
# **HYDROGEN** COMPATIBLE SEALING SOLUTIONS

TEADIT®

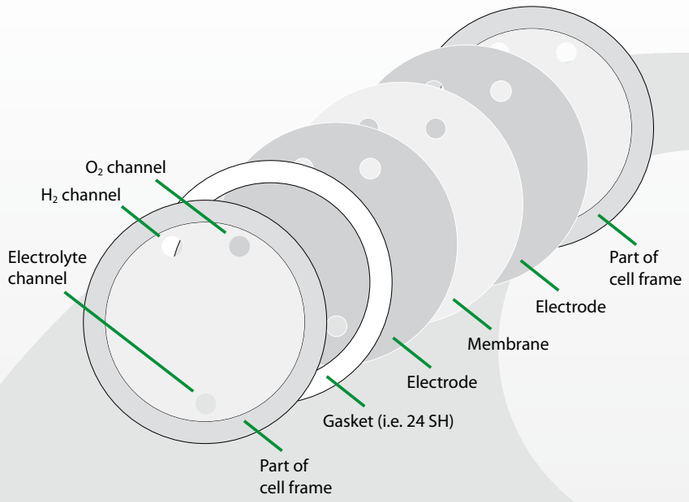
Sealing for a safer and greener tomorrow

# What we should know about the future with hydrogen

## Electrolyzers - the key technology in hydrogen extraction:

The majority (48 %) of hydrogen is produced by reforming of natural gas and refinery gas, as a by-product of chemical production (30 %) and coal gasification (18 %). Only about 4 % of global hydrogen production comes from electrolysis. However, water electrolysis is one of the most proven options for low-carbon hydrogen and plays a key role in mobility, industry or energy storage scenarios today. Electrolysis plays a major role in the global energy transition.

These electrolyzers can be scaled to meet a variety of input and output ranges, ranging in size from small industrial plants installed in shipping containers to large-scale centralized production facilities that can deliver the hydrogen by trucks or be connected to pipelines.
There are three main types of electrolyzers: proton exchange membrane (PEM), alkaline and solid oxide. These different electrolyzers function in slightly different ways depending on the electrolyte material involved. Both alkaline and PEM electrolyzers can deliver on-site and on-demand hydrogen, pressurized hydrogen without a compressor and 99.999% pure, dry and carbon-free hydrogen.



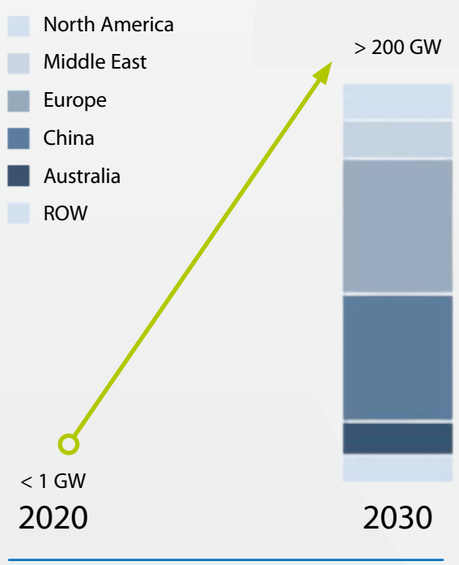


State of the art electrolyser as used in industrial plants for H2 production.

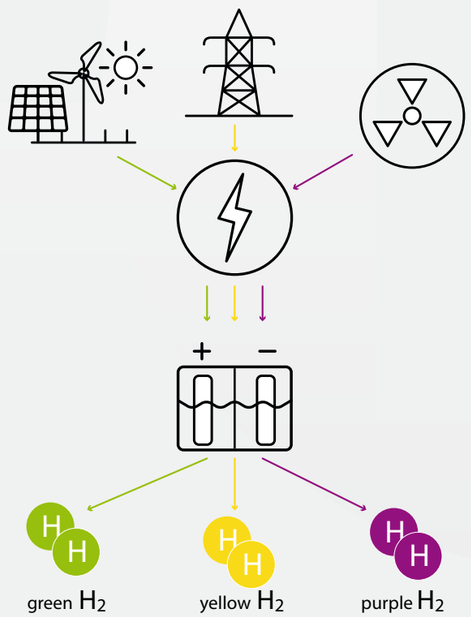


**Example of TEADIT® ePTFE project together with Fronius:** In this case Fronius used our ePTFE gasket material successfully for testing and research. This Electrolyser-Short-Stack creates the base for a large project called **"Hytechbasis4WIVA"** including the local production, usage and storage of Hydrogen (Photo Fronius ►)

### Expected electrolyzer market growth Cumulated Capacity, GW




### What is behind the H2 color palette?




## The difference between the main kinds of electrolyzers where TEADIT® ePTFE products are used:

**Alkaline Electrolyzers**

Uses a liquid electrolyte solution such as potassium hydroxide (KOH) or sodium hydroxide (NAOH), and water. The hydrogen is produced in a "cell" which consists of an anode, cathode and membrane. The cells are typically assembled in series in a "cell stack" that produces more hydrogen and oxygen as the amount of cell increases.
When current is applied on the cell stack, the hydroxide ions (OH-) move through the electrolyte from the cathode to the anode of each cell, with hydrogen gas bubbles generated on the cathode side of the electrolyzer and oxygen gas at the anode, as represented here.

**Proton Exchange Membrane (PEM) Electrolyzers**

PEM electrolyzers use a Proton Exchange Membrane which use a solid polymer electrolyte.
When current is applied on the cell stack, the water splits in hydrogen and oxygen and the hydrogen protons pass through the membrane to form H2 gas on the cathode side.

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# Tested and **approved** to seal the „smallest molecule“

## Sealability testing RESULTS

The aim of the investigation is to determine the following gasket parameters according to the European test standard DIN EN 13555, which are required for the calculation according to DIN EN 1591-1 and to approve TEADIT gasket solutions to seal hydrogen:

- Minimum surface pressure in the assembled state Qmin(L) ( 40 bar) and
- minimum surface pressure in the operating condition Qsmin(L) (40 bar).

**Deviating from the test standard, the leakage tests were carried out with the test medium hydrogen (H2).**
In the leakage test, the gasket is loaded and unloaded in several stages, with the leakage rate being determined for each surface pressure level. The leakage measurement is carried out up to a surface pressure level of 160 MPa. Not only the load curve is recorded, but also several unloading curves based on the surface pressure levels of 20 MPa, 40 MPa, 60 MPa, 80 MPa, 100 MPa, 120 MPa and 160 MPa. The smallest surface pressure level is 10 MPa.

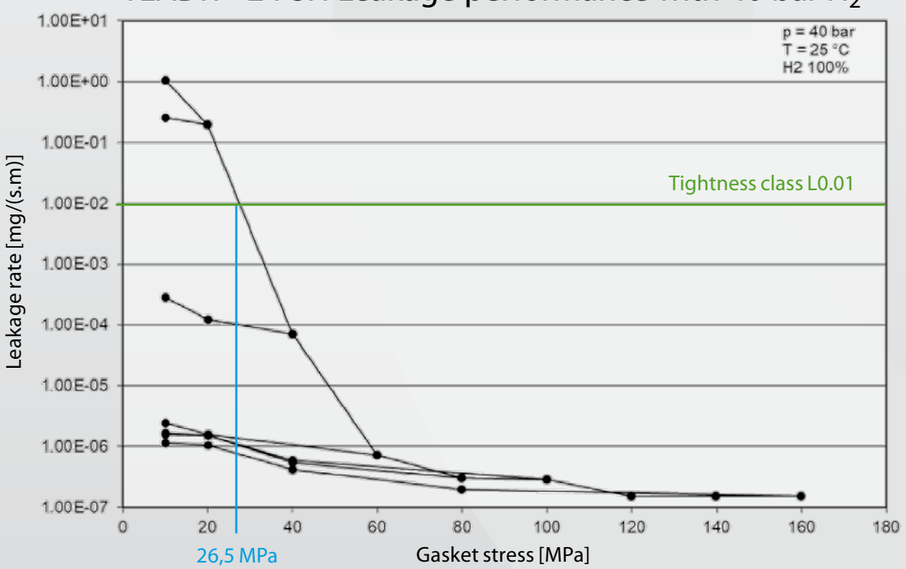
**The test medium for these leakage tests is hydrogen 5.0.**
The leakage curve can be used to calculate the required minimum surface pressure Qmin(L) for the various tightness classes L during assembly and the required minimum surface pressure Qsmin(L) during operation, depending on the previously applied initial surface pressure QA can be determined.

TEADIT engineers are qualified for both, to calculate flanges according EN 1591-1 and to perform multiple different inhouse tests.

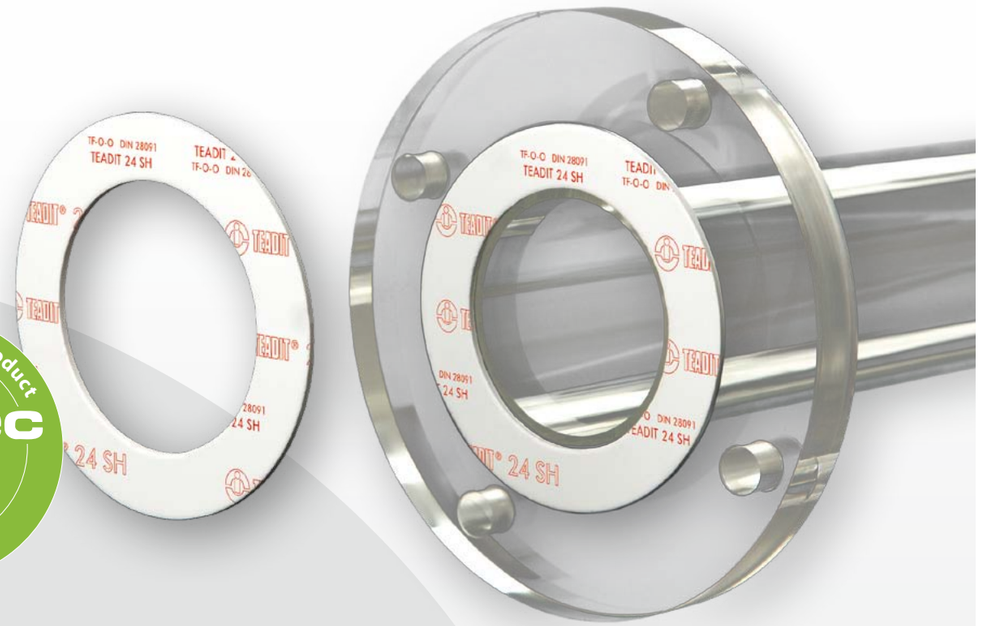
TEADIT® gasket tests were carried out on a TEMESfl.ai1 test equipment driven in amtec's test laboratories.

For several decades, amtec has been testing the properties of gaskets, calculating strength and measuring bolt forces. Over this time, amtec grew to the most important test lab globally. For many years amtec has been an important and reliable partner in keeping the quality of TEADIT® sealing products at the highest possible level.

### TEADIT® 24 SH Leakage performance with 40 bar $H_2$




The tightness class L0.01 was achieved at the test with 40 bar and a surface pressure of 26 - 27 MPa. If the PTFE flat gasket 24 SH is further loaded up to 160 MPa, the leakage rate decreases. The lowest leakage rate was measured at the surface pressure level of 160 MPa with 1.5 · 10-7 mg/s/m. The required minimum surface pressure Qsmin(L) in the operating state for tightness class L0.01 with an initial surface pressure QA = 60 MPa is Qsmin(0.01) = 10 MPa.




## Technical requirements for gaskets in electrolizers

❶ Extraordinary tightness (sealability) because of small H2 molecule size
Our PTFE sheets are universally employable for all applications. It is suitable for all types of flanges, nearly all media, a wide temperature range and for applications with the toughest demands on purity. It is inherently clean and non-toxic.
**Hydrogen is the smallest available chemical element and requires a suitable sealing system. TEADIT® performed already leakage tests at approved test lab with incredibly good results.**

❷ Electrically non-conductive (to isolate anode from cathode)
TEADIT PTFE fluoropolymer offers remarkable electrical stability over a wide range of frequency and environmental conditions. In this respect, they differ markedly from other insulating materials. Pure TEADIT PTFE has superior electrical properties with a high dielectrical strength of around 24kV/mm.

❸ Chemical resistance (i.e. against KOH)
TEADIT PTFE is chemically inert against all substances (pH 0-14), including the most aggressive acids and lyes. The only exceptions are molten alkali metals and elemental fluorine at high temperature and pressure.

❹ Mechanical stability (no relaxation, no creep)
Our ePTFE and TF products belongs to the PTFE types with the highest resistance to creep relaxation. This attitude leads to sealing products with a long lifetime.

❺ Long lifetime, no aging
TEADIT PTFE products are not subject to aging or weathering.
It can be stored indefinitely.

❻ Ease of handling
TEADIT PTFE gaskets are quick and simple to install. The used gasket can be removed easily and without residue.

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# **HYDROGEN** COMPATIBLE SEALING SOLUTIONS


**TEADIT SHEETS**

Structured PTFE products
- TF 1590
- TF 1580
- TF 1570
- TF 1510

Multi-directional ePTFE products
- 24 SH
- 30 SH

**TEADIT TAPES**

Mono-directional ePTFE products
- 24 B
- 24 BB
- 24 HD

Multi-directional ePTFE products
- 25 BI

**HIGH-PURITY ePTFE GASKET WITH DIFFUSION BARRIER**
- 28 LS-LE

Hydrogen has a very high potential in the future as an alternative for existing energy resources. Industry as well as governments worldwide are driving hydrogen production and its commercial use at an ever faster ppace.

This huge initiative requires sealing solutions for hydrogen in production, transport and applications. We see our responsibility in serving approved gaskets for all these areas. TEADIT® as a leading manufacturer in sealing solutions already provides gaskets for hydrogen service.

We are running a well-equipped lab with a highly qualified team to test gaskets at different conditions and with a variety of media, including small molecule gases.

Several ongoing industrial projects already rely on our technology to achieve effective sealing levels for hydrogen applications.

To demonstrate our excellent product quality and share our experiences, we are pleased to invite partners and end-users to discuss technical $H_2$ perspectives.

Please contact us for further details and solutions in your special application areas!

TEADIT Quality Product
$H_2$ suitable
TEADIT Quality Product

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**PTFE gasket material** • structured PTFE sheets • multidirectionally exp. PTFE sheets • multidirectionally exp. PTFE tapes • monodirectionally exp. PTFE tapes • **Braided gland packings** • Carbon / Graphite packings • PTFE packings • PTFE / Aramid packings • Aramid packings • Glass packings • Acrylic packings • Ramie packings • Polyimid packings • Novoloid packings • Nomex packings • Preformed packing rings • **Compressed fibre sheets** • Carbon / Graphite / NBR • Aramid /NBR • Cellulose / NBR • **Graphite sheets** • Graphite sheets with plain metal insert • Graphite sheets with tanged metal insert • Pure graphite sheets • **Gaskets** • PTFE envelope gaskets • Cut gaskets • Gaskets with metal eyelets • Double jacketed gaskets • Spiral-wound gaskets • Kammprofile gaskets • Hand- and manhole gaskets • Tank lid gaskets • Braided gasket tapes • **Jampak** • Injection gun • Jampak injectable compounds • Seal-Cage-System • **Expansion Joints** • Metallic and Non-Metallic Expansion Joints • **Accessories** • Various packing cutters • Packing extractors • Circular gasket cutter • **and many more…**

**www.teadit.eu**

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