AMTEC Advanced Measurement
Messtechnischer Service GmbH
Hoher Steg 13
D-74348 Lauffen
Phone: +49 7133 9502-0
Fax: +49 7133 9502-22
E-Mail: temes@amtec.de
Internet: www.amtec.eu

DAkkS Deutsche Akkreditierungsstelle D-PL-12008-01-00

Test Report

Customer:	UNI KLINGER LIMITED. Fluid Sealing Division, Gat No.1240, S.No-140, Village-Vadhu Budruk IN - Tal- Shirur, Dist-Pune-412 216
Project number (amtec):	304 341
Report number:	304 341 1/-
Test procedure:	Gasket Testing BS 7531
Material:	UNISIL CI 35 / UKL CI 35
Date:	September 22nd, 2020
Pages:	7
Appendices:	19

Dipl.-Ing. F. Herkert
Head of Laboratory

Dipl.-Ing. S. Weiler
Test Engineer

Test results are only relevant to the test objects submitted.

1. Subject of Investigation

The subject of investigation was a flat fibre gasket manufactured by UNI KLINGER LIMITED which is named

- UNISIL CI 35 / UKL CI 35.

Batch No. ISM 2708

2. Goal of Investigation

The goal of the investigation was the determination of the following gasket characteristics according to BS 7531 – Rubber bonded fibre jointing for industrial and aerospace purposes (dated 2006):

- Residual stress,
- Flexibility,
- Compressibility,
- Gas Permeability and
- Resistance to fluids.

The verification of the compliance according to BS 7531 for Grade X materials was the goal of the study in hand.

The Resistance to fluids test is not part of the accreditation of the laboratory of AMTEC Advanced Measurement Messtechnischer Service GmbH and was performed in an accredited laboratory nearby.

3. Test Specimens

The dimensions of the test specimens were different for the tests which were performed:

- Residual stress test (BS 7531): ∅ 75 mm x ∅ 55 mm,
- Flexibility test (BS 7531): strip 12.5 mm x 150 mm,
- Compressibility test (BS 7531): 4 x ∅ 6.4 mm,

- Gas permeability test (BS 7531): DN40/PN40 (∅ 92 x ∅ 49 mm),
- Resistance to fluids (BS 7531): 50 mm x 25 mm.

The thickness of the fibre gasket UNISIL CI 35 / UKL CI 35 was 1.5 mm for all tests.

All test specimens were conditioned prior testing according to the requirements of BS 7531.

4. Testing Equipment

The gasket tests were carried out on the following testing equipment:

	Test rig:	Serial number
Residual stress test:	TEMES*fl.ai1*	Ident-No. 010 506
Flexibility test:	Test mandrel 19.05 mm	
Compressibility test:	Klinger	Ident-No. 010 317
Gas permeability test:	TEMES*fl.ai1*	Ident-No. 010 181

Photos and the schematic view of the testing equipment are shown in **appendices 1 and 2**.

5. Test Procedure

5.1 Residual stress test

The residual stress is measured after 16 h at 300 °C from an initial gasket stress of 40 MPa. The test is performed in a hydraulic compression press used in the displacement-controlled mode with an adjusted stiffness of 313 kN/mm.

The test procedure consists of loading the specimen until the initial load is applied, re-loading after 5 minutes dwell time, and heating of the test rig until the test temperature is reached. Then the temperature is held constant for a period of 16 hours. During the heating period and at elevated temperature the stiffness-controlled mode of the equipment is activated. After the 16-hour period the remaining load being imposed by the press is noted.

The residual stress shall be not less than 25 MPa for grade X or 22 MPa for grade Y.

5.2 Flexibility test

The test piece is bended through an angle of 180° around and normal to the axis of a test mandrel within 2 seconds. The force shall be just sufficient to hold the test piece in contact with the mandrel. Hold the test piece 10 seconds in the bent position around the mandrel.

After that examine test piece visually. The test piece shall not crack or delaminate.

Repeat this test on a different section of the strip but with the other face in contact with the mandrel. After that examine test piece visually. The test piece shall not crack or delaminate.

5.3 Compressibility test

The test specimen is centred upon the anvil and a preload is applied and maintained constant for 15 s. Within the next 10 s the major load is applied. After further 60 s the load is decreased again to the original preload.

The gasket thickness is measured at the end of each dwell time under preload, major load und preload again. From these measurements the compressibility is calculated.

The preload is defined to 22.2 N and the major load is defined to 1112 N.

The compression expressed as percentage of the original thickness under preload shall be not less than 6% for all grades and not more than 14% for grades AX and AY.

5.4 Gas permeability test

The gasket specimen is put centrically between the raised faces of the test platens and is compressed with a gasket stress of 32 MPa. Afterwards the test apparatus is pressurized up to 40 bar Nitrogen.

Two hours after pressurization the leak rate is measured by the pressure drop method using a very sensitive differential pressure unit. The leak rate can be calculated from the increase of the differential pressure during the measuring period under consideration of the mean gasket circumference.

For passing the permeability requirements of BS 7531 the specific leakage rate must be lower than 1 ml/min.

5.5 Resistance to fluids

The thickness and weight of the test specimen before and after immersion to a test fluid is measured. After that the increase in thickness or weight can be calculated as a percentage of the original value.

Immersion tests are carried out with different fluids. For Grade X and Y an immersion in Oil No.3 (IRM 903) at 150 °C and in demineralized water at 100 °C should be measured. The duration of the immersion is 5 hours.

The thickness increase shall not be higher than 20% for an immersion in Oil No. 3 and not more than 15% for an immersion in water.

6. Results

6.1 Residual stress test

The results of the residual stress tests according BS 7531 are listed in **appendix 3**. The graphical presentation of the compression curves are shown in **appendices 4 and 5**. Two specimens were examined. The initial gasket stress was set to 40 MPa, the test temperature was set to 300 °C.

During heating up and during the dwell time a creeping of the gasket could be recognized. The remaining gasket stress after a dwell time of 16 hours was measured to 28.6 MPa resp. 28.4 MPa.

Therefore, the examined gasket material UNISIL CI 35 / UKL CI 35 has passed **the residual stress requirements of BS 7531 for grade X materials**.

6.2 Flexibility test

The results of the flexibility tests according BS 7531 are listed in **appendix 3**. Two specimens were examined. The test pieces were bended through an angle of 180° around the test mandrel of 19.05 mm. A second bending with the other face in contact with the mandrel was performed after that.

No cracks or delamination could be recognized at both test pieces after the test.

Therefore, the examined gasket material UNISIL CI 35 / UKL CI 35 has passed **the flexibility requirements of BS 7531**.

6.3 Compressibility test

In **appendices 6 and 7** the results of the compressibility tests are listed. Three tests of the material UNISIL CI 35 / UKL CI 35 were performed.

The average compressibility of the gasket sheet UNISIL CI 35 / UKL CI 35 between preload and major load is 8.1% and therefore more than 6% and not more than 14% which is required for grade AX and AY sheet material.

Therefore, the examined gasket material UNISIL CI 35 / UKL CI 35 has passed **the compressibility requirements of BS 7531 for grade X materials**.

6.4 Gas permeability test

The results of the gas permeability tests according BS 7531 are listed in **appendix 8**. The graphical presentation of the leakage curves is shown in **appendices 9 to 11**. Three specimens were examined. The gasket stress was set for all materials at 32 MPa, the test pressure level was 40 bar Nitrogen at each test.

In all 3 tests performed with UNISIL CI 35 / UKL CI 35 at ambient temperature, the recorded leak rates were lower than the limit of 1.0 ml/min defined in BS 7531. The lowest leak rate, measured with the test sample 20-431, was 0.43 ml/min. The highest leak rate, measured with the test sample 20-428, was 0.81 ml/min.

The examined gasket material UNISIL CI 35 / UKL CI 35 has fulfilled **the permeability requirements of BS 7531**.

6.5 Resistance to fluids

The results of the resistance to fluids tests according BS 7531 are listed in **appendix 12**. One specimen was examined in each test fluid.

After immersion in test fluid Oil No.3 the average thickness increase was 3.1%.

After immersion in test fluid water no thickness increase could be measured.

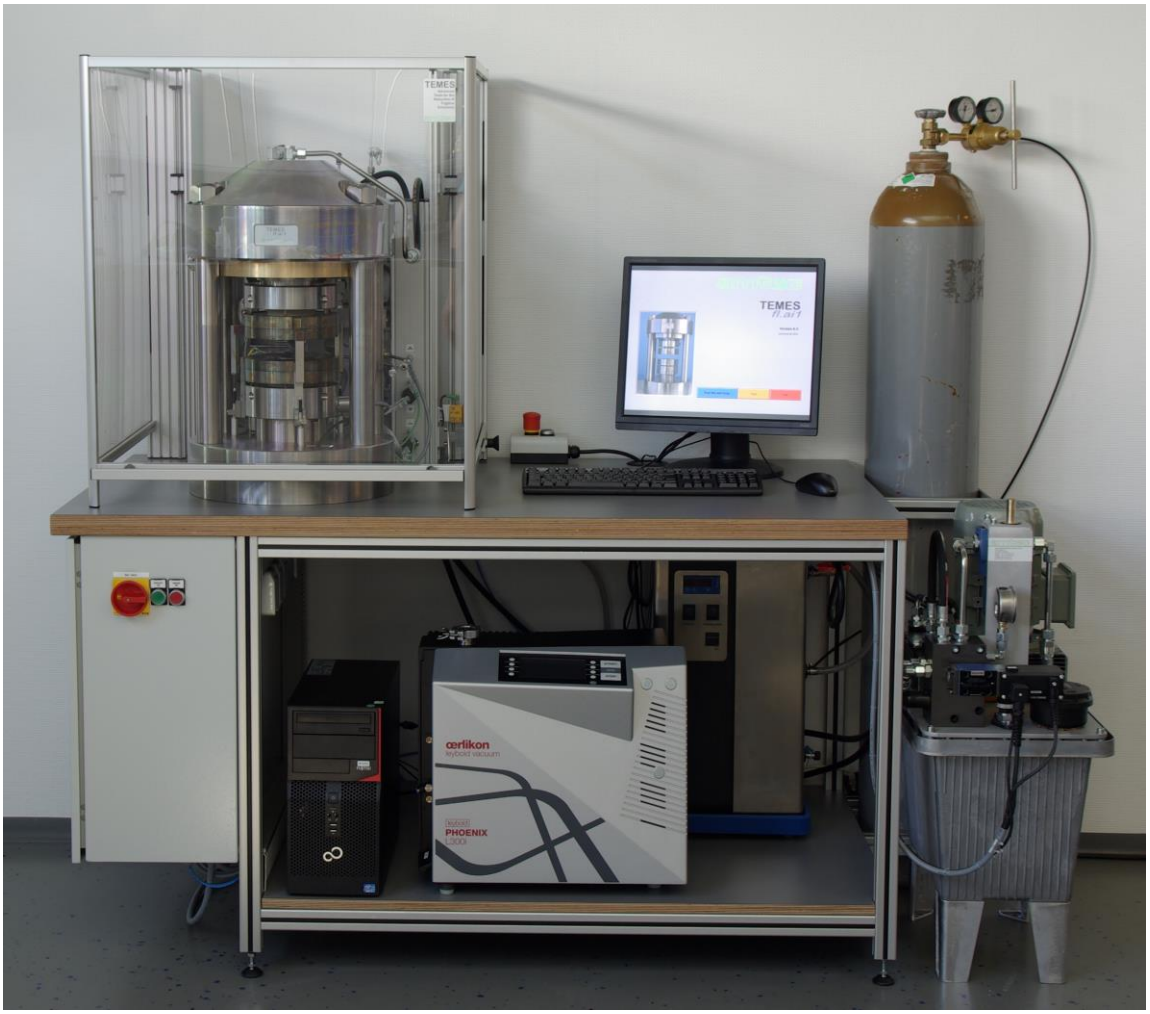
The examined gasket material UNISIL CI 35 / UKL CI 35 has fulfilled **the resistance to fluids requirements of BS 7531**.

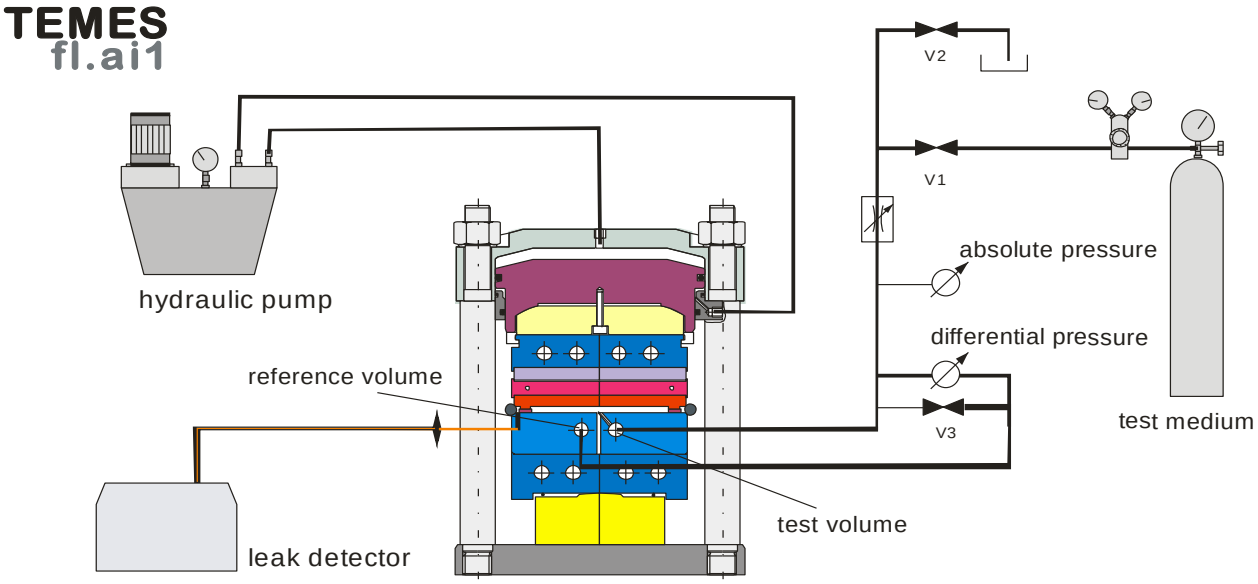
7. Photo documentation

In **appendices 13 to 19** photos of the tested gasket specimens UNISIL CI 35 / UKL CI 35 for the different test procedures are presented.

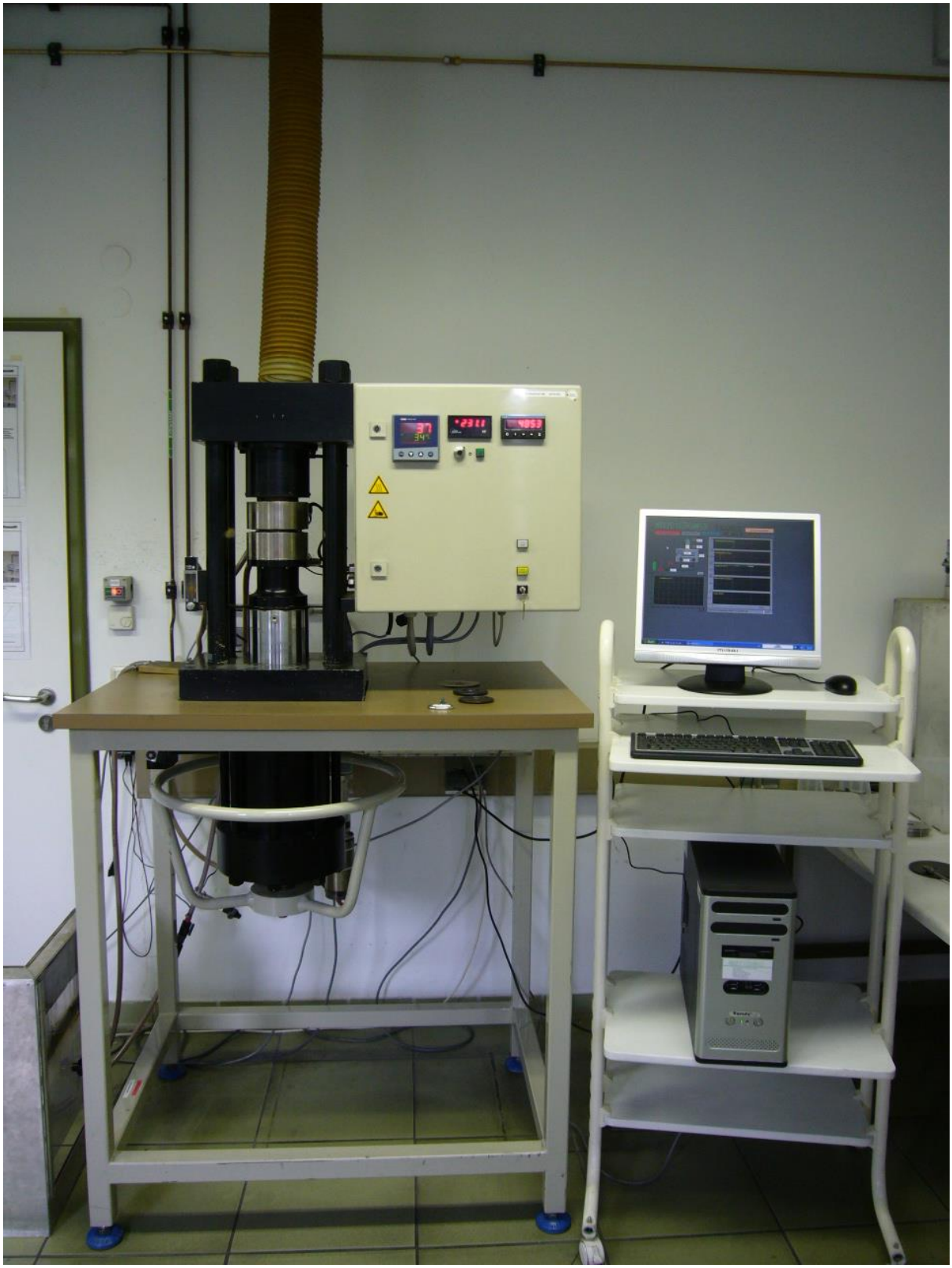
8. Summary

All values of the performed tests with the fibre gasket UNISIL CI 35 / UKL CI 35 manufactured by UNI KLINGER LIMITED with a nominal thickness of 1.5 mm followed the requirements of **BS 7531 for GRADE X** materials.





Testing Equipment TEMES*fl.ai1* (1000 kN)



Testing Equipment KLINGER Dichtungstechnik

Table 1: Data Sheet for Gasket Characteristics (BS 7531)

Manufacturer: UNI KLINGER LIMITED

Product: **UNISIL CI 35 / UKL CI 35**

Residual stress test BS 7531

Test temperature:	300	°C
Initial stress:	40	MPa
Residual stress of the jointing:	28.6	MPa
Requirements:	passed	
test no.	20-445	

Test temperature:	300	°C
Initial stress:	40	MPa
Residual stress of the jointing:	28.4	MPa
Requirements:	passed	
test no.	20-449	

Table 2: Data Sheet for Gasket Characteristics (BS 7531)

Manufacturer: UNI KLINGER LIMITED

Product: **UNISIL CI 35 / UKL CI 35**

Flexibility Test BS 7531

Test temperature:	20 ± 5	°C
Mandrel:	∅ 19.05	mm
First bending:	passed	
Second bending (other face):	passed	
test no.	20-392	

Test temperature:	20 ± 5	°C
Mandrel:	∅ 19.05	mm
First bending:	passed	
Second bending (other face):	passed	
test no.	20-393	

Residual stress test (BS 7531)

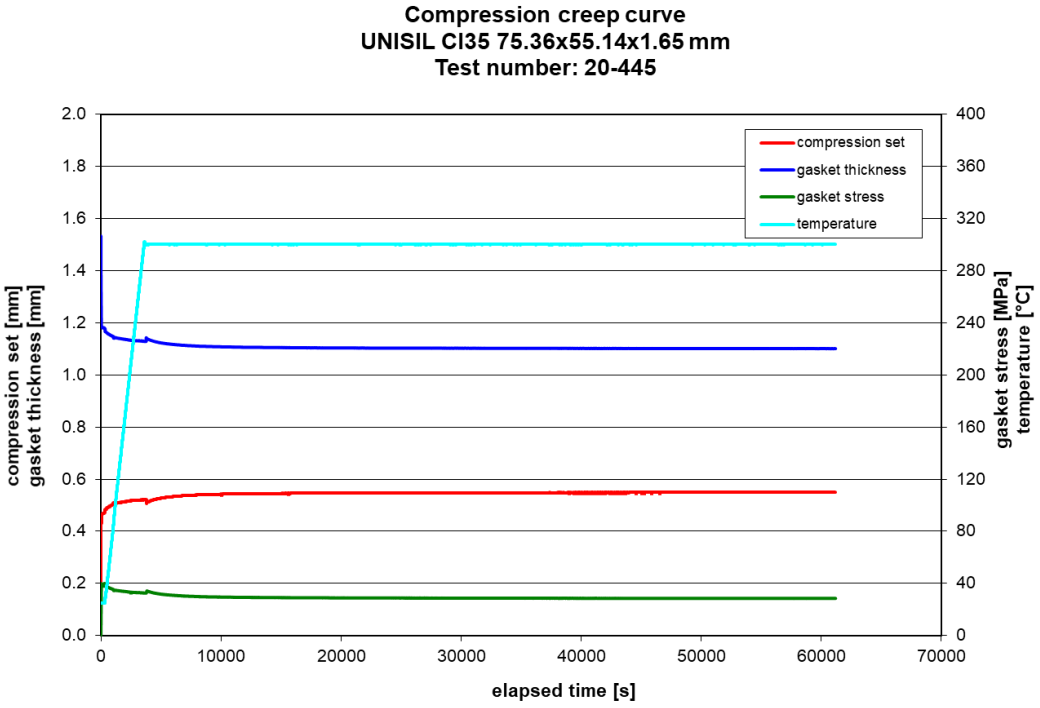
UNISIL CI35
75.36x55.14x1.65 mm
Test number: 20-445

Test parameters

Initial gasket stress:	40	MPa
Time at RT:	00:04	hh:mm
Test temperature T_P:	300	°C
Time at T_P:	16:00	hh:mm
Stiffness C:	313	kN/mm

Test results

Residual stress:	28.6	MPa



Residual stress test (BS 7531)

UNISIL CI35
75.49x55.32x1.58 mm
Test number: 20-449

Test parameters

Initial gasket stress:	40	MPa
Time at RT:	00:04	hh:mm
Test temperature T_P:	300	°C
Time at T_P:	15:59	hh:mm
Stiffness C:	313	kN/mm

Test results

Residual stress:	28.4	MPa

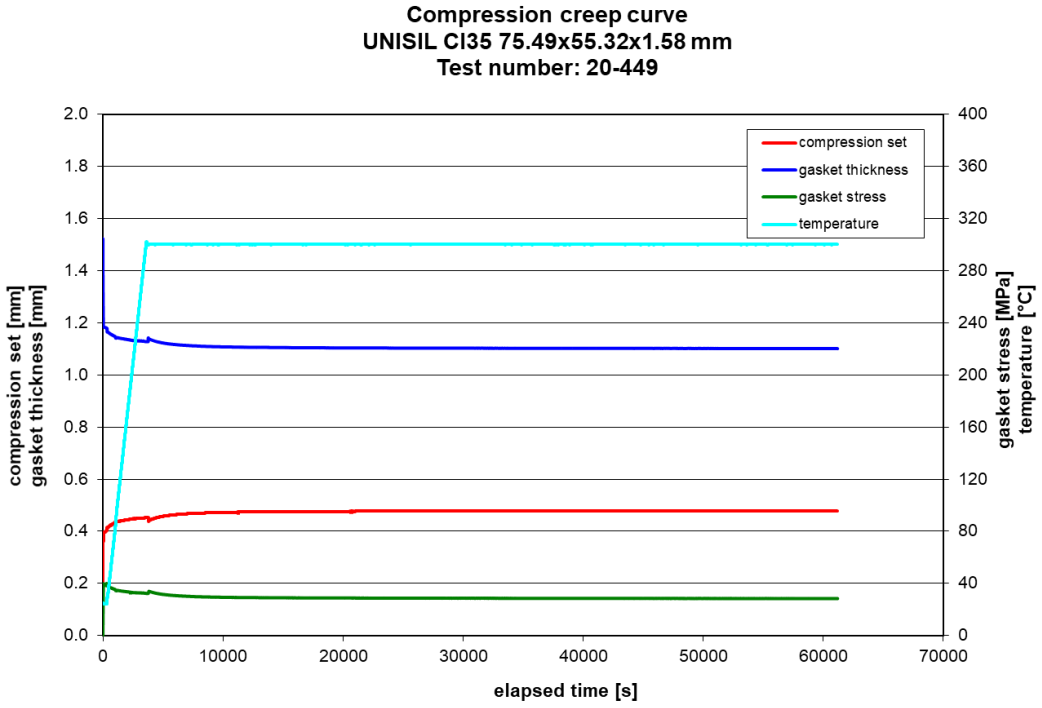


Table 3: Data Sheet for Gasket Characteristics (BS 7531)

Manufacturer: UNI KLINGER LIMITED

Product: **UNISIL CI 35 / UKL CI 35**

Compressibility test BS 7531

Test temperature:	20 ± 5	°C
thickness under preload	1.416	mm
thickness under major load	1.307	mm
Compressibility	7.6%	
Requirements:	passed	
test no.	20-396	

Test temperature:	20 ± 5	°C
thickness under preload	1.441	mm
thickness under major load	1.313	mm
Compressibility	8.9%	
Requirements:	passed	
test no.	20-397	

Test temperature:	20 ± 5	°C
thickness under preload	1.425	mm
thickness under major load	1.314	mm
Compressibility	7.8%	
Requirements:	passed	
test no.	20-424	

BS7531

Compressibility and recovery test
Uni Klinger Limited UNISIL CI35 - 4 x ∅ 6.4 mm x 1.50 mm
Test number: 20-396

Thickness under pre-load	1.416 mm
Thickness under load	1.307 mm
Recovery thickness	1.363 mm
Compressibility	7.6%
Recovery	51.0%

BS7531

Compressibility and recovery test
Uni Klinger Limited UNISIL CI35 - 4 x ∅ 6.4 mm x 1.48 mm
Test number: 20-397

Thickness under pre-load	1.441 mm
Thickness under load	1.313 mm
Recovery thickness	1.371 mm
Compressibility	8.9%
Recovery	45.3%

BS7531

Compressibility and recovery test
Uni Klinger Limited UNISIL CI35 - 4 x ∅ 6.4 mm x 1.45 mm
Test number: 20-424

Thickness under pre-load	1.425 mm
Thickness under load	1.314 mm
Recovery thickness	1.368 mm
Compressibility	7.8%
Recovery	49.1%

Table 4: Data Sheet for Gasket Characteristics (BS 7531)

Manufacturer: UNI KLINGER LIMITED

Product: **UNISIL CI 35 / UKL CI 35**

Gas permeability test BS 7531

Test pressure:	40	bar
Gasket stress level:	32	MPa
Leak rate:	0.81	ml/min
Requirements:	passed	
test no.	20-428	

Test pressure:	40	bar
Gasket stress level:	32	MPa
Leak rate:	0.43	ml/min
Requirements:	passed	
test no.	20-429	

Test pressure:	40	bar
Gasket stress level:	32	MPa
Leak rate:	0.43	ml/min
Requirements:	passed	
test no.	20-431	

Gas permeability test (BS 7531)

UNISIL CI35
90.21x50.2x1.52 mm
Test number: 20-428

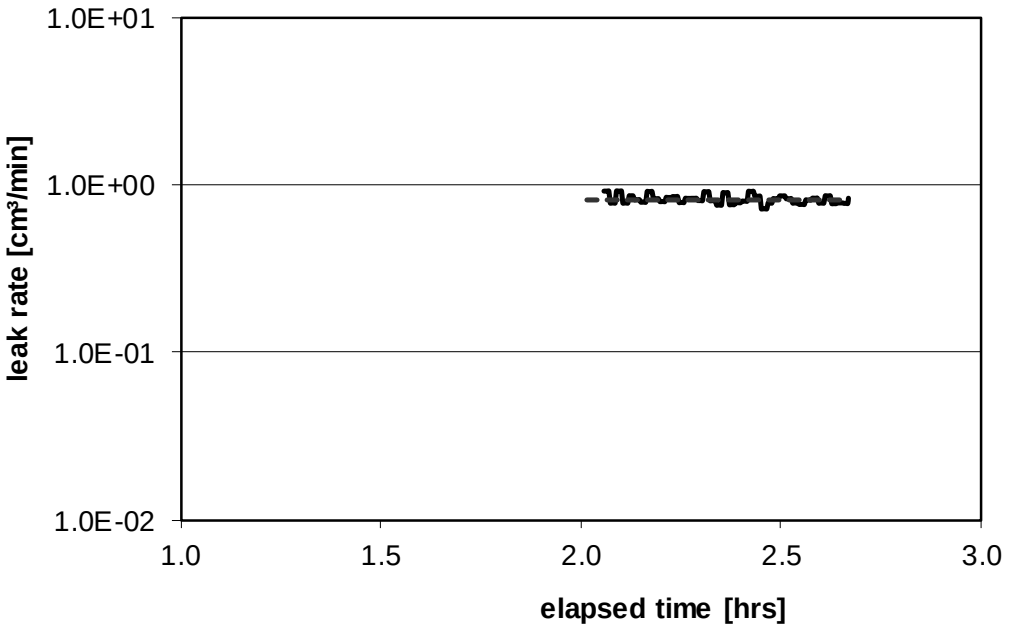
Test parameters

Initial gasket stress σ:	32	MPa
Internal pressure p:	40	bar
Test temperature T_P:	22	°C
Dwell time:	2:01	hh:mm
Measuring time:	0:38	hh:mm

Test results

Leak rate λ:	8.12E-01	cm³/min
	7.80E-02	mg/m/s

Leak rate acc. BS 7531 permissible



Gas permeability test (BS 7531)

UNISIL CI35
89.8x50.7x1.49 mm
Test number: 20-429

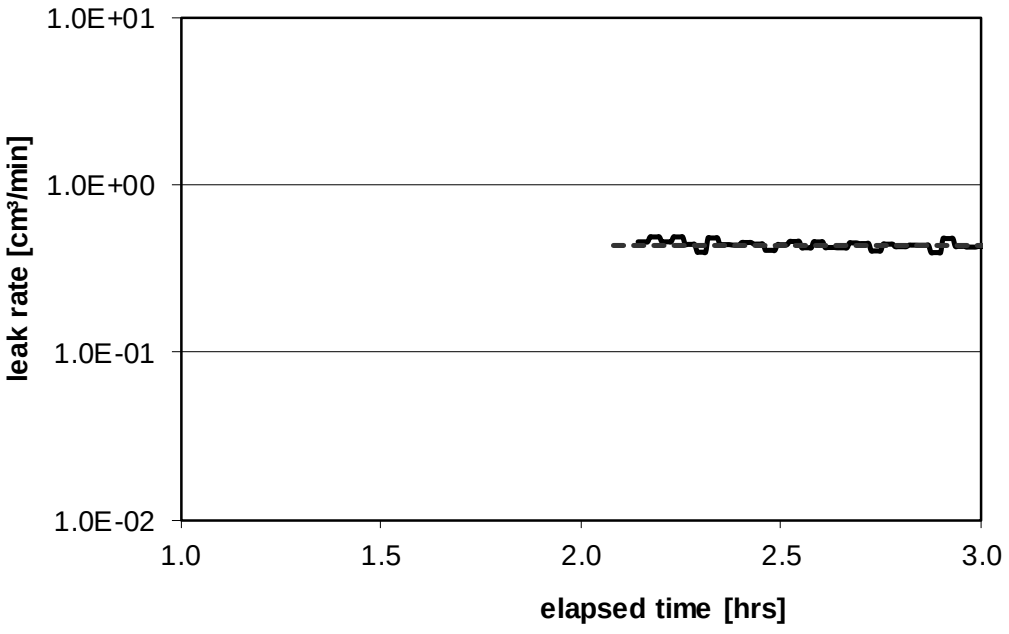
Test parameters

Initial gasket stress σ:	32	MPa
Internal pressure p:	40	bar
Test temperature T_P:	22	°C
Dwell time:	2:05	hh:mm
Measuring time:	1:11	hh:mm

Test results

Leak rate λ:	4.30E-01	cm³/min
	4.11E-02	mg/m/s

Leak rate acc. BS 7531 permissible



Gas permeability test (BS 7531)

UNISIL CI35
89.61x50.66x1.48 mm
Test number: 20-431

Test parameters

Initial gasket stress σ:	32	MPa
Internal pressure p:	40	bar
Test temperature T_P:	22	°C
Dwell time:	2:00	hh:mm
Measuring time:	0:30	hh:mm

Test results

Leak rate λ:	4.29E-01	cm³/min
	4.10E-02	mg/m/s

Leak rate acc. BS 7531 permissible

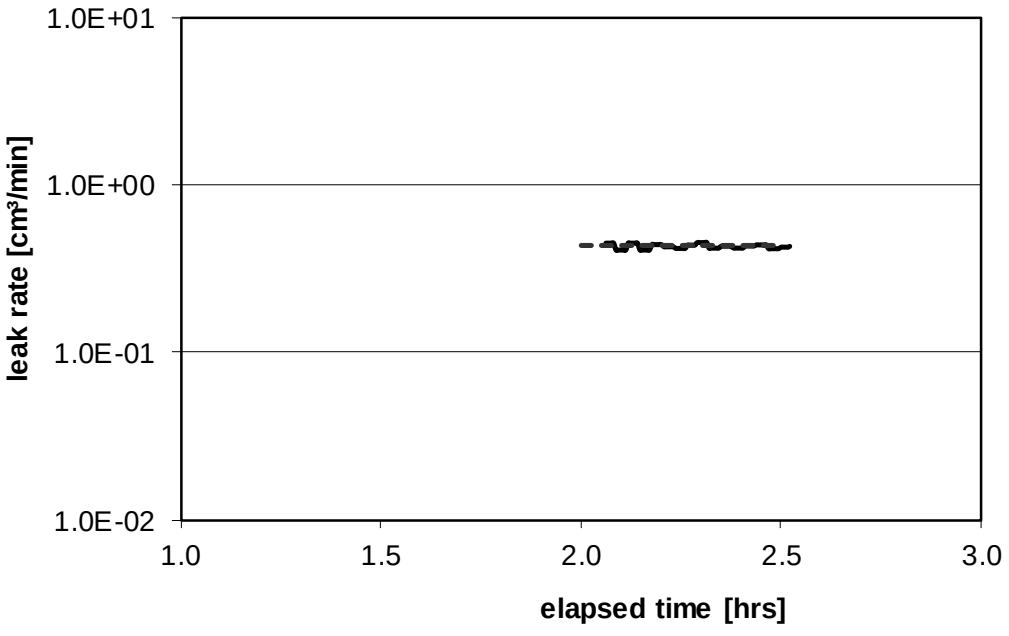


Table 5: Data Sheet for Gasket Characteristics (BS 7531)

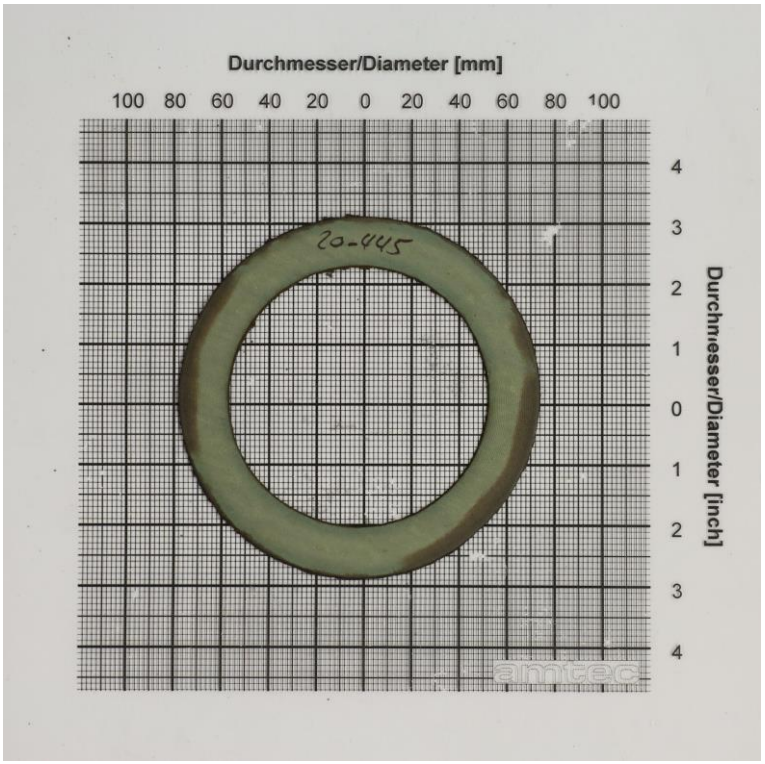
Manufacturer: UNI KLINGER LIMITED

Product: **UNISIL CI 35 / UKL CI 35**

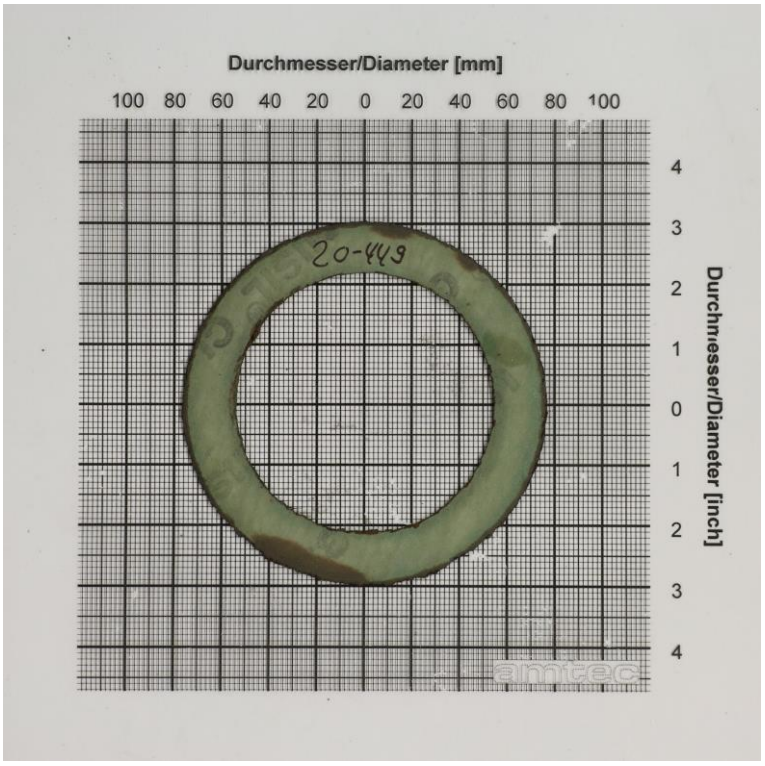
Resistance to fluids test BS 7531

Test temperature:	150 °C
Test duration:	5 h
Medium:	IRM 903/ Oil No. 3
Thickness increase:	3.1 %
Requirements:	passed
test no.	ext. Lab

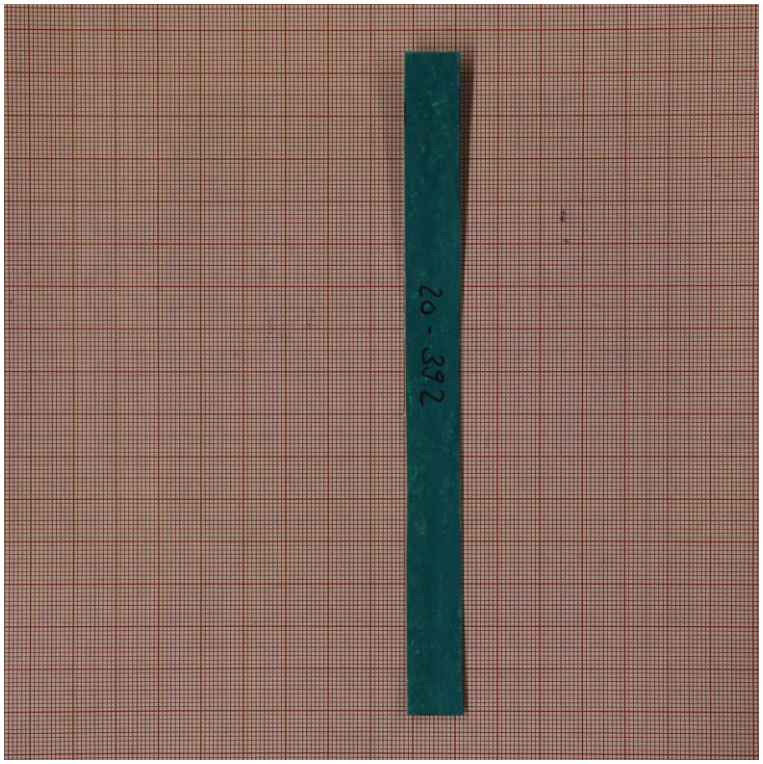
Test temperature:	100 °C
Test duration:	5 h
Medium:	Water
Thickness increase:	0 %
Requirements:	passed
test no.	ext. Lab



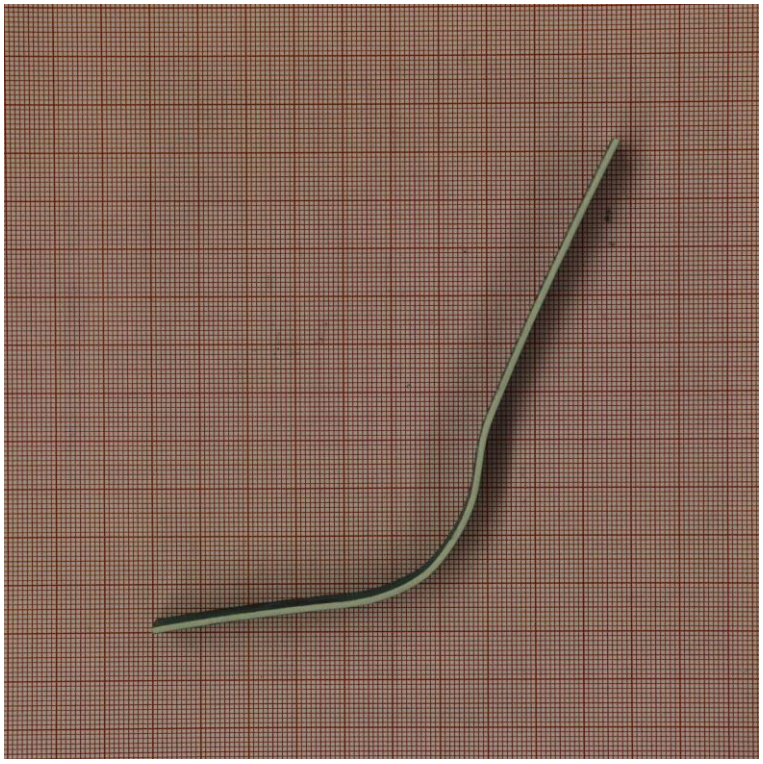
Residual stress test at 300 °C – 20-445



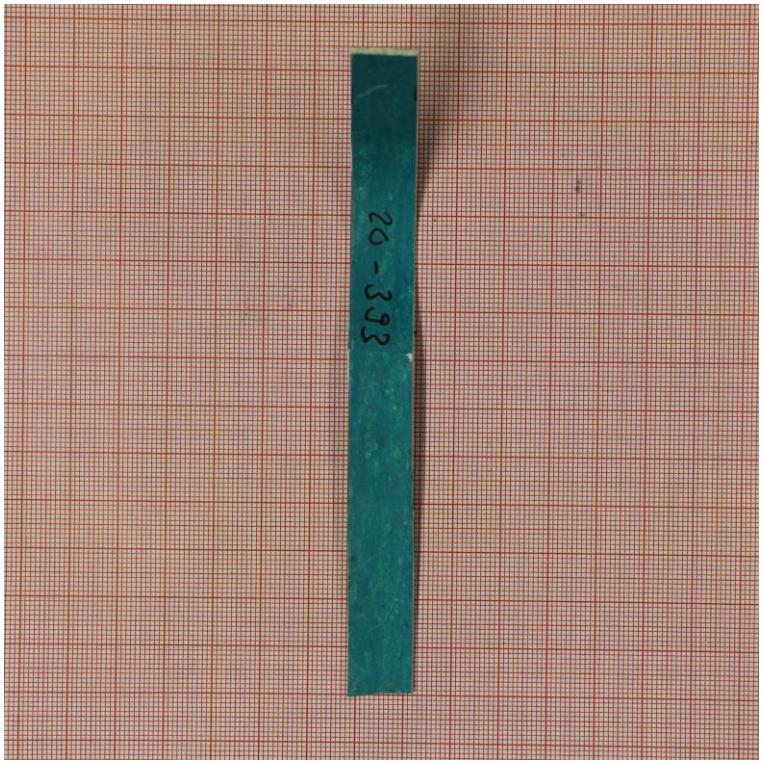
Residual stress test at 300 °C – 20-449



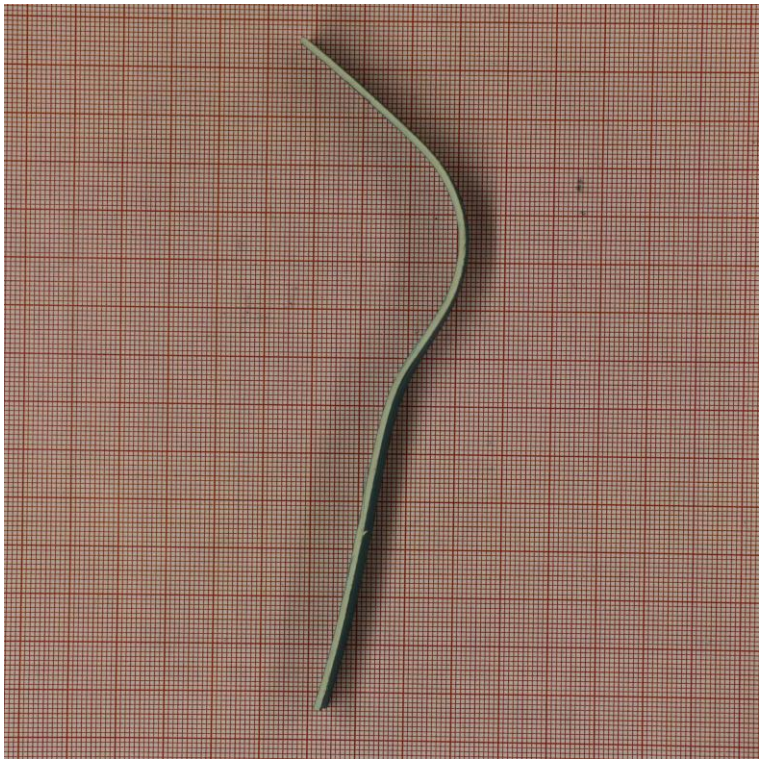
Flexibility test – 20-392



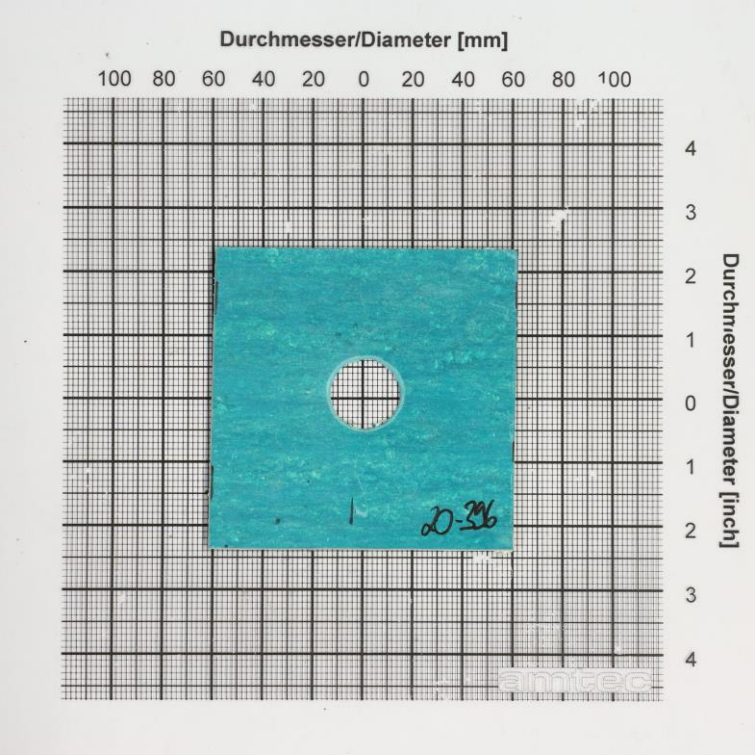
Flexibility test – 20-392



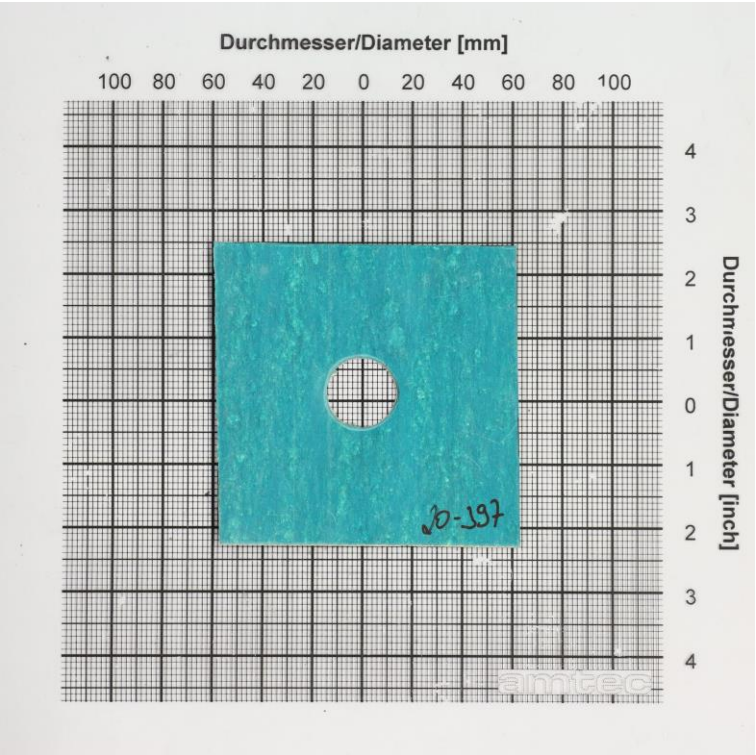
Flexibility test – 20-393



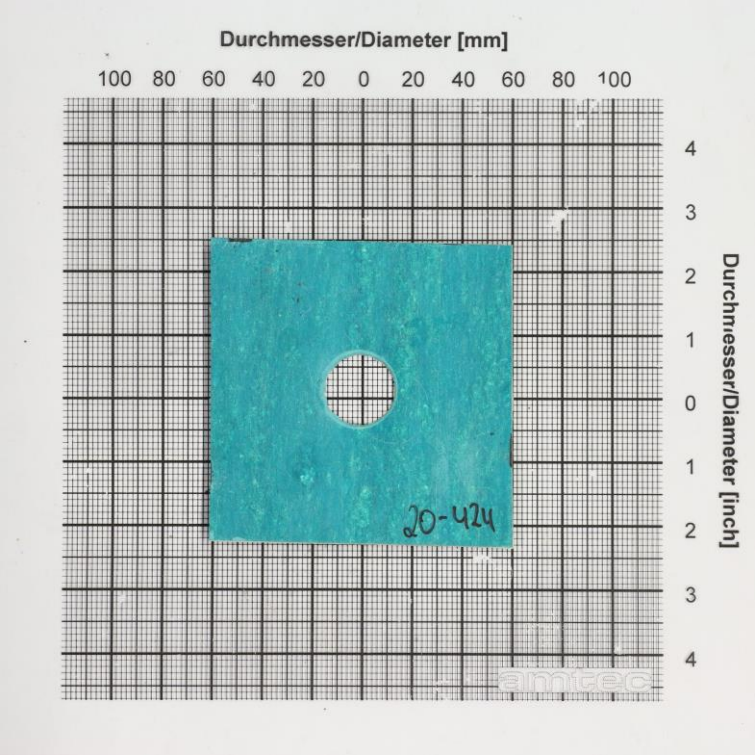
Flexibility test – 20-393



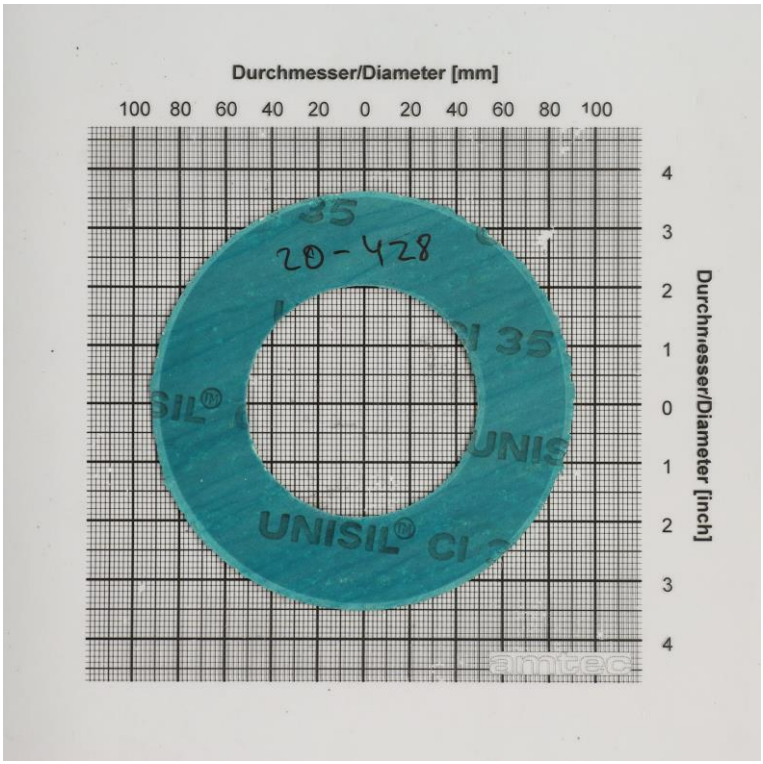
Compressibility test – 20-396



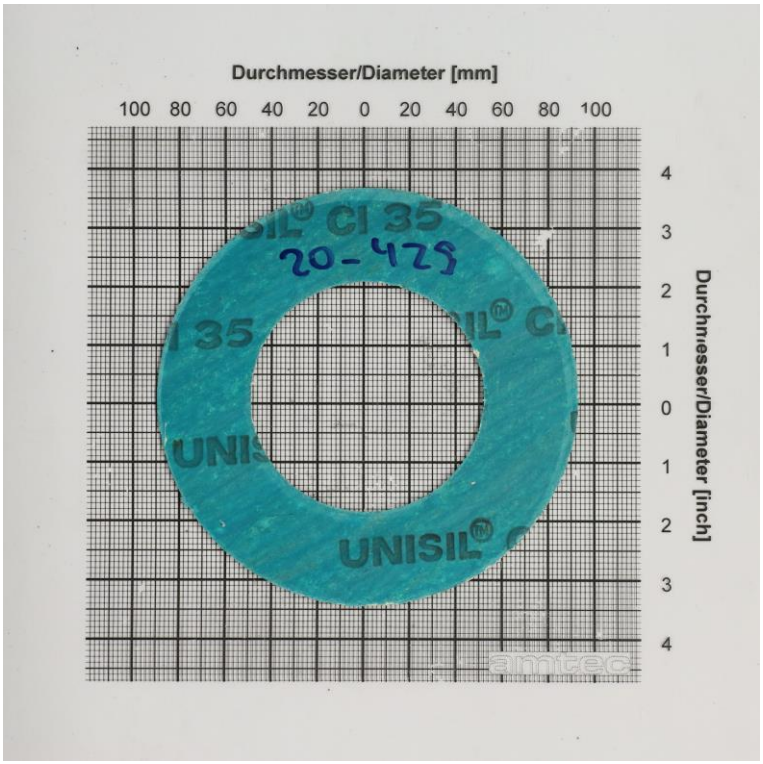
Compressibility test – 20-397



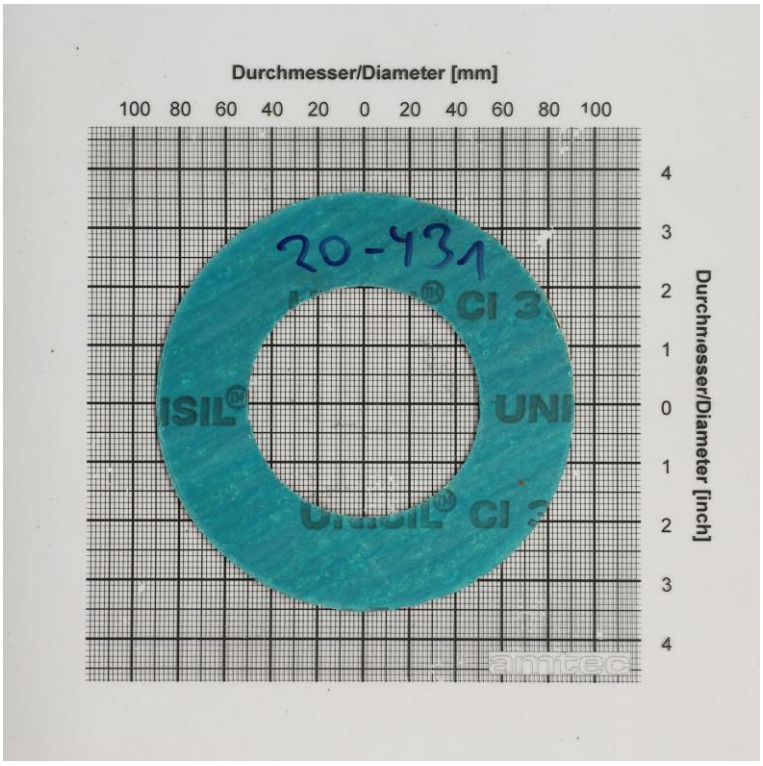
Compressibility test – 20-424



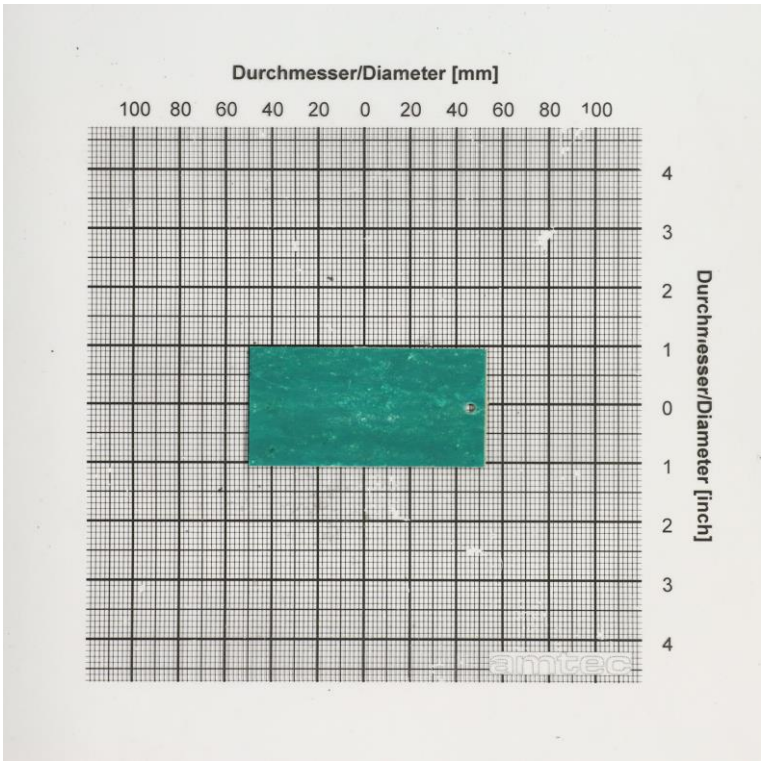
Gas permeability test at RT – 20-428



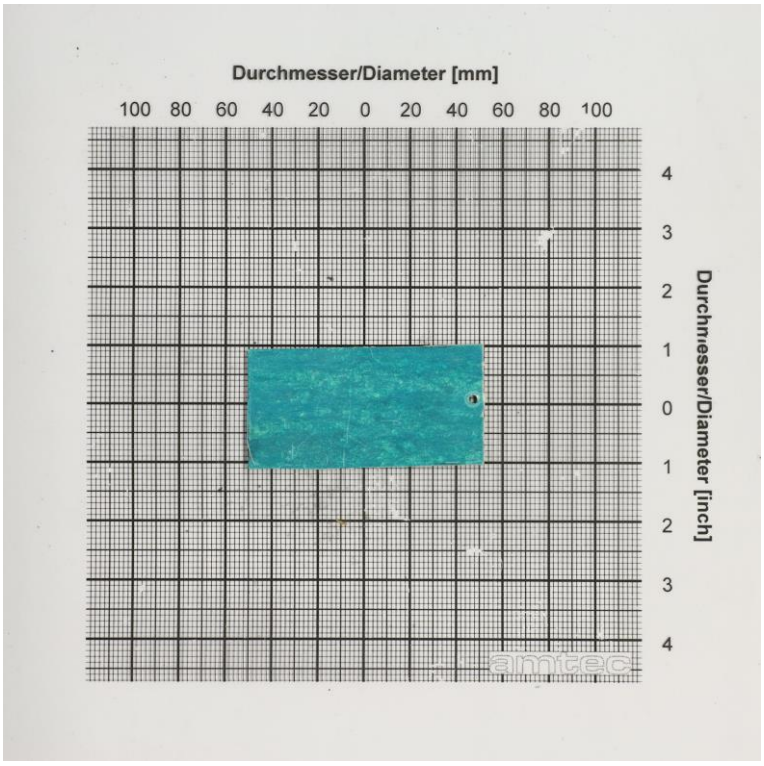
Gas permeability test at RT – 20-429



Gas permeability test at RT – 20-431



Resistance to fluids: Oil No. 3



Resistance to fluids: water