Garlock

GYLON®

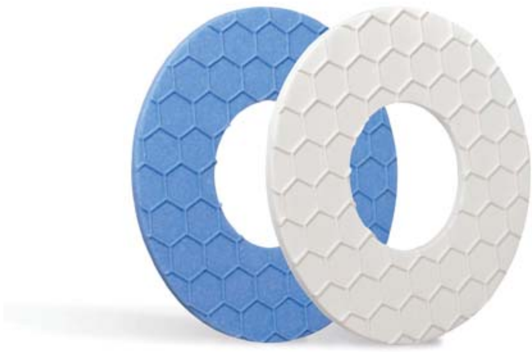
Style 3504 & Style 3510

Tested in Hydrogen according to the new TA-LUFT

GAIST Measurement- and Sealingtechnology

FH MÜNSTER Spin-Off

GYLON EPIX®



Style 3504 & Style 3510

Tested for Hydrogen Applications by

BAM

officially tested for Garlock H_2

Sealing Hydrogen Applications

Contents

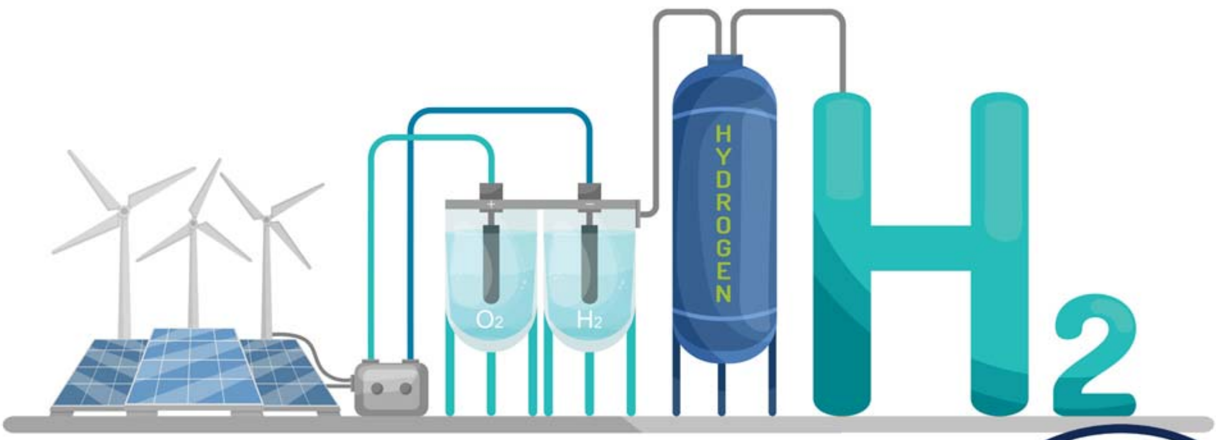
Energy transition with Hydrogen

The German Federal Ministry of Education and Research (BMBF) has officially turned on the turbo for the H_2 economy with the July 2023 update of its hydrogen strategy. The BMBF's stated goal is market leadership in this emerging market. In practice, the task is to seal hydrogen applications in the various industries and economic sectors safely and in accordance with all regulations and guidelines.

In hydrogen applications, a distinction is made between "green hydrogen," which is obtained from renewable energy sources or by electrolysis, and "gray hydrogen," which is obtained by a fossil fuel process. Sealing materials must therefore meet the requirements of gaseous applications as well as those of cryogenic and mixed applications.
As a general rule, third-generation GYLON® PTFE seals have been used in the H_2 (hydrogen) range for decades and their technical tightness is beyond question, since the current testing of the common EN 13555 sealing characteristics was carried out with the much smaller molecule helium.

Since the medium H_2 is always within the scope of TA-Luft, gasket materials must be used that can provide mathematical proof of technical tightness in accordance with VDI2290 by means of calculation in accordance with EN 1591-1 for circular flange connections. This means that it is necessary to determine EN13555 characteristics of the gasket materials with regard to creep at temperature or the maximum tolerable surface pressure.

Since in Germany any material that comes into contact with reactive material that can create an explosive atmosphere must be sampled by the Federal Institute for Materials Research and Testing (BAM) before it is used in practice, GYLON® & GYLON EPIX® Style 3504 and Style 3510 have also been sampled accordingly by BAM in Berlin.



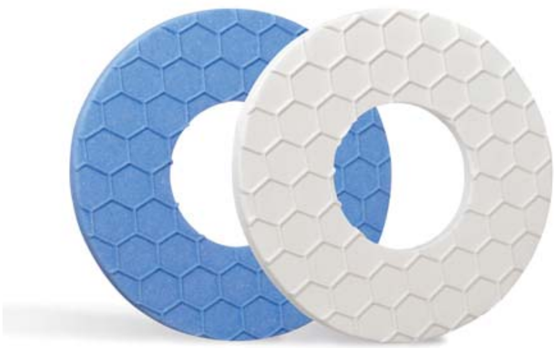
GYLON® & GYLON EPIX®

GYLON® is a calendered high-performance PTFE sealing material available with various modifications. Depending on the modification, different compressibility and recovery properties are given.

GYLON® and GYLON EPIX® Style 3504 & 3510 have been tested by the German technical Federal Institute for Materials Research and Testing (BAM) for hydrogen applications. The test report "Characterization of polymer materials before and after storage in hydrogen" showed very good test results and ideal properties of our GYLON® materials for sealing hydrogen applications.

BAM

GYLON® Style 3504 GYLON® Style 3510



GYLON EPIX® Style 3504 GYLON EPIX® Style 3510

STRESS SAVER® GYLON® 3504

Main Segments
» Chemical & Petrochemical Industry
» Food & Beverage
» Pharmaceutical
» Metal Industry
» Power Generation
» New Energies H_2 / Hydrogen

Key Benefits
» Wide range of application & unloading capabilities (QSmin/L = 3MPa*)
» Wide temperature range (-268°C to +260°C)
» Stopped cold flow
» High tolerated load (QSmax 230 MPa*)
» High pressure & vacuum duties
» Excellent media resistancy **
» Available with inner-/outer eyelet
» Good electrical insulating properties
» Unlimited shelf-life
» Weather and UV resistant

Certificates / Declarations *
» FDA
» KTW
» BAM
» EC1935/2004 incl. EC10/2011
» TA – Luft incl. Blow-out Proof
» DIN EN 13555 characteristics
» Phthalate free
» Silicone free
» ADI free (EMEA 410/01)
» USP Class VI <87> <88>
» USP <281> <661>
» Hydrocheck (Belgaqua)

* Depending on product and application details
** See Garlock resistance table

Testing results

The GYLON® & GYLON EPIX® gasket types were stored as follows:

1. Storage of more than one week under 150°C at 100 bar in hydrogen gas
2. Storage of at least six days in liquid hydrogen at cryogenic conditions
3. Then examination with regard to their hardness, tensile strength, elongation at break as well as density
4. Comparison of the determined values after H_2 storage with the previously determined values

The results of BAM mechanical properties sampling show that our 3rd generation seals are suitable to be used in cryogenic and higher temperature H_2 environments without damage.

BAM
Bundesanstalt für Materialforschung und -prüfung

				change *)
After storage at -253 °C over 2 h	hardness in Shore D	Median value $\tilde{x}$	46	-3 Shore D
		span R_4	<1	
	stress at 0,5 % strain in MPa	Mean value $\bar{x}$	3,7	-3 %
		standard deviation s	0,1	
	stress at yield in MPa	Mean value $\bar{x}$	---	---
		standard deviation s	---	
	strain at yield in %	Mean value $\bar{x}$	---	----
		standard deviation s	---	
	stress at break in MPa	Mean value $\bar{x}$	16,8	+5 %
		standard deviation s	0,9	
	strain at break in %	Mean value $\bar{x}$	281	-2 % rel.
		Standardabweichung s	5	
	density in g/cm³	Mean value $\bar{x}$	1,71	-2 %
		standard deviation s	0,007	

				change *)
After storage 7 days at 100 bar and 150°C	hardness in Shore D	Median value $\tilde{x}$	58	-1 Shore D
		span R_4	2	
	stress at 0,5 % strain in MPa	Mean value $\bar{x}$	6,7	+1 %
		standard deviation s	0,2	
	stress at yield in MPa	Mean value $\bar{x}$	7,7	-14 %
		standard deviation s	0,1	
	strain at yield in %	Mean value $\bar{x}$	1,4	+1 % rel.
		standard deviation s	0,3	
	stress at break in MPa	Mean value $\bar{x}$	15,7	-11 %
		standard deviation s	1,3	
	strain at break in %	Mean value $\bar{x}$	319	+2 % rel.
		Standardabweichung s	15	
	density in g/cm³	Mean value $\bar{x}$	2,84	±0 %
		standard deviation s	0,012	

Testing by BAM with excellent results after ageing in cryogenic (-253°C) and gaseous (+150°C) hydrogen (BAM file number 22048064_1: 01-2023).

Changes are within the error tolerance of the sensors.

To determine the achievable tightness classes, sampling of the technical tightness after ageing at -196°C in the cryogenic range and in the gaseous range at ageing of up to 200°C was carried out at the company GAIST (a spin-off of Münster University of Applied Sciences) in the set-up for the component test according to VDI2290 (still to be adopted).
The following tables show exemplary the achieved values of the sampling (certificates and test reports for the component test according to the new TA-Luft are available).

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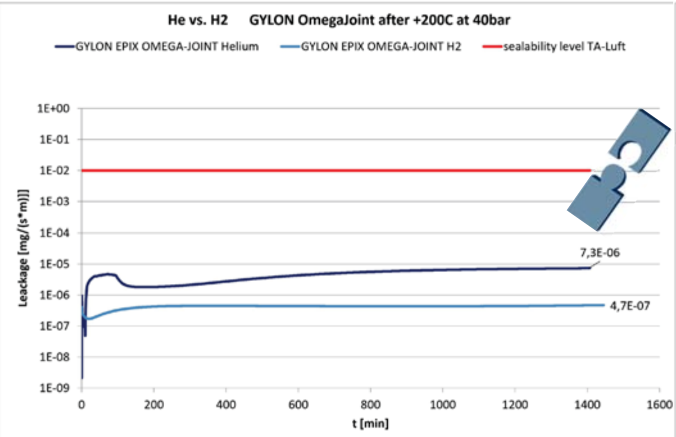
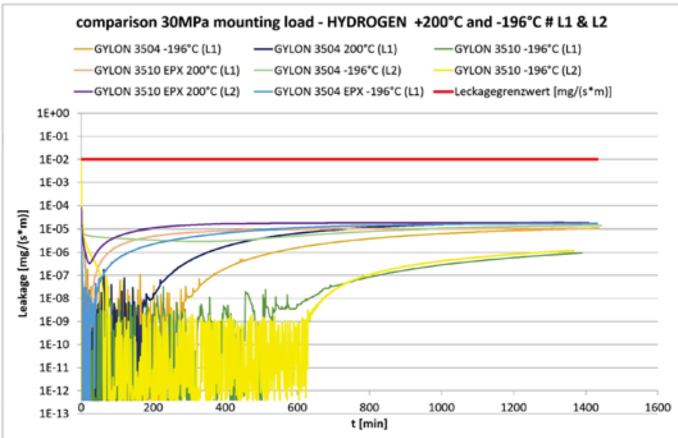
GAIST
Automation · Sealing Technologies





Conclusion

The results of BAM's mechanical properties sampling show that our modified PTFE GYLON® materials of the 3rd generation are suitable to be used in cryogenic and in higher temperature H_2 environments without being damaged.

Tightness classes achieved at 40bar with H2 hydrogen		
DN240 PN10-40 with 30MPa surface pressure	**at +150°C (L2) [mg/(m*s)]**	**at -196°C (L2) [mg/(m*s)]**
GYLON® Style 3504	Values not yet available at time of going to press	1,39E-05
GYLON® Style 3510	1,70E-06	1,18E-06
GYLON EPIX® Style 3504	1,80E-05	1,60E-05
GYLON EPIX® Style 3510	1,80E-05	1,20E-05
GYLON® Omega-Joint DN200 PN40 **GYLON EPIX® Omega-Joint** DN200 PN40 **GYLON® Multibutton Joint** DN200 PN40	1,05E-05 4,70E-07 3,00E-05	Values not yet available at time of going to press

Corresponding test reports and certificates in accordance with the new TA-Luft are available for all results and tests.

			Test method	GYLON® Style 3510 2,0 mm	GYLON® Style 3504 2,0 mm	GYLON EPIX® Style 3510 2,4 mm	GYLON EPIX® Style 3504 2,4 mm	STRESS-SAVER® GYLON® 3504 3,8 mm	GYLON® Style 3501-E 2,0 mm
Max. load during installation Q_{Smax}	**20°C**	[MPa]	EN 13555	200	200	230	200	200	230
	150°C		EN 13555	160	80	140	100	80	180
	200°C		EN 13555	140	80	120	80	50	180
	250°C		EN 13555	100	60	100	60	50	140
Min. load during installation $Q_{min (L = 0,01)}$	**at 10 bar**	[MPa]	EN 13555	10	7	5	5	5	15
	at 20 bar		EN 13555	14	9	5	5	5	21
	at 40 bar		EN 13555	14	13	5	14	5	23
Min. load during operation $Q_{Smin (L = 0,01)}$	**10, 20 bar**	[MPa]	EN 13555	<5	<5	<3	<3	<3	<5
	40 bar		EN 13555	<7	<6	<5	<6	<5	<7
Max. tightness class	**T = 20°C p = 40 bar**	[MPa]	EN 13555	1,0 x 10 E-05	1,0 x 10 E-04	1,0 x 10 E-06	1,0 x 10 E-05	1,0 x 10 E-04	1,0 x 10 E-06

Determination of the tightness classes

Good sealing classes can be achieved not only with seals that have been manufactured from one piece. Excellent sealing classes can also be achieved with segmented seals in the gaseous hydrogen environment. As expected, the residual surface pressures in the cryogenic range of the samples were higher than those in the gaseous range at +200°C. These were all rated as good.

Summary of the results

It could be proven that leakage tests under the medium H_2 hydrogen always result in exceeding the required tightness class of 1.0x10E-02 [mg/ (s*m)] under cryogenic conditions as well as under gaseous conditions.

The achieved "worst" results are with 1.39x10E-05 [mg/(s*m)] in the cryogenic range already 1000 times better than required by the TA-Luft and are also in the gaseous state three decades and thus approx. 1000 times better than the limit value of the TA-Luft.

Results obtained from testing with helium can be used to evaluate the technical tightness of a sealing material made of modified calendered PTFE with regard to compliance with TA-Luft.

Case Study GYLON® 3510

Green Hydrogen Production & Distribution Equipment

Industry

Green Hydrogen Production & Distribution Equipment

Customer

As a leading industrial player in hydrogen production and distribution equipment, our customer contributes to the global development of low-carbon hydrogen as a solution for the energy transition. By its nature, its business model is based on supporting national and European customers active in industry, mobility, and energy, in their efforts to decarbonize their activities.
The customer is a genuine "European native" with centers of excellence in France, Germany, and Italy since the company was established. Its industrial and commercial base is strongly European.

Background

Hydrogen is an energy carrier that complements the renewable energy transition. As an energy carrier with multiple applications, hydrogen plays a key role in the world energy transition. It can be turned into clean fuel to charge hydrogen vehicles, injected into gas networks, used as a raw material for industry, or as an energy storage solution to give the flexibility needed for smart grid monitoring

Challenges faced

Our customer wanted to ensure that the seals used were suitable for their hydrogen applications. They had to be media-resistant and ensure a long service life. In intensive discussions, they wanted to be informed about tests and results on the subject of hydrogen applications.

Operating Conditions

1. Media: Oxygen, Hydrogen, KOH (28%) (Potassium Hydroxide)
2. Temperature: 75°C
3. Pressure: 30 bar (g)

Solution and Benefits

Our customer specified GYLON® 3510 for the pipelines in a green electrolyzer 16MW plant. With the characteristic properties of GYLON®, and after successful tests, the customer was convinced to implement GYLON® 3510. Media resistance, service life and the typical character properties of GYLON® 3510 (white) have surpassed all competitor materials many times by far.

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