



Cast polyurethane solutions
for offshore windfarm applications





Using cast PU elastomers to boost the service life

Cast PU applications to secure and boost the offshore energy production

The world's fuel is energy. Societies use energy for everything: transportation, manufacturing, housing, and communication but also for industrial, commercial, and domestic purposes. Therefore, to run the world, it requires resources to be converted to produce this energy.

The resources available are of different kinds: although fossil fuels such as oil and gas make up the bulk of the world's current energy sources, renewable resources such as wind are gaining recognition as it can sustain indefinite human exploitation. A large part of the wind resource is available offshore.

Covestro provides the offshore wind industry with material to improve the life service of the equipment installed on the windfarms: subsea cable protection, cable bend control, turbine protection, etc.

Power producers need materials that are strong, durable and can withstand the demanding environmental conditions. With an excellent combination of properties, polyurethane elastomers from Covestro help keeping critical power projects energized.

Covestro addresses the requirements of the offshore wind industry by providing customized and cost-effective solutions.



Desmodur[®] elastomers for the offshore windfarms

Components made with Desmodur[®] boast a long service life and low maintenance costs – powerful attributes for the offshore wind energy industry heavily focused on reliability, efficiency and cost management. Most importantly, the systems make it possible to produce robust elastomers capable of withstanding extreme offshore environmental conditions. This brochure presents a selection of offshore windfarm applications which benefit from being manufactured with cast polyurethanes. Many others are available: please contact us for more information.



Cable protection



① Bend restrictor



② Bend stiffener



Tensioner pad



Graphic design: Quentin Fiorillo - Julien Becaud - Jean-Luc Va

Wind turbine protection

Wind blade protection



③ Boat fender



Dampening pad



Dunnage

Cable protection applications: robustness and hydrolysis stability for long service life

Long-lasting cable bending protection solutions



Installation and maintenance of subsea cables involve significant costs because the task typically requires the intervention of professional divers and, once installed, cables are continuously exposed to strong currents and tidal action. Such conditions have a direct impact on cable lifetime and cost of operation. For this reason, the preferred option is materials that last as long as possible, such as our cast PU elastomer systems.

Cable protection solutions created with cast polyurethane include, among others, the following parts:

Bend stiffener

Where any cable connects to a wind turbine, continuous movement can cause failure of the cable at the termination point. A Bend stiffener is conical shaped device that increases the overall stiffness of the cable in order to prevent over bending at the termination point.

The Desmodur® based cast polyurethane used for bend stiffeners develop the following properties:

- Good Stiffness with optimized modulus
- Good tensile strength and elongation
- Hydrolysis: good ageing in air and seawater
- Good thermal behaviour
- Approved for fatigue and creep resistance

Bend restrictor

Any flexible cable connected to a structure is subject to failures. Bend restrictors are used to prevent damage to cables that might result from over bending. The system comprises interlocking elements that articulate when subjected to external loads. These elements mechanically lock to form a semi-rigid curved structure that does not allow the cable to bend beyond a predetermined radius. The Desmodur® based system used for bend restrictors develop the following properties:

- High stiffness Young modulus (> 2700 Mpa)
- Elongation over 8%
- Corrosion and hydrolysis resistance in seawater
- Good thermal behaviour
- Impact resistance

Application	Hardness	Recommended system
Bend stiffener (less than 300kg)	90shA to 70shD	Desmodur® MTX6076 + Baytec® T4X + Baytec® XLB <i>and also available with more sustainable material</i>
Bend stiffener (more than 300kg)	60shD	Desmodur® LU-T 60D + Baytec® XL1705
Bend restrictor (standard grade)	82 ShD	Desmodur® B9M10 + Baytec® CG9 9086 82D MF
Bend restrictor (high temperature)	82 ShD 85 ShD	Desmodur® B9M10 + Baytec® BR-P100 82D Desmodur® B9M10 + Baytec® BR-P100 85D <i>and also available with more sustainable material</i>

Cable protection while installation



During cable laying operation, the tension of the cable has to be maintained at all sea conditions. Tensioner are the machines to maintain a constant tension on the cable when installing it into the seabed. The tensioner consists of a number of (caterpillar) tracks mounted in a frame. To maintain the tension, the cable is clamped between pads to prevent damage on the cable.

Tensioner pad

Tensioner pads made with cast polyurethane are able to prevent damage on the outer surface of the cables. They ensure a safe and better grip.

The Desmodur® based system used for tensioner pads develop the following properties:

- Low coefficient of friction
- High wear resistance (tear, abrasion)
- Excellent ozone and UV resistance
- Excellent resistance to aging
- Excellent seawater resistance
- Excellent pressure levelling properties and resistant to mineral oils, gasoline, greases and various solvents.

Application	Hardness	Recommended system
Tensioner pads Standard grade	From 85shA to 95shA	Desmodur® B9M10 + Baytec® LDF440 + Baytec® XL B <i>and also available with more sustainable material</i>
Tensioner pads High wear resistance	From 85shA to 95shA	Desmodur® LU-D + Baytec® XL1705
Tensioner pads High hydrolysis resistance	From 85shA to 95shA	Desmodur® LU-T + Baytec® XL1705

Wind turbine protection applications: preserve the turbine from deterioration

Materials for impact protection



To make wind energy more competitive with traditional energy resources, offshore wind farms require long lasting and easy-to-install protection solutions due to aggressive environmental conditions. The aim for the turbines is to be used over a long period of time with as little maintenance as possible. The steel towers supporting modern wind turbines can be up to 120 meters tall. Effective protection for these giants is a must.

Desmodur® systems enable the easy production of robust elastomers capable of withstanding extreme offshore environmental conditions and extend the service life of turbines.

Boat fenders

The fendering system of the maintenance vessel act as an elastic buffer device that is used to prevent damage to the ship and the turbine during the maintenance operation. To do this, boat fenders are able to absorb the collision energy during contact between the vessel and turbine tower.

Cast polyurethane are typically adapted to the production of fendering applications as they develop the following properties:

- Lightness to improve vessel speed and fuel consumption
- High impact absorption
- Excellent wear resistance (abrasion, tear and cut)
- High coefficient of friction

Dampening pads

Any motion of the turbine tower due to the tide or the wind can lead to equipment fatigue and damage. In order to prevent these vibration damages, the tower is set on a structure with interlocking elements able to absorb loadings and movements.

Made with cast polyurethane, the pads offer the following properties:

- Excellent resilience
- Excellent compression set
- Limited heat build-up
- Excellent damping properties
- High impact resistance

Application	Hardness	Recommended system
Boat fender with high wear resistance	From 75shA to 90shA	Desmodur® B9M10 + Baytec® LDF440 + Baytec® XL B <i>and also available with more sustainable material</i>
Boat fender without cushioning	From 75shA to 90shA	Desmodur® MTX6076 + Baytec® D24 + Baytec® XL B <i>and also available with more sustainable material</i>
Dampening pad	From 80 to 90 ShA	Desmodur® LU-T + Baytec® XL1705



Wind blade protection application: prevent damage during transportation

Solution to protect the blade during transport



To load and secure the wind blade during transport to the place of operation, whether on the road or on a boat, the solution is to place the wind blade on cushions. Both the grip to prevent the blade from slipping and the shock resistance to absorb any shock or vibration occurring during loading and transport of the blade must be ensured.

Elastomers based on Desmodur® systems allow the easy production of dedicated cushioning application with expected shock absorption and compression set to prevent damage during the blade transportation.

Dunnage

The cushioning system used for transporting the wind blade acts as an elastic damping device which is used to prevent damage to the blade.

Cast polyurethane are typically adapted to the production of cushioning applications as they develop the following properties:

- Fair compression set
- Good wear resistance

Application	Hardness	Recommended system
Dunnage	From 65shA to 85shA	Desmodur® B9M10 + Baytec® LDF440 + Baytec® XL <i>and also available with more sustainable material</i>



A comprehensive portfolio of machines and peripherals

A new concept that widens the perspectives whatever to the paths molders choose to walk

Covestro Elastomers offers solutions to industrialise all scales of cast PU part production. The accomplished experience in moulding pooled together with chemistry know-how and strong in-house engineering skills are key advantages allowing Baulé machines to be the most efficient tools for cast polyurethane part production. In that purpose, Covestro Elastomers build a comprehensive range of machines and peripherals.

Machines to produce cast PU parts at scale

Baulé® alpha machines

Options you can always upgrade

The alpha approach allows to pick from a wide range of configurations to end-up with the machine you need at the moment of the purchase, with the possibility of upgrading according to any evolving needs. A great number of combinations can be arranged to suit both your means and needs.



Baulé® alpha machines offer a comprehensive range of features:

- Output ranging from 2 to 30 kg per minute
- Tank capacity up to 400 liters
- Configuration from 2 to 4 components.

Baulé® omega machines

Designed to your specifications

With the omega approach, the only limit is the one our customers hold themselves to. Clear of the usual restrictions, Baulé® omega machines allow our customers to design their machine beyond any boundaries.



Thanks to our senior engineering team, any viable combination of features is possible. This customized approach has been designed to meet the most demanding and specific requests in order to meet our customers requirements.

Peripherals to enhance the machines capabilities

Baulé® machinery is developed to provide the highest levels of efficiency, ease of use and processing functionality. In order to enhance the capabilities of our machinery, Covestro Elastomers provides many options and peripherals for the processing machines. They expand the flexibility and increase the production capabilities of Baulé® machines and make the machines capable of overcoming the frequent barriers of industrial production whatever the chemical or processing challenges.

Covestro's equipment for offshore applications

Baulé® alpha and omega machines for an optimal processing of offshore wind applications

Covestro machines are designed to fit with your requirements regardless of the chemicals processed, the working environment and the application field. Operators use these productive and efficient units as a cost-effective means for achieving improved efficiency when processing cast polyurethane elastomers. Covestro specially developed variants of its equipment for the production of offshore Wind parts which require specific options.

Machine features

The Baulé® machine can process from two to four component systems. It features the superior qualities of all Baulé® machines and are designed for the processing of TDI, MDI and Quasi-MDI based systems.

Switch from TDI to MDI based systems

Thank to our strong knowledge in chemicals and machines, the equipment can be designed to start the production in TDI and switch to MDI on a second stage with very few machine modifications.

Design

- From 2 to 4 components
- Framed compact design
- Vacuum tight and stainless steel tanks
- Large tank capacities: up to 1000L
- Stirrer and looking glass on tanks

Output from 10kg/min to more than 300kg/min

Data storage

- Maintenance operations
- Easy data to provide accurate casting reports

Automation

- Machine control via an operator touch screen interconnected with a PLC
- Automatic disc degasser can be connected for higher productivity

Thermoregulation up to 100°C for all lines

Metering: a true mastery of flow accuracy

To achieve the final product with the expected properties and characteristics, the metering of each component has to be mastered in order to fully respect the targeted stoichiometry. Accuracy is a critical function of the machine. The choice of the best metering device (gear pump, mass flowmeter, etc.) is a must. However, to achieve perfect accuracy, a mastery of the working conditions (pressure, temperature...) is mandatory.

Flowmetering

Possibility to add complementary mass flowmeters to the Baulé® metering system to enhance accuracy of the pumps

Pressure control

- Proprietary self-adjusting pressure regulator
- Closed loop pressure regulation

Benefits

Cast PU processing is not a simple blending operation. It is a complex reaction process. Missing accuracy over the metering process leads to molding failure. Covestro machines embed the technologies to achieve the perfect metering of the components with the following benefits:

- Superior flow accuracy for each component.
- Real time metering control
- High accuracy whatever the casting mode

Covestro's field proven system solutions

Multiple chemical profiles available

Covestro's cast polyurethane systems are designed to meet requirements of a wide range of demanding offshore applications. Through in-depth research into elastomer behavior in various environments, our team has developed the most accurate and effective solutions.

Desmodur®B9M10 based systems

System nature:	MDI-Ether	Chain extender:	Baytec® CG9 9086 82D
Processing temperature:	< 35°C	Hardness :	82 ShD
		Chain extender:	Baytec® BR-P100 82D
		Hardness :	82 ShD
		Chain extender:	Baytec® BR-P100 85D
		Hardness :	85 ShD
		Chain extender:	Baytec® LDF440
		Hardness range:	35 ShA - 60 ShD

Desmodur® LU-T based system

System nature :	Low Unreacted TDI-Ether	Chain extender:	Baytec®XL1705
Processing temperature:	< 70°C	Hardness:	60 ShD

Desmodur® LU-D based system

System nature :	Low Unreacted TDI-Ester	Chain extender:	Baytec®XL1705
Processing temperature:	< 70°C	Hardness:	80 ShA - 60 ShD

Desmodur® MTX6076 based systems

System nature :	Quasi MDI-Ether	Chain extender:	Baytec®D24 + Baytec®XLB
Processing temperature:	< 50°C	Hardness range:	60 ShA - 76ShD
		Chain extender:	Baytec®T4X + Baytec®XLB
		Hardness range:	60 ShA - 75 ShD

Summary

Covestro offers several approved solutions for offshore wind energy applications. Considering the applications environment, among the various properties required, hydrolysis resistance is a must. However, all these solutions exhibit other mechanical properties and distinguish also themselves upon their processing.

Prepolymer	Desmodur® B9M10			Desmodur® MTX6076		Desmodur® LU-T	Desmodur® LU-D
	Baytec® CG9	Baytec® BR-P100	Baytec® LDF440	Baytec® T4X	Baytec® D24	Baytec® XL1705	Baytec® XL1705
Tensile Yield strength	★ ★	★ ★ ★	●	●	●	●	●
10% Elongation	●	●	★	★ ★	★ ★ ★	★ ★	★ ★
Impact	★	★ ★	●	●	●	●	●
Abrasion	★	★	★	★ ★	★ ★ ★	★ ★	★ ★ ☆
Tear Resistance	●	●	★	★ ★	★ ★ ★	★ ★	★ ★ ☆
Resilience	●	●	★	★ ★	★	★ ★ ★	★ ★ ☆
Hydrolysis	★ ★	★ ★ ★	★	★ ★ ★	★ ★	★ ★	★ ★ ☆
Dynamic properties	●	●	●	★ ★	★	★ ★	★ ★
Compression set	●	●	★	★ ★	★ ★	★	★
Behavior at high temperature	★	★ ★ ★	★	★ ★	★ ☆	★ ☆	★ ☆
Applications	Bend restrictor Cable protection system	Bend restrictor	Static and progressive bend stiffener Tensioner pad Dunnage Cable protection system	Dynamic Bend stiffener Boat fender J-tube seal	Boat fender	Dynamic bend stiffener Dampening pad Tensioner pad	Tensioner pad

● Not applicable



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