No barriers to hydrogen.

A hydrogen separator with an extremely thin palladium layer supplied ready for installation has made it possible: Pure hydrogen from natural gas.

In the past there was only one economically viable way to produce hydrogen: Steam reformation. When it comes to producing large volumes of the gas, the use of this process is undisputed. But for users with smaller requirements, steam reformation is not economical. In the past, such users who consume less than 500 cubic meters per hour had to be supplied with hydrogen by truck – a complex and expensive solution.

Thanks to a newly developed system, the company Linde has now managed to close the gap between large-scale hydrogen production and the supply of very small consumers using gas bottles. Using a membrane reformation method, customers can now be reliably supplied with pure hydrogen on-site. The key to the successful industrial implementation of the membrane reformation technique: A hydrogen separator supplied ready for installation. This consists of a number of tubes made of a porously sintered special alloy coated with an exceptionally fine palladium layer. This thin palladium layer possesses one outstanding property: It only permits the passage of hydrogen – all other gases are refused entry.

However, before it was possible to extract the pure hydrogen, the design engineers had to overcome another challenge. This results from the enormous load placed on the
components during operation. The gas mixture that is fed into the tubular reformer has a temperature of around 600 degrees Celsius. The carrier tube, which is manufactured from iron and chromium, must withstand these temperatures undistorted for over 20,000 operating hours. In addition, the carrier material and palladium layer must expand and contract as little as possible when heated and cooled to prevent stresses in the material microstructure. And, finally, it was also necessary to insert a ceramic separator layer between the iron-chromium tube and the palladium layer to prevent any interaction between the properties of the two materials.

So much for the principle. But, as ever, the devil is in the details. The problem lies in designing the manufacturing process in such a way that two key aims are achieved. One challenge consists in ensuring that the palladium layer remains genuinely impermeable to absolutely everything other than hydrogen. The layer must therefore be thick and gastight enough to act as an effective barrier against all other gases. But the aim pursued by the design engineers is practically the opposite: For them, the layer cannot be thin enough. The thinner the layer is, the greater the hydrogen flow through it. And a higher flow means a more efficient system.

For Plansee’s coating experts, the aim was therefore to develop a gastight layer that ensures a maximized hydrogen flow. The result: The eight micrometer thick palladium layer makes it possible to produce hydrogen of a purity of at least 99.95 percent. It is expected that this level will be improved in the future. This will also make the system attractive to customers who have even more exacting requirements regarding hydrogen purity.

The hydrogen separator, which is the fruit of an intensive development partnership between Linde and Plansee, represents another building block for the hydrogen-based economy. Our porous metal substrates have already been used for many years as carrier materials for electricity and gas distribution in high-temperature fuel cells.