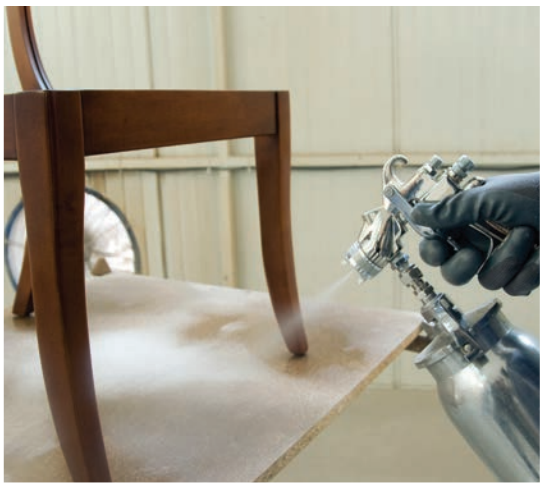
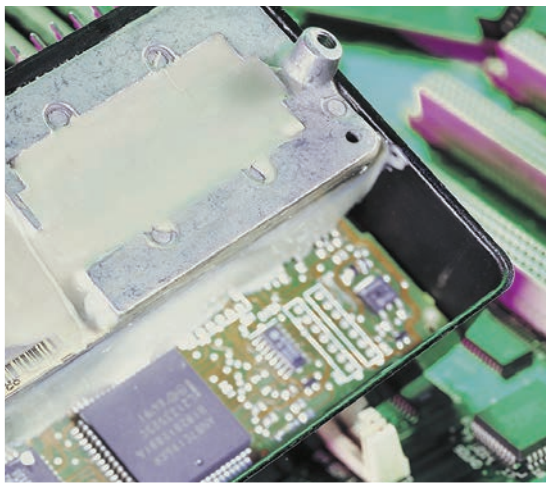
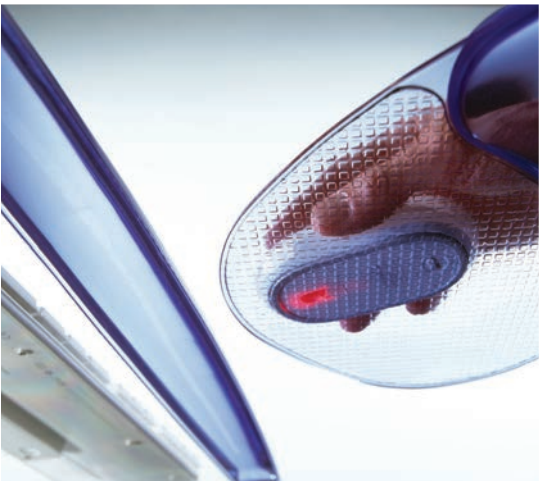
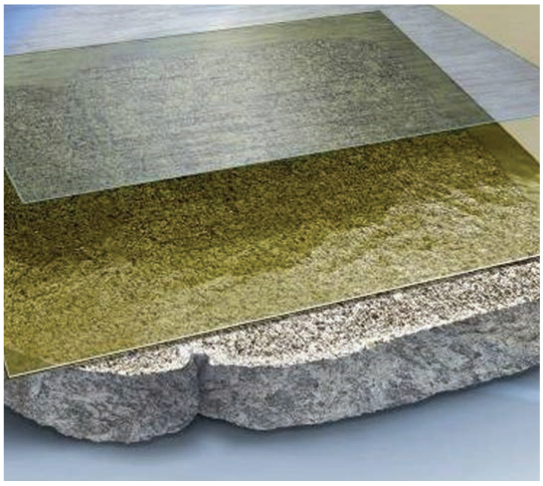
HUNTSMAN

Enriching lives through innovation

Adhesives, Coatings and Elastomers

Polyurethanes Product Line


RUBINATE® and SUPRASEC® MDI Specialty Isocyanates

JEFFOL® Polyether Polyols

Updated June 2013

Comprehensive Technical Support and Applications Development

When it comes to polyurethane chemistry for the Adhesives, Coatings & Elastomers (ACE) marketplace, Huntsman Polyurethanes is your most important resource. Our experience can help you at virtually every stage of product development, from formulation assistance to manufacturing.

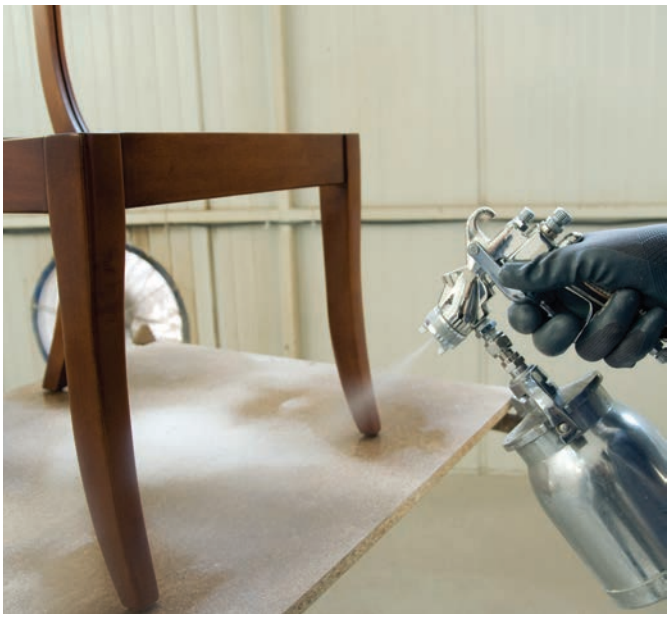
At our Auburn Hills, Michigan Technical Center, we take a hands-on approach to solving your technical and application questions. Through our QS-9000 approval process and A2LA accredited analytical and physical testing laboratories, we are able to meet the challenges found in today's CASE markets.

Polymeric MDI

Huntsman Polyurethanes is among the industry leaders in chemistry, technology and the manufacture of products for the Adhesives, Coatings and Elastomers (ACE) market.

Description	% NCO	Functionality	Specific Gravity @ 25°C	Equivalent Weight	Viscosity (cps) @ 25°C
STANDARD POLYMERIC					
SUPRASEC 5025 Isocyanate Low acidity polymeric optimal for controlled system reactivity	31.0	2.70	1.23	135	210
RUBINATE M Isocyanate Standard polymeric MDI	31.0	2.70	1.23	135	210
MODIFIED POLYMERIC					
RUBINATE 9016 Isocyanate Slow-reacting polymeric to provide extended open times	31.0	2.66	1.24	135	250
RUBINATE 1820 Isocyanate Medium functionality modified polymeric	32.0	2.47	1.23	131	70
SUPRASEC 9615 Isocyanate Polymeric MDI modified with a moderate level of 2,4' MDI isomer content	32.1	2.36	1.23	131	50
RUBINATE 1245 Isocyanate Polymeric MDI modified with a high level of 2,4' MDI isomer content	32.8	2.21	1.23	128	25
HIGH FUNCTIONALITY POLYMERIC					
RUBINATE 9257 Isocyanate Increased functionality polymeric	31.0	2.90	1.25	135	700

Monomeric MDI



Pure 4,4' methyl diphenyl diisocyanate (4,4' MDI) is the material of choice in urethane applications requiring high dynamic elastomeric properties. Although 4,4' MDI has a relatively high melting point and is solid at room temperature, Huntsman Polyurethanes has developed a family of specialty MDI isocyanates that can provide a portion of the benefits of 4,4' MDI, but are liquid at room temperature.

Description	% NCO	Functionality	Specific Gravity @ 25°C	Equivalent Weight	Viscosity (cps) @ 25°C
STANDARD PURE					
RUBINATE 44 Isocyanate Pure 4,4' MDI melting point 38°C	33.5	2.00	1.22	125	Solid
MODIFIED MONOMERIC					
MIXED ISOMER-MODIFIED					
Pure MDI containing different levels of 2,4' MDI isomer to improve low-temperature stability and lengthen reactivity					
RUBINATE 9433 Isocyanate	31.8	2.01	1.21	132	15
SUPRASEC 2004 Isocyanate	32.8	2.01	1.22	128	15
SUPRASEC 9150 Isocyanate	33.3	2.05	1.22	126	15
URETONOMINE-MODIFIED					
Modified pure MDI to maximize physical properties					
SUPRASEC 9561 Isocyanate	29.3	2.10	1.21	143	36
RUBINATE 1680 Isocyanate	29.5	2.12	1.23	142	40
RUBINATE 9225 Isocyanate	31.5	2.05	1.22	133	25

Modified Monomeric Alternatives

The photos above represent typical color. Actual color may vary slightly from lot to lot.

RUBINATE 44 Isocyanate
- > 98% 4,4' MDI
- Solid at room temperature
- 38˚C Melting Point

RUBINATE 9433 Isocyanate
- Low functionality liquid pure
- Also contains some 2,4' isomer
- Used as a precursor for 1k prepolymers

SUPRASEC 2004 Isocyanate
- Higher NCO alternative to RUBINATE 9433
- Contains a small amount of 2,4' isomer

SUPRASEC 9150 Isocyanate
- Highest NCO content of liquid pure products
- Slight amber color

SUPRASEC 9561 Isocyanate
- Specifically designed to provide significant improvements in shelf life and cold storage stability
- Used extensively in RIM elastomers and as a precursor for 1k prepolymers

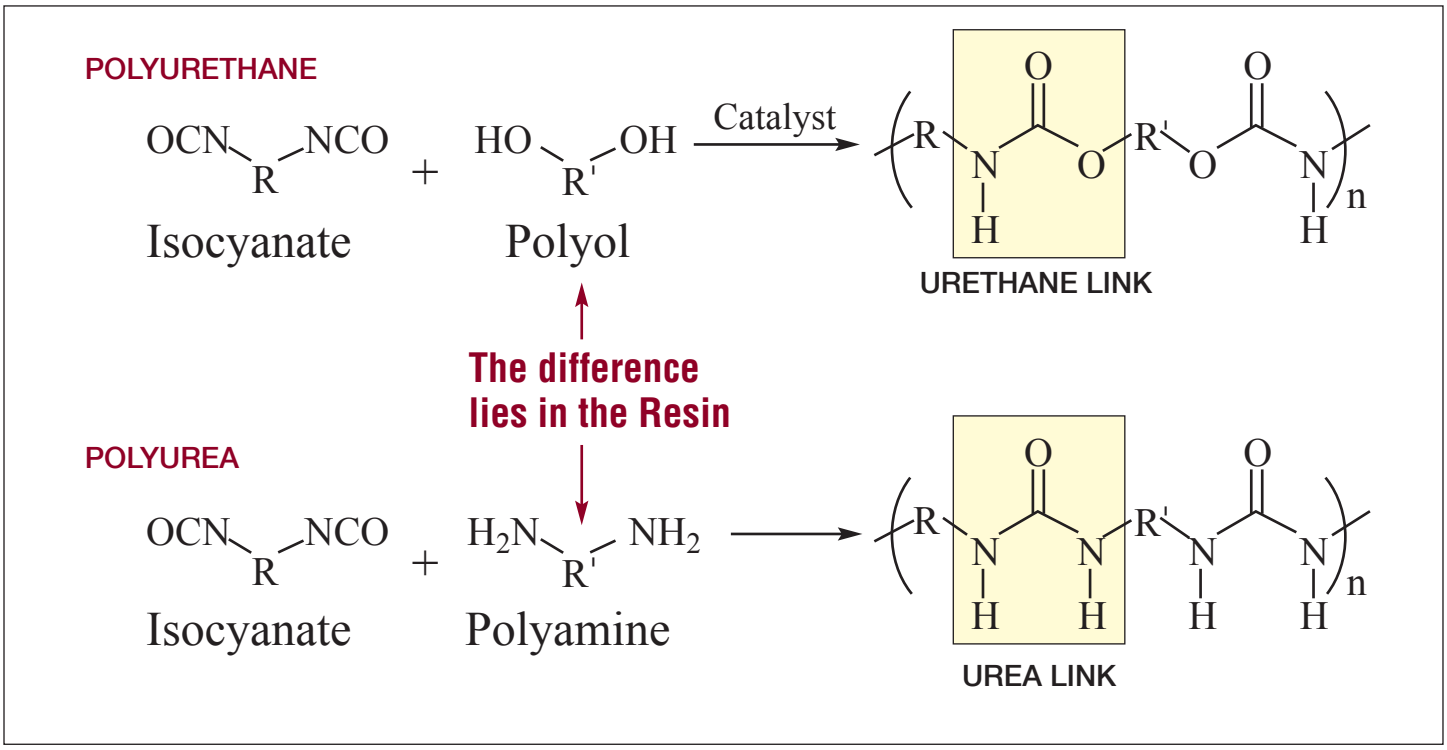
RUBINATE 1680 Isocyanate
- Industry standard for uretonomine modified pure
- Used extensively in RIM elastomers and as a precursor for 1-shot prepolymers
- Limited shelf life and cold storage instability

RUBINATE 9225 Isocyanate
- Pure adjusted with a moderate amount of 2,4' isomer to improve stability
- Used as a precursor for prepolymers

Polyurea Prepolymers

The concept of polyurea spray elastomer technology was introduced about 25 years ago. This application was based on the reaction of an isocyanate component with an amine blend to produce a polyurea elastomer system.

Description	% NCO	Functionality	Specific Gravity @ 25°C	Equivalent Weight	Viscosity (cps) @ 25°C
MIXED ISOMER-MODIFIED Polyether prepolymers containing different levels of 2,4' MDI isomer and propylene carbonate. Provides slightly longer reactivity and improved surface appearance.					
SUPRASEC 9114 Isocyanate	15.1	2.04	1.12	278	475
RUBINATE 9480 Isocyanate	15.2	2.00	1.14	276	370
SUPRASEC 9603 Isocyanate	16.0	2.00	1.14	263	250
URETONOMINE-MODIFIED Uretonomine-modified polyether prepolymers with higher levels of 4,4' MDI isomer to provide improved physical properties.					
RUBINATE 9447 Isocyanate • Contains propylene carbonate. • Designed for Shore A 80-90 hardness polyurea coatings.	12.3	2.05	1.10	341	1200
RUBINATE 9495 Isocyanate • Contains propylene carbonate. • Designed for Shore D 40-50 hardness polyurea coatings.	15.1	2.06	1.14	278	400
RUBINATE 9009 Isocyanate • Designed for Shore D 40-50 hardness polyurea coatings.	15.8	2.13	1.12	266	1200



What's the difference between Polyurea and Polyurethane?

POLYUREA

- The majority are spray-applied with an equal volume ratio
- Fast cure – tack free in seconds
  - No catalysts required
  - Lower reaction activation energy
- Broader temperature application range, mainly lower temperatures
- Very good physical properties
  - Chemical resistance
  - Better temperature stability
  - Lower sensitivity to moisture
- Contains no OH groups in the resin

POLYURETHANE

- Spray-applied, but can be at a number of different ratios: equal volumes, double resin, etc.
- Slower cure
  - Requires catalysts for quick cure
  - Higher activation energies: more dependence on component temperature
- Broader formulation range:
  - Harder and softer coatings
  - Lower stability at high temperatures
  - Wide range of physical properties possible
- Contains no NH groups in the resin

Typical Physical Properties of Coatings Systems

	POLYUREA	METHYL METHACRYLATE	POLYURETHANE
Hardness Shore D	45 - 50	50	50
Tensile Strength	2200 psi	1700 psi	1800 psi
Elongation	300%	130%	275%
Tear Strength	85 N/mm	70 N/mm	30 N/mm
Tack Free	< 20 sec	10 – 20 min	< 20 sec
Moisture Sensitivity	Low	Low	Moderate

Primers, Sealers and MDI Isocyanate Crosslinkers

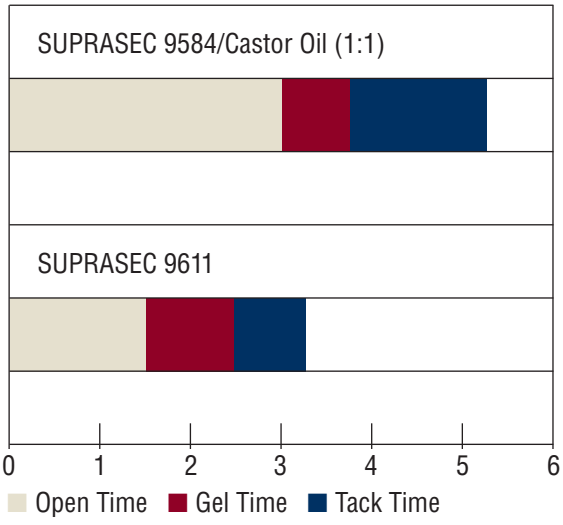
Description	% NCO	Functionality	Specific Gravity @ 25°C	Equivalent Weight	Viscosity (cps) @ 25°C
PRIMER & SEALERS					
SUPRASEC 9611 Isocyanate • A novel one-component (1k), VOC-exempt approach to polyurethane primers. • Can be used as is or modified with catalysts, pigments or other additives.	12.0	2.40	1.16	350	425
SUPRASEC 9584 Isocyanate • Designed for usage in two-component primer systems (2k), this VOC-exempt product works well with green resins, such as castor oil, to produce a primer on porous substrates.	24.1	2.67	1.22	174	45
RUBINATE 9259 Isocyanate • A chemically-modified MDI that can readily form an emulsion in water for two hours. • Produces a non-film forming coating on concrete.	30.2	2.67	1.23	139	210

APPLICATIONS

- Concrete and wood primer for polyurethane and polyurea spray coatings
- Industrial flooring, roofing, decking, truck bed liners, pipeline and tank coatings

ADVANTAGES

- VOC-exempt
- Penetrates and seals the surface, leaving a smooth, pinhole and bubble-free coating
- Excellent adhesion to a variety of substrates
- Good physical properties
- Outstanding stability at low temperatures
- Defoamers or deaerators can be used to further minimize pinholes



STABILITY OF 50:50 MIXTURES OF MDI ISOCYANATE & WATER

Crosslinking/catalyzing technology for latex or acrylic emulsions

To address the need for improved water-based coatings and adhesives, higher functionality isocyanates, specially modified to be readily dispersible in water-based polymer dispersions/emulsions, have been developed.

This technology allows for the use of an MDI isocyanate as a crosslinker for adhesives and coatings emulsions based upon latex or acrylic chemistries. This reaction mechanism involves the crosslinking of the reactive sites of the MDI with active hydrogen, preferably hydroxyl groups, in the emulsion system. It is also possible to adjust the reaction rate, as measured by an increase in viscosity and balanced with a build in adhesive strength by the proper selection of isocyanate.

The addition of the polyurethane linkages obtained from the MDI can impart certain benefits, including:

- Improved adhesion at low and elevated temperatures, especially compared to other cross linkers, e.g., melamine, epoxy, aziridine
- Improved solvent and water resistance
- Improved recovery after deformation
- Faster development of adhesive strength
- Improved physical properties, such as tensile and tear strength

Typical emulsion adhesive formulation

SB Latex	50%Solids; 6.0 pH; Anionic Surfactant		30%
Calcium Carbonate	OmyaCarb 5	Omya	25%
Polyvinyl Alcohol	10% Cevol 523	Celanese	35%
Defoamer	Surfynol DF-210	Air Products	0.2%
Biocide	Rocima BTNV2	Rohm & Haas	0.2%
Dispersant	Dynol 604	Air Products	0.2%
Water			9.4%
TOTAL			**100%**

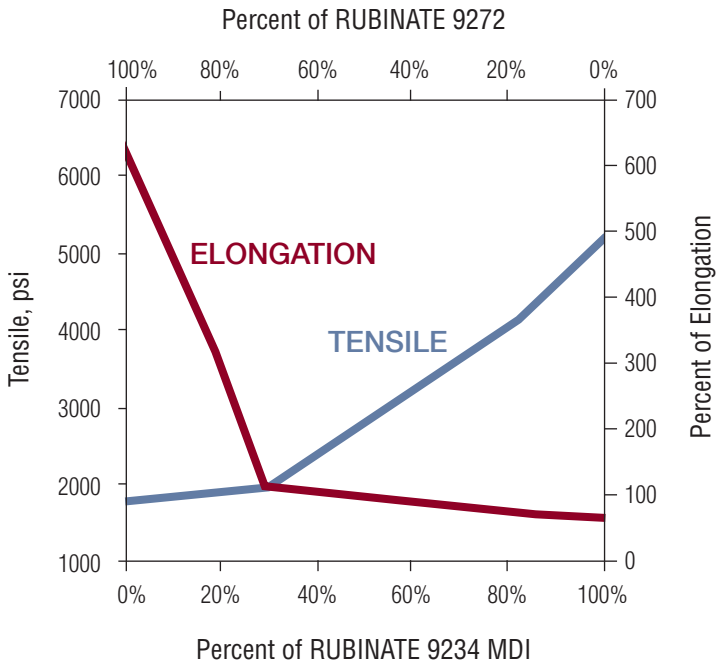
When used in production

MDI Isocyanate	RUBINATE 9259	15%
Emulsion Polymer		85%
TOTAL		**100%**

In certain cases, MDI can also interact with the substrate, e.g., wood or concrete, thus improving adhesion. The Huntsman Polyurethanes technology does not require heat activation. Once the water separates from the dispersion, the isocyanate is free to react completely with the polymer.

Moisture Cure Prepolymers

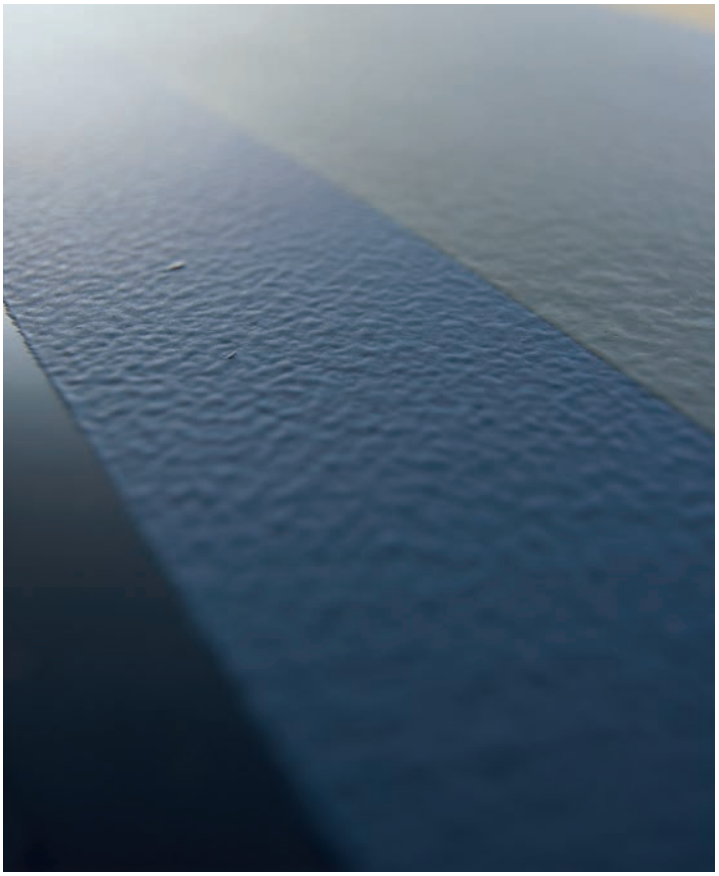
Description	% NCO	Functionality	Specific Gravity @ 25°C	Equivalent Weight	Viscosity (cps) @ 25°C
MOISTURE CURE PREPOLYMERS					
RUBINATE 9272 Isocyanate High elongation prepolymer, can be used as a flexibilizer for RUBINATE 9511 or RUBINATE 9234	8.4	2.00	1.08	500	2500
RUBINATE 9040 Isocyanate Clear, slow curing, flexible binder ideal for rubber crumb applications	9.7	2.00	1.10	433	2000
SUPRASEC 9577 Isocyanate Fast curing, amber prepolymer with improved heat and moisture resistance	15.2	2.32	1.11	276	3300
RUBINATE 9511 Isocyanate Amber prepolymer that provides excellent tensile, tear strength and bonding characteristics	15.9	2.41	1.13	264	2300
RUBINATE 9234 Isocyanate Comparable performance to RUBINATE 9511, but with an extended open time	16.0	2.53	1.12	263	3100



Varying physical properties with combinations of RUBINATE 9234 MDI Isocyanate and RUBINATE 9272 MDI Isocyanate

- When these materials are blended in appropriate ratios, coatings with varying degrees of rigidity and elasticity can result.
- At the intersection point, the blend is 30% RUBINATE 9234 MDI Isocyanate and 70% RUBINATE 9272 MDI Isocyanate.

Polymer Concrete



The next generation of trowelable flooring combine urethane resin binders with Portland cement and graded aggregates to deliver superior qualities for application in manufacturing areas, food processing facilities, cold storage and parking decks. These systems, based upon RUBINATE and SUPRASEC MDI Isocyanate technology from Huntsman Polyurethanes are heavy-duty, trowel applied urethane-modified cementitious toppings. In addition to excellent chemical resistance, these systems are moisture vapor tolerant or "breathing" and thus are a solution for many moisture problems. The textured surface reduces slipping under most wet conditions.

Description	% NCO	Functionality	Specific Gravity @ 25°C	Equivalent Weight	Viscosity (cps) @ 25°C
POLYMER CONCRETE					
SUPRASEC 9610 Isocyanate Modified isocyanate with longest open time and higher gloss surface	29.6	2.48	1.16	142	108
SUPRASEC 2496 Isocyanate Slightly higher functionality with a slower reactivity	31.3	2.52	1.23	134	85
RUBINATE 9041 Isocyanate Specialized isocyanate for polymer concrete and provides a matte surface	32.0	2.47	1.23	131	65

Specialty MDI Prepolymers

Description	% NCO	Functionality	Specific Gravity @ 25°C	Equivalent Weight	Viscosity (cps) @ 25°C
URETONOMINE-MODIFIED POLYESTER PREPOLYMERS					
RUBINATE 1234 Isocyanate Controlled, low acidity	18.9	2.01	1.18	222	1250
SUPRASEC 9612 Isocyanate Higher acidity for flexibility in controlling the reaction	19.0	2.01	1.18	221	1225
PURE-BASED POLYETHER PREPOLYMERS					
RUBINATE 2022 Isocyanate	23.1	2.01	1.22	182	525
MIXED ISOMER-BASED POLYETHER PREPOLYMERS					
RUBINATE 9271 Isocyanate Low temperature stable	23.5	2.00	1.20	179	500
URETONOMINE-MODIFIED POLYETHER PREPOLYMERS					
RUBINATE 1209 Isocyanate Low temperature stable	21.5	2.12	1.16	195	390
RUBINATE 9465 Isocyanate Low temperature stable	22.9	2.12	1.18	183	250
SUPRASEC 2029 Isocyanate Low temperature stable	24.1	2.10	1.22	174	500
RUBINATE 1670 Isocyanate	26.2	2.06	1.21	160	200
POLYMERIC CONTAINING POLYETHER PREPOLYMERS					
SUPRASEC 7507 Isocyanate	25.1	2.29	1.19	167	315
RUBINATE 1920 Isocyanate Low temperature stable	27.0	2.20	1.22	156	200

Proper choice of the Specialty MDI component will allow formulators to customize the end formulation to achieve specific physical performance targets.

Comparative Cast Elastomer Properties

Using a base polyol resin blend designed specifically to compare isocyanate performance, differences in physical properties can be observed. Molecular sieves were added to eliminate moisture and the isocyanate / resin ratio adjusted to maintain a consistent 102 isocyanate index.

Resin Blend Composition

	Parts By Weight
JEFFOL G31-35	89.9
1, 4 - Butanediol	10
DABCO DC-1	0.10

DABCO® is a registered trademark of Air Products and Chemicals, Inc.

TESTING PROCEDURE

1. Systems were mixed for 30 seconds using a dual assymetric centrifugal mixer (DAC) from Flacktek
2. Reactivity values obtained via a Gardco Gel Timer
3. Sample plaques molded in a 1/4" vertical mold @ 140°F (60°C) and allowed to cure
4. All plaques postcured for 24 hours at 140°F (60°C)

Description	Iso:Resin Ratio by Weight	Gel Time, Seconds	Median Break Stress, ASTM D412 (psi)	Median Break Stress, ASTM D412 %	Die C Tear, pli, ASTM D624	Shore A Hardness ASTM D2240-95	7 Day Low Temperature Exposure Limit, °F
PREPOLYMERS							
RUBINATE 1234	0.634	225	1000	260	210	72	70
RUBINATE 2022	0.514	200	1500	275	225	78	70
RUBINATE 9271	0.510	350	1100	300	200	70	20
RUBINATE 1209	0.557	205	1200	220	185	76	20
RUBINATE 9465	0.521	270	800	200	165	75	20
SUPRASEC 2029	0.489	195	1550	220	220	80	20
RUBINATE 1670	0.452	140	1100	170	200	78	35
RUBINATE 1920	0.444	250	1100	155	140	76	20
SUPRASEC 7507	0.477	235	550	90	90	69	35

Specialty Diols and Triols

Huntsman Polyurethanes produces a variety of polyether polyols essential to the development of systems for Coatings, Adhesives, Sealants and Elastomers. When used with RUBINATE or SUPRASEC MDI Isocyanates, formulators are able to tailor their efforts to reach the desired requirements.

Description	Molecular Weight	Functionality	Specific Gravity @ 25°C	OH#	Equivalent Weight	Viscosity (cps) @ 25°C
DI-FUNCTIONAL POLYETHER DIOLS						
ALL PO DIPROPYLENE GLYCOL-INITIATED						
JEFFOL PPG-1000 Polyol	1000	2.0	1.01	112	500	150
JEFFOL PPG-2000 Polyol	2000	2.0	1.01	56	1000	370
EO-TIPPED DIPROPYLENE GLYCOL-INITIATED						
JEFFOL PPG-2801 Polyol	2800	2.0	1.02	40	1400	525
JEFFOL PPG-3706 Polyol	3800	2.0	1.02	30	1870	775
TRI-FUNCTIONAL POLYETHER TRIOLS						
ALL PO GLYCERINE-INITIATED						
JEFFOL FX31-167 Polyol	1008	3.0	1.00	167	336	250
JEFFOL FX31-240 Polyol	700	3.0	1.00	240	236	250
JEFFOL G30-650 Polyol	260	3.0	1.09	650	86	880
EO-TIPPED GLYCERINE-INITIATED						
JEFFOL G31-28 Polyol	6000	3.0	1.02	28	2000	1175
JEFFOL G31-35 Polyol	4800	3.0	1.02	35	1600	900
HIGH EO GLYCERINE-INITIATED						
JEFFOL G31-43 Polyol	4000	3.0	1.06	43	1330	950

Amine, Phenol, Sorbitol and Sucrose-based Polyether Polyols

For applications such as insulation, spray foam or those that may require slightly more rigidity or reactivity, higher functional products are available.

Description	Molecular Weight	Functionality	Specific Gravity @ 25°C	OH#	Equivalent Weight	Viscosity (cps) @ 25°C
ALIPHATIC AMINE-INITIATED						
JEFFOL A-630 Polyol	265	3.0	1.06	635	90	430
JEFFOL A-800 Polyol	280	4.0	1.05	800	70	20000
AROMATIC AMINE/DEG-INITIATED						
JEFFOL AD-310 Polyol	580	3.2	1.06	310	180	2200
JEFFOL AD-500 Polyol	360	3.2	1.10	500	112	18000
PHENOL-INITIATED (MANNICH)						
JEFFOL R-350X Polyol	465	2.9	1.11	530	307	14000
NONYL-PHENOL-INITIATED (MANNICH)						
JEFFOL R-425X Polyol	422	3.2	1.06	425	132	4500
JEFFOL R-470X Polyol	394	3.3	1.06	470	120	8200
SORBITOL-INITIATED						
JEFFOL S-490 Polyol	538	4.7	1.11	490	115	9000
SUCROSE/AMINE-INITIATED						
JEFFOL SA-499 Polyol	487	4.3	1.11	495	113	6500
SUCROSE/DEG-INITIATED						
JEFFOL SD-361 Polyol	690	4.4	1.08	360	156	2500
JEFFOL SD-441 Polyol	550	4.3	1.08	440	127	6500
SUCROSE/GLYCERINE-INITIATED						
JEFFOL SG-360 Polyol	730	4.7	1.08	360	156	3500
JEFFOL SG-522 Polyol	539	5.0	1.17	520	108	27000

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