



Test Report

Customer: Kukil Inntot Co., Ltd.
17 Tapgeol-gil,
KOR - 689-871 Ulsan

Project number (amtec): 303 946
Report number: 303 946 1/-

Test procedure: Shell Specification MESC SPE 85/300
(dated February 2016)

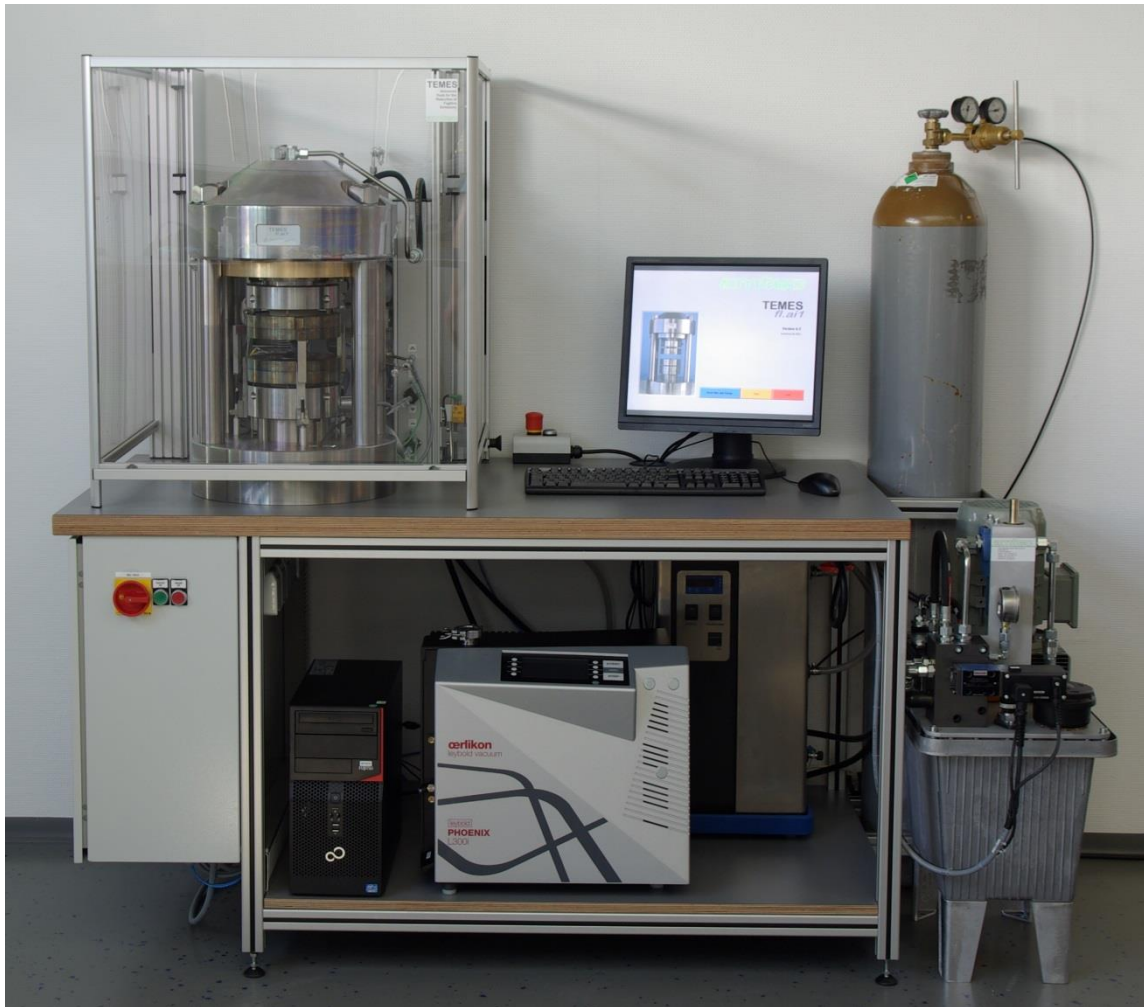
Material: K/# HIFLEX-HIFS

Date: March 19th, 2019
Pages: 15
Appendices: 32

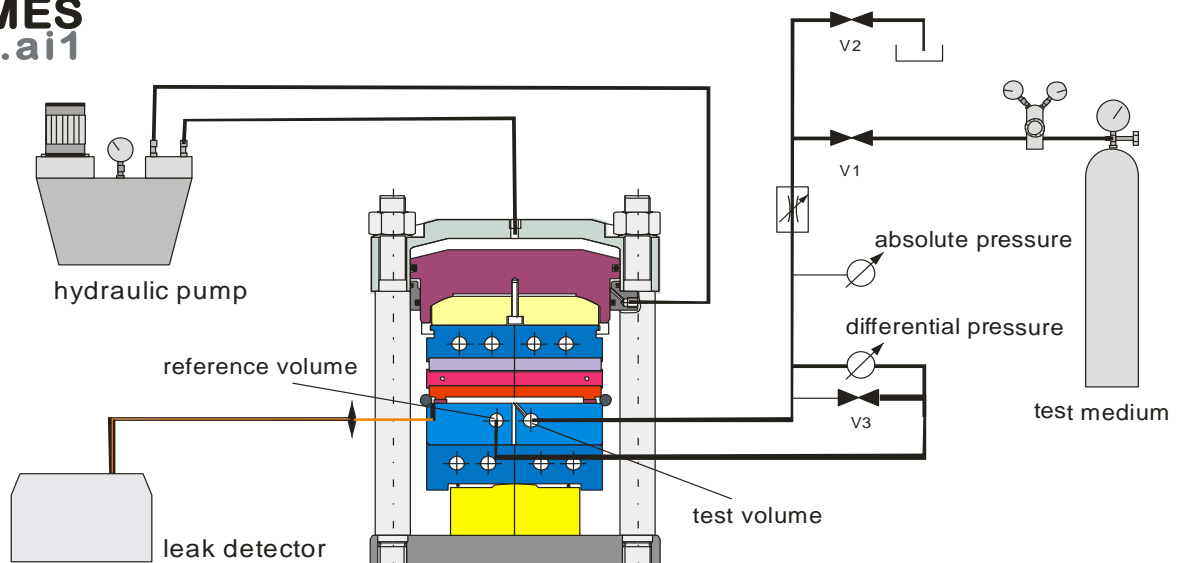
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Head of Laboratory

Dipl.-Ing. B. Unser
Test Engineer

Test results are only relevant to the test objects submitted.



TEMES
fl.ai1



Testing Equipment TEMES_{fl.ai1} (1000 kN)



Isolation testing device Megger MIT 525

Table 1: Data Sheet for Gasket Characteristics (EN13555)

Manufacturer: Kukil
Product: K/# HIFLEX-HIFS

Maximum allowable Gasket Stress Q_{smax} [MPa]

T [°C]	25	25	260	260
Q_{smax} [MPa]	100	100	100	100
test no.	18-927	18-930	18-928	18-931

Modulus of Elasticity E_G [MPa]

Q [MPa] \ T [°C]	25		25		260		260	
	E_G [MPa]	e_G [mm]	E_G [MPa]	e_G [mm]	E_G [MPa]	e_G [mm]	E_G [MPa]	e_G [mm]
0		6.350		6.210		6.330		6.330
1		5.896		5.880		5.913		5.942
20	1572	5.143	1541	5.186	4974	4.827	4218	4.890
30	2075	5.023	2271	5.075	4812	4.789	3944	4.835
40	3155	4.942	3221	4.982	4552	4.638	4625	4.678
50	3884	4.782	3804	4.786	6171	4.559	6379	4.598
60	5239	4.688	5342	4.673	8253	4.478	8782	4.523
80	9143	4.546	9765	4.545	16478	4.360	18340	4.405
100	14685	4.453	16965	4.431	27094	4.312	39151	4.349
test no.	18-927		18-930		18-928		18-931	

Creep-/Relaxation Factor P_{QR} [-]**Change in gasket thickness due to creep Δe_{GC} [μ m]**

C = 500 kN/mm \ T [°C]	25		260	
	P_{QR}	Δe_{GC} [μ m]	P_{QR}	Δe_{GC} [μ m]
50	0.97	31	0.74	197
test no.	18-935	18-940	18-937	18-944

Table 2: Data Sheet for Gasket Characteristics (EN13555)

Manufacturer: Kukil
Product: K/# HIFLEX-HIFS

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

p [bar] \ L	0.1	0.01	0.001	0.0001	0.00001	1.00E-06	1.00E-07	1.00E-08
40	5	9	13	17	22	43	80	-
test no.	18-938							
40	6	9	13	19	28	42	71	-
test no.	18-956							

Minimum required Gasket Stress in Operation $Q_{smin(L)}$ [MPa]

$p = 40$ bar	Q_A [MPa] \ L	0.1	0.01	0.001	0.0001	0.00001	1.00E-06	1.00E-07	1.00E-08
	10	5	8	-	-	-	-	-	-
20	5	5	8	13	-	-	-	-	
40	5	5	7	8	12	-	-	-	
60	5	5	6	8	12	40	-	-	
80	5	5	6	8	12	40	80	-	
100	5	5	6	8	12	26	80	-	
test no.	18-938								

Minimum required Gasket Stress in Operation $Q_{smin(L)}$ [MPa]

$p = 40$ bar	Q_A [MPa] \ L	0.1	0.01	0.001	0.0001	0.00001	1.00E-06	1.00E-07	1.00E-08
	10	5	8	-	-	-	-	-	-
20	5	5	9	17	-	-	-	-	
40	5	5	9	12	18	-	-	-	
60	5	5	9	10	17	40	-	-	
80	5	5	6	8	15	35	70	-	
100	5	5	6	8	11	24	65	-	
test no.	18-956								

Table 3: Data Sheet for Gasket Characteristics (Shell)

Manufacturer: Kukil
Product: K/# HIFLEX-HIFS

Shell leakage test at ambient temperature

Test pressure:	51 bar
Shell required gasket stress level:	62.5 MPa
Leakage rate:	5.57E-12 Pa·m ³ /s/mm
Shell tightness class:	A
test no.	18-942

Shell leakage test at 260 °C

Test pressure:	41.9 bar
Gasket stress level:	62.5 MPa
Leakage rate:	2.63E-09 Pa·m ³ /s/mm
Shell tightness class:	B
test no.	18-947

Shell cycle test at 260 °C

Test pressure:	41.9 bar
Initial gasket stress level:	62.5 MPa
Pressure drop in last cycle:	< 0.1 bar
Requirements:	passed
test no.	18-933

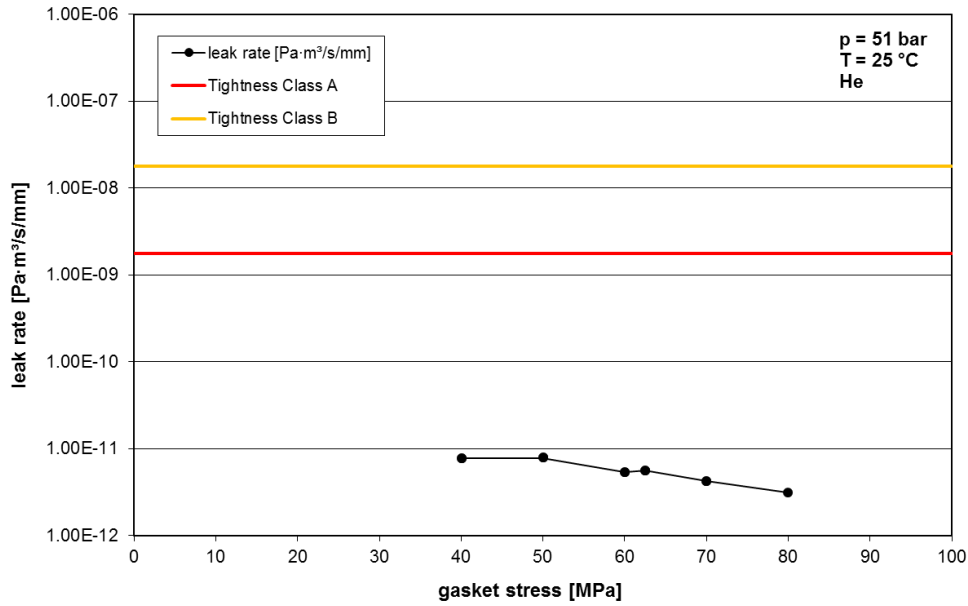
Hot Blowout Test (HOB T1)

Test pressure:	62.9 bar
Gasket stress level:	34.5 MPa
Temperature:	260 °C
Requirements:	passed
test no.	18-941

Electrical Isolation Test

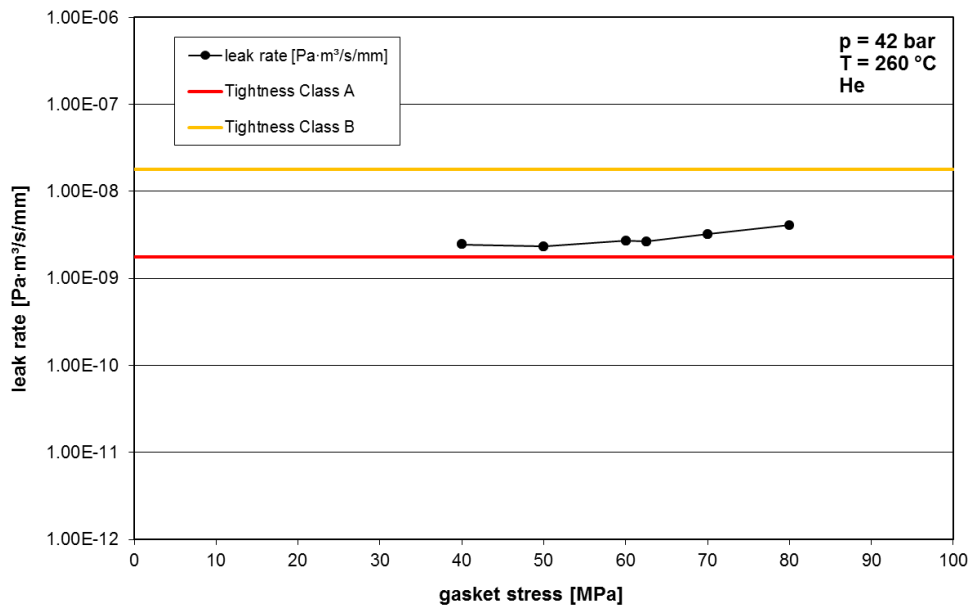
Initial gasket stress level:	68 MPa
Voltage (DC):	1500 V
Resistance flange to bolt (average):	1.68 TΩ
Resistance flange to flange:	362 GΩ
Requirements:	passed
test no.	19-112

Leakage curve
K/# HIFLEX-HIFS 153.28x108.99x6.22 mm
Test number: 18-942



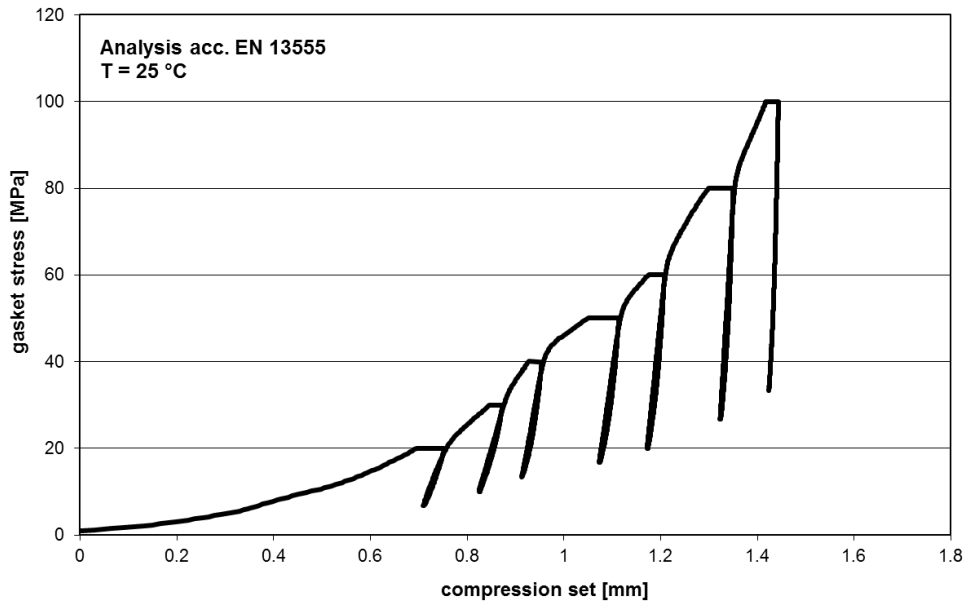
Shell leakage test (RT) according MESC SPE 85/300 - 3.3.2

Leakage curve
K/# HIFLEX-HIFS 153.31x108.52x6.15 mm
Test number: 18-947

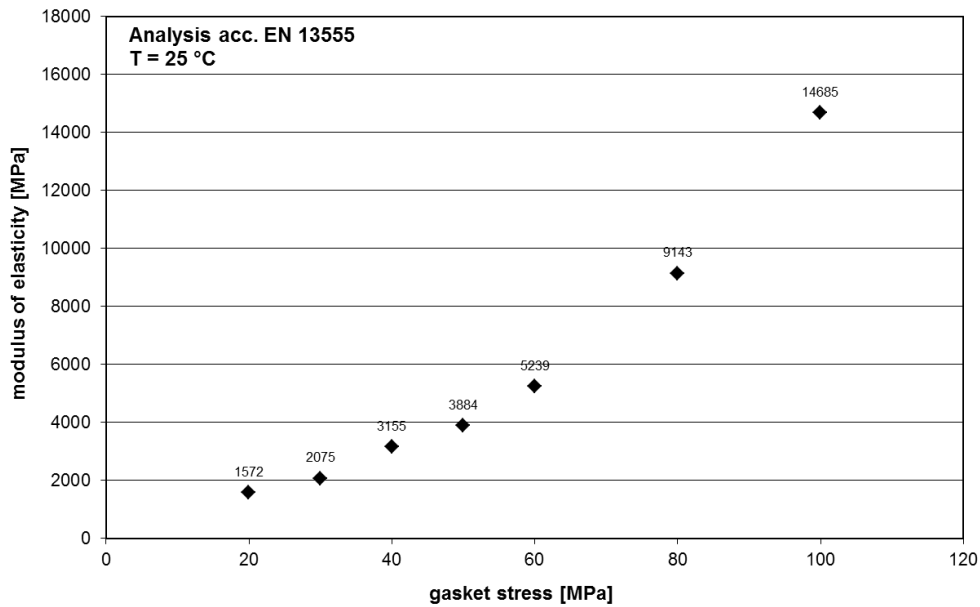


Shell leakage test (260 °C) according MESC SPE 85/300 - 3.3.2

Compression curve
 K/# HIFLEX-HIFS 153.63x108.75x5.896 mm
 Test number: 18-927

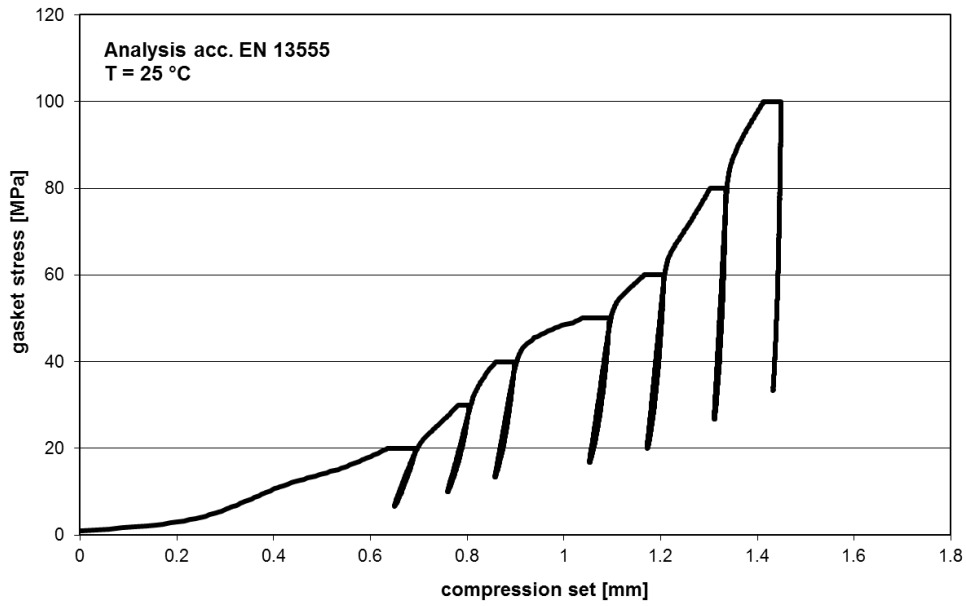


Modulus of elasticity
 K/# HIFLEX-HIFS 153.63x108.75x5.896 mm
 Test number: 18-927

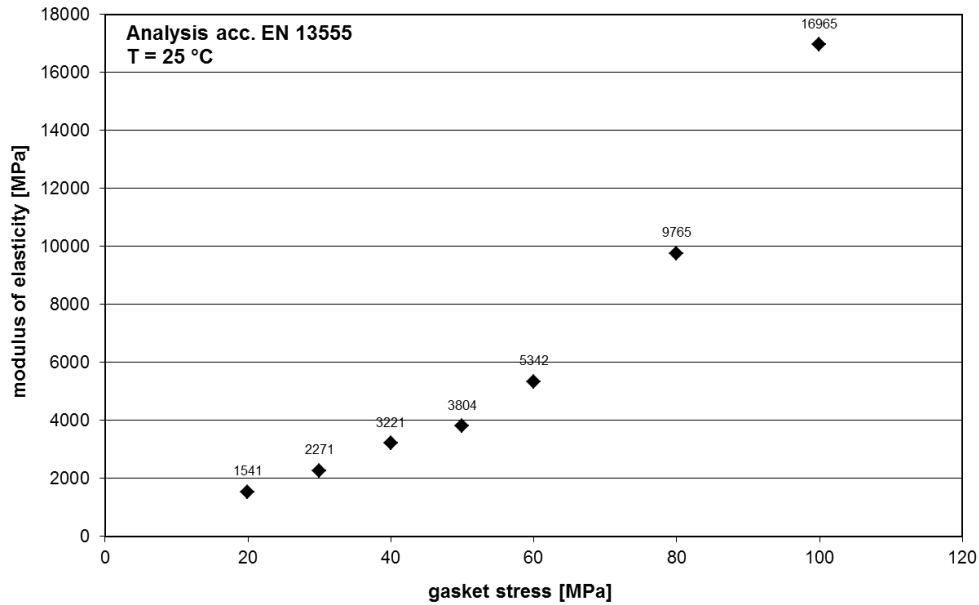


Compression test (RT) according EN 13555

Compression curve
 K/# HIFLEX-HIFS 153.33x108.51x5.88 mm
 Test number: 18-930

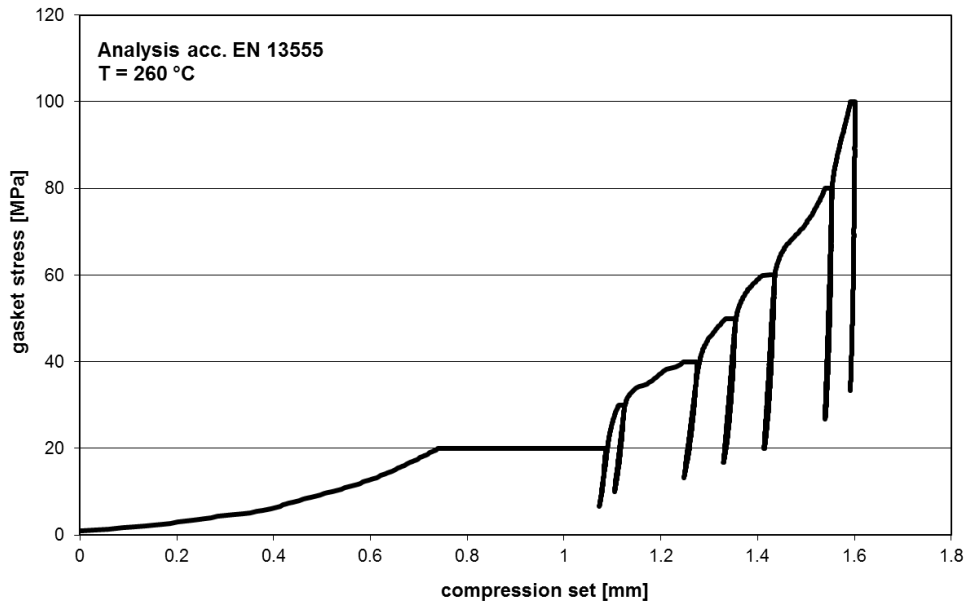


Modulus of elasticity
 K/# HIFLEX-HIFS 153.33x108.51x5.88 mm
 Test number: 18-930

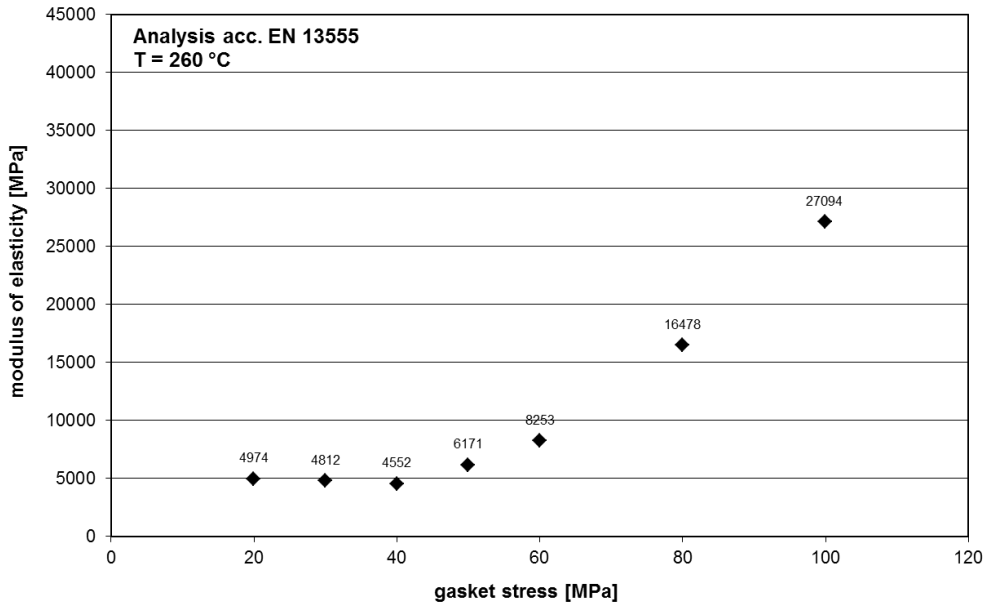


Compression test (RT) according EN 13555

Compression curve
 K/# HIFLEX-HIFS 153.4x108.63x5.913 mm
 Test number: 18-928

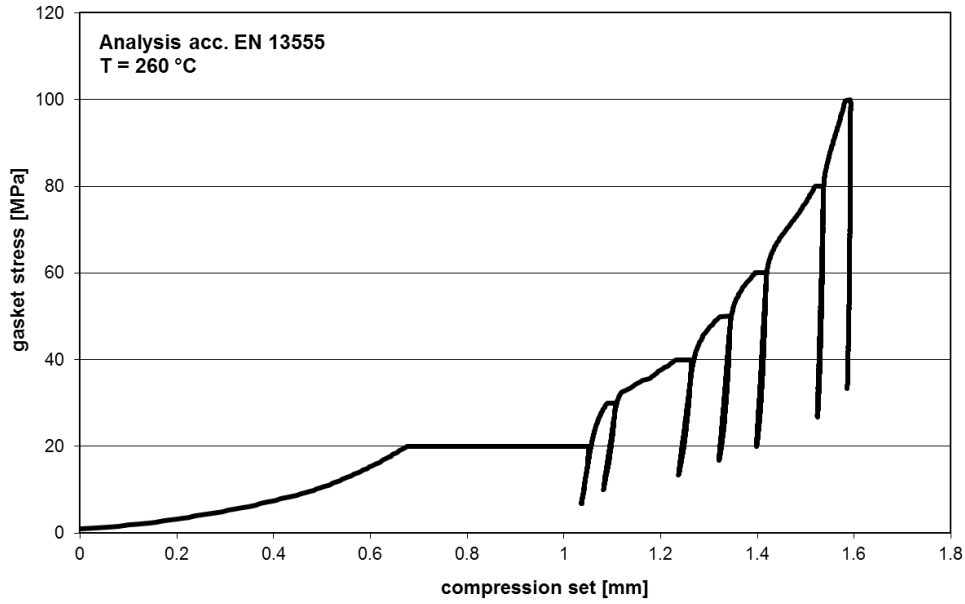


Modulus of elasticity
 K/# HIFLEX-HIFS 153.4x108.63x5.913 mm
 Test number: 18-928

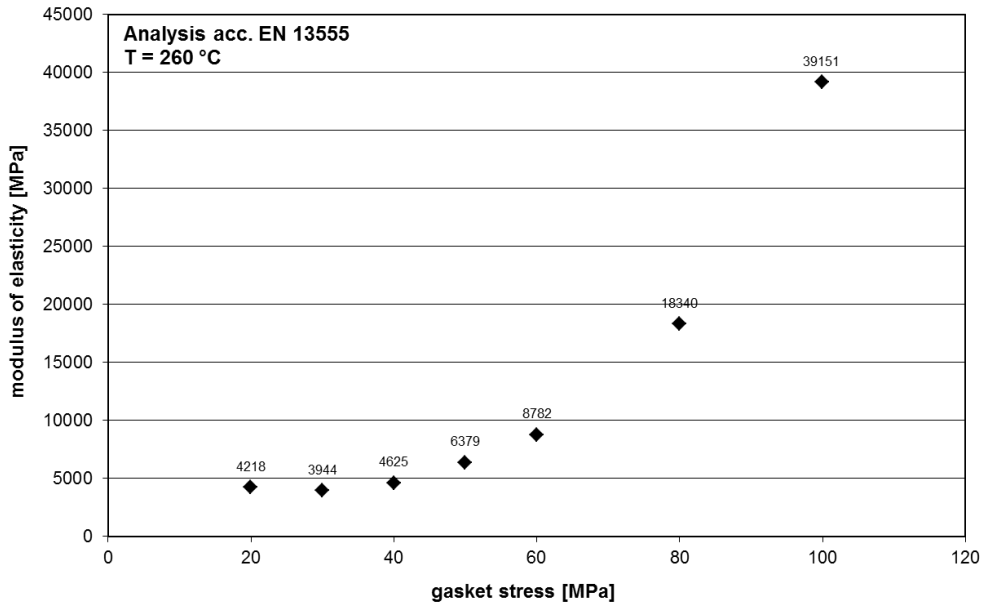


Compression test at 260 °C according EN 13555

Compression curve
K/# HIFLEX-HIFS 153.24x108.86x5.942 mm
Test number: 18-931



Modulus of elasticity
K/# HIFLEX-HIFS 153.24x108.86x5.942 mm
Test number: 18-931



Compression test at 260 °C according EN 13555

Creep relaxation test (EN 13555)

K/# HIFLEX-HIFS
153.54x108.53x5.98 mm
Test number: 18-935

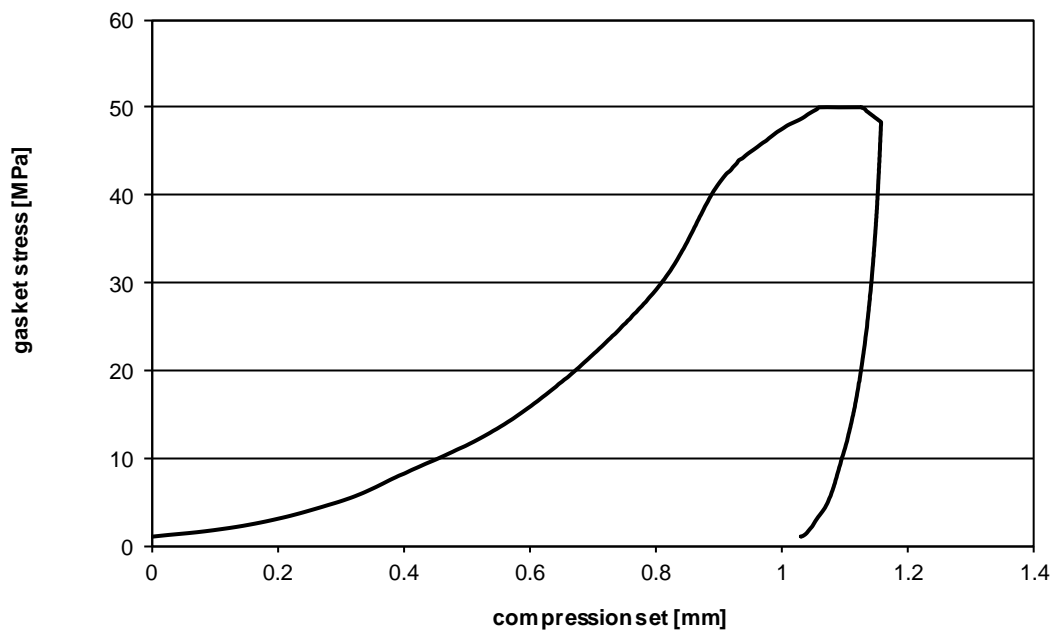
Test parameters

Initial gasket stress Q_i :	50	MPa
Test temperature T_P :	25	°C
Time at T_P :	4:00	hh:mm
Stiffness C:	500	kN/mm

Test results

Remaining gasket stress Q_r :	48.3	MPa
Relaxation factor $P_{QR}(T_P)$:	0.97	
Deflection Δe_{GC} :	31	μm

Compression creep curve
K/# HIFLEX-HIFS 153.54x108.53x5.98 mm
Test number: 18-935



Creep relaxation test (EN 13555)

K/# HIFLEX-HIFS
153.27x108.9x6.058 mm
Test number: 18-940

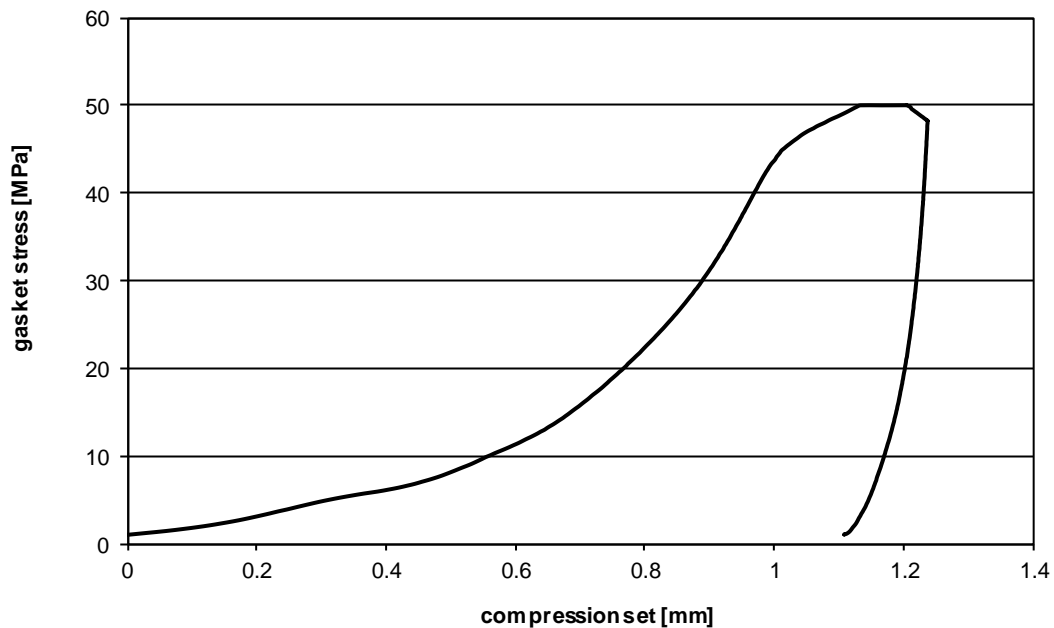
Test parameters

Initial gasket stress Q_i :	50	MPa
Test temperature T_P :	25	°C
Time at T_P :	3:59	hh:mm
Stiffness C:	500	kN/mm

Test results

Remaining gasket stress Q_r :	48.2	MPa
Relaxation factor $P_{QR}(T_P)$:	0.96	
Deflection Δe_{GC} :	32	μm

Compression creep curve
K/# HIFLEX-HIFS 153.27x108.9x6.058 mm
Test number: 18-940



Creep relaxation test (EN 13555)

K/# HIFLEX-HIFS
153.28x108.85x5.929 mm
Test number: 18-937

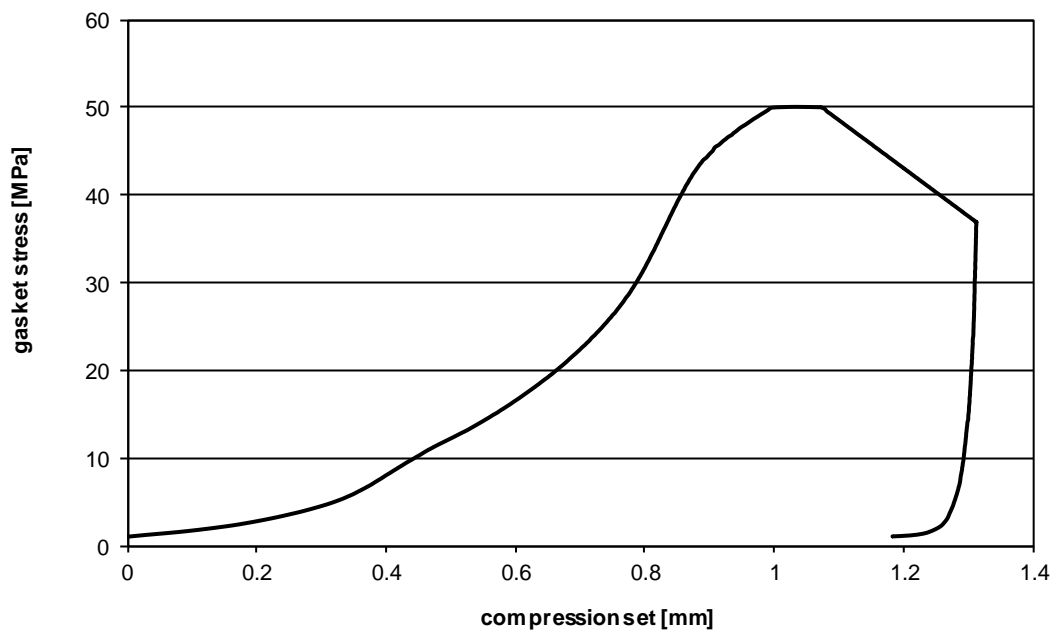
Test parameters

Initial gasket stress Q_i :	50	MPa
Test temperature T_P :	260	°C
Time at T_P :	3:59	hh:mm
Stiffness C:	500	kN/mm

Test results

Remaining gasket stress Q_r :	36.9	MPa
Relaxation factor $P_{QR}(T_P)$:	0.74	
Deflection Δe_{GC} :	240	μm

Compression creep curve
K/# HIFLEX-HIFS 153.28x108.85x5.929 mm
Test number: 18-937



Creep relaxation test (EN 13555)

K/# HIFLEX-HIFS
153.18x108.54x5.913 mm
Test number: 18-944

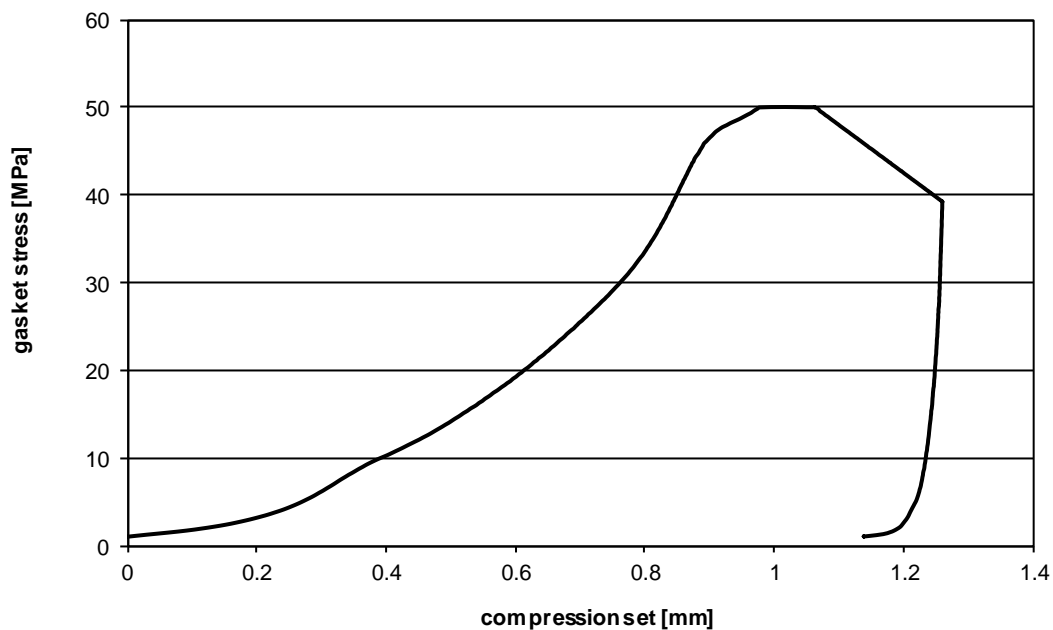
Test parameters

Initial gasket stress Q_i :	50	MPa
Test temperature T_P :	260	°C
Time at T_P :	3:59	hh:mm
Stiffness C:	500	kN/mm

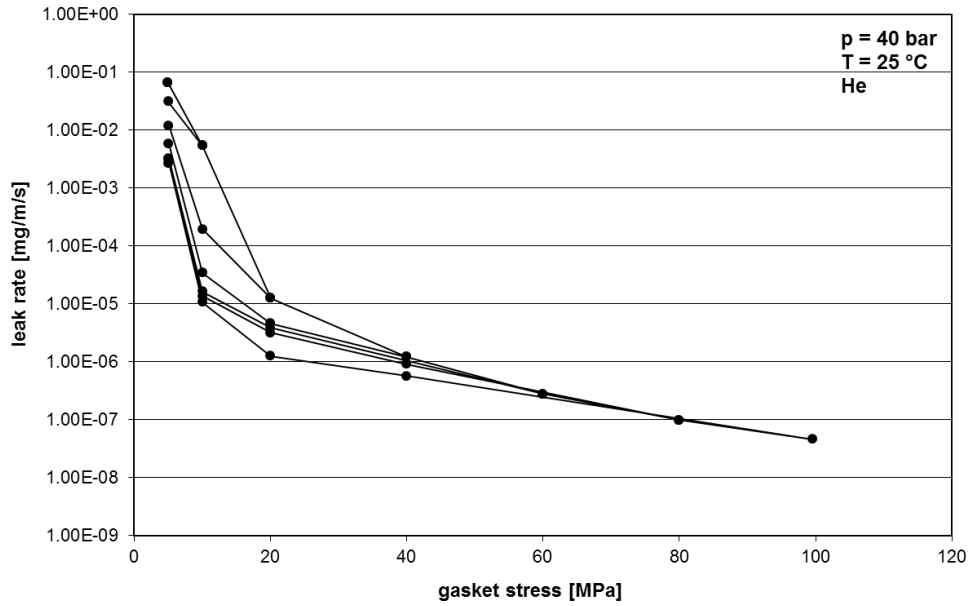
Test results

Remaining gasket stress Q_r :	39.2	MPa
Relaxation factor $P_{QR}(T_P)$:	0.78	
Deflection Δe_{GC} :	197	μm

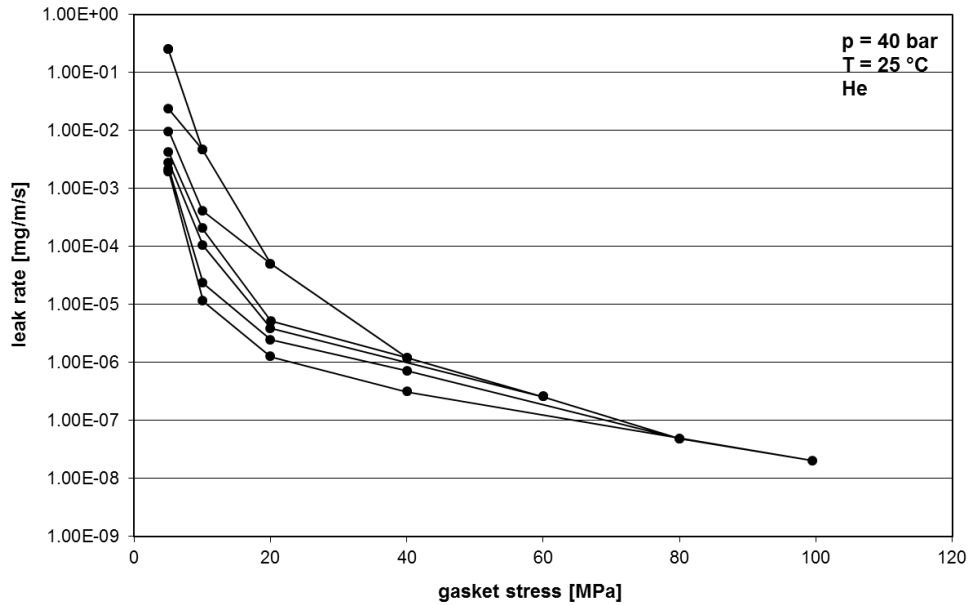
Compression creep curve
K/# HIFLEX-HIFS 153.18x108.54x5.913 mm
Test number: 18-944



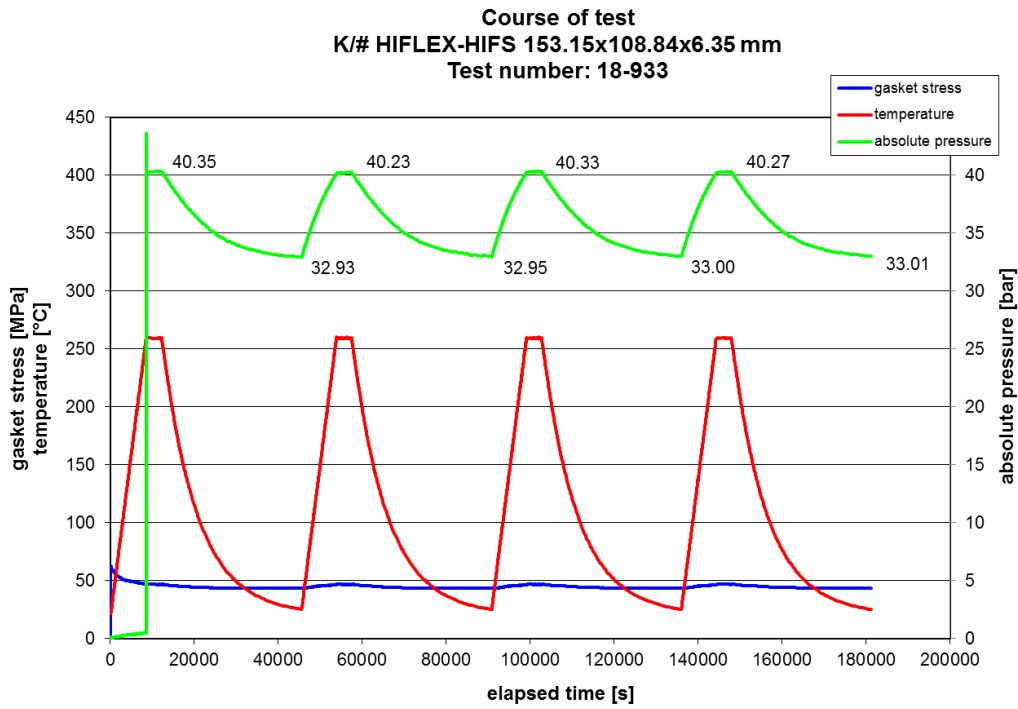
Leakage curve
K/# HIFLEX-HIFS 153.27x108.79x6.031 mm
Test number: 18-938



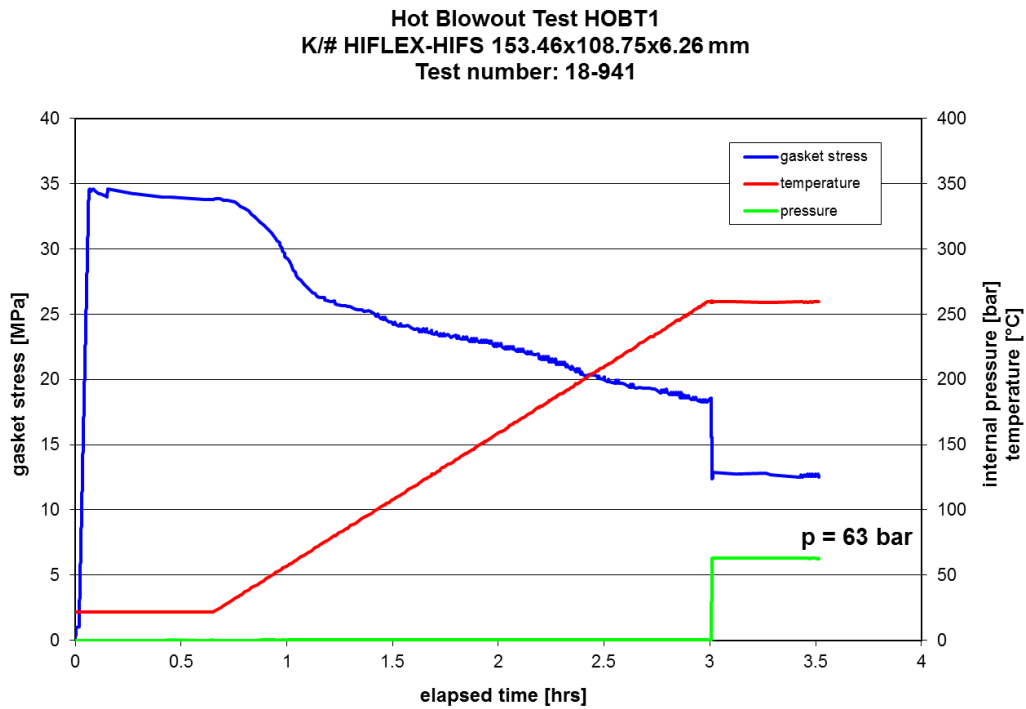
Leakage curve
K/# HIFLEX-HIFS 153.35x108.38x5.867 mm
Test number: 18-956



Leakage test according EN 13555



Shell cycle test at 260 °C according MESC SPE 85/300 - 3.3.5



Hot Blowout Test (HOBT1) according MESC SPE 85/300 - 3.3.6

Hot Blowout Test HOBT1

K/# HIFLEX-HIFS
153.46x108.75x6.26 mm
Test number: 18-941

Test parameters

Nominal initial gasket stress:	5000 psi	34.5 MPa
Nominal pressure:	912 psi	63 bar

Test results

Initial gasket thickness:	0.2465 in	6.26 mm
Final gasket thickness:	0.1905 in	4.84 mm
Initial gasket stress:	5020 psi	34.6 MPa
Actual test pressure:	911 psi	63 bar
Gasket stress S_g :	2672 psi	18.4 MPa
Gasket temperature T_g :	499 °F	259 °C

Hot Blowout Test (HOBT1) according MESC SPE 85/300 - 3.3.6

Isolation Test 19-112 Kukil K/# HIFLEX-HIFS

geometries

bolts	8
OD gasket Element 1	153.4 mm
ID gasket Element 1	108.9 mm
Height gasket Element 1	6.4 mm
mean gasket circumference Element	412.02 mm
gasket area Element	9167.44 mm ²
gasket contact area	9167.44 mm ²
OD raised faces flange (4" Class 300)	155 mm

calculation of gasket stress

hydraulic mounting device	
calibration factor	0.14 kN/bar
pressure	574 bar
force per bolt	77.92 kN
force total	623.39 kN
gasket stress	68.00 MPa

gauge

type	MIT525	
identification	I001011	

isolation test

measuring time	60.00 s
measuring voltage	1500.00 VDC
minimum insulation resistance	100.00 MΩ

measuring data

flange to bolt		
	1	1.01 TΩ
	2	2.00 TΩ
	3	1.30 TΩ
	4	2.00 TΩ
	5	2.00 TΩ
	6	1.10 TΩ
	7	2.00 TΩ
	8	2.00 TΩ
average		1.68 TΩ
flange to flange		362.00 GΩ

The insulation resistance of the gasket is higher than the minimum required value and satisfies the requirements of the SPE85-300.

Electrical Isolation Test – overview



Top flange gasket adhesion



Bottom flange gasket adhesion



Shell leakage test (RT) according MESC SPE 85/300 - 3.3.2



Shell leakage test (T) according MESC SPE 85/300 - 3.3.2



Compression test at RT (EN 13555)



Compression test at RT (EN 13555)



Compression test at 260 °C (EN 13555)



Compression test at 260 °C (EN 13555)



Creep relaxation test at 50 MPa - RT (EN 13555)



Creep relaxation test at 50 MPa - RT (EN 13555)



Creep relaxation test at 50 MPa - 260 °C (EN 13555)



Creep relaxation test at 50 MPa - 260 °C (EN 13555)



Leakage test at RT (EN 13555)



Leakage test at RT (EN 13555)



Shell cycle test (T) according MESC SPE 85/300 - 3.3.5



HOBT1 according MESC SPE 85/300 - 3.3.6