



RAIN CARBON INC.

NOVARES® / RUETASOLV® for the Coating Industry





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Company Profile

Rain Carbon Inc. is a global market leader in the field of aromatic chemicals. The company's success is based on flexibility and innovation along with partnership-based cooperation with clients. With more than 150 years of experience, Rain Carbon is a competent and reliable partner for a wide range of resins and their application fields, particularly when it comes to developing innovative products to meet new challenges and to satisfy evolving regulatory and societal requirements.



On Track for Durable Surface Protection

Our Products

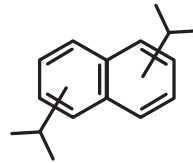
Novares resins are thermoplastic hydrocarbon resins based on petrochemical and carbon feedstock. With a high level of flexibility and innovative product solutions, Rain Carbon can satisfy a large range of individual customer needs. Our clients can choose from a broad selection of resins with a wide range of viscosities and softening points. These products can be customized to meet specific customer requirements.

Ruetasolv products are non-reactive modifiers based on naphthalene or biphenyl and are suitable for coatings, casting resins, reactive systems and waterborne formulations.

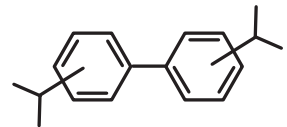
Delivery Forms

- Solid resins as pastilles supplied in paper bags and big bags
- Molten resins in heatable tank container
- Liquid resins in drums, IBCs or by tank truck

Our production processes, application technology and marketing system are certified according to DIN EN ISO 9001, DIN EN ISO 14001, DIN EN ISO 50001 and OHSAS 18001 quality and environmental standards.



Isopropyl-naphthalenes



Isopropyl-biphenyls





Application Range

Our products are suitable for various applications based on different polymer chemistry. In coatings, liquid products with low or non VOC content improve flexibility, hydro-

phobicity, corrosion resistance and wetting properties. The following chart presents the most common applications and the appropriate Novares or Ruetasolv product.

	Coating Application				Chemistry of Formulations					
	Corrosion Protection	Flooring	Sealing/ Membrane	Off shore	EP	2k-PUR	1k-PUR	Acrylic	Water-borne	Poly-sulfide
Novares L 100		+++	++		●	●	●	●		
Novares L 800			+++			●	●			
Novares LA 100 P	+	+++	+++		●	●				●
Novares LA 300										
Novares LA 300 P	++	++	+++	++	●	●		●		●
Novares LA 700										
Novares LA 700 P	+++	+	+++	+++	●	●				●
Novares LA 1200	+++	+	++		●	●				
Novares LA 2000 P	+++			+++	●					
Novares LS 500	++	++	+	++	●			●		
Novares LC 5		+++	++		●	●				
Novares LC 15	+++	+++	++	++	●	●				●
Novares LC 25	++		++	++	●	●				●
Novares LC 40	+++		++	++	●					●
Novares LC 65	++		+	++	●			●		
Novares HA 30		+++				●				
Novares HA 1100	+++			+++	●					
Novares H 1100	+		+++	++	●		●			
Novares HA 2100	++		++	+++	●	●				
Novares HA 1200 L	+			+++	●					
Novares HA 2500	+++			+++	●	●				
Novares TL 10	+++			+++	●	●	●			
Novares TM 20 AS	+++		+	+++	●	●	●	●		
Novares W	+++	+++							●	
Novares WA 2	+++	+++							●	
Novares WA 7	+++	++							●	
Ruetasolv DI	+	+++	++		●		●			
Ruetasolv BP M	+	+++	++		●	●	●	●		
Ruetasolv BP D	+	+++	++			●	●			

+++ excellent ++ good + partially usable

● suitable

	Product Properties		Application Profile			
	Viscosity at 25°C [mPa s]	OH content [%]	Curing Accelerator in Epoxy	Viscosity Reduction	Flexibility	Hydrophobicity
Novares L 100	50 - 150	0	0	+++	++	+
Novares L 800	800 - 1000	0	0	0	++	++
Novares LA 100 P	50 - 150	1,5	0	++	++	+
Novares LA 300	300 - 400	1,7 - 2,2	0	+	++	++
Novares LA 300 P						
Novares LA 700	700 - 800	2,3 - 2,8	0	+	++	++
Novares LA 700 P						
Novares LA 1200	1200 - 1500	2,4 - 2,7	+	0	++	+++
Novares LA 2000 P	2000 - 2700	2,9	+	0	++	+++
Novares LS 500	400 - 1400	7,0 - 7,6	+++	0	++	++
Novares LC 5	70 - 130	0,4 - 0,6	0	+++	++	+
Novares LC 15	100 - 180	1,4 - 1,6	0	++	++	+
Novares LC 25	150 - 250	2,3 - 2,7	0	++	++	+
Novares LC 40	350 - 450	3,8 - 4,2	+	+	++	++
Novares LC 65	650 - 800	6,2 - 6,6	+++	0	++	++
Novares HA 30	25 - 35	0,9 - 1,3	0	+++	++	+
Novares HA 1100	800 - 1200	1,4 - 1,9	0	0	++	+++
Novares H 1100	800 - 1200	0	0	0	++	+++
Novares HA 2100	2200 - 2800	1,6 - 2,0	0	0	++	+++
Novares HA 1200 L	600 - 1000	1,3 - 1,7	0	0	++	+++
Novares HA 2500	2500 - 3000	2,1 - 2,5	0	0	++	+++
Novares TL 10	liquid	0	0	0	++	+++
Novares TM 20 AS	liquid	0	0	0	++	+++
Novares W	50 - 150	0	0		+++	+++
Novares WA 2	350 - 450	1,5 - 2,6	0		+++	+++
Novares WA 7	1300 - 2300	6,4 - 7,2	+++	0	+++	+++
Ruetasolv DI	6 - 10	0	0	+++	+++	+
Ruetasolv BP M	4 - 6	0	0	+++	+++	+
Ruetasolv BP D	10 - 20	0	0	+++	+++	+

+++ strong effect ++ good effect + low effect 0 no effect



General Properties

Liquid hydrocarbon modifiers are chemically inert and lipophilic by nature. The low molecular weight results in a low Tg, a high solvency power and low viscosity. For different applications these material properties are generally used to:

- adjust viscosity of formulations
- improve hydrophobicity and chemical resistance
- enhance flexibility

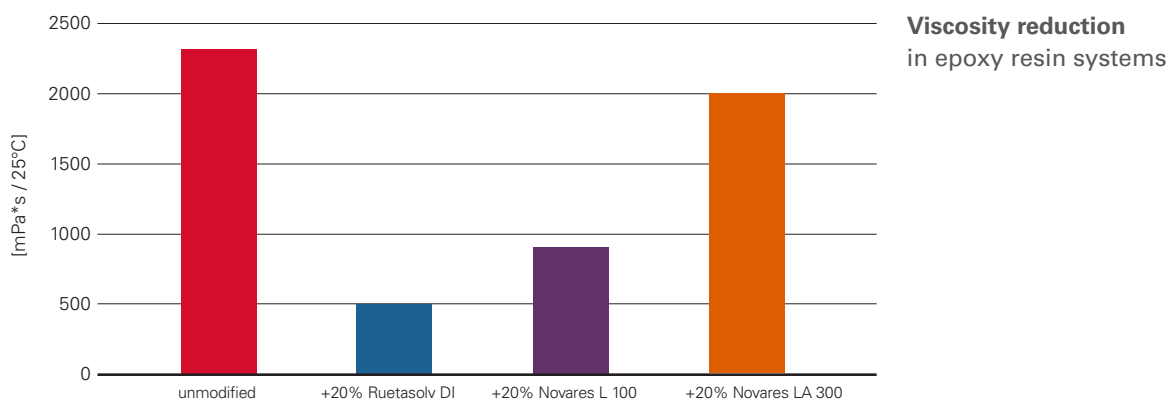
These positive effects of Novares liquid hydrocarbon modifiers are a result of the chemical structure of the products and their compatibility with different formulations and chemical systems, e.g. epoxy formulations for heavy corrosion protection, industrial and civil engineering applications. The below demonstrated properties are achieved in a recipe using Bisphenol A liquid epoxy resins, cross linked by an isophorone diamine based hardener. Those effects have a general validity in many industrial coatings.



Viscosity Reduction

Ruetasolv and Novares products are low viscous and low VOC liquids with high solvency power. In coating formulations, the special properties lead to a significant reduction of

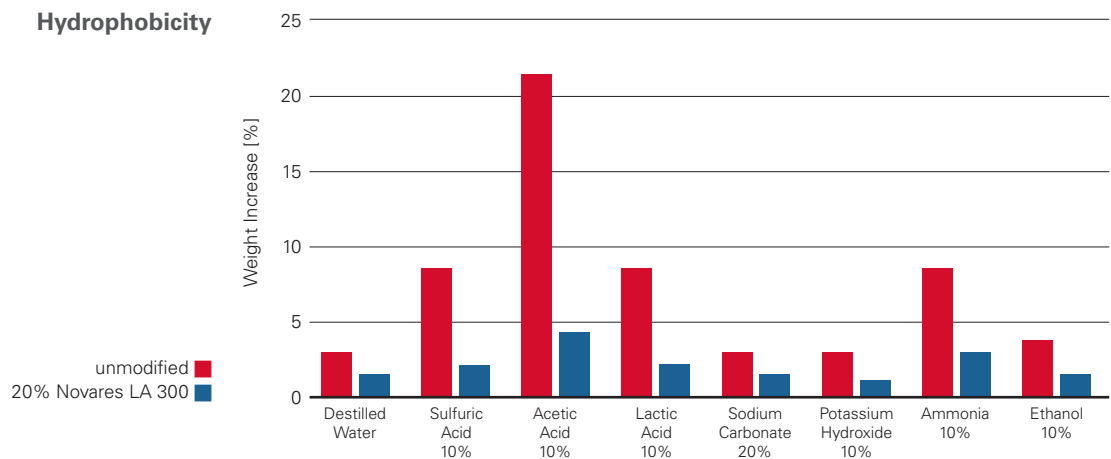
viscosity. The low VOC content of the products make them ideal diluents, particularly in high solid systems.



Hydrophobicity and Chemical Resistance

Novares resins and Ruetasolv products have a very hydrophobic, aromatic structure that significantly increases the resistance of civil engineering and corrosion-protection systems against moisture and aqueous media. After 6 months storage in a range of aqueous media, the Novares modified epoxy system exhibited a much lower weight increase than the unmodified reference system.

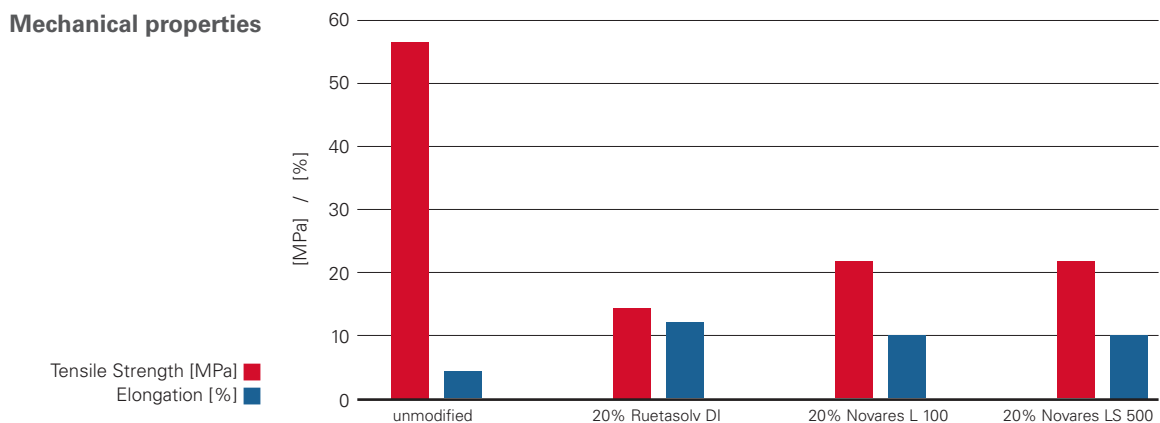
The modified epoxy systems show a much better performance under heavy environmental conditions, compared with unmodified formulations. Because of their positive characteristics the modifiers generally help to extend the life-span of a formulation and provide an increased surface protection.



Flexibility and Plasticizing

Novares and Ruetasolv modifiers are liquid products with low Tg and high compatibility to a wide range of chemical macromolecules. In coating films, they work as internal softener in the polymer network, reduce tensile strength,

increase the elongation and the low temperature flexibility. The high compatibility ensures stable embedding of the products in coating films and prevents migration.





Acceleration of Epoxy Curing



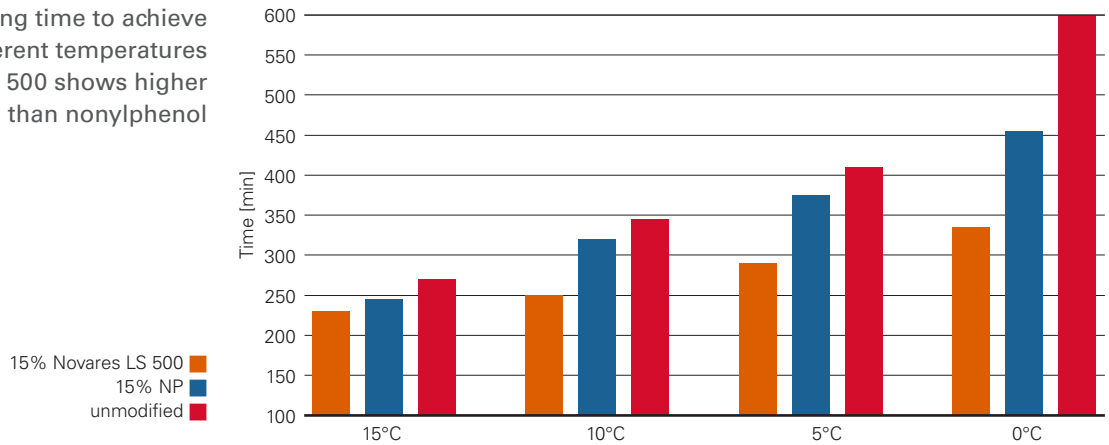
Depending on the epoxy formulation type and application conditions, the cross linking between the components needs to be accelerated. Nonylphenol is an excellent accelerator, but banned in the European Union and many other countries due to its high hazardous potential. Alternatively, Novares LS 500 works as an excellent accelerator. The acidity of the phenolic OH-functionality in LS 500 is able to associate with amine functionality of the hardners and catalyzes their reaction with glycidyl group of the epoxy resin.

In terms of catalytic activity, Novares LS 500 is comparable to nonylphenol at room temperature. In low temperature curing, LS 500 distinguishes itself by outstanding activity. Below tests compare the curing time to achieve a viscosity of 250 kPa·s at different temperatures, for a non-accelerated, a nonylphenol and a LS 500 accelerated system. The differences are an evidence for a higher activity of LS 500.

Test Formulation

Components	Weight in %	
	Recipe for Fig. 1 and 3	Recipe for Fig. 2
Bisphenol A liquid epoxy resin	56,7	53,3
IPDA based adduct hardener	28,3	26,7
Novares liquid modifier / nonylphenol	15,0	20,0
Total	100,0	100,0

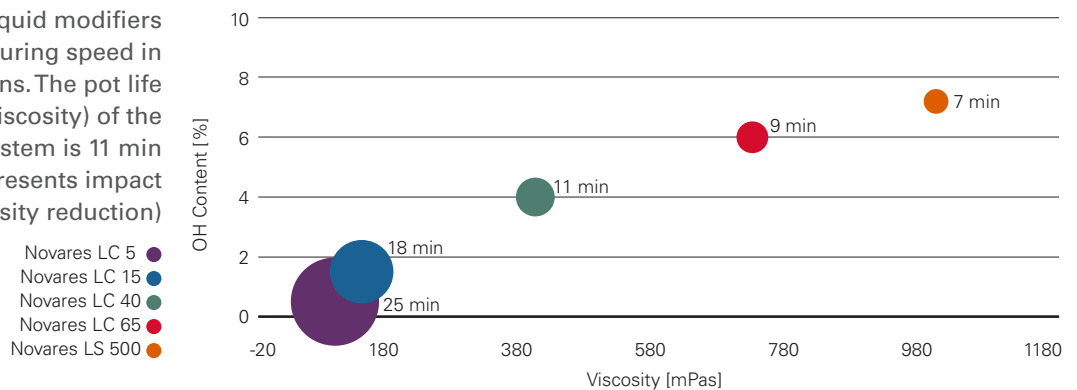
Fig. 1 Curing time to achieve 250 kPa-s at different temperatures
Novares LS 500 shows higher acceleration speed than nonylphenol



In addition to Novares LS 500, another group of modifiers, the LC series is part of the Novares portfolio. Novares LC products are available with different OH contents,

customized catalytic activity and have nuanced impacts on pot life, flexibility and viscosity. This enables to adjust flexibility and curing speed simultaneously.

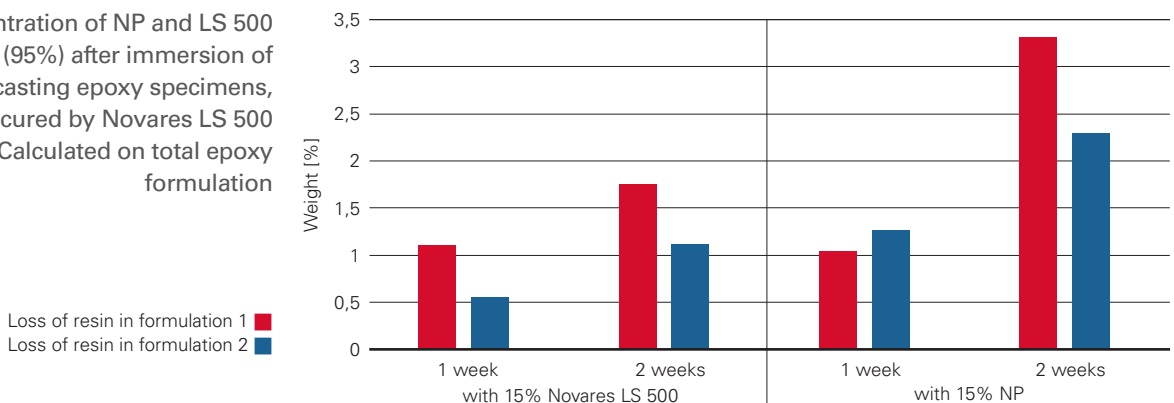
Fig. 2 OH content of liquid modifiers and their impact on curing speed in epoxy formulations. The pot life (double initial viscosity) of the unmodified system is 11 min (Bubble size represents impact on viscosity reduction)



Novares LS 500 results in a better chemical resistance compared to nonylphenol (NP), as a result of the immobile bulky structure, which is better anchored into the epoxy network.

The integrity of the polymer network is a prerequisite for the durability of coatings with regard to their chemical and mechanical performances.

Fig. 3 Concentration of NP and LS 500 in ethanol (95%) after immersion of casting epoxy specimens, accelerated cured by Novares LS 500 and NP. Calculated on total epoxy formulation





Improvement of Alkyd Applications

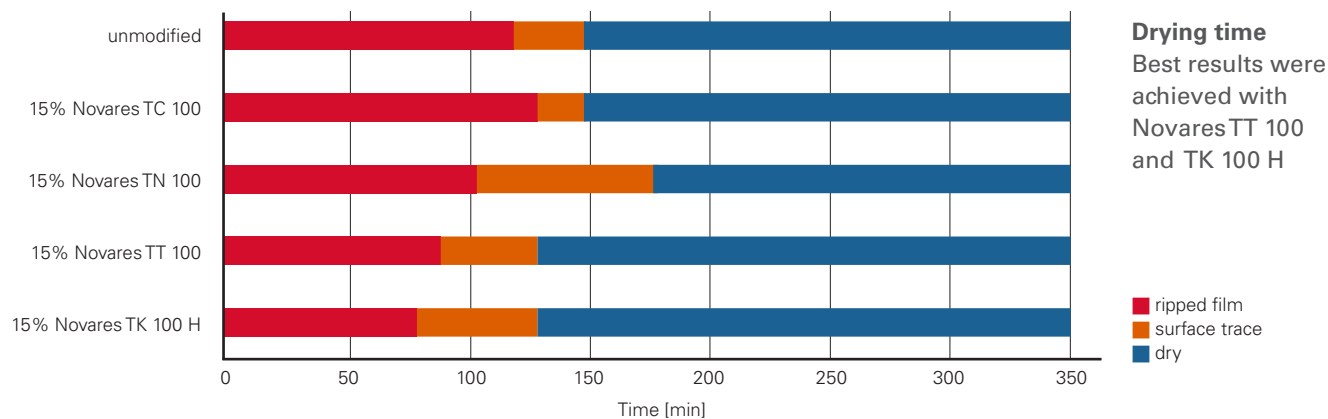
With more than 30% market share, the alkyd coatings are the biggest solvent based coating type in the market. They are popular for metal-, wood-, maintenance- and decorative coatings. Long chain oil based binder systems need proper driers to support the drying and hardness development.

Additional to driers, the use of solid hydrocarbon resins is an alternative way to improve the drying time, mechanical properties, solid content and hydrophobicity. These enhancements contribute to long durability and reliability of the coatings.

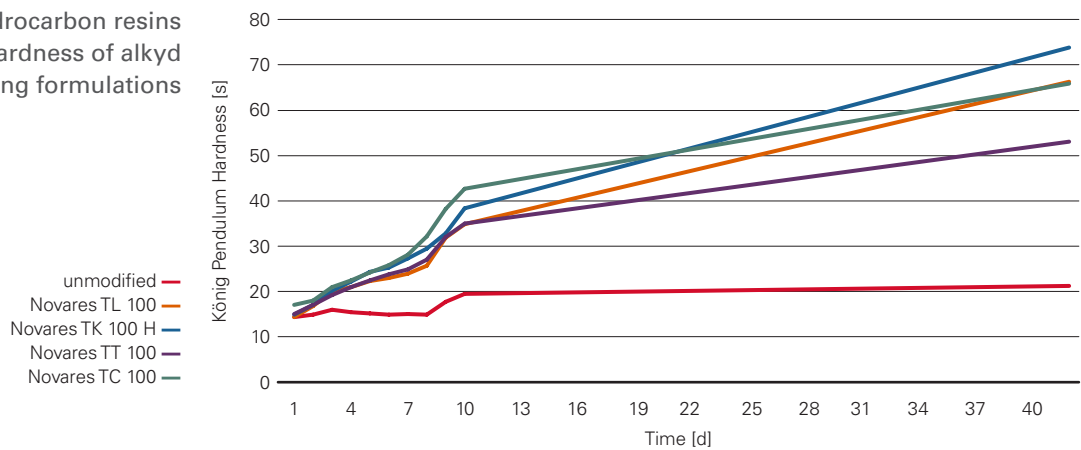
Test Formulation

Components	Weight in %
Alkyd resin	42,3
Low aromatic white spirit	52,7
Hydrocarbon resins* (15% on reactive solids)	3,2
Calcium (4%) driers	1,3
Zirkonium (18%) driers	0,3
Cobalt (6%) driers	0,2
Total	100,0

*Dosage of hydrocarbon resins is 15% based on alkyd binder solids. In the recipe, the resin is used as a 50% dilution in solvents.

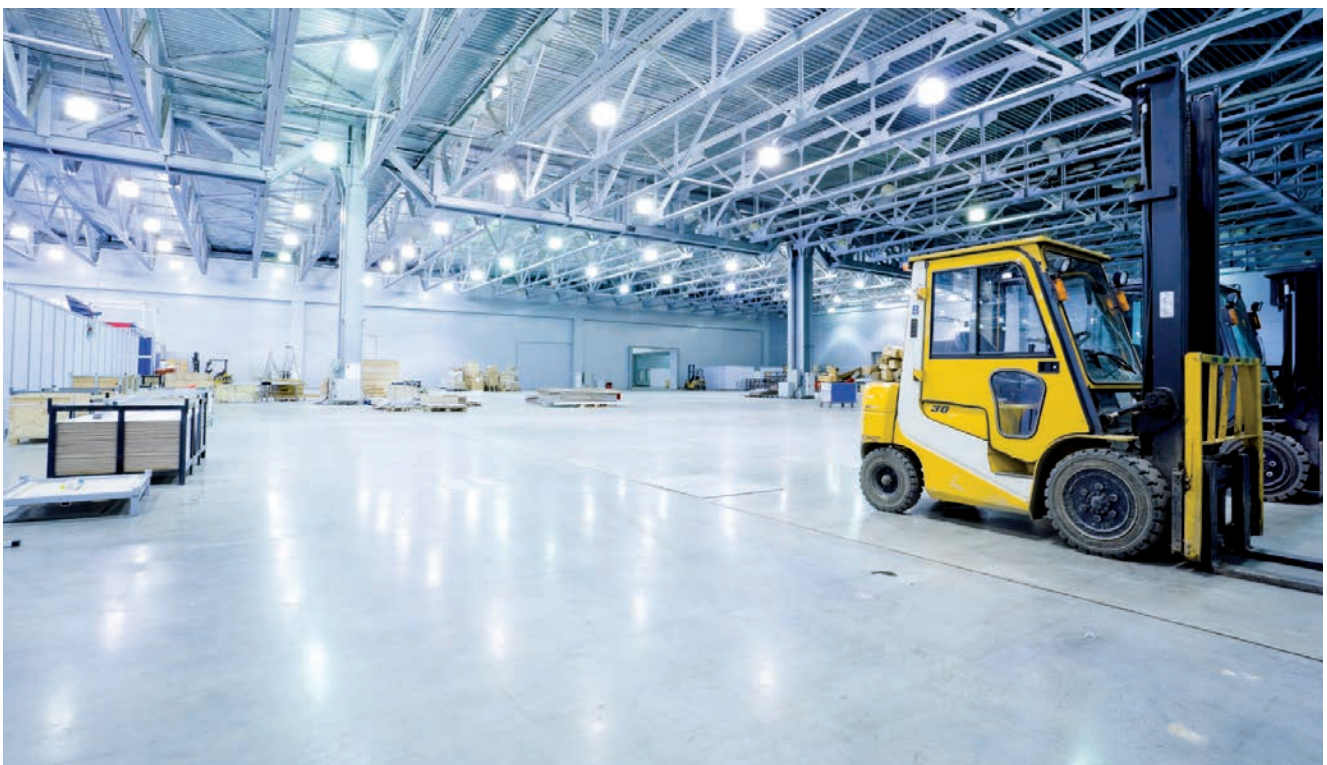


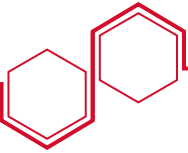
Novares solid hydrocarbon resins improve the hardness of alkyd coating formulations



During the drying process the solvents evaporate and the resin gets back to its solid form. The solid hydrocarbon resin works as functional filler, which improves the mechanical

properties. Its aromatic structure leads to an enhancement of the hydrophobicity and chemical resistance.





Pot life Optimizing of Polyaspartic Systems

Polyaspartic coating systems are known for their fast drying, high corrosion resistance and high mechanical strength. On the other hand, the fast curing often causes handling problems, especially under poor weather conditions. Due to their low viscosity, chemical inertness and high compatibility, our aromatic modifiers are used to optimize polyaspartic formulations in:

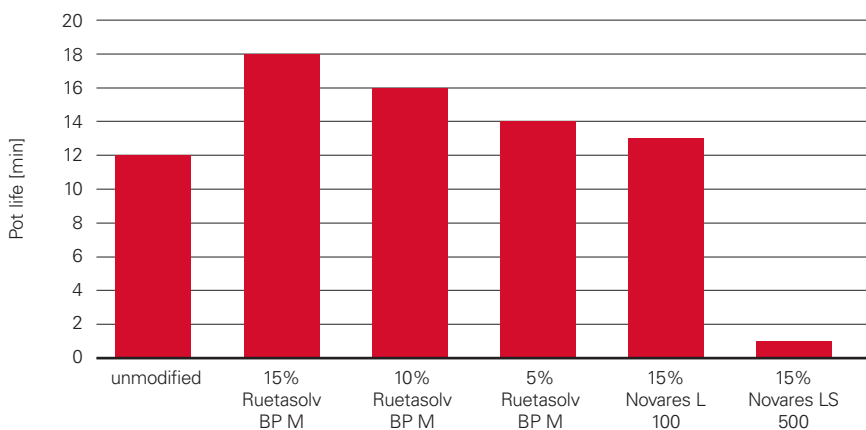
- enhancing chemical and corrosion resistance
- optimizing the application process by accelerating curing or extension of pot life
- improving flexibility
- acting as low/non VOC diluents
- improving surface wetting properties

Test Formulation

Components	Weight in %		
	unmodified	2% Novares LS 500	15% Modifier
NH-functional aspartic ester	60,6	59,5	51,8
HDI based isocyanate	39,4	38,5	33,2
Novares modifier		2,0	15,0
Total	100,0	100,0	100,0

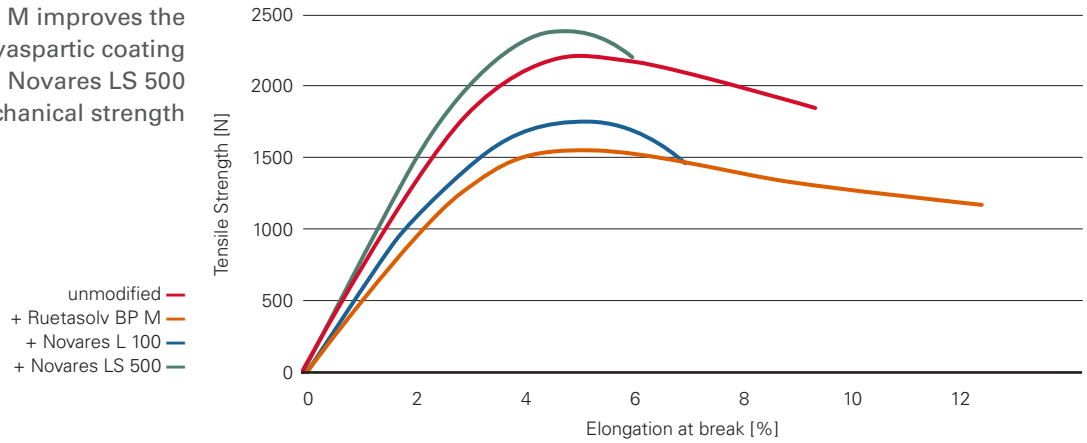
Novares and Ruetasolv modifiers can be used to adjust the pot life of the formulation according to customized needs.

OH-free modifiers extend the pot life by diluting the reactive components. OH-functional modifiers can be used as catalyst.



Ruetasolv BP M extends the pot life whereas Novares LS 500 accelerates the curing

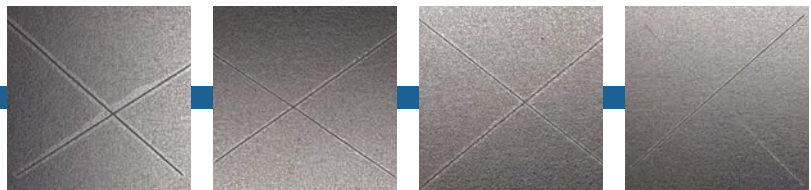
Ruetasolv BP M improves the flexibility in polyaspartic coating formulations, while Novares LS 500 increases the mechanical strength



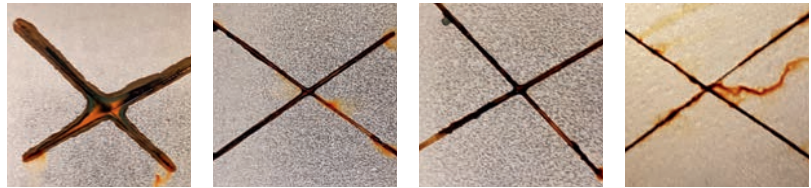
Fast curing speed and insufficient wetting often provoke bad adhesion of polyaspartic coatings. Novares products are useful to prolong the pot life, improve wetting properties

and increase hydrophobicity. This results in a better adhesion and anticorrosive performance.

Improved adhesion due to better wetting properties and higher flexibility

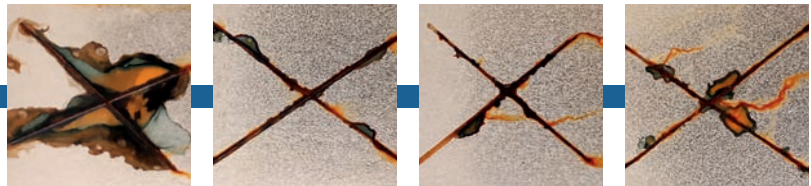


0 h



24 h

The unmodified formulation failed after 48 h, almost no impact on modified formulations



48 h



216 h

unmodified

Novares L 100

Ruetasolv DI

Ruetasolv BP M

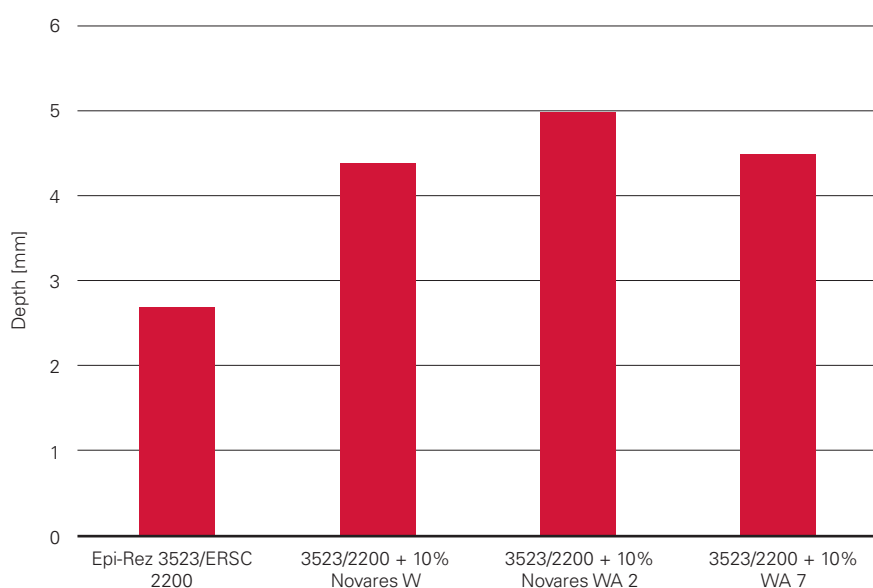


Modification of Waterborne Formulations

Novares W resins are water miscible modifiers, compatible with a wide range of different waterborne coating systems, based on reactive binders like epoxy, polyurethane, as well as physical drying dispersion of acrylic, PVA, PUR, etc.. The aromatic backbone, low molecule weight and compatibility of the modifier structure improve coating formulations in many aspects:

- Enhanced flexibility
- Boost of chemical resistance
- Increase of salt spray resistance
- Improvement of pigment wetting and grinding
- Decrease of the glass transition temperature of the polymer and improvement of the film coalescing
- Improvement of levelling

Novares W Grades	Viscosity @ 25°C [mPa*s] DIN 53019	Functionality	Tg [°C]	Typical Color Gardner (undiluted)	Application Scope
Novares W	50 - 150	Non	-57	1	Non-polar low viscous hydrophobic plasticizer, pigment grinding carrier
Novares WA 2	300 - 400	Hydroxyl functional	-40	2	Polar hydrophobic plasticizer, pigment grinding carrier
Novares WA 7	1200 - 2300	Hydroxyl functional	-24	4	High polar hydrophobic plasticizer, epoxy curing catalyst



Erichsen test

The new lipophilic modifiers improve the flexibility in a wide range of raw materials in clear coat, as well as pigmented formulations

Novares W products are based on aromatic monomers and are strongly hydrophobic by nature. Their structure positively influences the wetting properties on metal. In waterborne ep-

oxy, this leads to improved adhesion, hydrophobicity and enhanced anticorrosive properties. Especially the results of the continuous condensation test demonstrates these benefits.

unmodified



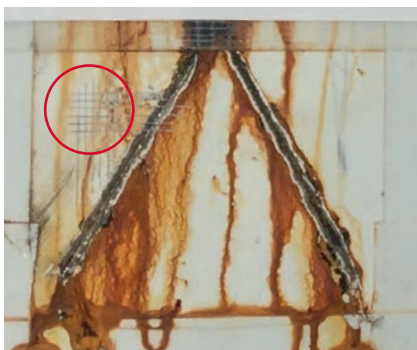
7,5%
Novares W



7,5%
Novares WA 2

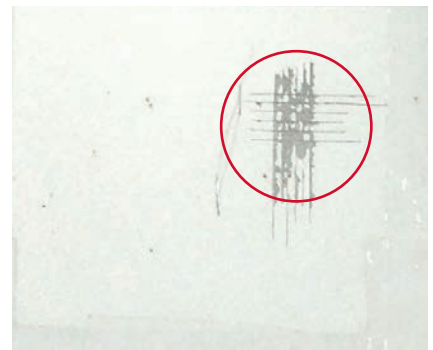


7,5%
Novares WA 7

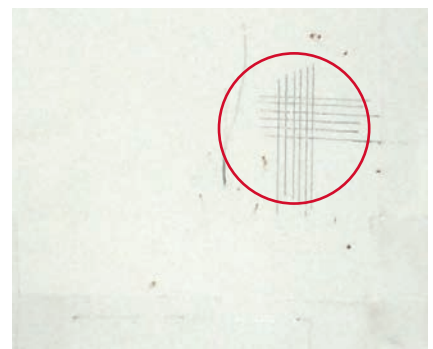


Salt spray results on 2k waterborne epoxy white coat after 1000 h

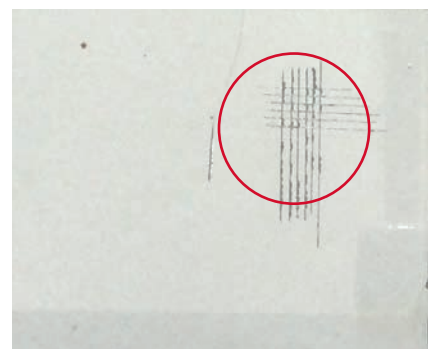
unmodified



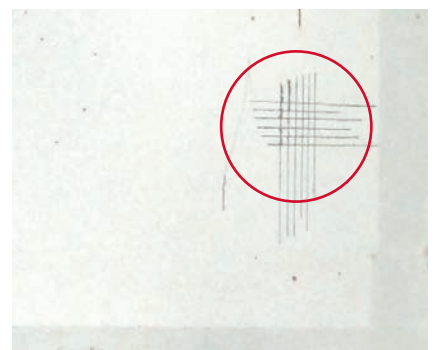
7,5%
Novares W



7,5%
Novares WA 2



7,5%
Novares WA 7

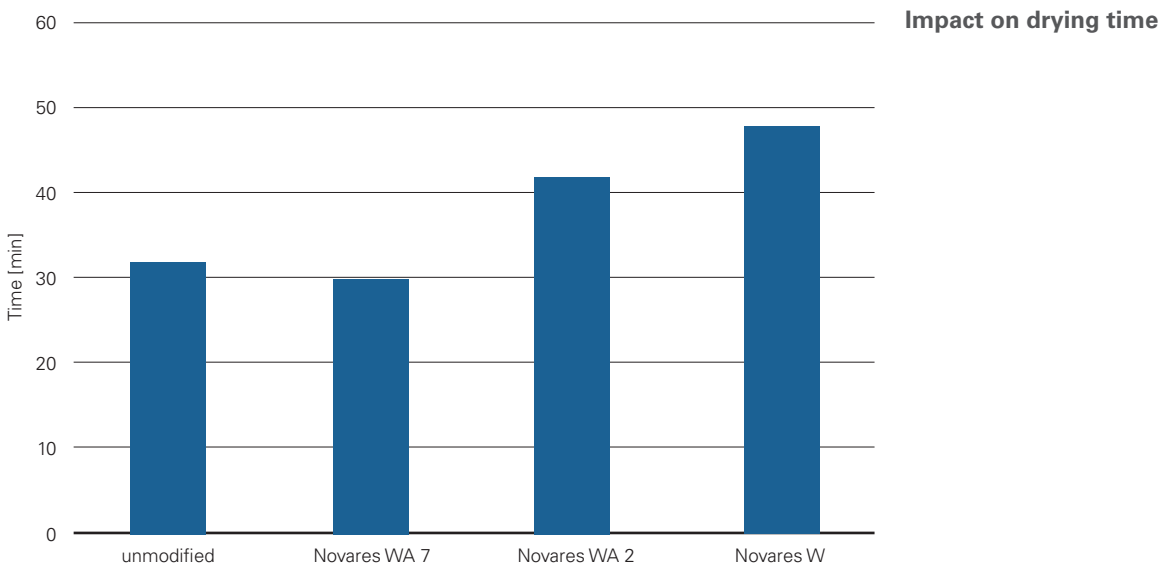


Continuous condensation of white coat waterborne epoxy after 1000 h



Novares W series offers the possibility to modify the drying behavior of waterborne epoxy formulations to specific needs. On the one hand, Novares W and WA 2 can be used to slow down the curing, which leads to better self-levelling

properties, especially required for flooring applications. On the other hand, Novares WA7 will accelerate the curing of waterborne epoxy formulations.



Novares Modifier for Waterborne Acrylics

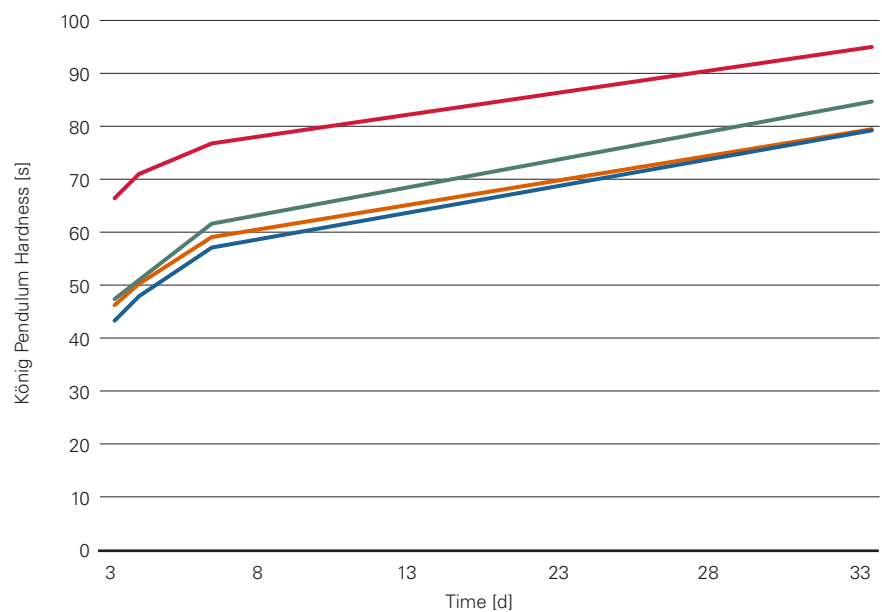
In addition to waterborne epoxy formulations, these new modifiers have also positive impacts on waterborne acrylic formulations. The improvement of wetting properties on metal and hydrophobicity are the aimed properties for which the Novares W products are used for. Due to the

low Tg -27 - 57°C, these modifiers can also be used as a non/low-VOC coalescent agent, which remains in the system as a permanent plasticizer. Especially Novares W qualifies for this usage with a Tg -57°C.

Mechanical properties

The Novares W series has no reactive groups. They can be used as a plasticizer with outstanding long-term performance in waterborne acrylic formulations

unmodified —
7,5% Novares W —
7,5% Novares WA 2 —
7,5% Novares WA 7 —



Improvement of surface properties

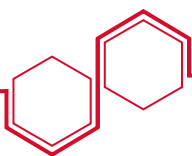
Novares W and WA 2 can be used as a non VOC coalescent agent, which results in improved surface properties, especially gloss and levelling, due to the low Tg



Novares W



unmodified



Hydrophobicity

Novares W modifiers are based on aromatic raw materials which are very hydrophobic by nature. They can be used to

effectively improve the water and chemical resistance of waterborne acrylic formulation.



unmodified



+5% Novares W

Hot water immersion test (24h @ 60°C)

The unmodified formulation failed due to heavy blistering. No blisters on modified formulation

Anti-Corrosion Properties

Besides the hydrophobicity, these new modifiers improve the wetting properties and result in improved anticorrosive properties in various formulations, proven by the continuous

salt spray test. In this test the Novares W series convinces with excellent performance after 240 hours.



Waterborne Acrylic



7,5% Novares W



7,5% Novares WA 2



7,5% Novares WA 7

Benzyl Alcohol Replacement

In conventional epoxy systems benzyl alcohol is widely used to reduce the viscosity, speed up curing and to improve flexibility. But due to the low boiling point benzyl alcohol is counted as a VOC in some regions and tends to migrate and evaporate out of the coating films. The migration of benzyl alcohol has an environmental impact, destabilizes the

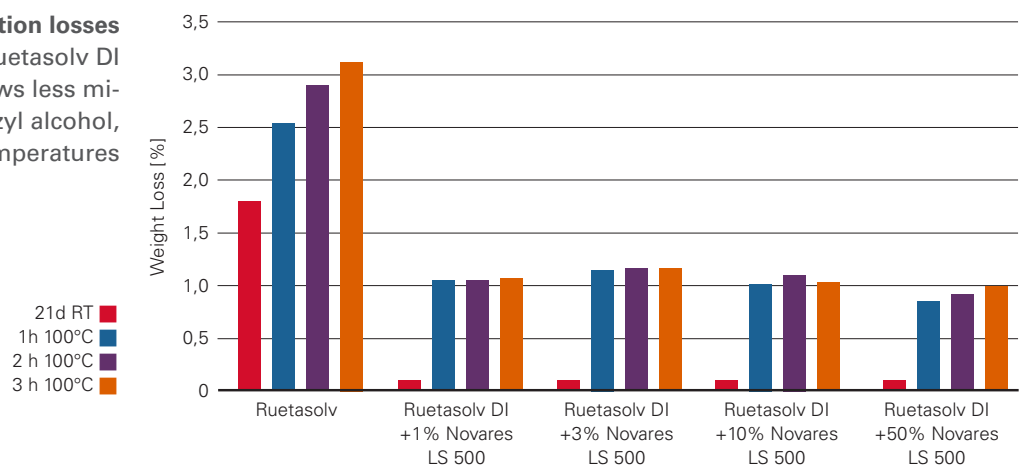
polymer network and results in reduced corrosion resistance. Ruetasolv DI is capable to achieve the same viscosity reduction and high flexibility as benzyl alcohol, but without heavy migration. In combination with LS 500 the product can match the complete application profile of benzyl alcohol, including the acceleration effect.

Formulation for hardeners based on benzyl alcohol and Ruetasolv DI / Novares LS 500

Components	Weight in %	
Benzyl alcohol	44,00	–
R DI + N LS 500*	–	44,00
Isophorone diamine	44,00	44,00
Bisphenol A liquid epoxy	12,00	12,00
Total	100,00	100,00

*The Novares LS 500 amount varies on demand. The values in the next tests are related to Ruetasolv DI. For this tests, series hardeners are prepared according to above recipe and cured with a Bisphenol A liquid epoxy resin.

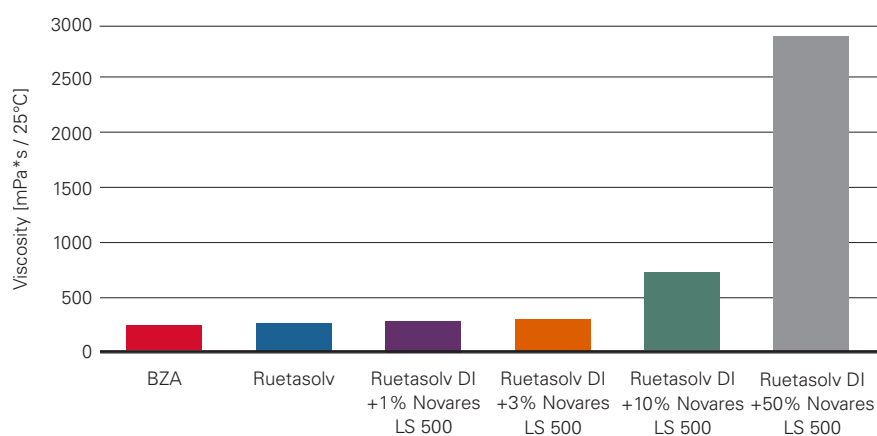
Evaporation losses
The combination of Ruetasolv DI and Novares LS 500 shows less migration compared to benzyl alcohol, even at high temperatures





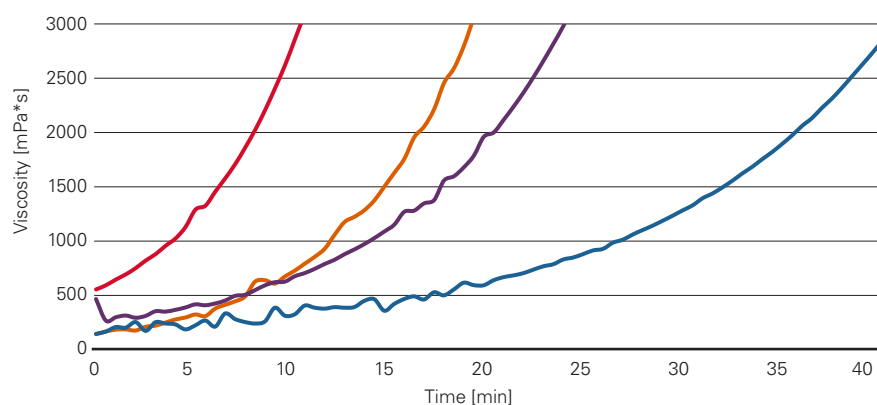
The combination of Novares LS 500 and Ruetasolv DI serves as adjusting screw for the curing speed and viscosity of a hardener. Formulators can either dilute the viscosity by a

high dosage of Ruetasolv DI or alternatively accelerate the curing by a higher dosage of Novares LS 500.



Viscosity

Ruetasolv DI modified hardeners show a similar viscosity range as the conventionally with benzyl alcohol formulated products. With an increasing amount of Novares LS 500 in Ruetasolv DI, the viscosity of the hardener increases accordingly



Hardness development

The acceleration properties can be adjusted by the ratio of LS 500 and Ruetasolv DI

- BZA
- Ruetasolv DI +3% Novares LS 500
- Ruetasolv DI +10% Novares LS 500
- Ruetasolv DI +50% Novares LS 500

Novares and Ruetasolv in PUR-Systems

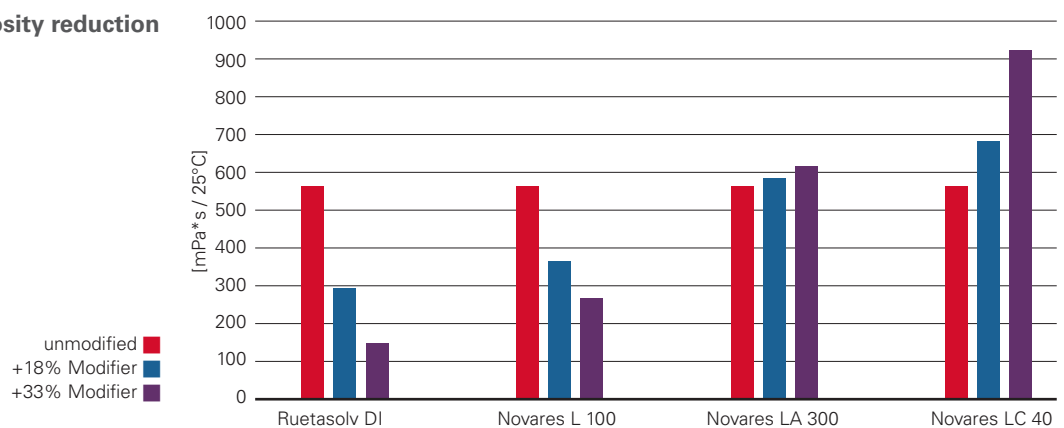
As well as epoxy resins, polyurethanes are an important reactive resin group with a wide range of applications, including civil engineering and corrosion-protection.

The tests show how Novares liquid resins and Ruetasolv products affect a PUR system, a polyether polyol cross-linked with an aromatic polyisocyanate based on diphenylmethane diisocyanate.

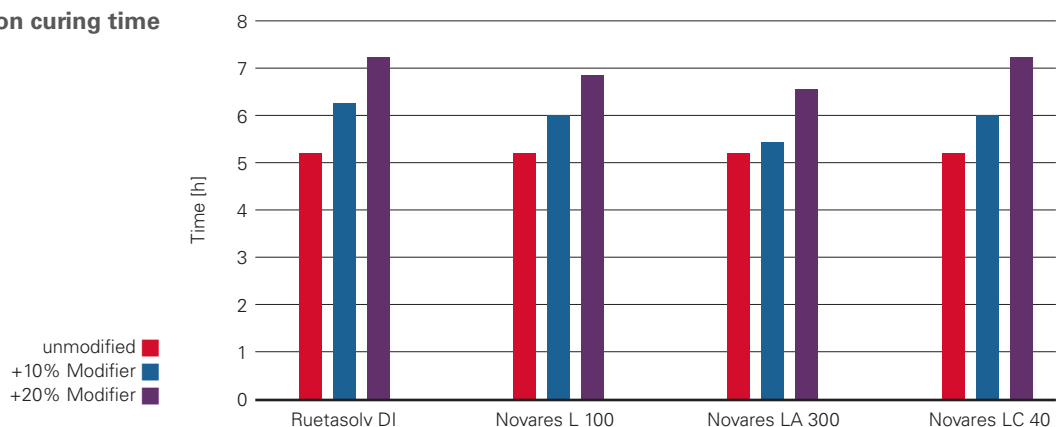
Nonpolar modifiers such as Ruetasolv and Novares L 100 will reduce the viscosity, depending on the concentration level. While a rise in the viscosity of the formulation can be observed, the polarity of the liquid resin increases.

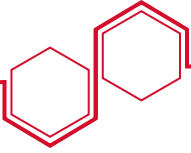
Novares resins and Ruetasolv products dilute the reactive components of the formulation. This will increase the curing time of the systems.

Viscosity reduction



Impact on curing time

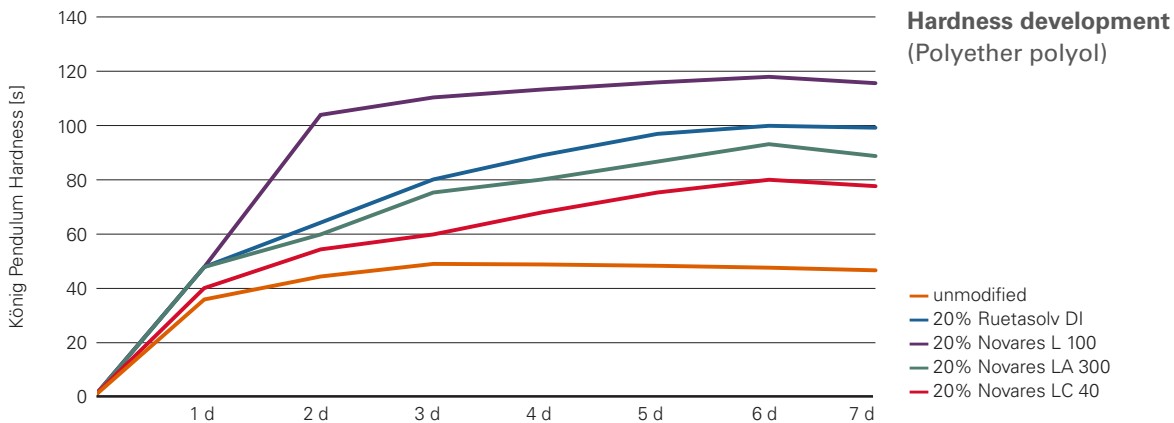




Impact on Hardness Development

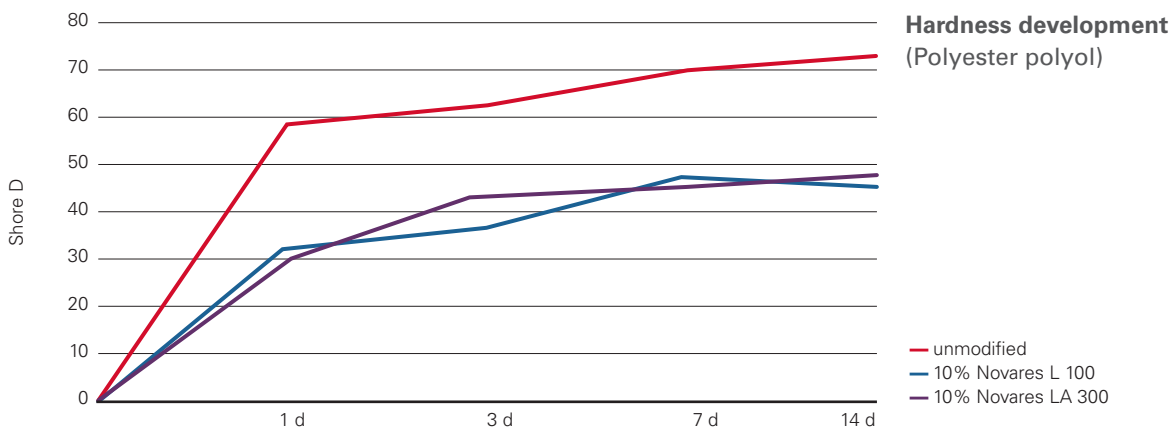
The unmodified PUR system exhibits the lowest hardness development (König Pendulum Hardness). The reaction of polyol with isocyanate lead to a build-up of molecular structures that increase the viscosity of the system and consequently restrict the mobility of the remaining reactants.

By using Novares and Ruetasolv the reaction partners remain mobile and a more uniform structure with a higher level of cross-linkage (higher hardness level) is able to develop.



This behaviour applies specifically to the named reactants and may vary when other polyols are used.

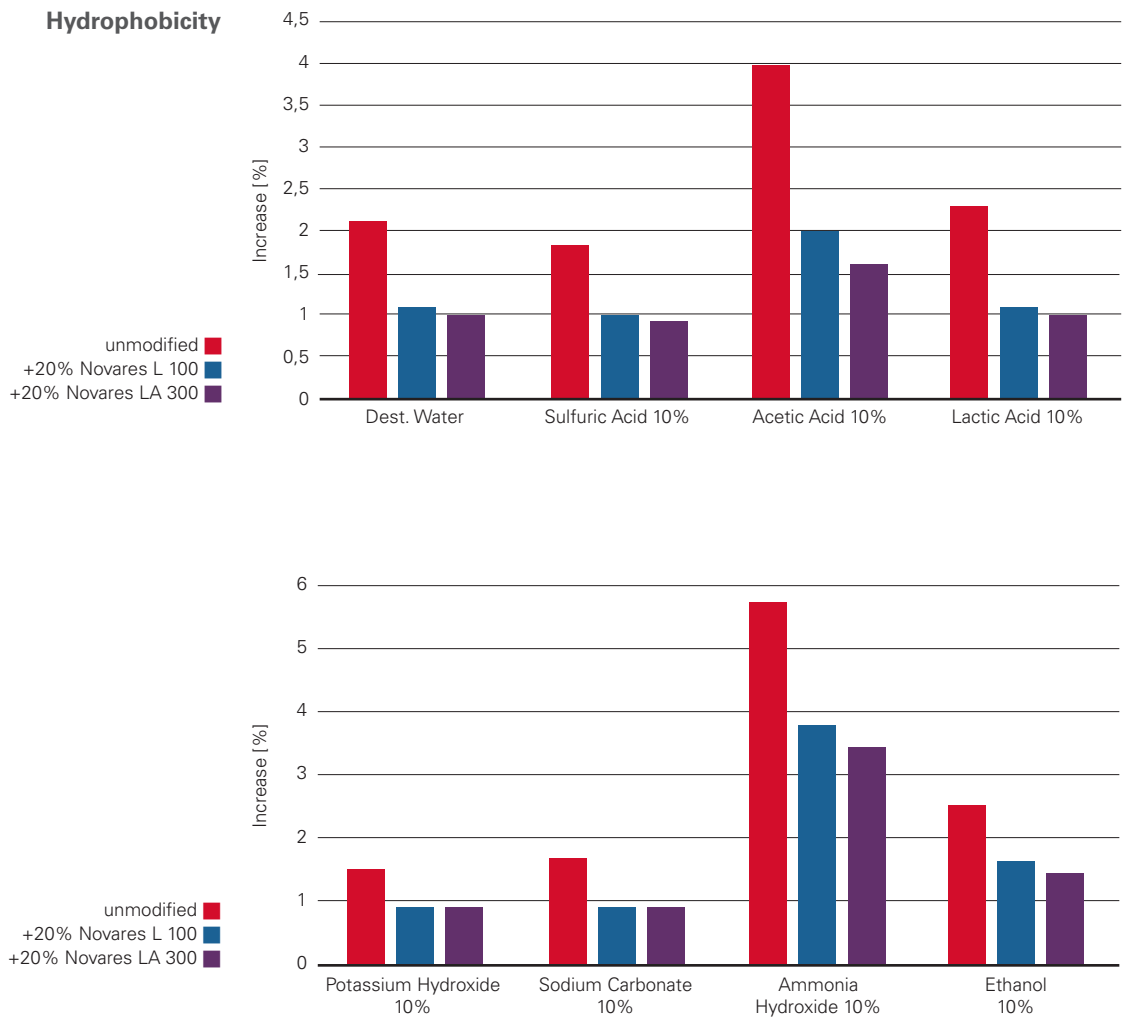
In the following graph the polyether polyol has been replaced by a polyester polyol. The impact of the modifier on the curing process can be clearly seen.



Water and Chemical Resistance

The aromatic structure of Novares resins improves the hydrophobicity, both during and after the curing of the PUR system. Test specimens of modified and unmodified PUR systems were stored for 6 months in the below mentioned media and their weight increases were determined.

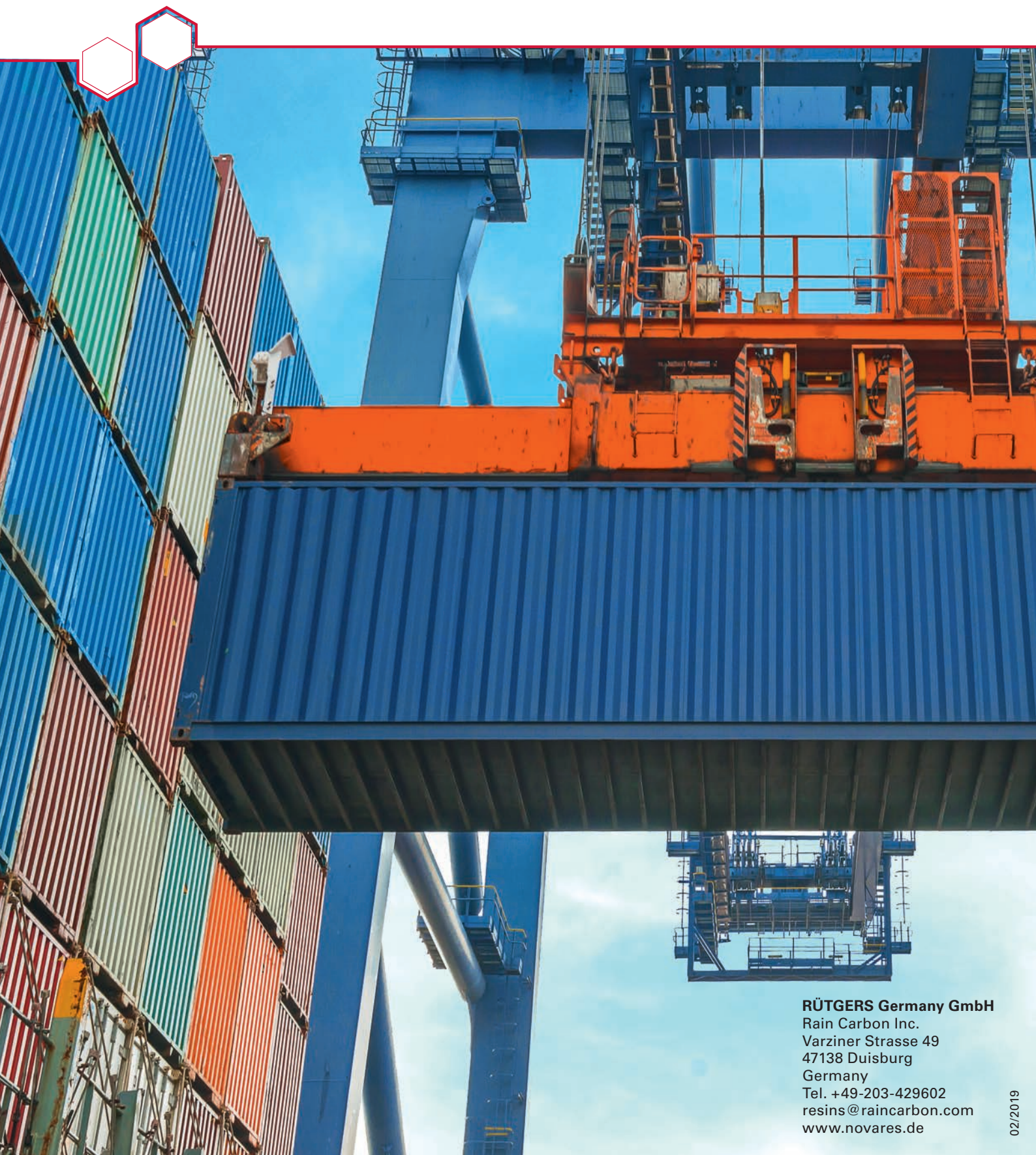
The positive effect of the Novares resins can be clearly seen in the graphs below. The modified systems exhibit a much lower increase in weight than the unmodified reference system. Using Novares modifiers in PUR provides reliable, long-term surface protection.



This information is based on present level of knowledge. Since the individual application conditions are beyond our control, no warranty or product liability can be given.



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