable.

To help drive this initiative, we have recently launched a series of bismuth catalysts under the KOSMOS® MB tradename. The KOSMOS® MB series are Bismuth-based catalysts are versatile alternatives to traditional Organotin catalysts. KOSMOS® MB 16 and MB 19 are 16 and 20 wt% bismuth dissolved in neodecanoic acid. And KOSMOS® MB 10 is a specialty developed grade of bismuth that has been optimized for moisture stability to ensure a consistent pot life and cure time during extended storage and application.

This technology enables formulators and manufacturers to use ecologically safe polyurethane catalysts and create products and systems that are Tin-, Lead and Mercury-free. Furthermore, they exhibit low volatility with little or no odor. KOSMOS MB® series are ideal for all type of Coating, Adhesives & Sealants and Elastomers polyurethane applications.

Viscosity profiles of KOSMOS® MB series and of DABCO® T 12 (DBTL)



Catalyst level: 0.02 pphp *0.04 pphp

Overview of DABCO®, KOSMOS® and POLYCAT® catalyst solutions

		HYDROLYTIC STABILITY	VISCOSITY (mPa·s @ 25°C)	CALCULATED OH NUMBER (MG KOH/G)	MINIMUM CURE TEMPERATURE °C	PRODUCT DESCRIPTION
	INDUSTRY STANDARD CATALYSTS					
AMINE	POLYCAT® DBU	+++	14	0	RT	100% diazabicycloundecene (DBU). Strong gel catalyst that provides snap cure at ambient temperature
	DABCO® CRYSTALLINE	+++	NA	0	RT	100% solid triethylene diamine (TEDA). Used in the synthesis of prepolymers and curing of polyurethanes
	DABCO® 33 LV	+++	125	560	RT	33% TEDA dissolved in various solvents (dipropylene glycol, monoethylene glycol and 1,4 butanediol respectively). Used in the synthesis of prepolymers and curing of polyurethanes
	DABCO® EG	+++	60	1207	RT	33% TEDA dissolved in various solvents (dipropylene glycol, monoethylene glycol and 1,4 butanediol respectively). Used in the synthesis of prepolymers and curing of polyurethanes
	DABCO® 33 S	+++	135	830	RT	33% TEDA dissolved in various solvents (dipropylene glycol, monoethylene glycol and 1,4 butanediol respectively). Used in the synthesis of prepolymers and curing of polyurethanes
	DABCO® DMDEE	+++	18	0	RT	100% dimorpholinyldiethylether (DMDEE). This catalysts is isocyanate stable and favorises the "blow reaction". It is commonly used in 1K moisture cured applications in CASE.
TIN	DABCO® T 12	–	60	0	RT	Dibutyltin dilaurate (DBTL). Strong gel catalyst with moderate hydrolytic stability.
	KOSMOS® T 900	–	2000	0	RT	Stannous octoate free of 2-ethylhexanoic acid (2-EHA). Strong gel catalyst. Very low hydrolytic stability.
	KOSMOS® 16	+	35	0	RT	Tin catalyst with good hydrolytic stability and with a more beneficial EHS profile compared to standard DBTDL
	KOSMOS® T 100	–	2500	0	RT	Fast initiating tin catalyst suitable for fast curing applications such as spray coating and RIM
	KOSMOS® T 820	+	16	0	RT	Tin catalyst with good hydrolytic stability and with a more beneficial EHS profile compared to standard DBTL. This product is more reactive than KOSMOS® 16
	SPECIALTY CATALYSTS					
THERMOLATENT AMINE	POLYCAT® SA 1	+++	400	0	35	Latent catalyst which provides an excellent back end cure profile.
	POLYCAT® SA 1/10	+++	600	0	35	Improved version of POLYCAT® SA 1 with global product registration. Product can help further extend pot life and will remain in liquid form at low temperatures.
	POLYCAT® SA 2 LE	+	2600	0	35	Heat activated catalyst that exhibits a front end delay with rapid back end-cure and low emission.
	POLYCAT® SA 4	+++	4000	84	50	Heat activated catalyst with higher de-blocking temperature and longer pot life time than POLYCAT® SA 1/10.
	POLYCAT® SA 8	+	9500	258	>70	Heat activated co-catalyst with an excellent front-end delay.
DELAYED ACTION AMINE	DABCO® 1027	+++	75	1195	RT	Acid-free delayed action catalyst that is useful in microcellular applications requiring stronger back-end cure. 1027 is for MEG extended and 1028 is for 1,4 butanediol polyester and polyether systems.
	DABCO® 1028	+++	125	900	RT	Acid-free delayed action catalyst that is useful in microcellular applications requiring stronger back-end cure. 1027 is for MEG extended and 1028 is for 1,4 butanediol polyester and polyether systems.
	DABCO® 8154	+++	160	0	RT	Acid-blocked delayed action catalyst showing high efficiency for extending pot life.
LOW EMISSION AMINE	DABCO® NE 1070	+++	1200	730	RT	Gel reactive catalyst use in replacement of TEDA-based catalysts like DABCO® 33 LV
	DABCO® NE 1550	+++	550	313	RT	Strong gel reactive catalyst use in replacement of TEDA-based catalysts like DABCO® 33 LV. Offers higher gel selectivity than DABCO® 1070.
TRIMERIZATION SALTS-BASED	DABCO® TMR 7	+++	200	900	RT	Can be utilized in composite applications or as co catalyst in microcellular elastomers to reduce demold time. Contains no CMR substances
	DABCO® TMR 31	+++	135	500	RT	Delayed action catalyst. Has lowest impact on pot life when used as cocatalyst.
HIGH PERFORMANCE HYBRID METAL/ AMINE	DABCO® DC 1	++	400	689	RT	Catalyst that gives a back-end cure similar to a tin catalyst and a similar working time as an amine catalyst.
	DABCO® DC 2	++	391	603	RT	Catalyst that gives a back-end cure similar to a tin catalyst and a similar working time as an amine catalyst. DABCO® DC 2 is more reactive than DABCO® DC 1.
	POLYCAT® SA 20	+	5000–11000	45	RT	Dibutyltin-free and low emission catalyst providing back-end cure similar to a tin catalyst and a similar working time as an amine catalyst.
HIGH SUSTAINABILITY BISMUTH	KOSMOS® MB 10	+	> 30000	530	RT	Bismuth-based catalysts with 10 wt% of metal. This grade offers improved hydrolytic stability of the catalyst.
	KOSMOS® MB 16	–	2500	0	RT	Bismuth carboxylate-based catalysts with 16 wt% of metal. Strong gel catalyst for replacing Tin-based catalyst in formulations
	KOSMOS® MB 19	–	9500	0	RT	Bismuth carboxylate-based catalysts with 19 wt% of metal. Strong gel catalyst for replacing Tin-based catalyst in formulations

+ = Good ++ = Very Good +++ = Excellent - = Not Recommend; RT= Room Temperature

low/no labelling catalyst / NE / sustainable

INDUSTRY STANDARD CATALYSTS – METAL- AND AMINE-BASED

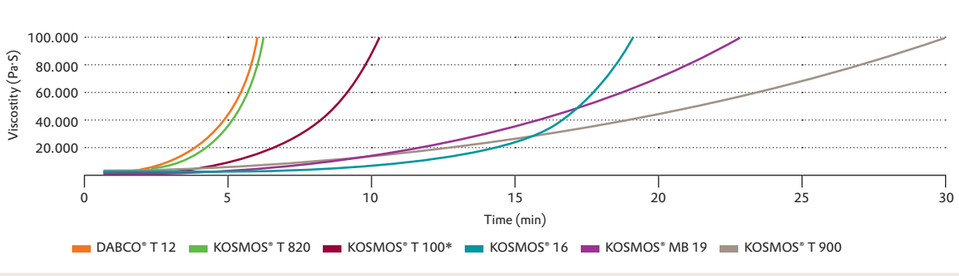
Evonik provides a catalysts portfolio consisting of various tin compounds and amine blends.

In addition to the industry standard DABCO® T 12, our tin portfolio includes KOSMOS® T 820 which provides improved shelf life stability in formulated systems. KOSMOS® T 100 offers the highest activity within this portfolio (note that use level of T 100 in the below chart is only half of the other ones) and has a fast viscosity build-up in fast curing spray and RIM applications. DABCO® T 131 provides longer pot life. KOSMOS® 16 is a delayed-action, hydrolytically stable tin compound with a friendlier EHS profile compared to standard DBTDL.

Amine-based gelling catalysts are the industry standard for many applications in CASE. Evonik offers triethylenediamine-based (TEDA) catalysts in various solvents like DABCO® 33 LV in dipropylene glycol or DABCO® 33 S in butanediol. Beyond TEDA, we also offer another strong gelling catalyst, POLYCAT® DBU, containing diazabicycloundecene.

For Foaming applications requiring moisture curing, we offer dimorpholinyldiethylether (DMDEE), which favors the blow reaction helping to prevent early cross-linking.

Isothermal (25°C) viscosity profiles in a standard aromatic elastomer formuation

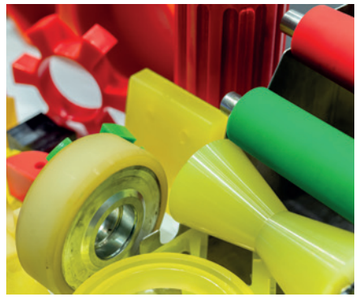


Use level: 0.02 pphp *0.01 pphp

PERFORMANCE ADDITIVES AND RELEASE AGENTS

Performance additives and surfactants from our ORTEGOL®, DABCO®, and TEGOSTAB® product lines help formulators customize final material and processing properties to meet their specific needs. Our additives help enhance miscibility, promote electrical conductivity and abrasion resistance, support adhesion, or can also serve as degassing agents.

Release agents from the GORAPUR® line help to ensure a safe molding process for any PU-based elastomer. Although designed for optimal processing and efficiency, they can be adapted to enhance surface appearance and haptics. The products below provide a short selection, please contact us for more options or to discuss unique application specific products.



	COATINGS	ADHESIVES	SEALANTS	ELASTOMERS	PRODUCT DESCRIPTION
ORTEGOL® AST 8	●	●	●	●	Highly potent antistatic agent with no impact on physical properties.
ORTEGOL® AB				●	Silicone-based abrasion reducer; easy to blend into the system.
ORTEGOL® NOP	●	●	●	●	Emulsifier enhancing miscibility of polyester or polyether polyols with natural oil based polyols.
ORTEGOL® 215	●	●	●	●	Emulsifier for enhanced miscibility of 1,4-BDO in polyols.
DABCO® LK 221		●	●	●	Organic surfactant that serves as a good emulsifier, epsecially for 1,4-BDO in polyol blends, and improves adhesion.
TEGOSTAB® B 8950			●	●	General purpose silicone surfactant that serves as a good emulsifier, especially for 1,4-BDO in polyol blends.
TEGOSTAB® B 8900	●		●	●	Silicone-based surfactant with strong cell-opening and degassing properties.
ORTEGOL® IR 2				●	Silicone-based additive reducing stickiness of soft elastomers and gels to facilitate processing of final parts.
ORTEGOL® BW 1		●			Isocyanate-stable wetting agent for binder applications.
DABCO® BA 316		●	●		Additive to improve hydrolytic stability of PU sealants and adhesives, especially when reactive catalysts are used.
GORAPUR® IMR 412 T				●	Internal mold release agent to improve process stability and reduce the necessary amount of external mold release.
GORAPUR® LI 0245-29 B				●	High solid, solvent-based mold release agent for elastomers with a silky matt surface finish. Ready to use or dilutable up to 1:2.
GORAPUR® LS 1459-19				●	100% pure silicone based release agent concentrate for dilution with organic solvents; for demolding parts of isocyanate bound rubber chips such as anti-slip and protective mats, sports and leisure applications.
GORAPUR® LS 1035-2 W				●	Water-based, general purpose release agent for PU elastomers. Dilutable up to 1:20.
GORAPUR® LS 1646-119 B				●	Highly efficient solvent-based release agent for glossy elastomers.

VERSALINK® CURATIVES

The VERSALINK® products are specialty polymeric, non-toxic diamines that can be used as curatives and chain extenders. The range consists of varying molecular weights for use in high-performance polyurethane, polyurea and polyurea-hybrid applications. They can be processed as a liquid and incorporated with MDI and TDI/MDI prepolymers to improve final performance properties.

Formulations using our VERSALINK® curatives combine the high performance of polyurea with the ease of application due to the extended pot-life and application time.

Properties

- Excellent abrasion resistance
- Excellent tear resistance
- Excellent dynamic properties
- Low linear shrinkage
- Excellent adhesion
- Excellent low-temperature properties
- Thermal stability up to 150 °C
- Hardness from 40A – 80D
- Non-toxic – FDA approved grades available

Processing

- Low system viscosity
- Long pot life
- Low process temperature
- Low sensitivity to moisture

	VISCOSITY (mPa·s @ 25 °C)	PHYSICAL STATE (25 °C)	EQUIVALENT WEIGHT
VERSALINK® 740 M	solid	solid (mp 130 °C)	157
VERSALINK® P 250	solid	solid (mp 60 °C)	220–250
VERSALINK® P 650	2,500	liquid	335–475
VERSALINK® P 1000	3,000	liquid	575–625
VERSALINK® P 2000	solid	solid (mp 35 °C)	940–1245

Processing and final elastomer properties of liquid MDI cured with VERSALINK® P-series:

	VERSALINK® P 250	VERSALINK® P 650	VERSALINK® P 1000	VERSALINK® P 2000
Isocyanate	Liquid 4,4´- MDI (29wt% NCO)	Liquid 4,4´- MDI (29wt% NCO)	Liquid 4,4´- MDI (29wt% NCO)	Liquid 4,4´- MDI (29wt% NCO)
Mix Ratio* by weight (VERSALINK® to Isocyanate)	1.5	2.8	3.8	7.1
Approximate pot life (min)	2	12	20	40
FINAL ELASTOMER PHYSICAL PROPERTIES**				
Hardness (Shore D)	84	55	50	35
Ultimate Tensile Strength (MPa)	66	55	31	28
Ultimate Elongation (%)	10	350	460	550
Die C Tear Strength (N/mm)	1051	806	736	578

*Calculated based upon a 95% stoichiometry
**Cured @ 25 °C for 7 days

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