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Raw Materials for Corrosion Protection – so Steel Lasts Longer

Bayhydrol® Bayhydur® Bayhytherm®
Desmodur® Desmophen® Pergut®

Contents

Covestro – leading in material solutions

As the world's leading manufacturer of aliphatic and aromatic polyisocyanates, Covestro offers an extensive range of innovative products and solutions for the coatings and adhesives industries. As your customers become more demanding in their expectations for the quality, durability, workability and sustainability of your products, we can help you to turn these challenges into a competitive advantage. That is what drives us to push the boundaries of what is possible.

The key to creating added value for you, our customers, as well as for society and the environment is innovation. At Covestro, we innovate not only to address the key global challenges of population growth, urbanization, climate change, digitalization and increasing mobility; we innovate to have a sustainable business that enables us to live up to our business purpose of "making the world a brighter place." In the final analysis, this comes down to developing sustainable solutions that take the entire life cycle of a product into account. We are increasing our on-site efficiency, e.g., by recycling salt and water in our production plants. We are expanding our resource base, e.g., by turning CO_2 into a raw material in the manufacturing of plastics. And we are developing materials that are more energy-efficient and save natural resources.

In our Coatings, Adhesives, Specialties (CAS) segment, we systematically develop and supply aliphatic and aromatic isocyanates and their derivatives as well as polyurethane dispersions. Our raw materials are used for coatings, adhesives, sealants and specialty products, such as elastomers, high-quality films, 3D printing products, cosmetics, textiles and medical products. The main application areas are in the automotive, transportation, infrastructure, construction, wood processing and furniture industries. In this segment our innovative efforts are focusing on enhancing efficiency, improving quality, boosting sustainability and environmental aspects such as reducing solvent content.

We are proud of over 80 years of groundbreaking innovations. But we are not defined by our past. Even with decades of experience behind us, Covestro remains a young enterprise. In a corporate world that can often be dull and uninspiring, we want to act in a curious, courageous, and colorful way: trying out new things, questioning established ways, and pushing boundaries – for your benefit.

The way ahead

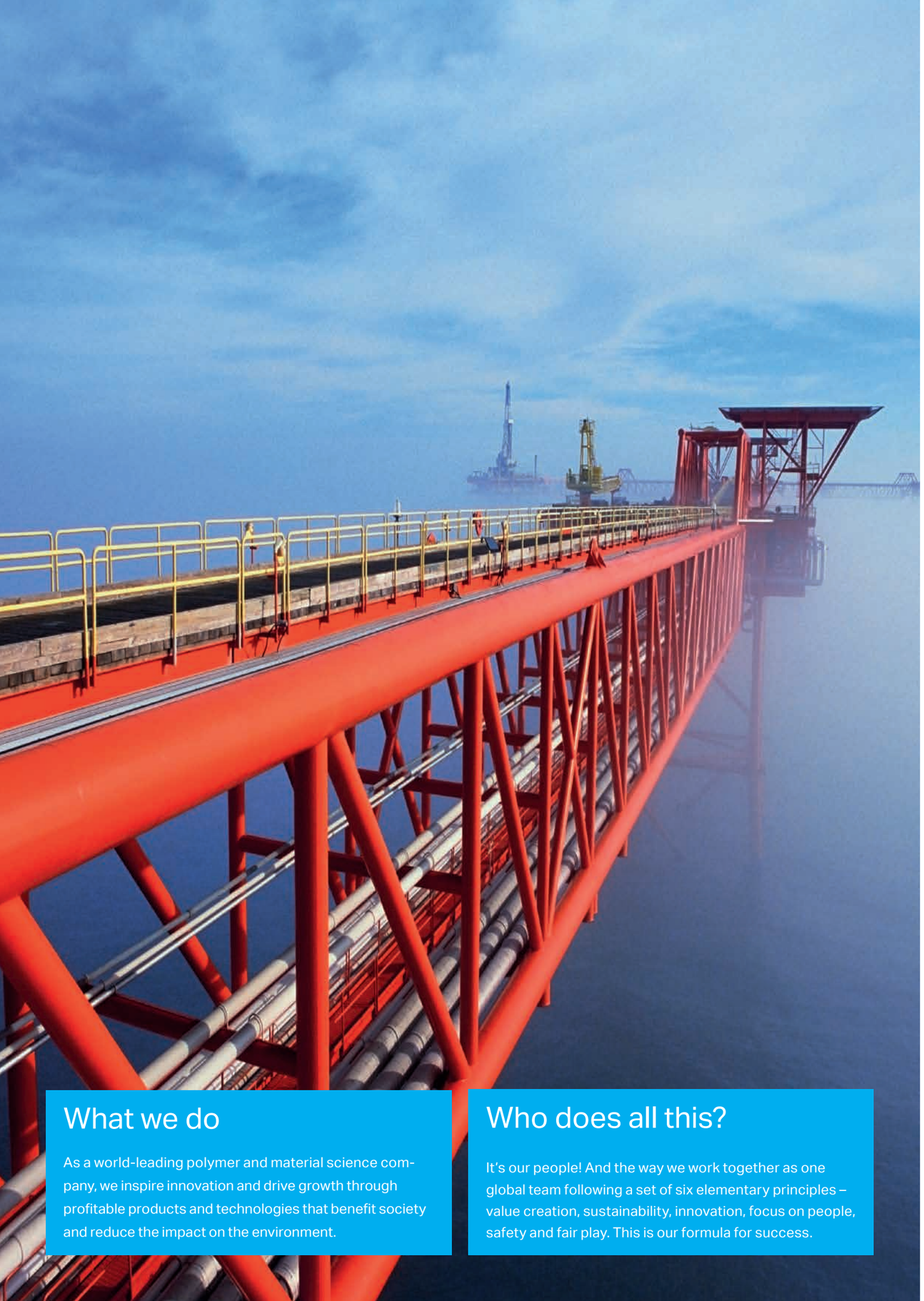
All kinds of steel constructions can be optimally protected against corrosion through the application of specific coatings. That is why corrosion protection coatings make an indispensable contribution to the long-term preservation of valuable capital investments. However, the precondition for achieving such long-term protection is the right choice of coating systems. At Covestro, we supply a wide range of raw materials for coating systems that make effective corrosion protection possible.

In a market segment specifically oriented to long-term perspectives it is particularly important to take into account long-term trends in the corrosion protection market:

- **Renewable energy sources:** As more and more countries strive to increase the share of primary energy supplies generated from renewable sources, there is an increasing demand for corrosion protection solutions for onshore and, in particular, offshore wind turbines.

- **Aging infrastructure:** The corrosion protection market is also growing as a result of aging steel constructions in developed countries and infrastructure booms in emerging economies.

- **Increasing maintenance costs:** As maintenance costs rise, not least due to higher labor costs, there is also a growing demand for long-lasting, low-maintenance coatings to protect all kinds of steel constructions.



What we do

As a world-leading polymer and material science company, we inspire innovation and drive growth through profitable products and technologies that benefit society and reduce the impact on the environment.

Who does all this?

It's our people! And the way we work together as one global team following a set of six elementary principles – value creation, sustainability, innovation, focus on people, safety and fair play. This is our formula for success.

What this means for our Coatings, Adhesives and Specialties business

Quality & supply security
Our products are of outstanding quality and we offer supply security – worldwide.

Covestro, the world's leading manufacturer of aliphatic and aromatic polyisocyanates, offers an extensive range of raw materials and services for the coatings and adhesives industry. This allows the very latest technology to be used extremely effectively for a variety of applications.

Our global setup enables you to increase your competitive advantage.

What we offer:

- A global network of research & development centers where our staff are dedicated to offering solutions for the coatings and adhesives industry.
- A unique setup and worldwide network of state-of-the-art production sites ensuring short lead times and supply chain flexibility.
- Outstanding product quality through fulfilling the requirements of state-of-the-art quality, environmental and safety (HSEQ) as well as energy management standards; we are proud of having enjoyed ISO 9001, ISO 14001, ISO 18001 and ISO 50001 certifications for many years.

Covestro is your reliable partner for polyurethane chemistry.

Solutions to enhance your process efficiency
Nowadays, the quality demands made on industrial processes are very high. This is equally true of the cost-cutting requirements. However, both goals can be achieved by increasing process efficiency. At Covestro, we have a wide range of solutions designed to enhance your process efficiency. Why not take advantage of our know-how? These solutions will benefit your bottom line.

Sustainability
Sustainability is at the heart of the Covestro strategy. We inspire innovation and drive growth through profitable products and technologies that benefit society and reduce the impact on the environment.

Our coatings, adhesives and specialties products and solutions contribute to sustainability through:

- **Saving energy – fast and smart**
  Polyurethane systems represent a benchmark in productivity and process efficiency in many industries. We strive to further push the limits of efficiency by developing game-changing new solutions.
- **Reducing waste**
  We offer solutions such as innovative 1K technologies that enable our value chain partners to use materials more efficiently and reduce waste.
- **Cutting emissions**
  Bayhydur® and Desmodur® grades are key enablers for low-emission solutions in the coatings and adhesives industries – waterborne and high solids/solvent-free!
- **Responsible management of natural resources**
  Highly durable PU-based coatings and adhesives significantly extend the lifetime of a coated product and thus help to prolong resource use.
- **Closing the loop (circularity)**
  Through economically viable products made from bio-based raw materials – with no deterioration in performance – we help our customers and value chain partners to reduce their carbon footprint and offer solutions that incorporate renewable building blocks.

Where corrosion protection makes all the difference

Polyurethane-based protective coatings
At Covestro, we develop and produce the raw materials used for protective coatings that are applied in a wide variety of fields:

- Oil and gas production, treatment and distribution
- Infrastructure
- Power generation
- Industrial processing

Whatever the application – industrial plants, cranes, wind turbines, power pylons, etc. –, tried-and-tested polyurethane coating systems provide lasting protection against corrosion, aggressive chemicals, salts and solvents for all kinds of heavy steel constructions. Moreover, these coating systems bring the additional benefits of good adhesion on steel, speedy and efficient application, a high degree of weathering and chalking resistance, and long-lasting color and gloss fastness.

Specific advantages of Pasquick®
Covestro offers polyaspartic technology under the brand name Pasquick®. Polyaspartic acid esters not only offer the customary proven benefits of 2-component (2K) polyurethane coating systems but also make significantly higher productivity levels in the coating process possible since the number of coatings can be reduced. Pasquick® polyaspartic technology permits a higher film thickness than conventional 2K polyurethane coatings and cures two or three times faster than conventional systems at normal ambient temperatures. As a result, significant cost savings are possible in the protective coating process.

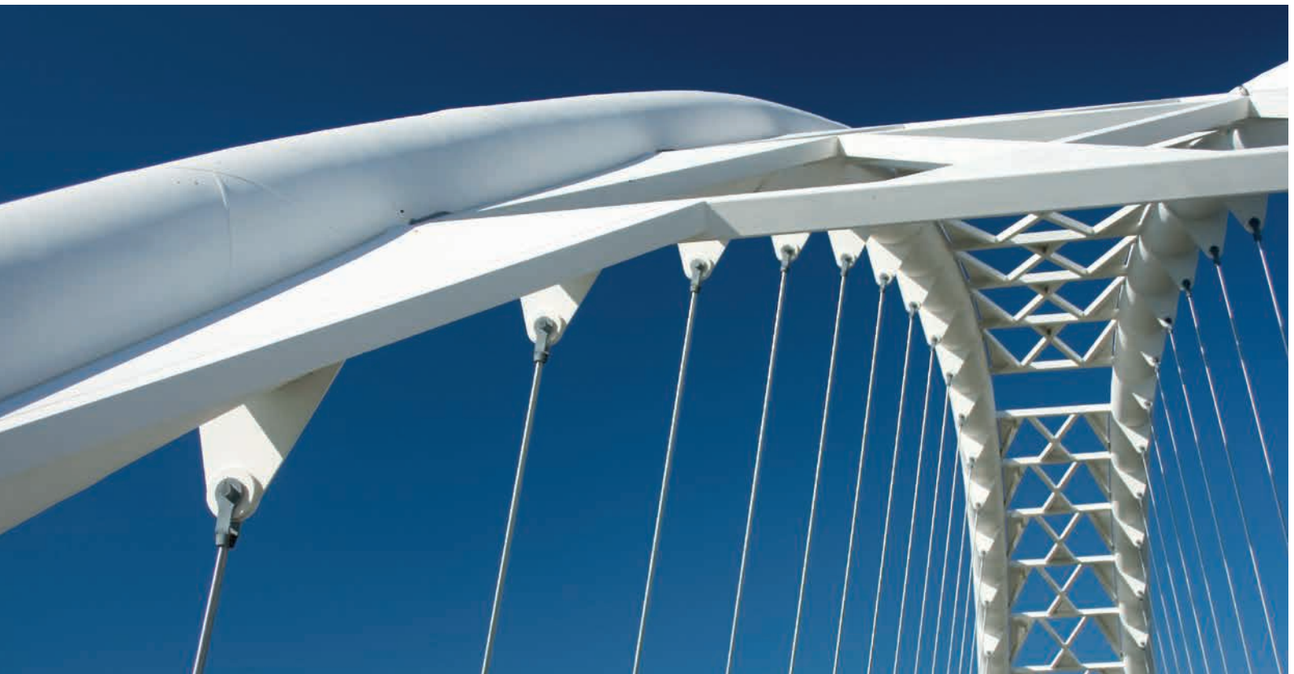
Marine coatings
Marine coatings have to offer long-term protection to steel hulls in a highly aggressive environment. The outstanding protective properties of polyurethane systems mean they are the ideal solution for protective marine coatings since they cure quickly (even at low temperatures) and are resistant to sea- and freshwater, diesel oil and most chemicals. The raw materials we provide for primers, intermediate coatings and topcoats make long-lasting and reliable corrosion protection possible. These raw materials include aromatic and aliphatic polyisocyanates from the Desmodur® range and their co-reactants from the Desmophen® range. Aliphatic polyurethane systems are particularly suitable for marine coatings in view of their high degree of lightfastness and weathering resistance. Last but not least, coating systems based on Pergut®, Covestro's trade name for a group of chlorinated rubber-based raw materials, are frequently used for marine repairs as a result of their excellent water resistance and simple processability.

Effective pipeline coatings
Effective corrosion protection for the steel pipelines used to transport oil, gas or water is of great economic significance. Liquid polyurethane systems are particularly suitable for this kind of application because they can be applied directly to the substrate in a single layer up to 2 mm thick without a primer. Our Desmodur® and Desmophen® raw materials are particularly suitable for the formulation of 100% solids polyurethane pipeline coatings. As these coating systems offer the advantages of fast, pore-free curing, even at low temperatures, excellent long-lasting elasticity, high impact resistance and good cathodic protection, they are even suitable for field joints and repair coatings. What's more, 2K polyurethane systems are ideal for use in even the toughest conditions, e.g., permanent wet stress, service temperatures above 80°C, and extremely salty soils.

Industry-leading technologies

Our outstanding binders are particularly suitable for use in heavy corrosion protection systems. This is particularly important if the longevity and safety of steel structures are to be significantly improved. Depending on the application area and technology required, we provide a range of solutions for heavy corrosion protection.

APPLICATION AREAS	TECHNOLOGIES				
	WATER-BASED SYSTEMS	SOLVENT-BASED AND 100% SOLIDS SYSTEMS			
	2K PU	2K PU	MOISTURE-CURING PU	CHLORINATED RUBBER	POLY-ASPARTICS
Protective coatings	●	●	●	●	●
Marine coatings	To some extent	●	●	●	●
Pipeline coatings		●			To some extent



Solvent-based 2K polyurethane raw materials for heavy corrosion protection

Solvent-based 2K polyurethane systems are extremely popular for heavy corrosion protection applications. This is particularly true of topcoats, where these solutions are currently state of the art. They offer long-term protection at an excellent price-performance ratio, are lightfast, resistant to wind, weather and atmospheric pollutants, can be applied in almost any weather conditions, and are impact-resistant. The systems most frequently used are based on hydroxyacrylates in combination with polyisocyanates.

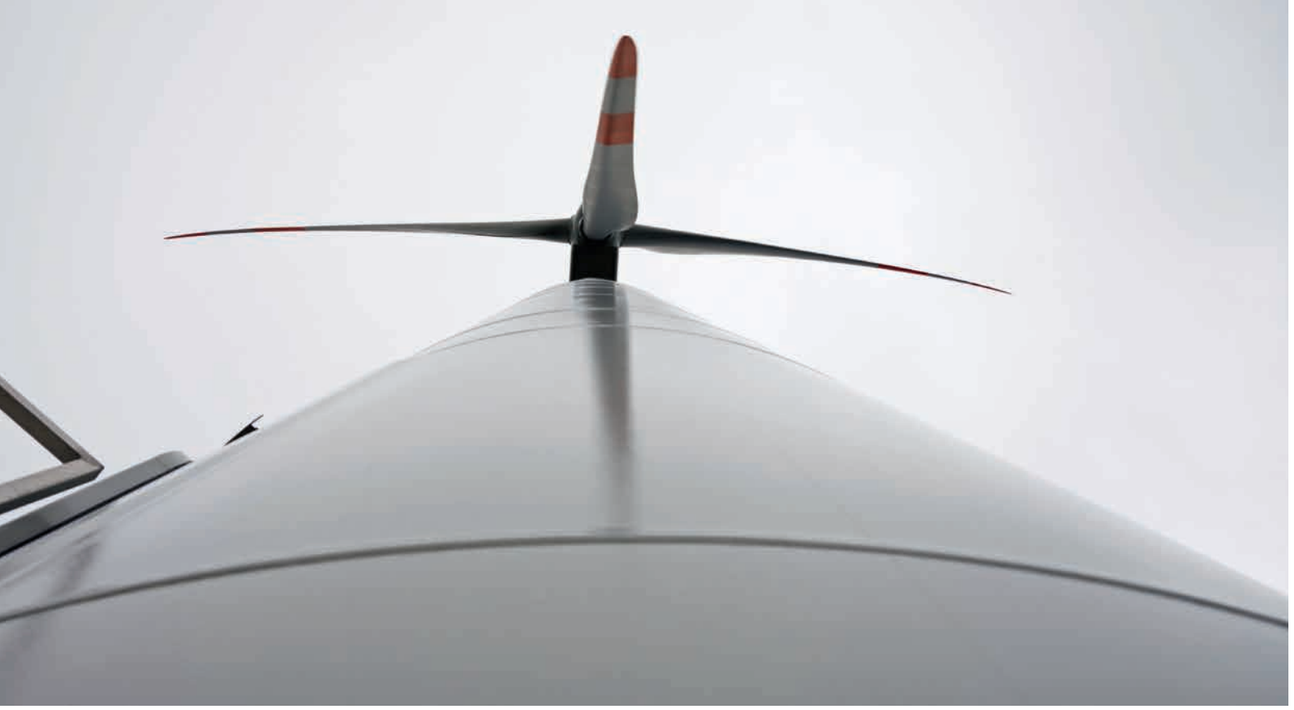
A selection of polyisocyanates for 2K solvent-based corrosion protection coatings is listed below:

PRODUCT	TYPE	SOLID CONTENT [%]	NCO ON SOLIDS [%]	VISCOSITY AT 23°C [mPa · s]	CHARACTERISTICS/ APPLICATIONS
Desmodur® N 75 MPA/X	HDI biuret	75	16.5	250	Chemical- and weather-resistant, good mechanical resistance.
Desmodur® ultra N 3390 BA	HDI trimer	90	19.6	550	Good chemical and weather resistance, high mechanical resistance; suitable for high-solid coatings.
Desmodur® ultra N 3300	HDI trimer	100	21.8	3,000	100% solids; otherwise the same characteristics as N 3390.
Desmodur® ultra N 3600	HDI trimer	100	23.0	1,200	Good chemical and weather resistance, high mechanical resistance; suitable for high-solid coatings.
Desmodur® eco N 7300	PDI trimer	100	21.5	9,500	Bio-based hardener, perfomance similar to N 3300.

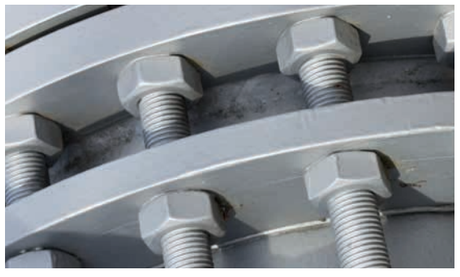
The combination partners mainly used with these Desmodur® N grades are hydroxyacrylates. However, hydroxyl polyesters may also be used as co-reactants when particularly high chemical resistance is required.

The following table lists a selection of polyesters for 2K solvent-based corrosion protection coatings:

PRODUCT	OH CONTENT [%]	SOLID CONTENT [%]	VISCOSITY AT 23°C [mPa · s]	CHARACTERISTICS/ APPLICATIONS
Desmophen® 650	65	5.3	20,000	Suitable for weather-resistant topcoats with high chemical resistance qualities.
Desmophen® 670	100	4.3	2,200	Suitable for flexible topcoats/co-binders to make coatings, systems more flexible.



Pasquick® for highly productive coating processes



A frequent challenge facing protective coating manufacturers is to increase the productivity of coating operations. This is especially true for the fast-growing market of direct-to-metal (DTM) coatings. The answer to this challenge is Pasquick®, our new brand for polyaspartic technology. Pasquick® technology is suitable for high-quality aliphatic 2K topcoats based on the Desmophen® NH and Desmodur® N ranges.

Since Pasquick® technology can be applied at high film thicknesses, the number of layers can be reduced. Moreover, Pasquick® technology cures fast at normal ambient temperatures. All this helps to achieve greater productivity in coating operations, which makes the coating process more economical. Last but not least, Pasquick® technology is also suitable for formulating ultra-high solids. In recent years, numerous practical examples of protective coating applications made possible by our Pasquick® technology have shown the benefits this technology brings:

- Increased productivity through high film thickness, fewer coating layers and shorter curing times
- Suitable for ultrahigh-solid coatings

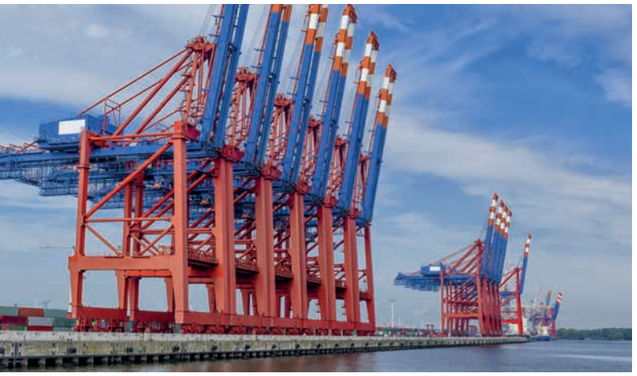
The most suitable Pasquick® raw materials we offer are listed in this table:

PRODUCT	SOLID CONTENT [%]	EQUIVALENT WEIGHT	VISCOSITY AT 23°C [mPa · s]	CHARACTERISTICS/ APPLICATIONS
Desmophen® NH 1520	100	290	1,500	Low reactivity.
Desmophen® NH 1420	100	276	1,500	Medium reactivity.
Desmophen NH 1423	100	272	1,500	Medium, better gloss retention than NH 1420 and improved industrial hygiene.
Desmophen® NH 1220	100	234	100	High reactivity.
Desmophen® NH 2850 XP	100	295	100	Flexibilization in combination with NH 1420.

The most suitable polyisocyanate crosslinkers are listed in this table:

PRODUCT	TYPE	SOLID CONTENT [%]	NCO CONTENT [%]	VISCOSITY AT 23°C [mPa · s]	CHARACTERISTICS/ APPLICATIONS
Desmodur® ultra N 3390 BA	HDI biuret	90	19.6	550	Good chemical and weather resistance, high mechanical resistance.
Desmodur® ultra N 3600	HDI trimer	100	23.0	1,200	Good chemical and weather resistance, high mechanical resistance; suitable for high-solid coatings.
Desmodur® N 3900	HDI polyiso-cyanate	100	23.5	730	Suitable for ultra-low VOC coatings.
Desmodur® XP 2763	HDI/IPDI blend	86	10.2	2,300	Longer pot life and extended recoat window.
Desmodur® N 3800	HDI trimer	100	11.0	6,000	Flexibilization in combination with ultra N 3600 or N 3900.
Desmodur® E 2863 XP	HDI prepolymer	100	11.0	1,350	Lower viscosity and higher elongation than N 3800.

Raw materials for moisture-curing 1K corrosion protection coatings



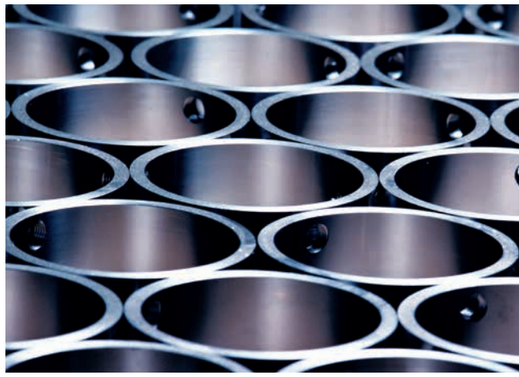
Moisture-curing polyurethane systems are well-proven coating solutions, in particular for primers and intermediate coats, and offer a number of benefits:

- Long-lasting corrosion protection
- Simple processability as no mixing is required
- Curing even at cold ambient temperatures

The most suitable products we offer are listed in this table:

PRODUCT	TYPE	SOLID CONTENT [%]	NCO CONTENT [%]	VISCOSITY AT 23°C [mPa · s]	CHARACTERISTICS/ APPLICATIONS
Desmodur® E 1361 MPA/X	TDI prepolymer	61	6.8	500	Fast curing, blistering-proof; suitable for primers and intermediate coats.
Desmodur® E 21	MDI prepolymer	100	16.0	5,400	Slower curing than E 1361, higher solids content; suitable for primers and intermediate coats.
Desmodur® E 23	MDI prepolymer	100	15.4	1,800	Slower curing than E 21, higher solids content than E 1361; suitable for primers and intermediate coats.
Desmodur® E 14	TDI prepolymer	100	3.3	6,800	Co-resin for flexibilization.
Desmodur® MT	MDI prepolymer	100	16.8	900	Stabilizer for pigmented moisture-curing aromatic 1K polyurethane coatings.
Desmodur® ultra E 3370	HDI prepolymer	70	10.0	1,400	Suitable for weather-proof topcoats.
Desmodur® LD	HDI prepolymer	100	12.0	75	Stabilizer for pigmented moisture-curing aliphatic 1K polyurethane topcoats.

100% solids aromatic 2K polyurethane raw materials



100% solids aromatic 2K polyurethane raw materials are mainly used for pipeline coatings, with a clear focus on repair and field joint coatings. The broad range of raw materials we offer allows properties such as flexibility, adhesion, cathodic corrosion protection, and abrasion resistance to be customized to meet your specific requirements. The raw materials used are mainly polyethers and MDI-based isocyanates.

The following table shows a selection of suitable polyethers for 100% solids aromatic 2K polyurethanes:

PRODUCT	OH CONTENT [%]	VISCOSITY AT 23°C [mPa · s]	CHARACTERISTICS/ APPLICATIONS
Desmophen® 1400 BT	12.1	370	Rigid to flexible properties, very good chemical resistance and very good impact resistance in combination with Desmophen® 2061 BD.
Desmophen® 1380 BT	11.7	600	Good adhesion, very good chemical resistance and very good impact resistance with Desmodur® VL as a hardener.
Desmophen® 4050 E	18.8	19,200	Very good adhesion and impact resistance and very good cathodic disbonding properties at ≥ 80°C in combination with Desmophen® 2061 BD or Desmophen® 1400 BT.
Desmophen® 4051 B	14.2	5,400	Very good adhesion and very good cathodic disbonding properties at ≥ 80°C with Desmodur® E XP 2753 as a hardener.
Desmophen® 2061 BD	1.7	345	Co-resin with flexibilization properties.

The following table shows a selection of suitable isocyanates for 100% solids aromatic 2K polyurethanes:

PRODUCT	TYPE	NCO CONTENT [%]	VISCOSITY AT 23°C [mPa · s]	CHARACTERISTICS/ APPLICATIONS
Desmodur® VLR 20	MDI	31.5	200	Higher reactivity than Desmodur® VL.
Desmodur® VL	MDI	31.5	90	Standard type.
Desmodur® E XP 2753	MDI prepolymer	21.5	400	Improved adhesion, self-catalyzing, mixing ratio by volume of 1 : 1.

Pergut® chlorinated rubber – simple and good

As a binder in premium corrosion protection coatings, Pergut® displays an impressive combination of properties, such as good adhesion to numerous substrates, easy processing, and high resistance. The various Pergut® grades are suitable for a broad range of primers, intermediate coat and topcoat applications in solvent-based, fast-curing corrosion protection coatings. The benefits include:

- Easy processing and fast-curing
- Good adhesion to metals such as steel, iron and zinc
- Excellent repaintability even after many years
- High corrosion resistance
- Resistant to chemicals, acids and bases, water and saline solutions
- Resistant to environmental influences
- Suitable for anti-fouling coatings
- Soluble in many solvents
- Good compatibility with numerous resins, polymers, plasticizers, pigments and fillers
- High paint storage stability in closed containers
- 1K application
- Resistant to bacteria, mold and fungi

The most suitable Pergut® grades are listed in this table:

PRODUCT	MOLECULAR WEIGHT (g/mol)	VISCOSITY AT 23°C [mPa · s] (18.5% solution in toluol)	IODINE COLOR VALUE	CHARACTERISTICS/ APPLICATIONS
Pergut® S 5	60,000	5	≤ 7	Suitable for fast-curing, weather-, water- and chemical-resistant coatings.
Pergut® S 10	85,000	11	≤ 7	Suitable for fast-curing, weather-, water- and chemical-resistant coatings.
Pergut® S 20	135,000	20	≤ 7	Suitable for fast-curing, weather-, water- and chemical-resistant coatings; combination partner for alkyd resins.
Pergut® S 40	165,000	42	≤ 7	Suitable for fast-curing, weather-, water- and chemical-resistant coatings; improves curing and resistance to inorganic acids.

Polyurethane raw materials for water-based corrosion protection coatings

Water-based 2K polyurethane systems are suitable for coatings that provide light to moderate corrosion protection, and are mainly used as topcoats for in-shop applications. Water-based 2K polyurethane systems can significantly reduce the VOC content of coatings while largely maintaining the performance properties of conventional 2K polyurethane systems.

The most suitable polyurethane dispersions for water-based 2K systems are listed in this table:

PRODUCT	TYPE	SOLID CONTENT [%]	OH CONTENT [%]	VISCOSITY AT 23°C [mPa · s]	CHARACTERISTICS/ APPLICATIONS
Bayhydrol® A 145	Polyacrylic dispersion	45	3.3	950	Good pigment wetting, high shear stability; suitable for high-gloss topcoats with good adhesion and solvent and water resistance.
Bayhydrol® A 2695	Polyacrylic dispersion	40–43	5.0	2,000–3,500	Superior chemical resistance.
Bayhydrol® A 2542	Polyacrylic dispersion	48–51	3.8	1,000–3,500	Suitable for low-VOC water-based coatings.

The most suitable polyisocyanate crosslinkers for water-based 2K systems are listed in this table:

PRODUCT	TYPE	SOLID CONTENT [%]	NCO CONTENT [%]	VISCOSITY AT 23°C [mPa · s]	CHARACTERISTICS/ APPLICATIONS
Bayhydur® ultra 304	HDI polyisocyanate	100	18.2	4,000 ± 1,500	Hardener that can be easily emulsified in the aqueous phase.
Desmodur® ultra N 3600	HDI trimer	100	23.0	1,200	High gloss, good chemical and weather resistance, high mechanical resistance.
Desmodur® N 3900	HDI polyisocyanate	100	23.5	730	Same characteristics as N 3600, but more easily emulsified in the aqueous phase.

Fast-lane access to polyurethane innovations

At Covestro, innovation is in our DNA. Ever since Otto Bayer discovered polyurethanes in 1937, we have been driving polyurethane innovations in coatings and adhesives as well as in other application areas. As our partner, you enjoy fast-lane access to polyurethane innovations, and can help us in developing the next generation of polyurethanes to meet the industry's upcoming challenges and needs. What can we offer you?

- Powerful know-how on both established and new polyisocyanates, as well as on new polyurethane hybrid technologies.
- The prospect of new application technologies to enable efficient processes.
- More sustainable, biomass- or CO_2-based materials that do not sacrifice high performance.

Join us to shape the future!