



## Test Report


Customer: KLINGER A.W. Schultze GmbH  
Mercatorstraße 10  
DE – 21502 Geesthacht


Project number (amtec): 304 946  
Report number: 304 946 2/-

Test procedure: Gasket Testing EN 13555 (dated April 2021)  
- Leakage test

Material: EGRAFLEX STEELFLON 2.0 Waveline WLP

Date: May 2<sup>nd</sup>, 2022  
Pages: 5  
Appendices: 4

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Test Engineer

Test results are only relevant to the test objects submitted.

## 1. Subject of Investigation

The following documents and samples were submitted to amtec.

The subject of investigation was a gasket from KLINGER A.W. Schultze GmbH which is customer named:

- EGRAFLEX STEELFLON 2.0 Waveline WLP

EGRAFLEX STEELFLON 2.0 Waveline WLP is a multilayer three-component gasket made from several layers of pure SIGRAFLEX graphite foil, stainless steel and PTFE. The gasket has an inner eyelet made of stainless steel.

Samples receipt: January 20<sup>th</sup>, 2022.

## 2. Goal of Investigation

The goal of the investigation was the determination of the following gasket characteristics according to the European Standard EN 13555 (dated April 2021) which are necessary for calculation procedures according EN 1591-1 (dated April 2014):

- minimum required gasket stress in assembly  $Q_{\min(L)}$  (40 bar)
- minimum required gasket stress in service  $Q_{s\min(L)}$  (40 bar)

Deviant from the standard Hydrogen was used a test medium for the leakage tests.

## 3. Test Specimens

The dimensions of the test specimens were DN40/PN40 with an OD of 92 mm and an ID of 49 mm. The gasket thickness was 2.2 mm.

## 4. Testing Equipment

The gasket tests were carried out on the following testing equipment in the laboratory of amtec:

Leakage test: TEMES<sub>fl.ai1</sub> Ident-No. 010 599

A photo and the schematic view of the testing equipment are shown in **appendix 1**.

## 5. Test Procedure EN 13555

### 5.1 Leakage Test

The leakage test procedure consists of loading and unloading the gasket in a cyclic manner with measurement of the leak rate at several effective gasket stress levels with an internal gas pressure of 40 bar.

The procedure therefore consists of loading to 10 MPa, holding the load and measuring the leak rate, and then raising the gasket stress to 20 MPa. The load is then held whilst the leak rate is measured. In the next step the load is reduced to 10 MPa and the leak rate is measured. Then measurements are done for the next loading-unloading cycle at 40 MPa, 20 MPa, 10 MPa and so on until either the 160 MPa loading-unloading cycle is completed or the value of  $Q_{smax}$  is exceeded.

The test gas used for this test is Hydrogen 5.0.

From the generated leakage curve the minimum required gasket stress in assembly  $Q_{min(L)}$  and the minimum required gasket stress in service  $Q_{smin(L)}$  as a result of the gasket surface pressure prior to the unloading  $Q_A$  can be evaluated for different tightness classes L.

## 6 Results

Test date: April 22<sup>nd</sup> to May 9<sup>th</sup>, 2022.

In **appendix 2** all test results of the gasket tests with EGRAFLEX STEELFLON 2.0 Waveline WLP are listed. The following gasket characteristics are summarized in these tables:

- minimum required gasket stress in assembly  $Q_{\min(L)}$
- minimum required gasket stress in service  $Q_{\min(L)}$  in dependence on the gasket surface pressure prior to the unloading  $Q_A$

### 6.1 Leakage Tests

The tightness behavior of the gasket material EGRAFLEX STEELFLON 2.0 Waveline WLP was examined in leakage tests with Hydrogen at 40 bar.

For the determination of the leak rate two different measurement devices were used in parallel. The pressure drop method with a differential pressure was used for the leak tightness evaluation for leak rates higher  $1.0 \cdot 10^{-3} \text{ mg}/(\text{s}\cdot\text{m})$ . For lower leak rates the signal of the leak detector was taken for the calculation of the leak rate.

The graphical presentation of the leakage curves are shown in **appendix 3**.

With an internal pressure of 40 bar the tightness class  $L_{0.001}$  was reached when the gasket stress raised above 14 MPa resp. 16 MPa. The minimum gasket stress in assembly for the tightness class  $L_{0.001}$  is  $Q_{\min(0.001)} = 16 \text{ MPa}$ . The highest tightness class which could be reached was  $L_{0.000001}$ , therefore a gasket stress of 57 MPa resp. 81 MPa is necessary.

The leak rate decreases with an increasing gasket stress up to 160 MPa. The lowest leak rate which could be measured at 160 MPa was  $1.5 \cdot 10^{-7} \text{ mg}/(\text{s}\cdot\text{m})$ .

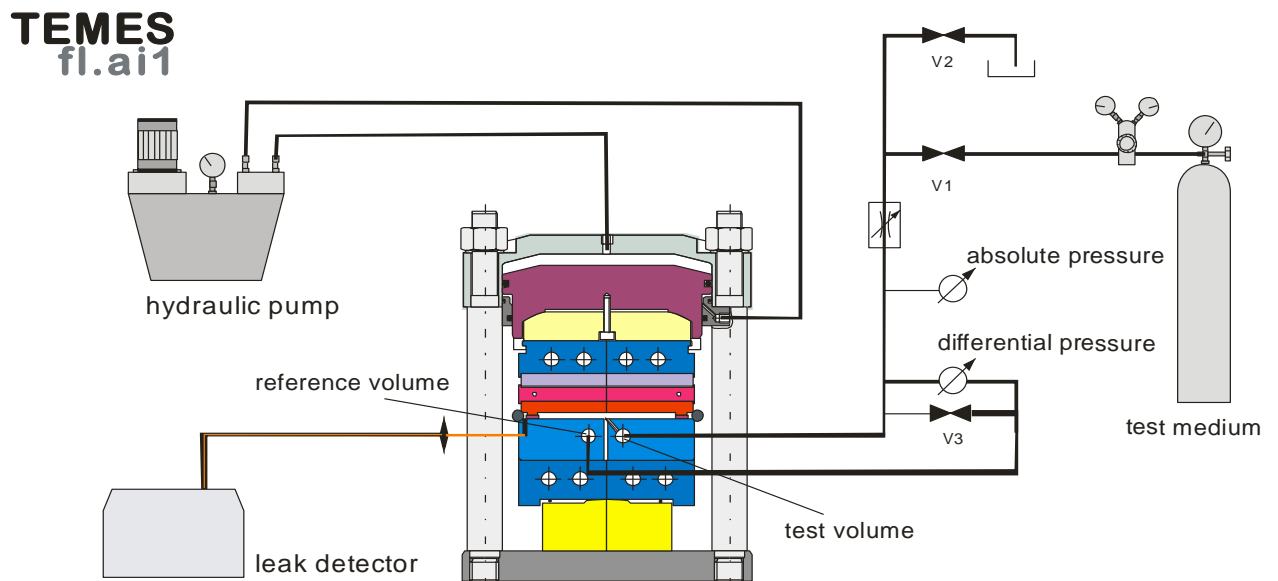
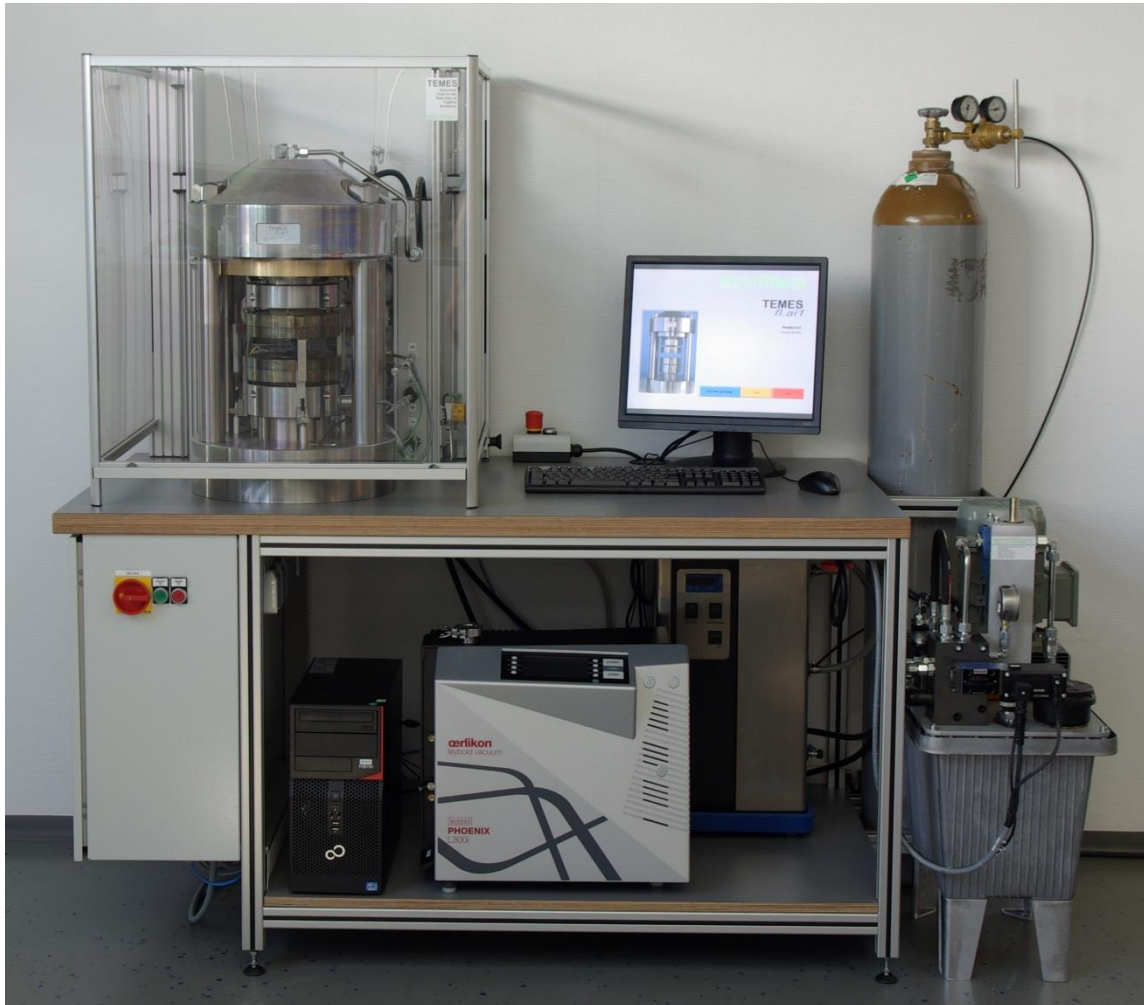
During the unloading cycles the leak rate increases again, but the gasket is clearly tighter than during the first loading to these lower, defined gasket stress levels. With a preload of 160 MPa a significant increase of the leakage is noticeable during

unloading from 20 MPa to 10 MPa. For all other unloading cycles no drastic increase of the leak rate could be observed.

The minimum gasket stress in service for the tightness class L<sub>0.01</sub> for an initial gasket surface pressure  $Q_A$  of 60 MPa is  $Q_{\text{min}(0.01)} = 10 \text{ MPa}$ .

## 7. Photo documentation

In **appendix 4** photos of the tested gasket specimens EGRAFLEX STEELFLON 2.0 Waveline WLP are presented.



**Testing Equipment TEMES<sub>fl.ai1</sub> (1000 kN)**

**Table 1: Data Sheet for Gasket Characteristics (EN 13555)**

Manufacturer: KLINGER A. W. Schultze GmbH  
 Product: EGRAFLEX STEELFLON 2.0 Waveline WLP

**Minimum required Gasket Stress in Assembly  $Q_{\min(L)}$  [MPa]**

$p$ [bar] \ L	10	1	0.1	0.01	0.001	1.00E-04	1.00E-05	1.00E-06	1.00E-07
40	10	10	10	10	16	25	41	57	-
test no.	22-322								
40	10	10	10	10	14	19	41	81	-
test no.	22-355								

**Minimum required Gasket Stress in Operation  $Q_{s\min(L)}$  [MPa]**

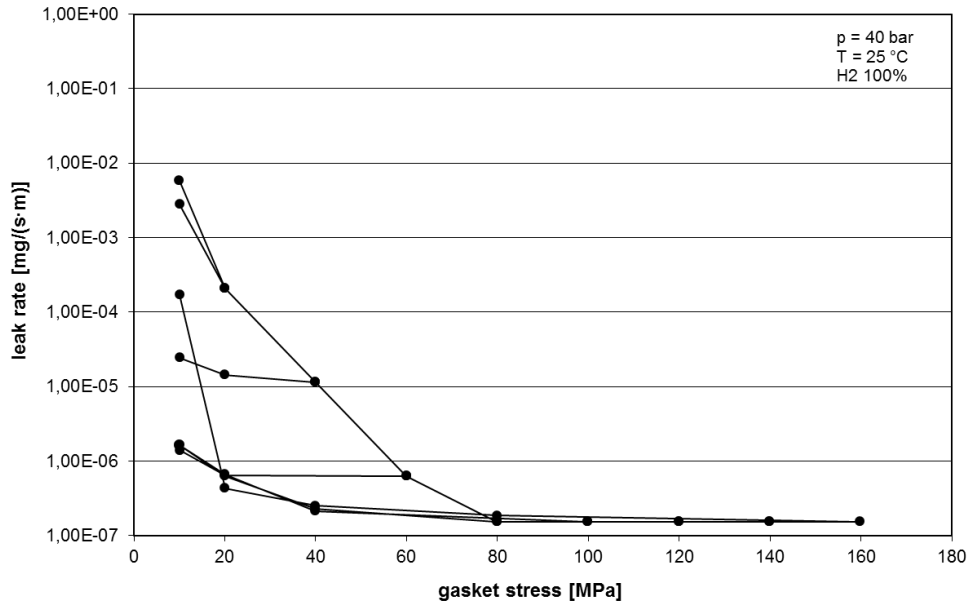
$p = 40$ bar	$Q_A$ [MPa] \ L	10	1	0.1	0.01	0.001	1.00E-04	1.00E-05	1.00E-06	1.00E-07
	20	10	10	10	10	13	-	-	-	-
40	10	10	10	10	10	10	-	-	-	
60	10	10	10	10	10	10	10	15	-	
80	10	10	10	10	10	10	10	15	-	
100	10	10	10	10	10	10	10	15	-	
160	10	10	10	10	10	11	15	19	-	
test no.	22-322									

**Minimum required Gasket Stress in Operation  $Q_{s\min(L)}$  [MPa]**

$p = 40$ bar	$Q_A$ [MPa] \ L	10	1	0.1	0.01	0.001	1.00E-04	1.00E-05	1.00E-06	1.00E-07
	20	10	10	10	10	10	19	-	-	-
40	10	10	10	10	10	19	-	-	-	
60	10	10	10	10	10	11	19	-	-	
80	10	10	10	10	10	10	10	-	-	
100	10	10	10	10	10	10	10	13	-	
160	10	10	10	10	10	10	14	18	-	
test no.	22-355									

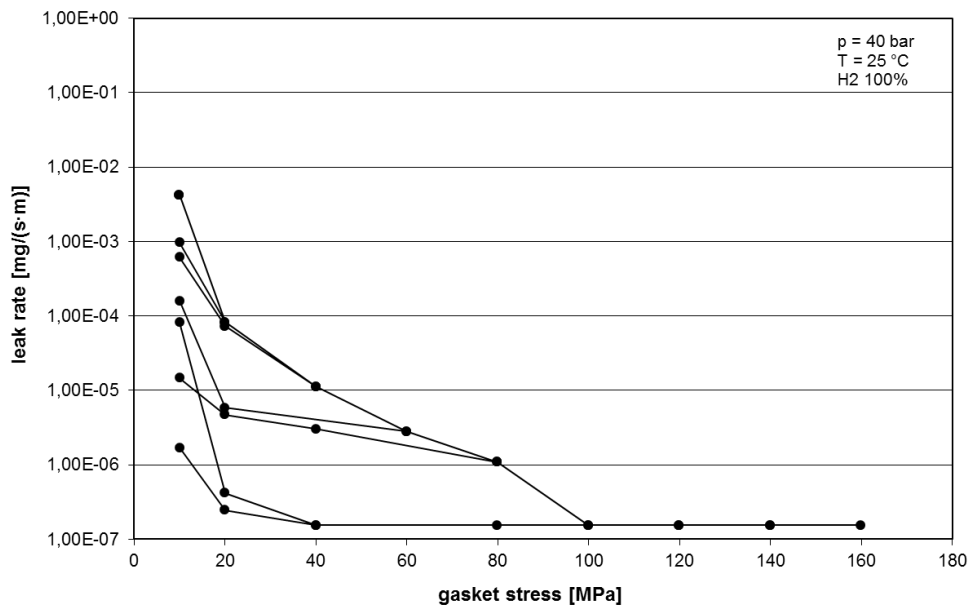
not a typical behaviour of a gasket

**Leakage curve**  
**Egraflex Steelflon 2.0 92.27x49.12x2.22 mm**  
**Test number: 22-322**



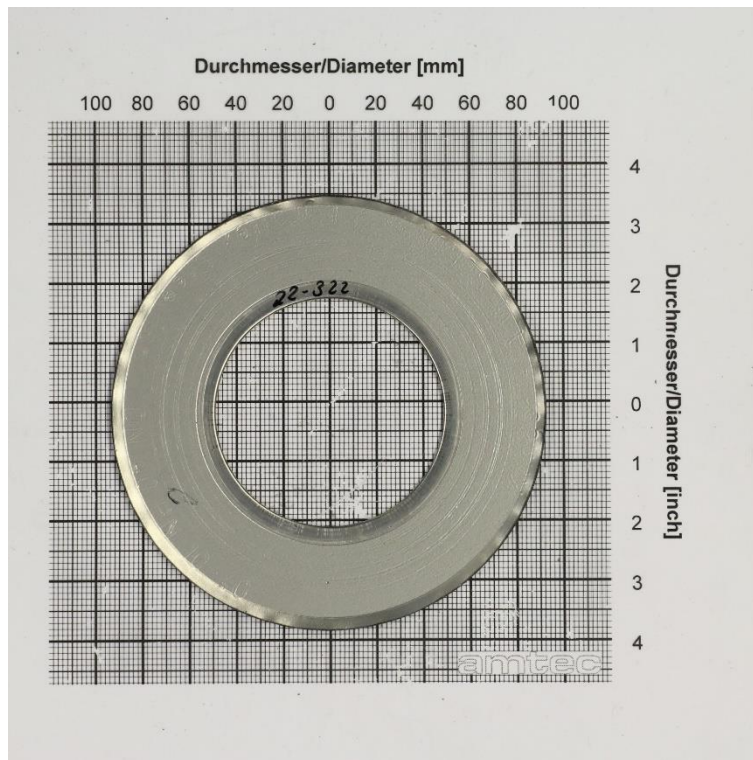
**Leakage Test 40 bar according to EN 13555**

**Leakage curve**  
**Egraflex Steelflon 2.0 92.31x49.06x2.022 mm**  
**Test number: 22-355**

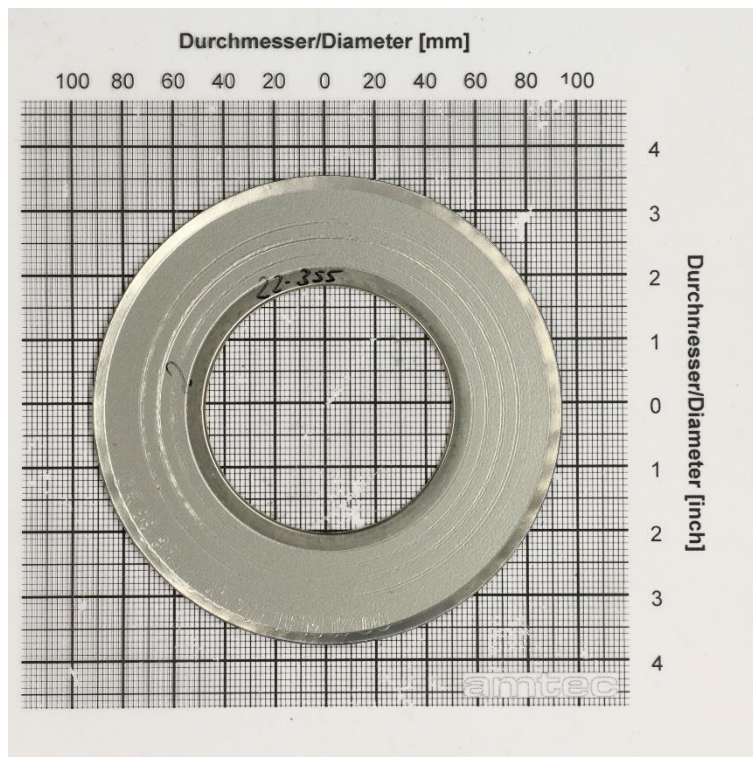


**Leakage Test 40 bar according to EN 13555**





**Leakage Test – 40 bar (EN 13555)**



**Leakage Test – 40 bar (EN 13555)**