

High-tech rubber in the service of the energy transition

K in Düsseldorf is the world's most relevant trade fair for not only the plastics but also the rubber industry. Sustainability and saving resources, however, are also burning issues here that nobody can ignore. One more reason to shed some light on just how important rubber is in "green" applications in the run-up to K 2025.

by Dr. Stefan Albus

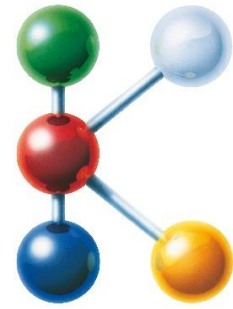
Our society is faced with completely new challenges due to climate change. Does the material that is rubber, invented over 180 years ago after all, still play a role here?

Geothermal

Of course! Often it is precisely those materials made of particularly advanced synthetic rubbers that come to the fore here. One such application for rubber of this kind is heat recovery from deeper layers of the earth. After all, geothermal drilling can reach depths of 1,000 to even 3,000 metres. In the process so-called packers are deployed – roughly 1-metre-long downhole devices used to seal the space between the wellbore casing and the drilling tubing; these consist, amongst others, of heat-resistant rubber. In the spaces isolated by these packers temperature or pressure measurements can be taken for example.

Incidentally, in such deep drilling – in geothermal projects but also in the crude oil sector – engines with a spiral rotor in a stator housing are used that are clad with rubber inside. The rubber components used here are virtually a Who's Who of advanced rubber applications technology: Nitrile Butadiene Rubber (NBR), NBR-HR (High-Resistance NBR), Hydrogenated Nitrile Butadiene Rubber (HNBR) and even extremely chemical-resistant fluorelastomers – depending on the temperature profile and aggressiveness of the flushing liquids.

Speaking of deep drilling: natural gas is also still considered an interim fuel for comparatively CO₂-low energy production. At present, Germany



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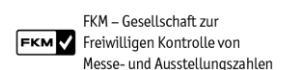
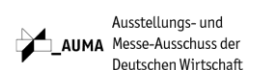
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sources plenty of natural gas from the USA where around 88% of this energy carrier are obtained through fracking.

The components needed for this application also include extremely high-performance hoses that can also withstand contact with aggressive liquids, which are injected into the rock to release the gas trapped there. For these, multi-layered products are preferred because their inner layers consist of an acid-resistant synthetic rubber; for the outer layer rubber grades with excellent wear and ageing resistance are used.

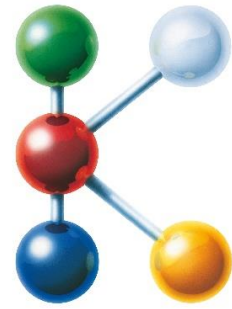
One feared hazard in natural gas extraction are uncontrolled, violent releases of gas from deposits, known as “blowouts”. These are prevented with the help of so-called blowout preventers (BOPs), i.e. extremely hard-wearing rubber seals – which also survive contact with hydrogen sulphide and both corrosive and abrasive media. These seals are very expensive and therefore expected to last accordingly. This is why HNBR is a preferred solution.

Biogas and hydrogen

In 2021 about 9% of Germany’s total agricultural land was used for producing renewable raw materials for biogas production.

Biogas, however, contains not only the fuel that is methane but also corrosive ingredients such as hydrogen sulphide and ammonia. This is why such materials as EPDM membranes (Ethylene-Propylene-Dien-Rubber) are used in biogas production plants, alongside their rivals like double membranes from OVC-coated polyester wovens. Both materials have their pros and cons in this application; but EPDM rubber is a little more flexible, and easy to recycle.

While the tasks described for highly advanced rubber materials so far might be addressed with half-way “traditional” approaches, things get really tricky with hydrogen. Hydrogen only liquifies under normal pressure at extremely low temperatures. Which is why the sealing materials for a future hydrogen economy should be designed to cover a wide temperature range (-40 to over +80°C). In addition, high pressures are to be withstood.



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The problem here is that non-polar H₂ molecules can permeate and thereby impair conventional sealing materials. If hydrogen gradually deposits in the sealing material explosive decompressions can occur that destroy the sealing gasket. And these sealing gaskets are urgently needed in the hydrogen economy: for electrolysis, in valves or membranes, for transport in tanks and pipelines and, of course, in fuel cells.

In actual fact, truly effective H₂-tight rubber sealings are still the subject of current research; probably some progress can be made by a smart combination of gas-tight rubber grades and fillers that obstruct hydrogen swelling and permeation. Qualifying here as basic elastomers are butyl rubber – already relatively gas-tight by definition – or also fluor rubber; additives with a plate-type shape such as layered silicates or graphites can help to additionally reduce gas permeation.

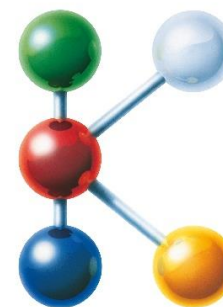
To ease hydrogen transport alternative carrier media have also been under discussion as of late, such as NH₃, (gaseous ammonia at room temperature) which is easier to liquify and store. This application also requires low-temperature and especially alkaline-resistant high-performance rubbers.

Needless to say, hydrogen already serves its purpose in fuel cells very reliably. But there is no such thing as a “one-fits-all” sealing material for fuel cells. Because there is no such thing as a “one-fits-all” fuel cell: for instance, there are alkaline and phosphoric acid, polymer electrolyte and high-temperature fuel cells. Here, too, elastomer-bonded sealing materials with a high content of special fillers are already used for sealing tasks.

Wind power

Wind turbines are growing to ever greater heights. Today, they can achieve nominal outputs of over 10 MW with rotor diameters of 150 to 220 m.

In this application offshore locations, UV radiation, ozone (not rarely present in the surroundings of electrical equipment), salt water and strongly fluctuating temperatures all make high demands on the elastic



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materials deployed here. On top of this, ultimate flame-proofness is required because nacelles that have caught fire can practically not be extinguished.

These nacelles include components for the vibration isolation and elastic bearing of the generator: rubber buffers can be found at the connections between the rotor blades and the hub where they absorb forces, help minimize vibrations and also dampen noise.

Among the several hundreds of kilos of elastomer materials built into wind turbines, you will hardly find any natural rubber not least because of its problematic resistance to weathering and ozone. Instead, NBR is the preferred option for full-rubber rotary shafts. In radial shaft gaskets you will also often find ozone-resistant HNBR, which, in addition, also withstands temperatures as high as 170°C for short periods. With the corresponding reinforcement HNBR can also be used for large-diameter bearings, and thanks to its oil-resistance even in grease-lubricated main bearings.

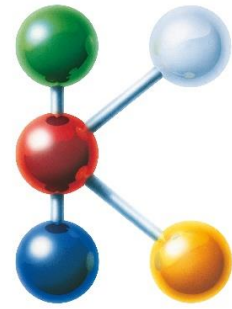
The cables transmitting power from offshore wind parks can become very hot. This is why rubber materials with a higher temperature resistance are required, like EPDM in addition to HNBR.

And let's not forget: rubber is not only in demand for operating these systems – it is also already required for the manufacturing of the rotors from glass-fibre reinforced elements with sections of silicon, butyl or EPDM rubber.

Solar systems

PV systems, of course, also need sealing gaskets, that keep the modules aligned and prevent water ingress. Vertical sealing gaskets, for example, that keep the offset between several PV modules, are made of silicon rubber or weather-resistant EPDM.

However, the pivotal sealing tasks are mostly performed by another material. Solar modules are often encapsulated in ethylene-vinyl-acetate films (EVA). In the process the solar modules are encapsulated in two layers of this material; when the film melts it perfectly envelops the cells. EVA is extremely translucent and weatherproof and boasts a



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wide processing window; it is not a classical elastomer but can – depending on its EVA content – be considered an “elastomer-similar” material by all means. There are also approaches to replace EVA films from fossil sources with alternatives that contain a percentage of bio-based “sugarcane ethylene”.

To make sure the solar panels stay in place on today’s stylish flat roofs, installers like to use EPDM mats. These provide additional support on slippery ground and prevent the modules from shifting over time.

Speaking of buildings: needless to say, heat pumps can hardly do without rubber either. However, this application calls for (weather-resistant) sealing gaskets and hoses which are also sufficiently flexible at lower temperatures; but also for vibration-dampening rubber mats that reduce undesired pump vibration.

So rubber is anything but an “obsolete” material. Without extremely performant rubber grades the energy transition and fight against climate change would not work.

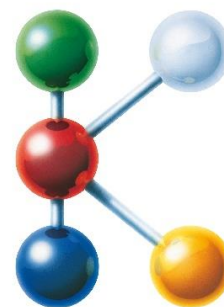
At K 2025 Rubberstreet will again serve as the showcase for the innovative power and operational excellence of the elastomer industry. It has already been the first point of contact and orientation for all those seeking information about elastomers (rubber and TPE) at K since 1983. The patronage of Rubber Street comes care of the Trade Association of the German Rubber Industry wdk (Wirtschaftsverband der deutschen Kautschukindustrie).

About the author:

Dr. Stefan Albus is a Doctor of Chemistry and freelance trade journalist. His focal themes include polymer chemistry as well as plastic and rubber applications technology

About K in Düsseldorf:

In 1952 K was held by Messe Düsseldorf for the first time and runs in a 3-yearly cycle. The latest K in 2022 registered 3,020 exhibitors from 59 countries on over 177,000 m² net exhibition space and 177,486 trade visitors, 71% of whom came from abroad. For more information go to www.k-online.com.



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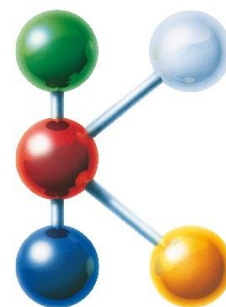
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