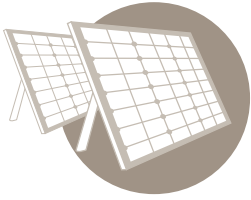


The bundle of energy

High performance solutions
for the energy market

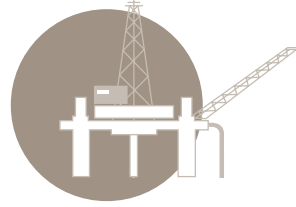




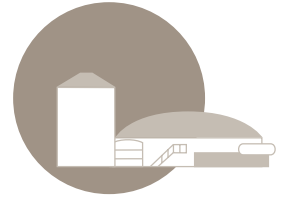
Solar



Wind power



Oil & gas
industry



Energy-efficient
separation

Bundling energy efficiently

System solutions by Evonik Industries

Evonik provides commercially viable solutions for using resources more efficiently – ranging from products for generating and storing solar power, to concepts for mobility-enhancing electric vehicles, through to plastics that deliver high performance.

Technology leader

As a technology leader with decades of experience in high-performance polymers, we provide solutions specially geared to the energy market. Our high performance polymers are used in a wide range of applications, including pipes for oil exploration and gas distribution, wind turbine blades, flexible photovoltaics, and energy-efficient separation systems such as hot-gas filtration.

Growing demands

Whether it's renewable or fossil energy sources, the demands placed on energy yields and energy transportation keep growing. With the aim of maximizing the former and optimizing the latter, we work closely with our customers on developing new solutions that are based on our high-performance plastics.

Enabling technologies

When improving efficiency is no longer enough, it's time to take new paths and open up new fields of application. With our expertise, you can make your applications a reality – our portfolio of barriers for flexible photovoltaic modules is a perfect example. We assist our customers down this path, including advice on choosing materials, support and guidance in permit procedures, and engineering services for optimizing the components.

Company information

Evonik, the creative industrial group from Germany, is one of the world's specialty chemical leaders. Its activities focus on the key megatrends of resource efficiency, globalization, and health and nutrition.

Our high performance solutions

At a glance

Solar



Flexible front barrier sheet

Flexible modules have a key advantage: low weight. Less than one-third the weight of glass modules, they open up new fields of application for solar modules. Flat roofs which cannot support the heavy, rigid solar modules can now be used for energy generation.

FLEXOSKIN replaces the heavy front glass and enables flexible module construction.

Wind power



Light weight design: wind turbine blades

The structural foam ROHACELL® WIND combines the economic processing properties, outstanding weight specific mechanical properties and durability to decrease process cycle time and cost as well as to increase the life cycle of wind turbine blades significantly.

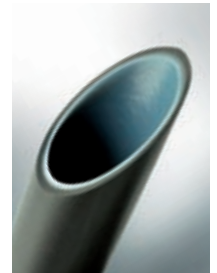
Corrosion protection for offshore construction applications

A vast number of wind turbines are scheduled for construction offshore in the next few years. In many cases, the current corrosion protection technologies have revealed their vulnerability to operational failures.

And repairing offshore structures is extremely expensive and time-consuming.

In cooperation with consortium partners from the entire supply chain, Evonik is working on a project (and has applied for public funding) to develop an innovative technology based on thermoplasts.

Oil & gas industry



Flexible pipes

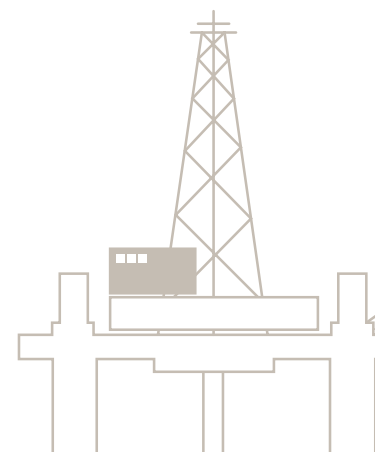
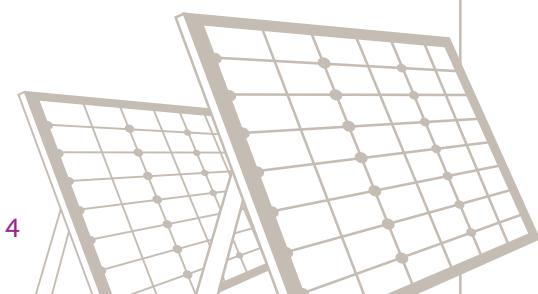
Flexible pipes are a key element for exploiting and opening up subsea oil fields. Because of their flexibility, they can be used in floating platforms and, thus, in opening up oil fields at great depths. Polyamide 12 is a basic element for designing flexible pipes.

Applied in layers, its sealing and corrosion-protecting properties help improve the safety of offshore oil production.

Umbilicals

Umbilicals are an integral part of controlling, regulating, and operating offshore oil and gas fields and connect the subsea units with the platform. As a rule, the word refers to a bundle of pipelines and cables that carry signals and also process media.

Evonik offers innovative solutions for multi-layer pipelines that address the high standards placed on the durability, useful life, and reliability of this equipment.





Steel pipe protection

Trenchless pipeline installation methods, such as horizontal directional drilling, have become increasingly important in recent years. Steel pipes benefit from increased corrosion protection by these methods.

Here, Evonik offers a high-strength and long-lasting technology based on PA12, which is able to withstand all mechanical stresses.



Liner

Liners are used for rehabilitation of existing and lining of new pipes for on-shore and for lining of new pipes for offshore pipelines. With Polyamide 12 former limitations of the application can be pushed and e.g. lined subsea production pipelines are becoming a valuable alternative to corrosion resistant alloys (CRA) showing potential cost savings of more than 30 % in an offshore pipeline project.



Gas pipes

VESTAMID® is a high molecular grade PA12 material with increased performance characteristics that translates into safe operations over the life of the installed pipeline. That makes it an ideal choice for expanding the use of thermoplastic piping systems at higher operating pressure and larger diameters to replace metallic piping systems in a safe and cost effective manner.

Energy-efficient separation



Organic solvent nanofiltration

Organic solvent nanofiltration (OSN) is a key tool for energy-efficient processes in chemical production. Using membranes for molecular separation means that the need for high energy-consuming phase-change processes can be reduced substantially.



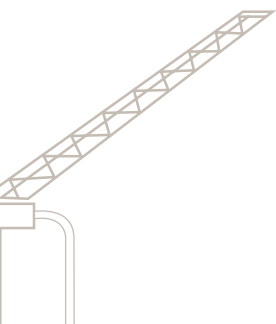
Biogas upgrading/ Gas separation

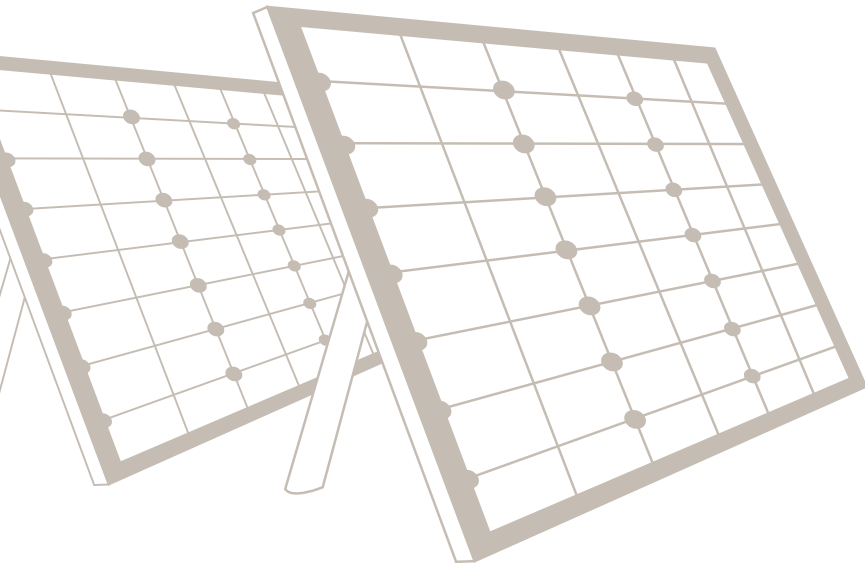
Evonik's gas separation membranes are based on the polyimide polymeric fiber-spinning technology. These membranes lead the market when it comes to selectivity, an advantage that translates into significant energy savings and an improvement in product quality for users. One of the main applications is the separation of CO₂ and CH₄ e.g. upgrading biogas to biomethane.



Hot gas filtration

All around the globe the trade mark of P84® and the yellow fiber colour are the synonym for top quality filter material supplied and used by the leading companies in the industry. Because of its unique multilobal cross section, P84® fibers became a standard for highest filtration efficiency meeting the toughest environmental laws.





Solutions for the photovoltaic industry

The solar radiation on earth is nearly 3.000 times higher than the world energy consumption. Turning a part of it into electricity makes a significant contribution to the CO₂ balance.

A new technology is coming up – thin film photovoltaics

Thin-film solar cells and modules are among the fastest growing segments in photovoltaics. Unlike wafer technology, the photovoltaically active layer is only a few micrometers thick, which enables cost-efficient, resource-saving production.

At a glance

- Light transmission 87 %
- Excellent barrier properties in the high barrier region
- Partial discharge voltage of 1280 V
- Excellent adhesion to conventional encapsulating materials
- Width: 1200 mm, thickness: 350 µm

Tests are being conducted in accordance with IEC 61646 and IEC 61730.





FLEXOSKIN – Enabling new flexible solar module technology

Flexible modules have a key advantage: low weight. Less than one-third the weight of glass modules, they open up new fields of application for solar modules. Flat roofs, which were once ruled out because they cannot support the heavy, rigid solar modules, are now a proposition – and an especially attractive one for commercial and municipal properties, which often have flat roofs.

Another completely different market is also opening up for thin-film solar cells: vehicles. By virtue of their low weight and thin profile, flexible modules can be integrated into the roofs or other areas of cars, trucks, and buses. Flexible solar cells are also an attractive option for the consumer electronics industry, for making the growing number of mobile devices – cell phones, smartphones, laptops – less dependent on electricity.

Handbags or backpacks with integrated flexible thin-film solar cells on their exterior are already entering the market.

The technology behind FLEXOSKIN

FLEXOSKIN multi-layer film is used as the front barrier sheet in flexible photovoltaics. It consists of several active and compound layers that ensure the barrier, as well as an outward-facing, fluorine-free overlay.

The overlay protects the lower layers of film with exceptional efficiency against the elements, thereby ensuring the essential longevity.



Solutions for wind power

In the future, wind power will represent a major pillar in the generation of environmental friendly and resource-efficient power



Light weight design for wind turbine blades

ROHACELL® WIND, a polymethacrylimide foam (PMI), can be used as core material for the spars and shells of wind tower rotor blades.

Reduced cycle times due to increased process temperatures

Since ROHACELL® is extremely temperature-resistant, increased process temperatures are not a problem. These leads to higher quality sandwich structures and shorter production cycles. Manufacturers prefer short cycle times because they allow for optimal capacity use of expensive tools.

Other structural foams quickly meet their limitations in these temperature ranges, especially when exothermal reactions create even greater heat locally.

No follow-up work

However, such stable curing processes not only improve the quality of the components, but also eliminate expensive follow-up work. As a consequence, the use of high-quality PMI foam pays off in every regard.

Cost and weight savings

Especially the ROHACELL® WIND-F with smaller cell size designed for liquid-resin-infusion and consequently lower resin up-take is able to reduce the weight of the blades. Optimized resin up-take and high specific mechanical core values lead to a lower rotor weight. Cost savings in the turbine assembly, lower breakaway torque and weight saving in the mast design are additional effects.

Corrosion protection for offshore construction applications

Thermoplastic high-density coating

The useful life of a corrosion protection method is highly important. A thermoplastic material applied at high density provides optimal corrosion protection for steel structures in the maritime sector.

Pre-coated steel construction pipes

Pre-coated steel construction pipes reduce lead times, thereby significantly lowering the costs of producing foundation structures for the offshore segment.

Highly resistant corrosion protection

The maritime sector is subject to a variety of stresses. Corrosion protection must withstand a combination of UV radiation, maritime flora, seawater, and mechanical and thermal stresses over its entire useful life.



At a glance

- light-weight
- corrosion-protective
- cost-efficient

Corrosion protection for offshore construction applications – the task of the future

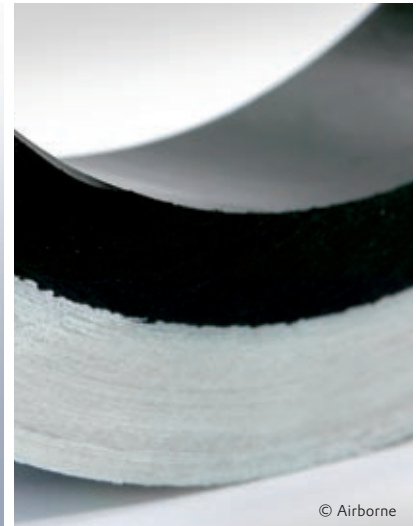
Solutions for oil & gas industry



© Wellstream



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VESTAMID® improves the performance of unbonded flexible and composite pipes

Flexible pipes

VESTAMID® is the only polyamide 12 approved for use in the manufacture of unbonded flexible pipes

With its experience in materials and composites, Evonik today supports the development of improved flexible pipe solutions and has a solid track record.

VESTAMID® PA 12 for pressure and outer sheath distinguishes itself from other polyamides:

- doubles the lifetime or increased MOT*
- excellent methanol compatibility
- superior fracture mechanical performance
- extended safety in operations
- withstands arctic conditions
- ease of processability resulting in an improved product quality

* Maximum operation temperature

Anti Wear Tape avoids failure of armor layers

Anti Wear Tape (AWT) is placed between the metallic reinforcement layers of a flexible pipe to avoid failures caused by wear. Higher temperatures and pressure are placing higher demands on the thermoplastic materials used in AWT.

With specially designed VESTAMID® and VESTAKEEP® PEEK Polymer materials, Evonik offers valuable solutions that stand out for their

- improved abrasion and friction performance
- increased resistance to creep

Umbilicals

30 years of experience

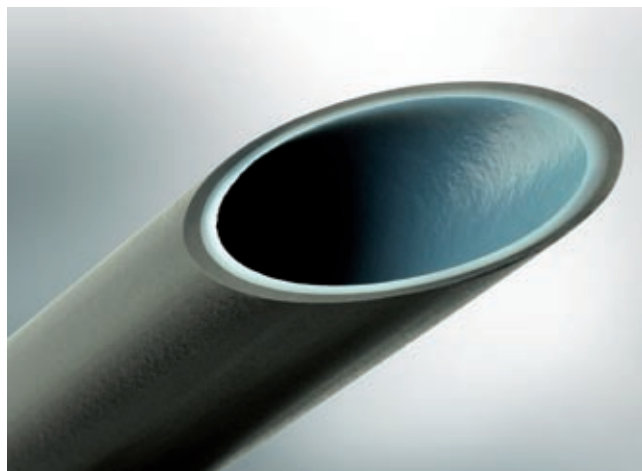
Evonik is a pioneer in multi-layer plastic pipe systems and can look back on more than 30 years of experience. One of our core competencies is making the bonding between different polymer layers inseparable.

Multi-layer tubing is the future in thermoplastic umbilicals

VESTAMID® multi-layer tubing (MLT) offers the following advantages:

- close to zero permeation for a broad spectrum of media
- optimized chemical resistance because of internal fluoropolymer layer
- inseparable layer bonding
- no oligomer elution
- broad application window in umbilicals as a chemical injection and hydraulic line

With these advantages over conventional thermoplastic hose solutions, Evonik contributes to the increased requirements on umbilicals.



Evonik's multilayer solution allows for multi-purpose applications

At a glance

- increased safety
- longer lifetime
- improved chemical compatibility

References

- Petrobras, Project Marlim Sul
- Maersk, Gryphon Field

Solutions for oil & gas industry

At a glance

- High pressure rating
- Superb stress crack resistance
- Pushes limits of liner technology

References gas pipes

- Energy West Montana (USA)
- Atmos Mississippi (USA)

References steel pipe protection

- E.On Avacon in Algermissen (DE); HDD
- Wasserversorgung Bayrischer Wald (WBW) in Wallersdorf (DE); plough technology

Steel pipe protection

Sophisticated applications

The versatile, mechanically durable VESTAMID® coating system combines the advantages of a polyethylene coating and a fiber cement mortar casing. The new pipe coating can be used in non-conventional methods of pipe laying such as

- Horizontal Directional Drilling (HDD) method with percussive impact
- Soil displacement technique with non-streerable hammers
- Dynamic ramming technique with non-steered ramming machines
- Ploughing/Plowing method

Product benefits and characteristics

The principal benefits of VESTAMID® (PA12) as a coating material are its

- exceptional impact resistance and viscosity, temperatures
- superb stress crack resistance
- excellent abrasion resistance
- low sliding friction coefficient

Product properties in comparison to other coating materials

VESTAMID®, a polyamide 12, offers a greater degree of shore hardness than polyethylene or polypropylene.

Unlike a polyethylene or polypropylene coating, the anticorrosion barrier created by the VESTAMID® coating additionally offers highest mechanical protection for the coated steel pipe. For years now, VESTAMID® has been used in the cable industry, in medical applications and in the making of machines and instruments.



© Swagelining



© Pipelife



VESTAMID® – the material of choice for multiple pipe applications



Liner

VESTAMID® PA12 is the first and only Polyamide material applicable for compression fit design

PA 12 liner opens the door for liner in subsea production lines and extends the benefits of PE liner in onshore production fields:

- maximum stability of liner by compression fit
- highest reliability
- excellent compatibility to H₂S, methanol and crude oil
- pushes the temperature limits above 60 °C
- significant capex savings over corrosion resistant alloy designs
- clear opex savings over corrosion allowance design

VESTAKEEP® PEEK Polymer a unique material for liner in downhole applications

Especially in downhole casings thermoplastic liner are getting more and more in focus. With increasing requirements driven by an increase of operation temperatures and pressures VESTAKEEP® PEEK Polymer with its high temperature capabilities combined with its excellent impact resistance offers a valuable solution. VESTAKEEP® PEEK Polymer differentiates from other PEEK materials by:

- 15 % higher impact resistance
- 50 % higher tensile modulus at 150 °C

Gas pipes

VESTAMID® piping systems offer a 25 % increase in the overall operating pressures as compared to the closest other high pressure plastic material

VESTAMID® offers many of the same benefits as conventional PE piping systems

- Tough and durable
- Corrosion resistant
- Resistant to heavy hydrocarbons
- High resistance to Slow Crack Growth and Rapid Crack Propagation
- Increased installation efficiencies
- Worry free performance

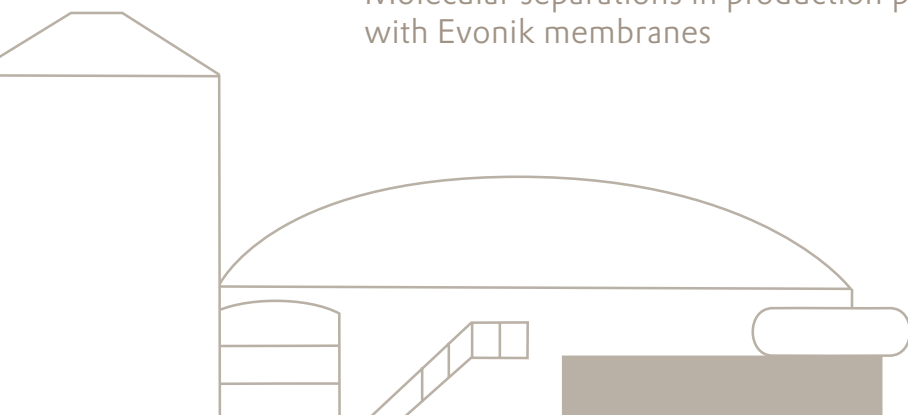
These characteristics make the VESTAMID® PA12 material an ideal choice when selecting appropriate thermoplastic piping materials in extending your gas distribution infra-structure.

Following years of extensive research, the VESTAMID® material complies with ASTM F2785, ISO 22621 and ISO 16486 specifications. A complete system exists to allow gas utility companies to take advantage of the numerous benefits of VESTAMID® piping systems at higher operating pressures.

Read further to discover the benefits of VESTAMID® and how it can help your company maximize its capital budgets and extend the benefits of plastic piping materials within your natural gas distribution infra-structure in a safe and reliable manner.

Solutions for energy-efficient separation

Molecular separations in production processes with Evonik membranes



Biogas upgrading with Evonik membranes

One of the main applications for these innovative membranes is the upgrading of biogas. The high selectivity of the membranes enabled Evonik to develop a multi-staged membrane process, dedicated to the needs of biogas upgrading.

For the first time it is now possible to enrich methane to concentrates higher than 97 % using only one compression step, while the waste gas contains more than 99 % CO₂ and less than 0.5 % CH₄.

This multi-staged membrane process is an inexpensive and efficient way to produce biomethane. The key advantages compared to alternative technologies are: reduced operational and energy costs, low investment and easy to operate.

Biogas upgrading / gas separation

More efficiency, less energy demand

Polyimides are high-performance polymers that are extremely pressure and temperature resistant. In recent years Evonik has developed membranes based on these polyimides.

Gas separation with polymer membranes exploits the fact that gas molecules vary in size and solubility in the polymer. Evonik's membranes feature a market leading high selectivity, an advantage that translates into significant energy savings and an improvement in product quality for users. Evonik gas separation membranes are particularly suited to separating CO₂ and CH₄.

Products and services

We offer superior hollow-fiber gas separation modules combined with comprehensive process and engineering solutions for your separation operation.

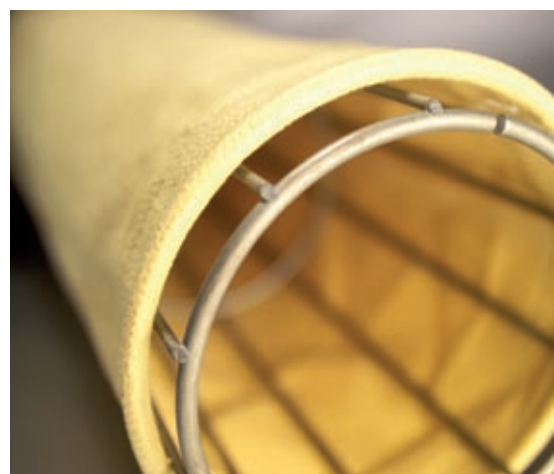
- Hollow-fiber gas separation modules
- Consultation in design/implement scale-up
- We work with OEM partners who specialize in state-of-the art industrial installations

At a glance

- Energy-efficient
- Cost efficient
- Easy to operate

Reference

- Biogas upgrading pilot plant in Neukirchen (Austria)



Multi-staged membrane modules, dedicated to the needs of biogas upgrading



The Evonik technology improves biogas upgrading significantly

Organic solvent nanofiltration

A key tool for energy-efficient processes in chemical production

Molecular separations in production processes

Energy-efficiency can be achieved through applying green chemistry techniques and/or through reducing energy use in separations. Membranes will replace or complement thermal separations doing the separations more energy and material efficient. Separation performance is driven by molecular size difference.

Organic solvent nanofiltration (OSN): energy saving in production processes

One of the key advantages of utilizing membranes for molecular separations is that there is no phase change during the filtration. Hence, the energy requirement for a given separation is much less than the conventional process. Calculations comparing the cost of running an evaporation process versus the cost of running an OSN process revealed that concentrating a molecule in a dilute methanol solution by a factor of ten requires < 10 % of the energy using membranes than the equivalent evaporation process.

Key features

The DuraMem® and PuraMem® membranes are among the market leaders in this field. With their excellent stability in process solvents such as acetone, methanol, toluene, or hexane, they can readily integrate and leverage existing production set-ups.

Hot gas filtration

P84® fiber characteristics

The P84® fiber is a polyimide based fiber with a typical textile character. Polyimides are known to be used in a wide range of operating temperatures starting from cryogenic applications and ending at high temperature applications at the limits of polymer based materials. P84® fibers have a rather unique cross section offering the highest specific surface of all available standard textile fibers.

P84® for dry filtration

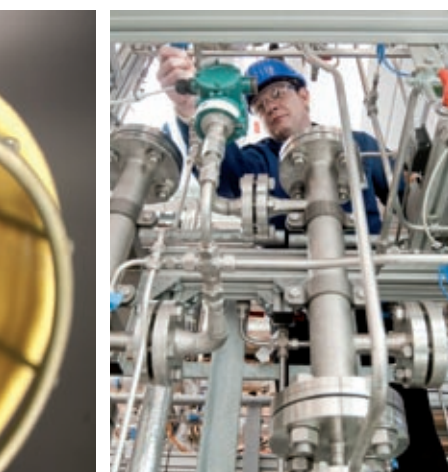
P84® fibers with its unique multilobal cross section became a standard for highest filtration efficiency meeting the toughest environmental laws. Furthermore P84® polyimide fibers can be used in a wide range of chemical environments. Due to its chemical composition P84® polyimide fibers are a preferred material in dry filtration processes.

The advantages of P84® fiber based needle felts

- Low maintenance costs
- Low operating costs
- High availability of the plant
- High flexibility in use
- Robust solution
- Easy disposal of the bags



The membrane module for biogas upgrading is available in different sizes



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EVONIK
INDUSTRIES

Evonik Industries AG

High Performance Polymers
45764 Marl
Germany

PHONE +49 2365 49-9227

FAX +49 2365 49-809227

www.evonik.com

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