

**Baydur® PUL**

**Versatile polyurethane  
resin systems for pultrusion**

enable high productivity of  
durable composite parts



# Baydur® PUL – Empower your composite solutions in pultrusion

As one of the world's leading suppliers of plastics and polymer raw materials, Covestro has developed a range of highly reactive aromatic polyurethane (PU) resin systems tailored for glass and carbon fiber pultrusion. These systems combine cutting-edge mechanical properties with fast processing for a wide variety of applications.

Baydur® PUL systems are tailored for high productivity in pultrusion applications, offering

outstanding material properties that meet application-specific requirements including: high stiffness and strength, excellent thermal insulation, corrosion resistance and low creepage. These properties make polyurethane composites a cost-competitive alternative to traditional plastics, wood, and metals for demanding applications in different segments such as Building & Construction, Renewable Energy, Infrastructure, and Mobility & Transportation.



**Building & Construction**



**Infrastructure**



**Renewable Energy**



**Mobility & Transportation**

## Go-to partner:

We support our customers in qualification, development, and technology implementation.

Our team of experts offer profound expertise in polyurethane composite technology and its applications. Our know-how in fiber-reinforced composites helps to expand the range of applications for PU pultrusion. Our experience in pultrusion gives peace of mind to processors of Baydur® PUL at every stage of composite part development: from the concept phase, material selection and engineering design, on to the production phase, including launch and troubleshooting. Together with our partners,

we help increase our customers' pultrusion productivity, reducing the time and efforts required to produce high-quality, lightweight parts from composite materials.

Developed over a decade of in-depth research, our innovative Baydur® PUL resins nowadays make pultrusion a cost-competitive alternative to conventional resins in multiple composite applications. A few examples from our global application portfolio are shown below.



High-strength and energy-efficient glass fiber-reinforced window profiles



Pultruded solar module frames with glass fibers



Carbon & glass fiber-reinforced planks for wind blade spar caps



Carbon fiber beam for light commercial vehicles

# Baydur® PUL – Versatile polyurethane resin systems

## Design flexibility:

Baydur® PUL resins allow tailoring of system properties to enable our customers to create simple or complex composite profiles.

Covestro has developed a range of tailored polyurethane systems for glass and carbon fiber pultrusion that combine superior properties with fast processing. These material solutions are part of the Baydur® PUL family, a series of two-component, aromatic polyurethane material systems with excellent processability and outstanding mechanical properties.

By combining different components of the Baydur® PUL resin family, the system can be tailored towards ideal mixing viscosities and

reactivity levels to meet specific applications' requirements, such as either glass or carbon fiber reinforcements or a specific design aspect. This makes Baydur® PUL resins a versatile solution for a wide range of applications.

A key advantage of Baydur® PUL arises from combining low viscosity with high reactivity. This results in a very good fiber impregnation, leading to outstanding mechanical properties on the one hand, and allowing for high pultrusion line speeds of the other.

## BAYDUR® PUL (POLYOLS)

DESMODUR® (ISOCYANATES)	BAYDUR® PUL (POLYOLS)			
	20PL10 Versatile	20PL20 Phase stable Lower viscosity Higher reactivity		
	10PL01	↑ VISCOSITY	↑ REACTIVITY	↓ PROFILE THICKNESS
	10PL02	• MV: ~ 530 mPas • F: GF	• MV: ~ 560 mPas • F: GF	
10PL03	• MV: ~ 300 mPas • F: GF, CF	• MV: ~ 310 mPas • F: GF, CF		
	• MV: ~ 150 mPas • F: GF, CF	• MV: ~ 160 mPas • F: CF		

MV: mixing viscosity 75 sec. after mixing at 25 °C  
F: preferred fiber type  
GF/CF: glass/carbon fibers



Contact an expert or  
Watch our pultrusion case studies

# Baydur® PUL – Smooth production with a boost in productivity

## Fast but stable processing:

Baydur® PUL offers low viscosity and high reactivity for an efficient impregnation of glass and carbon fibers, fast pultrusion line speed and high productivity while maintaining high part quality.

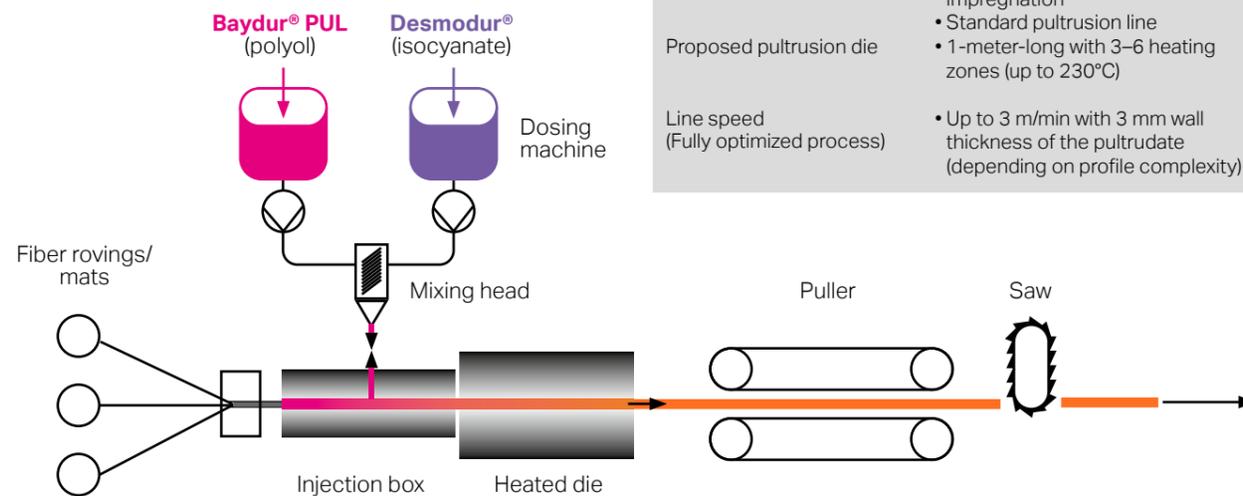
Traditional manufacturing processes for composite parts with thermoset matrix systems involve shaping, fiber impregnation, and matrix curing as separate steps. The pultrusion process combines these steps into one continuous process. This allows for a very efficient production of fiber-reinforced parts possessing a constant cross-section.

To protect the PU resin from exposure to air that potentially contains moisture, a closed impregnation unit is used that is integrated into the pultrusion line.

Both components of the resin system are dosed and mixed by means of a metering machine containing a mixing head and injected into the so-called injection box.

This controlled process prevents the formation of voids and improves the quality of the part. As the profile is shaped, cooled, and cut, a pulling system keeps the process continuous. All these aspects make the processing of Baydur® PUL resins very smooth, providing highest process stability and low scrap rates.

## Technical processing information



- |                                      |                                                                                                                                                                      |
|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Processing equipment                 | <ul style="list-style-type: none"> <li>• 2K dosing and mixing machine</li> <li>• Injection box for fiber impregnation</li> <li>• Standard pultrusion line</li> </ul> |
| Proposed pultrusion die              | <ul style="list-style-type: none"> <li>• 1-meter-long with 3–6 heating zones (up to 230°C)</li> </ul>                                                                |
| Line speed (Fully optimized process) | <ul style="list-style-type: none"> <li>• Up to 3 m/min with 3 mm wall thickness of the pultrudate (depending on profile complexity)</li> </ul>                       |



Watch this video to learn more!

# Baydur® PUL – Excellent properties for long-lasting applications

## Outstanding performance:

Baydur® PUL resins offer excellent mechanical properties and corrosion resistance, allowing for use in various high demanding applications.

Pultrudates from Baydur® PUL offer superior mechanical properties, both in longitudinal and transversal direction. This accounts for smaller wall thicknesses and makes additional fiber reinforcements perpendicular to the main fiber direction unnecessary, thus reducing complexity

and also potentially decreasing costs. With Baydur® PUL designers are free to create simple structural reinforcements or complex geometric profiles, meeting strict mechanical requirements and allowing for lightweight design.

## Typical mechanical properties of profiles reinforced with unidirectional glass and carbon fibers:

Stated fiber volume content exemplary (more data upon request).

PROPERTY	Unit	Glass fibers*		Carbon fibers*		
		0°	90°	0°	90°	
<b>Fiber Volume</b>	%	65		69		
<b>Density</b>	g/cm³	2.1		1.6		
<b>Flexural</b> DIN EN ISO 14125	Strength	MPa	1,300	70	1,300	145
	Modulus	GPa	52	15	162	8.7
<b>Tensile</b> DIN EN ISO 527-5	Strength	MPa	1,000	40	2,400	60
	Modulus	GPa	55	12	160	9.3
<b>Compression</b> DIN EN ISO 14126	Strength	MPa	1,400	140	1,280	180
	Modulus	GPa	53	14	144	9.8

\* Glass fibers: unidirectional rovings (4.800 tex), Carbon fibers: unidirectional rovings (50K)

Baydur® PUL resins surpass steel and aluminum in corrosion resistance and outperform other thermoset resins in chemical resistance, making them versatile for various applications.

Additionally, their surfaces can be easily coated after appropriate treatment, such as grinding or sand blasting.

## Chemical resistance of Baydur® PUL to selected chemicals compared to other thermoset resins:

	Baydur PUL®	EP	UP
Sulfuric acid (10%)	✓	✗ -100	✗ +47
Hydrochloric acid (10%)	✓	✗ -84	✓
Caustic soda (10%)	✓	✗ -31	✗ -75
Gasoline	✓	✗ -92	✗ -53
Diesel oil	✓	✓	✓
Motor oil	✓	✓	✓
Ethanol	✗ -23	✗ -92	✗ -39
Acetone	✗ -80	✗ -83	✗ -61
Ethyl acetate	✗ -70	✗ -88	✗ -64

EP: epoxy, UP: unsaturated polyester  
ILSS change (>15%) after 90 days exposure

## Baydur® PUL – Higher line speeds, lower costs

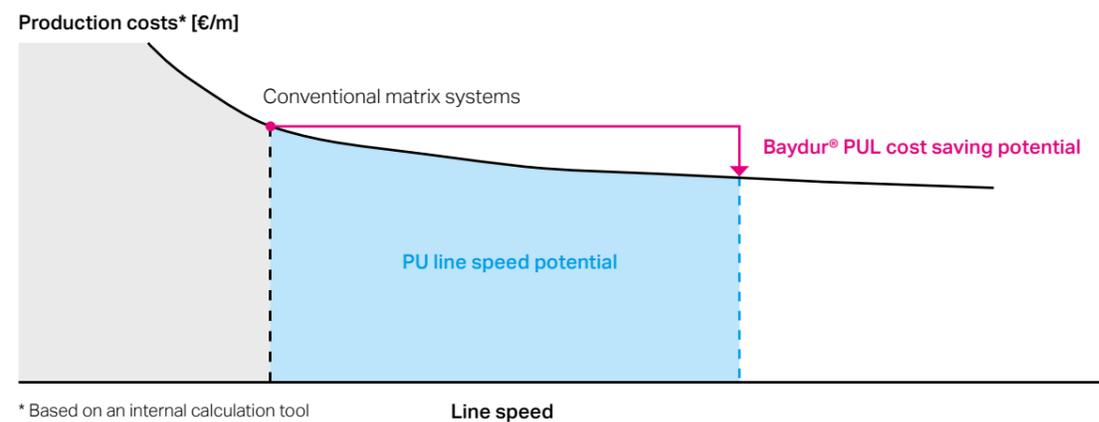
### Cost saving:

Baydur® PUL pultrusion technology helps pultruders saving by as much as 20%\* on production costs compared to alternative resins.

Our innovative Baydur® PUL resins offer significant advantages for the pultrusion process. Due to the combination of low viscosity and high reactivity, they allow for increased pultrusion line speeds maintaining a high quality of the finished parts. This eventually leads to significant improvements in productivity and reduced manufacturing costs. Covestro internal studies show that polyurethane pultrusion

with Baydur® PUL technology potentially reduces production costs by as much as 20% compared to commonly used resin systems in pultrusion. In addition, the yield per line can be increased by as much as about 65% by using Baydur® PUL instead of a conventional resin system restricted to lower line speeds.

### Pultrusion production costs over line speed: Baydur® PUL cost saving potential



\* Based on an internal calculation tool developed by Covestro

## Baydur® PUL – More sustainable solutions available today

### More sustainable:

Baydur® PUL resins offer ISCC PLUS-certified mass balance attributed products, allowing to reduce the carbon footprint of the neat resin by up to 76%<sup>2</sup> while being a drop-in solution.

Next to own efforts to create more sustainable materials through our corporate aim of achieving operational climate neutrality by 2035, we are taking steps toward a sustainable, climate-neutral and circular economy that not only thinks in terms of visions for tomorrow, but also offers opportunities for acting today.



Our mass balance approach is an easy drop-in solution, which ensures the incorporation of specific feedstock material (such as biomass) early into the value chain. Mass balance attributed products can comply with the same technical requirements as conventional products. And it is already available today.



Learn more about...

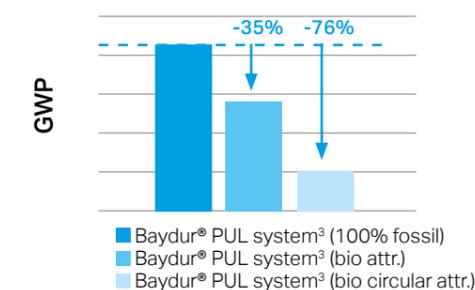
### Mass balance attributed Baydur® PUL resins

Our mass balance attributed products of the Baydur® PUL resin family have been attributed to feedstock originating from biomass, biowaste and bioresidues. To enable sustainable sourcing and transparent attribution of our more sustainable raw materials, our operations and the upstream supply chain hold an ISCC PLUS certification audited by an independent third party<sup>1</sup>. Our pultrusion products have been attributed a certain share of bio or biocircular feedstock, e.g. MDI with an attributed product share

of ~60% ISCC PLUS certified bio or bio-circular feedstock as determined by a mass balance approach.

All available mass-balanced attributed versions of the Baydur® PUL family allow for relevantly reducing the Global Warming Potential (GWP) of the neat resin between 35% and 76% compared to our conventional 100% fossil-based resin<sup>2</sup>.

### Relative carbon footprint reduction<sup>2</sup> of mass-balanced attributed Baydur® PUL systems<sup>3</sup>:



<sup>1</sup> In a methodology review, TÜV Rheinland has confirmed that the LCA methodology used by Covestro Deutschland AG is in accordance with ISO 14040:2006 + A1:2020 and 14044:2006 + A1:2018 + A2:2020, reflects the state of the art and is scientifically based.

<sup>2</sup> Environmental impacts of the manufacturing of 1 kg product (cradle-to-Covestro-gate) (without transport/packaging) based on the methodology of international standards ISO 14040 / ISO 14044 Environmental management – Life cycle assessment. Impact assessment according to CML 2001 – Jan. 2016.

Calculation based on Covestro-specific production and supply chain data, replacing fossil raw material with ISCC PLUS certified renewable feedstock via the mass balance approach.

The LCA data represent the situation at the time of data collection and LCA modelling. Covestro is updating its LCA data sets constantly but shall not be obligated to inform the receiving party in case updated LCA data is available.

<sup>3</sup> Baydur® PUL system: Desmodur® 10PL03 + Baydur® PUL 20PL20



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Edition: 2\_6-2024 · Printed in Germany