The colours of hydrogen and sealing technology

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Does hydrogen have a colour and what does that have to do with sealing technology? – is what one might ask that about this title. Of course, the physical property of hydrogen in terms of colour does not play a role here. No, hydrogen is assigned colours by us.

But let's start at another point: climate protection

Climate protection affects us all – climate goals are defined and their achievement is immensely important for our global society. These goals can mainly be achieved by reducing greenhouse gases. And the most important greenhouse gas to be reduced is CO_2. We generate it in many technical processes – almost everywhere where energy is converted. When we drive cars and use fossil fuels such as gasoline and diesel, burn kerosene when flying, heat with gas, coal, petroleum or wood, draw electricity from the power grid or even produce steel – there is always a little chemical formula that throws a wrench into our good intentions: $C + O_2 = CO_2$.

In order to get away from this equation, this chemical conversion, i. e. to decarbonise it, there are only a few options:

- no longer drive a car, no longer heat, no longer produce steel, etc.

or

- instead of carbon (C) we burn hydrogen (H_2)

Then it looks like this: $2\ H_2 + O_2 = 2\ H_2O$ and so we have water as "exhaust gas".

The exciting thing about hydrogen is something else too: H_2 can be used in extremely diverse technological areas and can be the key to global decarbonisation – many speak of it being the "oil of tomorrow".

But where do we get the hydrogen and what is its background with regard to its production?

And now colour comes into play and then sealing technology too:

Grey hydrogen is obtained from fossil fuels. As a rule, natural gas is converted under heat into hydrogen and CO_2 during production (steam reforming). The CO_2 is then released unused into the atmosphere and thus intensifies the global greenhouse effect: the production of one ton of hydrogen produces around 10 tons of CO_2.

Blue hydrogen is grey hydrogen, but its CO_2 is separated and stored when it is generated. This is called Carbon Capture and Storage (CCS). The CO_2 generated during hydrogen production does not get into the atmosphere and hydrogen production can be considered CO_2-neutral in the balance sheet.

Turquoise hydrogen is produced through thermal splitting of methane, i. e. CH_4 (methane pyrolysis). Instead of CO_2, solid carbon is produced. The prerequisites for the CO_2-neutrality of the process are that the high-temperature reactor is supplied with heat from renewable energy sources and that the carbon is permanently bound. (Source: BMBF)

Green hydrogen is produced by electrolysis of water, with electricity from renewable energies being used exclusively for the electrolysis. Regardless of the electrolysis technology chosen, the production of hydrogen is CO_2-free, as the electricity used comes 100 percent from renewable sources and is therefore CO_2-free.

So, if we want to meet our future hydrogen needs with green hydrogen, then this means huge investments. From the generation of electricity to electrolysis systems in pipe networks, but also in system technology to generate other products from hydrogen. And these are all process engineering systems in which fluids are treated, transported and converted. It doesn't work without sealing technology.

As a high-performance industrial nation, these investments are largely made by us. Germany plays a leading role in technology and can use its export strength here. The German federal government has recognised the complexity of the economic and technological interrelationships and is trying to intervene in a guiding and supportive manner via a "National Hydrogen Strategy" (NWS) and to prepare the basis for a comprehensive hydrogen economy.

What are the implementation strategies and what does this mean for us as a seal manufacturer?

There are a total of 38 measures planned here, some of which involve substantial subsidies. Example measure 3: Electrolysis systems. The plan is to build up production capacities of 5 GW of electrolysis capacity by 2030 – incidentally, at EU level, 6 GW should be achieved by 2024.

For us, this broad approach to activities is interesting in that it creates demand in plant construction. Star-

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ting with the plants that generate green electricity from renewable energies to the delivery points of the gaseous or liquid end products.

The generation of green electricity can be generated not only through photovoltaics, but also through steam generation and subsequent turbines in solar power plants. Elements that prevent corrosion are helpful between the tower segments of wind turbines. Hydropower plants have pressure lines. All fields of application in which sealing materials play an important role.

Green electricity is here – now comes the hydrogen electrolysis: Typical conditions are, for example, potassium hydroxide with concentrations between 20 % and 40 %, temperatures up to 80 °C and pressures up to 20 bar. We are able to provide the right sealing materials. The following sealing materials are important for planners, designers and the implementing companies: KLINGERSIL C-4500, C-8200 as well as KLINGERtop-chem 2000 and KLINGERtop-chem 2003. These are the appropriate materials to use as flange and housing seals to meet the requirements for the various electrolysis processes.

As a further measure of the National Hydrogen Strategy, point 8 includes the establishment of a needs-based tank infrastructure. The topic of infrastructure and supply has its own chapter with measures 20, 21 and 22. Among other things, this refers to the gas infrastructure with the entire line construction. The companies that operate in this environment are well prepared with our products for the change in this area: Together with us, the DBI GUT Institute (Gas and Environmental Technology) has the areas of application of standard products under the aspects of material, function and technical documentation evaluated for a hydrogen content of up to 100 % and created corresponding product profiles for the products KLINGERSIL C-4400, KLINGERSIL C-4430, KLINGER CompenSil and KLINGER KGS G II. TÜV Süd has also tested the above-mentioned products as well as the PTFE-based sealing materials KLINGERtop-chem 2000, -2003 and -2000 soft and rated them as particularly high-quality in terms of their tightness and resistance to hydrogen.

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The measurements were carried out with helium and hydrogen at different pressures in order to compare the two smallest gas molecules with regard to their leakage behaviour and to be able to draw conclusions about higher pressure levels. The measured and calculated values were approx. 2 powers of ten lower than required. In connection with the verification of the intended function under operating conditions and the design of the flange connections based on the characteristic values according to EN 13555, sealing connections using these materials can be labelled as technically tight in the sense of TA-Luft (Section 5.2.6.3). With these products, we offer the security of supplying the executing companies as well as gas suppliers, municipal utilities and network operators with future-proof sealing products.

Now we have looked at the path of "green energy" from generation to consumers.

However, there are other possibilities, even further steps in the processing of hydrogen

The production of methane, methanol and hydrocarbons with longer carbon chains, but also the synthesis of ammonia – all as raw materials for chemistry. Also here, our sealing materials for liquid and gaseous media are in their element. The rubber-

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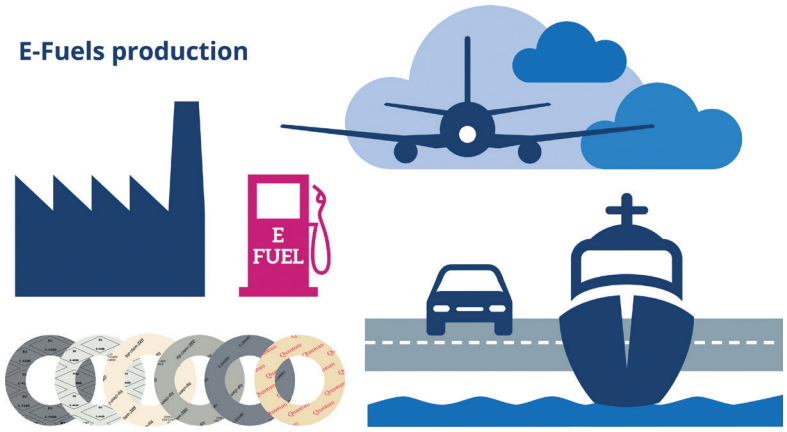
steel seal KLINGER KGS G II and the "standards" KLINGERSIL C-4400 and C-4430 are used in supply and product lines. If aggressive chemicals are involved, the PTFE-based sealing materials score. KLINGERtop-chem 2003 and especially the silicon carbide-PTFE combination KLINGERtop-chem 2000 at temperatures up to 250 °C and extreme mechanical stability are a safe choice for the designer in these processes, which are partly supported by catalysts during the process and thus become technologically interesting. If it gets even hotter, the KLINGERmilam PSS mica sheet metal sealing plate can be used.

The mobility of the future will be diverse. In addition to battery-powered electric drives for short and medium distances and smaller vehicles, alternatives will be necessary for the remaining areas. Hydrogen for fuel cells in trucks, buses and rail vehicles will be an important energy source. It becomes more difficult in the area of aircraft and larger ships. Solutions through the production of e-fuels are conceivable here. These are fuels like gasoline, kerosene and diesel, but made from the originally green hydrogen. Using various production processes (Fischer-Tropsch, Sasol, etc.), these can also be used as "green" energy sources as fuel for the existing drive concepts. Just imagine the positive effects this would have on



CO_2 emissions from the existing old fleet. Depending on the process conditions, the appropriate products for these process plants can also be found in the company's portfolio. Temperatures of 300 °C and pressures of 30 bar are operating parameters that exemplify the working range. The correct selection depends on the process-specific layout of the systems, so that sealing materials based on graphite and mica can also be used.

So we see, even if a seal is only a small part of a system, like all parts it has its relevance and needs attention.

Last but not least, what are the next steps?

Before the seals are used, technical advice is provided to the system manufacturers, executing companies, gas suppliers, municipal utilities and network operators. It certainly means a lot of effort to do justice to this growing market, because there are still uncertainties among users. But here is also the chance to pave the way for the new hydrogen economy with our products and to contribute to the decarbonisation and "defossilisation" of our country. We can use our competence to bring together the detailed knowledge that we as a seal manufacturer have with that of our customers and to enable an application-oriented selection of sealing materials.

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