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TTRL
Tightness Testing and Research Laboratory

TECHNICAL REPORT

Quotation	:	S250501-A1
Item No.02	:	HOBT2 without thermal cycle, Helium at 435 psig on Teadit special PFTE-based with silica gasket sheet, 3½"ID x 5"OD x 1/16" thick.
Gasket Ref.	:	TD10

Client	:	Teadit Indústria e Comércio Ltda. Av. Automóvel Clube, 8939 - Colégio 21530-010 Rio de Janeiro – RJ, Brazil
Contact	:	Denise Simão

Test Technician	:	Thierry Lafrance, jr eng.
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Le génie sans frontières

Technical Report

Hot Blow-out Test – Without thermal cycle

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Technical Report

Hot Blow-out Test – Without thermal cycle

Test Purpose

Increasing use of PTFE gasket products for difficult service and as substitute for asbestos and nonasbestos fiber reinforced materials has fostered interest in developing standard test protocols that measure and qualify the performance of PTFE based gaskets on the basis of a direct measure of their margin of safety against blow-out. This has led to the development of a Hot Blow-out Test (HOBT) for gauging PTFE gasket tightness performance under extreme relaxation conditions.

The main goal of this test is to determine the gasket resistance to hot relaxation and the gross leakage susceptibility to blow-out conditions.

Test Procedure Summary

The test consists to slowly heat the compressed gasket under a fixed internal helium pressure until a blow-out occurs. The test is performed twice for results repeatability evaluation. The whole description of the procedure is presented in Appendix 2. For quick reference, the procedure is summarized as follows:

- Testing rig : Hot Blow-out Test Rig
- Rig flanges : NPS 3" Class 150 Slip-on
- Rig bolts : 4 bolts 5/8"-18UNF
- Pressurizing gas : Helium 4
- Nominal gas pressures : 435 psig
- Nominal initial gasket stress : 5000 ± 250 psi
- Initial gasket temperature : 75 ± 5 °F
- Heating rate : 3.0 °F/min.

Gasket Specimens

- Teadit special PTFE-based with silica gasket sheet
- Nominal gasket inside diameter : 3.5"
- Nominal gasket outside diameter : 5.0"
- Nominal gasket area : 10.0 in^2
- Nominal gasket thickness : 0.063"

Note : The gasket sheets were cut in our facility to the required nominal gasket dimensions. The nominal gasket area is computed using the nominal gasket diameters which are measured before loading. Any increase in gasket area upon loading is not taken into account.

Tests Results

The two tests are identified by the test numbers TD10HB01 and TD10HB02. The results are summarized in Tables 1 and 2, and are presented graphically in Figs 1 and 2.

- Table 1 compares the initial and the final gasket dimensions.
- Table 2 summarizes the test results. Since **no blow-out was recorded** during the tests for the present material, the maximum test temperature and the minimum gasket stress are given in place of the blow-out parameters.
- Figure 1 gives an overview of the tests. The gasket stress and the gasket temperature are plotted as a function of the elapsed time. The steps presented in the figure are described in details in Appendix 2.
- Figure 2 shows the relationship between the gasket stress and the gasket temperature. A very good repeatability of the test results can be observed in this figure.
- Photos1, 2 and 3 show an untested and the two tested gasket samples after they were removed from the test rig.

Repeatability

Tables 1 and 2, as well as Figure 2, show a very good repeatability of the test results.

PTFE-based Material Extrusion – Table 1

At the end of the test, it was observed that the material has extruded out of the raised face flange surfaces in the inner and outer directions. The final width of the gaskets is 0.98 in. as compared 0.75 in., their initial width values. Also, the gaskets did not recover their initial thicknesses after the cool down showing a permanent thickness change of 0.019 in..

Table 1 Gasket specimen's initial and final dimensions

Test No.	Test No.	Inside Diameter (in)		Outside Diameter (in)		Gasket width (in)		Gasket thickness (in)	
		Initial	Final	Initial	Final	Initial	Final	Initial	Final
1	TD10HB01	3.50	3.34	5.00	5.29	0.75	0.98	0.060	0.041
2	TD10HB02	3.50	3.34	5.00	5.29	0.75	0.98	0.059	0.040

Blow-out Characteristics – Table 2

According to this test procedure, the Teadit special PTFE-based with silica gasket sheet has a blow-out temperature above 692 °F, the maximum test temperature, since no blow-out was recorded during the tests. The minimum gasket stress of 360 psi was measured at 650 °F. This is below the nominal gas pressure of 435 psig, indicating a possible adhesion of the gasket to the flange surfaces.

Table 2 Summary of test results

Characteristic	Max gasket temperature **(no blow-out)** (°F)		Minimum gasket stress (at 650 °F) (psi)		Helium pressure at max temperature (psi)	
	TD10HB01	TD10HB02	TD10HB01	TD10HB02	TD10HB01	TD10HB02
Test value	692	692	361	371	439	405
Average values	692		366		422	

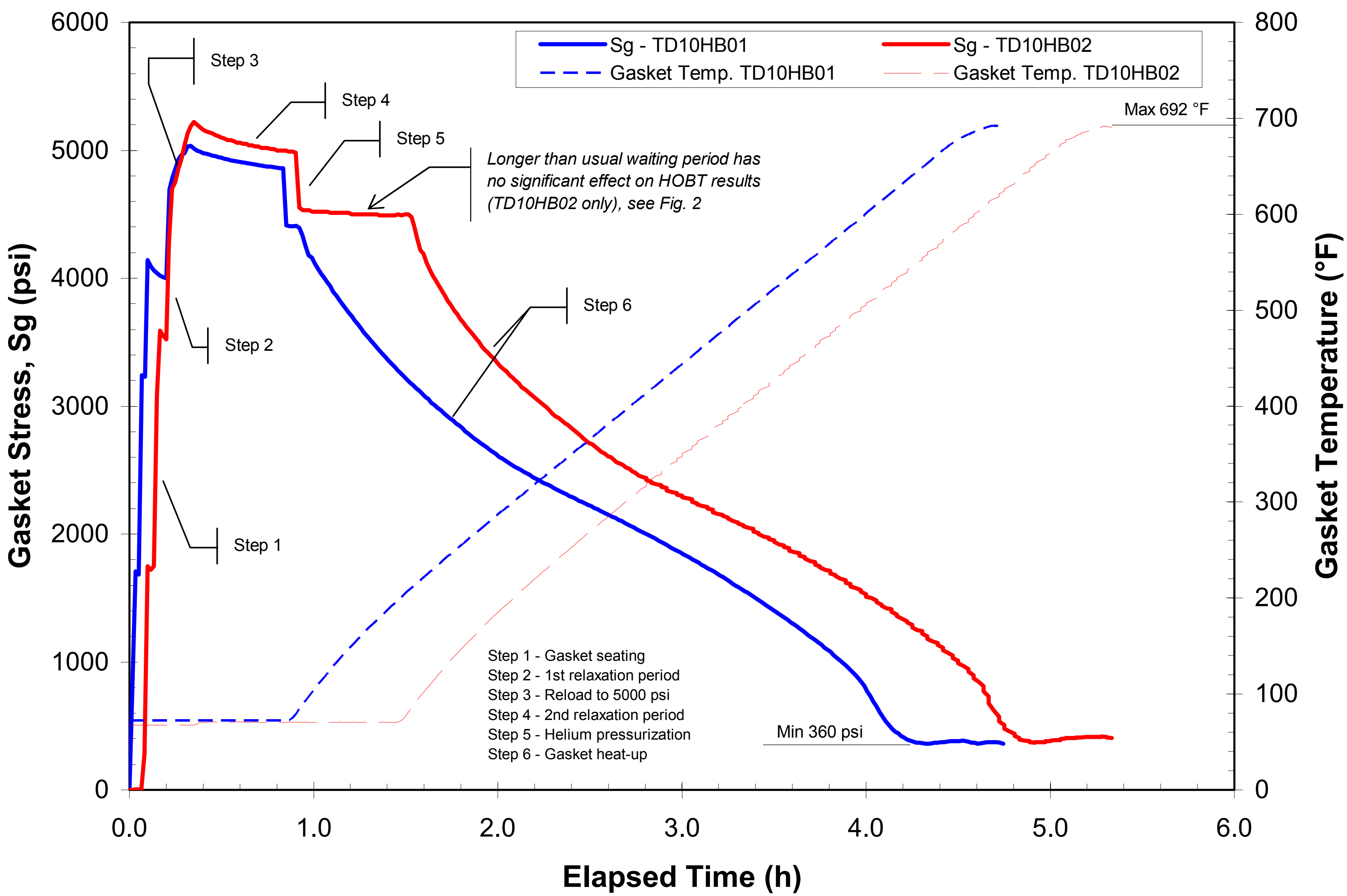
Creep/Relaxation Behaviour – Figure 2

In both HOBT tests, the gasket stress relaxation is relatively rapid at the beginning of heating but it decreases to a minimum rate value (slope of curves) at about 300° F. From that point, the relaxation curves show a curvature reversal and this behaviour pattern characterizes gaskets with an intermediate safety reserve. Between 600 °F and 650 °F, the gaskets experience a rapid stress relaxation that stabilises at a minimum gasket stress value of 360-370 psi. From 650°F up to 692°F, the maximum temperature reached during the tests, no significant amount of relaxation was recorded and both tests ended without a blow-out.

Tested Gasket Appearance – Photography 1, 2 and 3

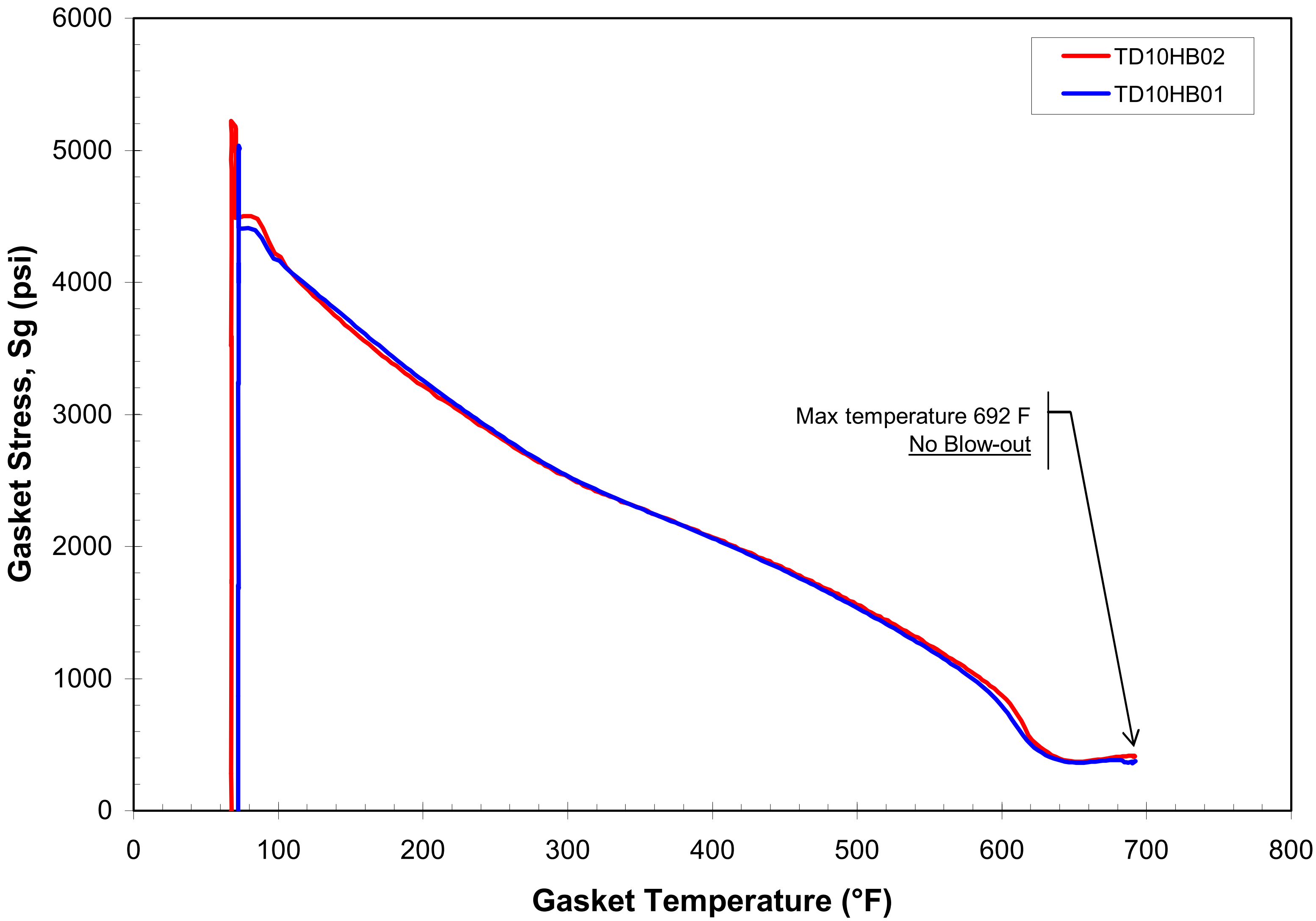
After cool down to room temperature, the gaskets samples were removed from the test rig and visually inspected. We observed the following for both samples:

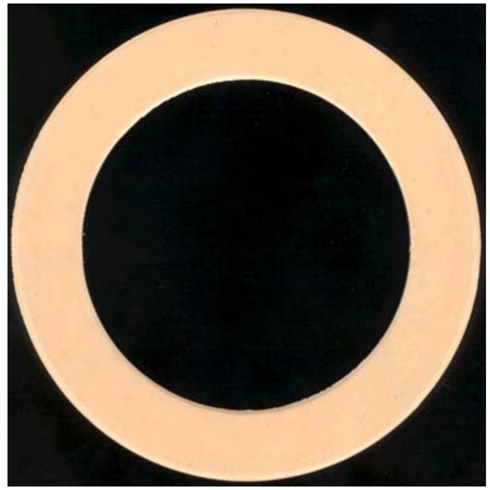
- The gaskets have a regular geometry showing some radial extrusion in both the inner and the outer directions;
- The color of the gaskets is unchanged on most of their surfaces. However, there are some discoloured spots (beige color) in the area compressed by the flanges. In these spots, the gasket material has a rougher texture.



Sg - TD10HB01
Sg - TD10HB02
Gasket Temp. TD10HB01
Gasket Temp. TD10HB02
Step 1
Step 2
Step 3
Step 4
Step 5
Step 6
Longer than usual waiting period has no significant effect on HOBT results (TD10HB02 only), see Fig. 2
Max 692 °F
Min 360 psi
Step 1 - Gasket seating
Step 2 - 1st relaxation period
Step 3 - Reload to 5000 psi
Step 4 - 2nd relaxation period
Step 5 - Helium pressurization
Step 6 - Gasket heat-up
Gasket Stress, Sg (psi)
Gasket Temperature (°F)
Elapsed Time (h)
0
1000
2000
3000
4000
5000
6000
100
200
300
400
500
600
700
800
0.0
1.0
2.0
3.0
4.0
5.0
6.0

Figure 2
Gasket Stress VS Gasket Temperature





Photography 1
Untested gasket sample

Photography 2
Tested gasket sample TD10HB01

Photography 3
Tested gasket sample TD10HB02

Appendix 1 Testing Equipment and Measurement Instruments

- Testing rig : Hot Blow-out Test Rig
- Leak measurement : Pressure transducer OMEGA, model PX303-2KG10V
- Data acquisition : AGILENT Data acquisition / Switch unit, model 34970A
- Temperature : Type J and K thermocouples
- Temperature controller : OMEGA Engineering, model CN77342-C2
- Bolt load and gasket stress : Instrumented bolts with strain gages
- Gasket dimensions : Mitutoyo calliper, model CD-8"P

Appendix

2 Hot Blow-out Test Description

Summary of Test Method

The Hot Blow-out Test can be described as being a six steps procedure. The first step seats the gasket by conducting a sequential room temperature loading. The second step is short waiting period for gasket creep and relaxation. The third step reloads the gasket to the nominal gasket stress of 5000 psi. The fourth step is a second waiting period that allows the gasket to creep and relax. The fifth step is the helium pressurization of the gasket while the sixth and final step heats the gasket until a blow-out occurs or until the maximum temperature of the rig is reached.

Apparatus

The Hot Blow-out Test Rig per figure 1 is designed to reproduce hot blow-out conditions in a real gasketed flanged joint subjected to a maximum compressive load of 50000 lb, at a working temperature of up to 750 °F and with helium gas pressure up to 1000 psig. Tested gaskets are NPS 3", 3.5" ID x 5" OD for sheet gaskets, with a surface area of about 10 in^2.

The rig is composed of a pair of standard NPS 3" Class 150 flanges with raised faces. Both flanges are welded to schedule 80 pipes and are equipped with four 5/8" – 18 UNF high-strength steel bolts. The flange surface finish is in accordance with the ASME/ANSI B16.5 standard. The joint axial rigidity is evaluated to 4.4x10^6 lb/in.

Flanges are mounted on a steel cylindrical core welded to a steel base plate. Gasket loading is performed with a torque wrench, and the usual criss-cross sequence is used to torque the four bolts. These calibrated bolts are equipped with special extensometers to measure the bolt stretch that is converter to bolt load. Each extensometer consists of a pair of long ceramic rods that are spring loaded. The extensometers are compensated for thermal effects. To measure bolt strech, a displacement transducer is placed at the end of each extensometer. These transducers are placed at the bottom of the rig, well below the heated zone, and measure the relative displacement between the pair of ceramic rods.

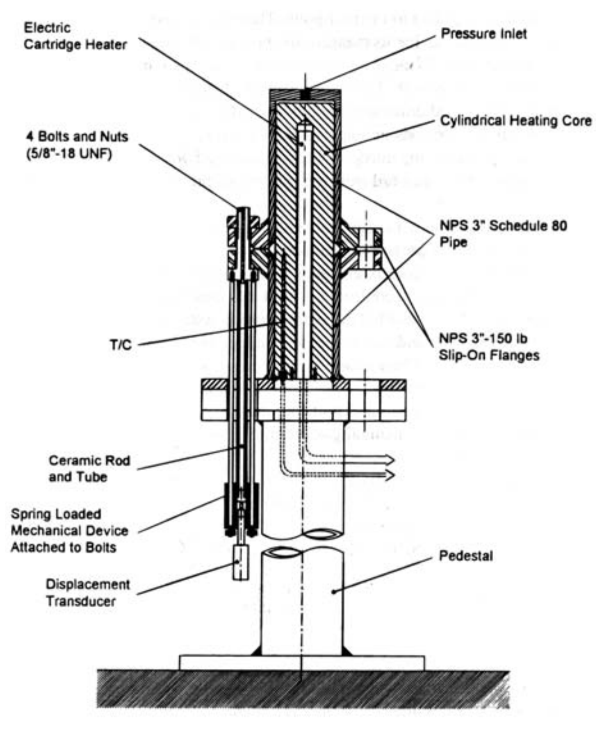


Figure 3 Hot Blow-out Test Rig

The helium gas is supplied by a high-pressure gas cylinder. The pressure is adjusted with a precise manual pressure regulator and it is measured with an electronic pressure transducer.

The central heating core is embedded with a 2000 W electrical cartridge heater. An electronic temperature controller is used to achieve a constant temperature increase of 3.0 °F/min. Temperature

Hot Blow-out Test Description

is measured at three locations: in the solid core and inside the top and the bottom flanges at mid gasket diameter (not shown on the figure), close to the raised face surface.

The top and bottom parts of the fixture are insulated to minimize thermal gradients (not shown on the figure). The top insulation casing is removable to allow for gasket change and bolt torquing.

A manual relief valve permits gas purging during heating to prevent internal pressure increase. In order to minimize the gas flow when a blow-out occurs, the gas volume inside the fixture is minimized by the use of the solid central core and the gas flow from the pressure regulator is restricted by a micrometric valve. Gasket deflection and leakage are not measured during the HOBT test.

Test Procedure

Step 1 – Gasket Seating

The ambient temperature should be 75 ± 5 °F. Open the system to the atmospheric pressure. Tighten the four bolts with a torque wrench using four levels: 30, 60, 75 and 80[1] lb-ft, to reach the nominal gasket stress of 5000 ± 250 psi. Make a one-pass crisscross pattern in about 15-30 seconds for each torque levels and wait one minute between each level. For the last one, reverse the pattern.

Step 2 – Waiting time

Wait 5 minutes to allow for the initial gasket creep and relaxation

Step 3 – Reloading to the target stress level

Retighten the bolts to adjust the gasket stress back to 5000 ± 250 psi.

Step 4 – Waiting time

Wait 30 minutes to allow for the gasket creep and relaxation.

Step 5 – Helium pressurization

Connect the pressurizing line to the pressure inlet and apply an internal helium pressure of 435 psig.

Step 6 – Gasket heat-up

Turn on the electrical cartridge heater inside the central heating core at its maximum power until the core temperature reaches 180 °F. Then, continue to heat the gasket at a rate of 3.0 °F/min until a blow-out occurs or until the average temperature between the top and bottom flanges reaches 680 °F (maximum test temperature).

[1] 80 lb-ft is a suggested value. The final torque value will depend on the gasket type and on the lubrication of the bolts. The experimenter must select the appropriate torque to achieve a gasket stress of 5000 ± 250 psi.