

BOLTED FLANGE AND SEALING IN ARCTIC ENVIRONMENT

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Introduction

Oil&Gas exploration and production in low temperature arctic environment

- ▶ Arctic environment bring new questions on equipment design rules
- ▶ Sealing systems: key elements for safety, reliability and environmental impact
- ▶ Seals performances under low temperature not easily available from public sources

The ARCTICSEAL project:

- ▶ Sponsors:  **TOTAL**  **Schlumberger**  **SAIPEM**
- ▶ Manager:  **cetim**
- ▶ Involved sealing technologies:
 - ▶ Flange gaskets
 - ▶ *Elastomeric "O" rings (not presented here)*

ARCTICSEAL project description

Bolted flange gasket activity program

► Tested gasket material and types (selection of sponsors) :

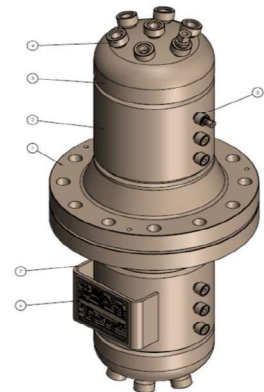
Type	Gasket material	Class
Sheet gasket	Fibre based	300
	PTFE based	300
	Graphite based A	300
	Graphite based B	300
	Graphite based C	300
Standard spiral wound gasket (SWG)	Metal/graphite	600
Low stress spiral wound gasket (LS SWG)	Metal/graphite	300

ARCTICSEAL project description

Bolted flange gasket activity program

- ▶ Gasket test under compression press (NPS 8 & 16 gasket sizes)
 - ▶ Low temperature mechanical & sealing tests
 - ▶ Additional test involving hot/cold thermal cycling before low temperature exposure

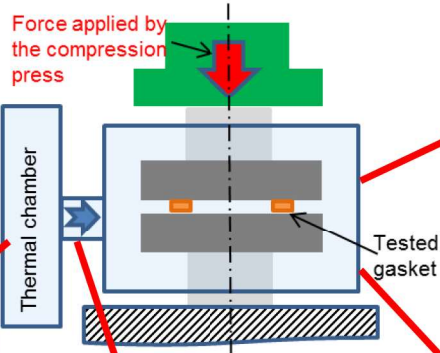
- ▶ Test on a dedicated NPS 8 flange connection exposed to quick heat-up after low temperature environment exposure



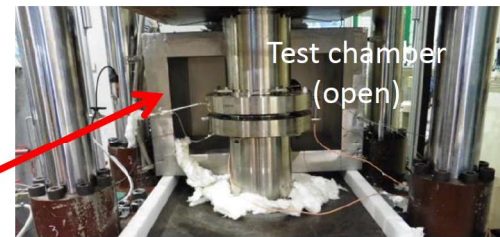
Gasket test under compression press

Test facility

Climate chamber:
-90°C/ +180°C

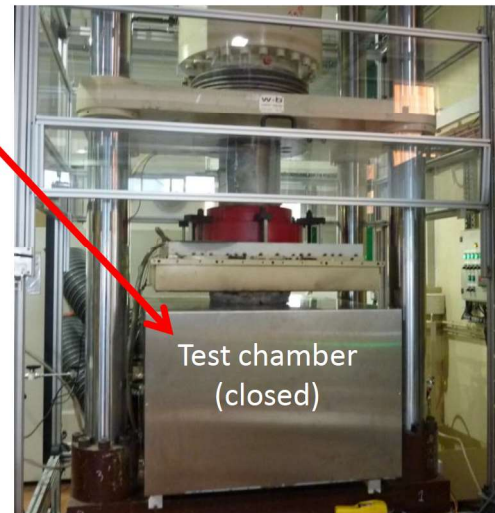


Cold/hot air to test chamber



Test chamber
(open)

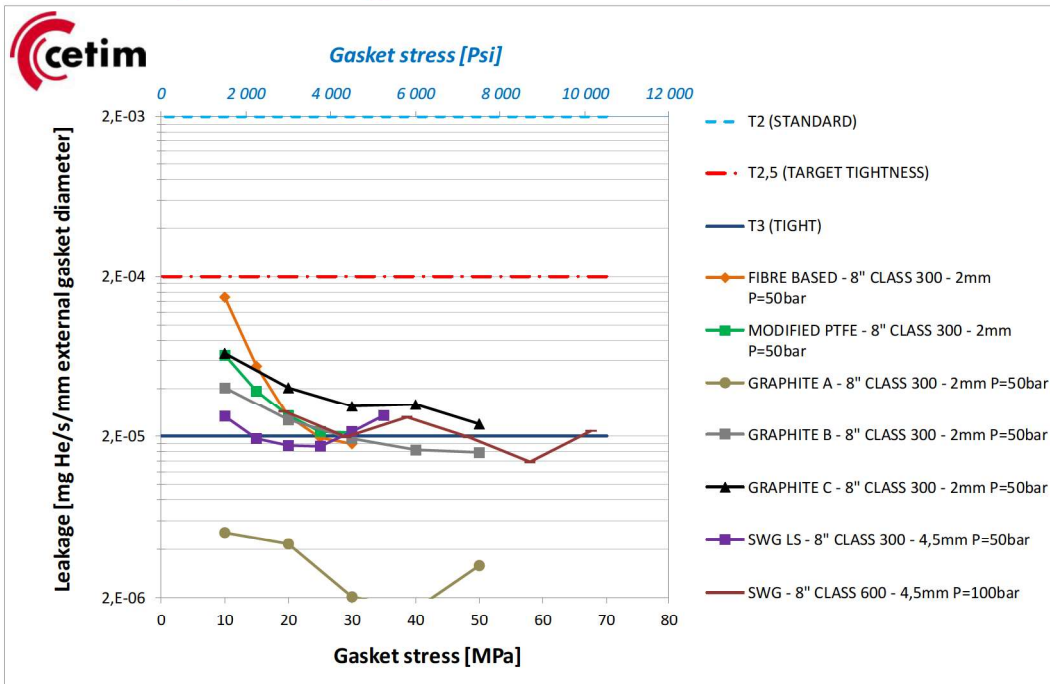
500 tons compression press



Test chamber
(closed)

Gasket test under compression press

Low temperature gasket characterization test results



Close (or better) to T3 at initial loading

T2,5 fulfilled at lowest residual stress

- 20MPa/2900 Psi for SWG
- 10 MPa/1450 Psi for others

[to transient test](#)

Test rig short description

-
- Tight connections for internal heating power + 1 connection for pressure supply
- Tight connections for temperature measurement
- The diagram shows a vertical cylindrical vessel with a flange at the top and a control panel on the side. Callouts 1 through 6 point to various ports and features. A dashed circle at the top highlights the heating and pressure supply connections. An inset photograph shows the interior of the vessel, which is lined with a red, spiral-shaped heating element.

	Material
Flange	A350 LF2
Pipe	A333 Gr6
Threaded rod	A320 L7
Nut	A194 Gr7

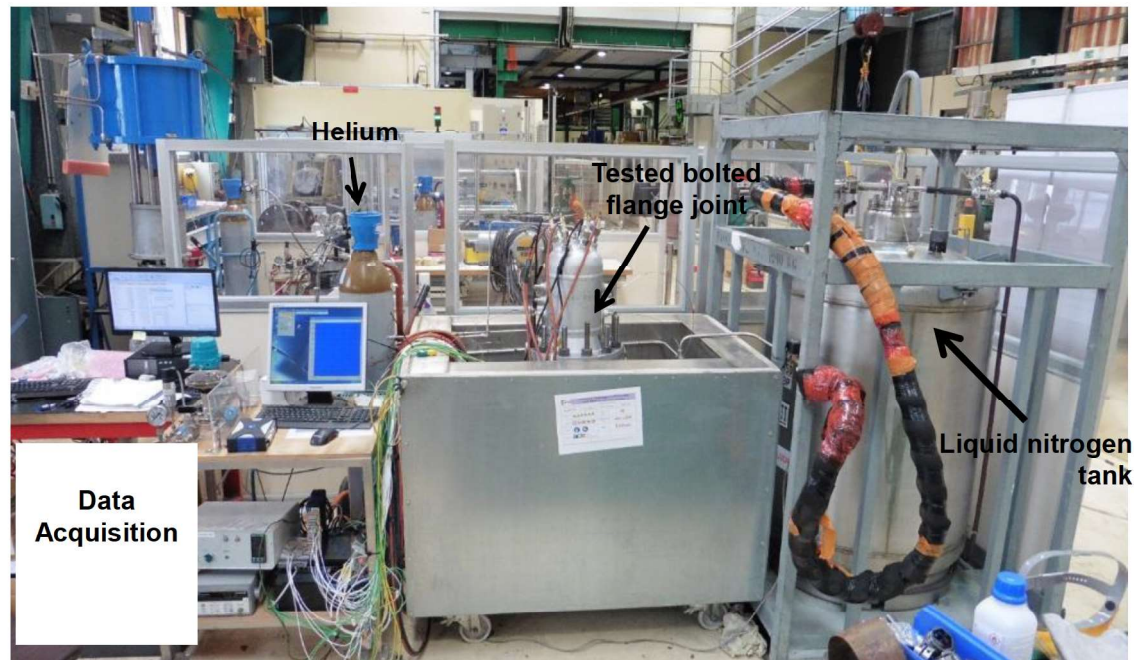
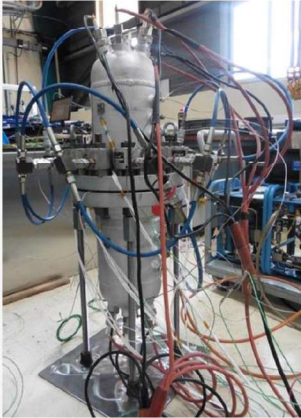


+ 4/12 instrumented bolts

BFJ exposed to quick heat-up after low temperature exposure

Test rig short description

Tightening with
12 bolt tensioners



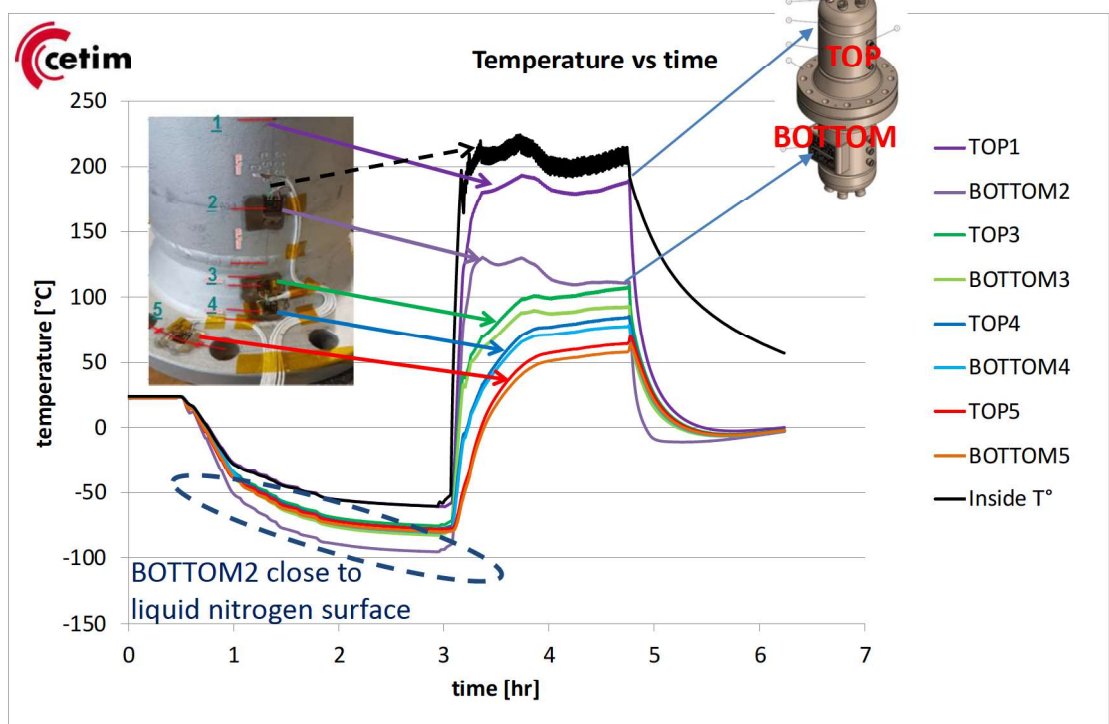
BFJ exposed to quick heat-up after low temperature exposure

Test procedure

- Quick internal heat-up (~5 minutes to reach 200°C on flange and pipe internal diameter).



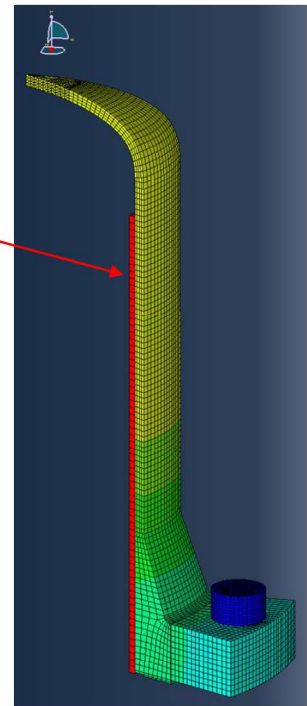
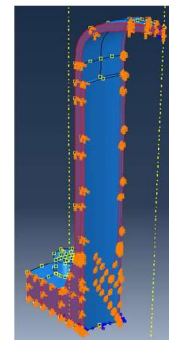
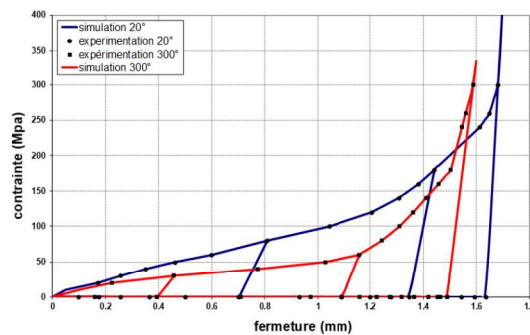
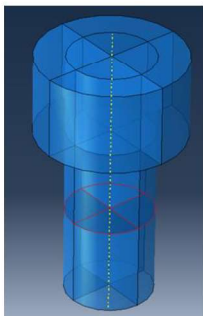
- Natural cooling after temperature stabilization



BFJ exposed to quick heat-up after low temperature exposure

FEA

- ▶ Thermal calculation: Internal heating elements @ 200°C and “heat transfer” elements
- ▶ Mechanical calculation
 - ▶ Tightening (“bolt load”)
 - ▶ Mechanical contacts: Bolt/flange & Gasket/flange
 - ▶ Gasket modelling: « Gasket function » strain/stress curve



BFJ exposed to quick heat-up after low temperature exposure

Thermal results

► FEA thermal results

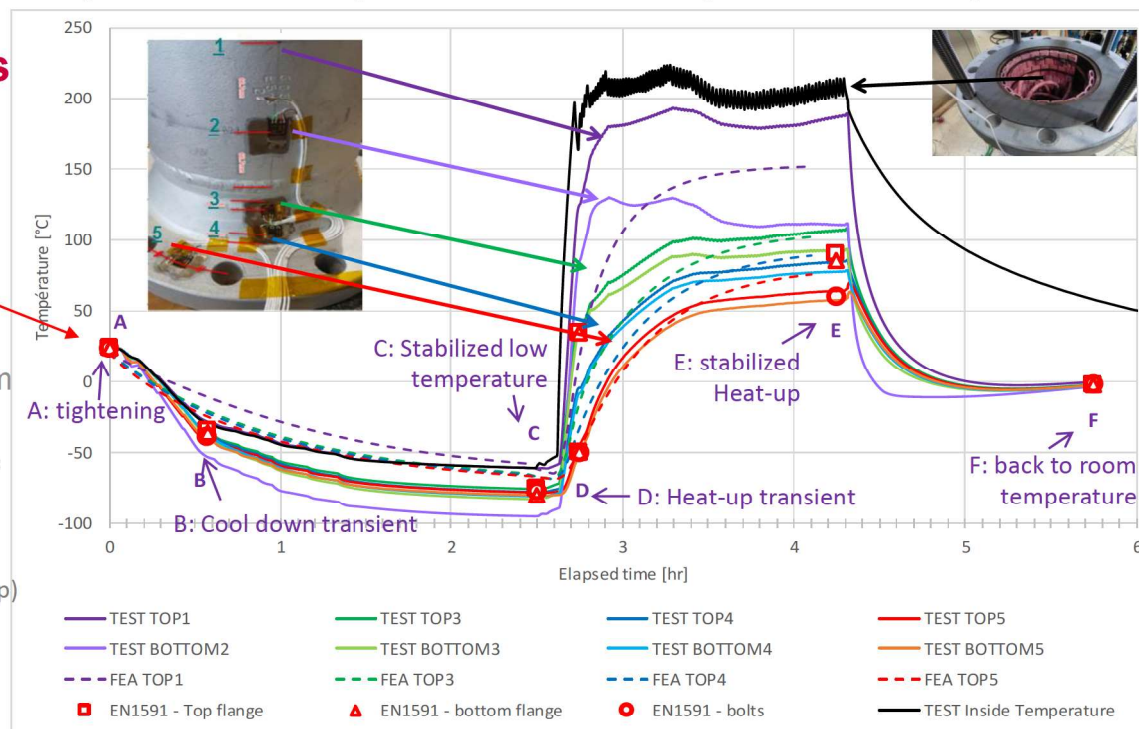
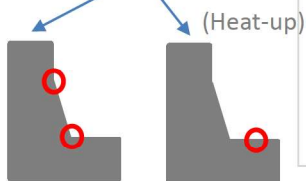
► EN1591-1

► Selected times

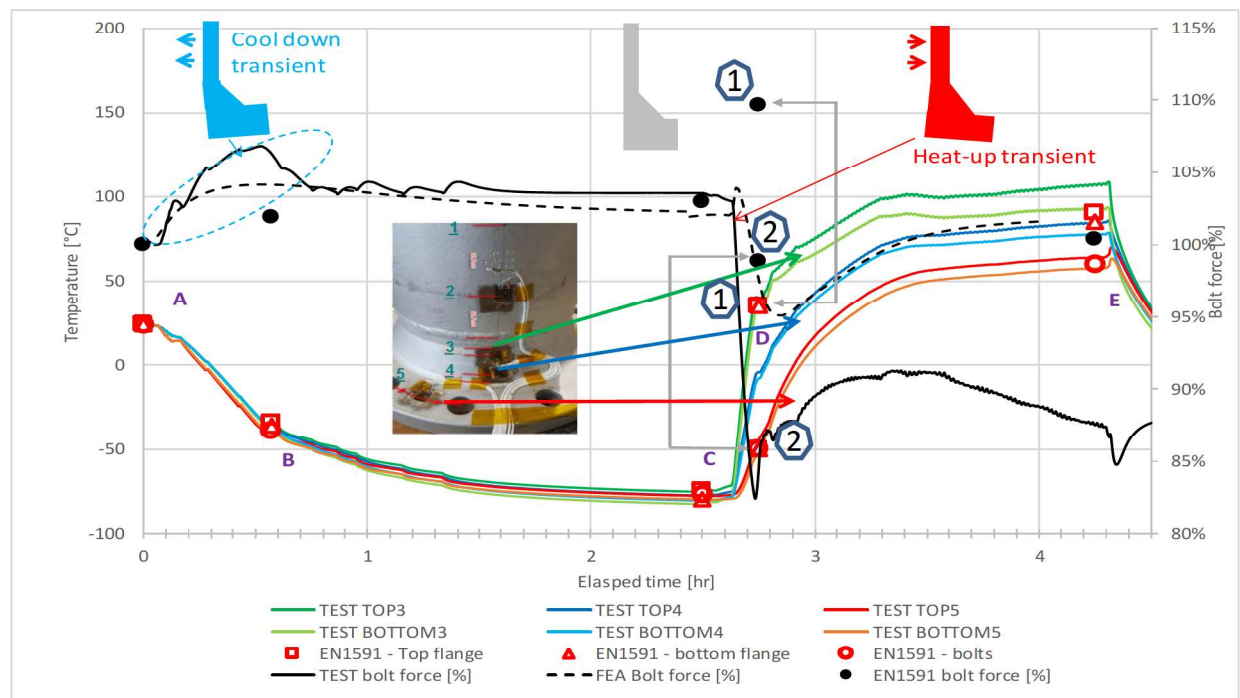
► Average temperature from tests

► Bolt & gasket = flange ring

► Flange

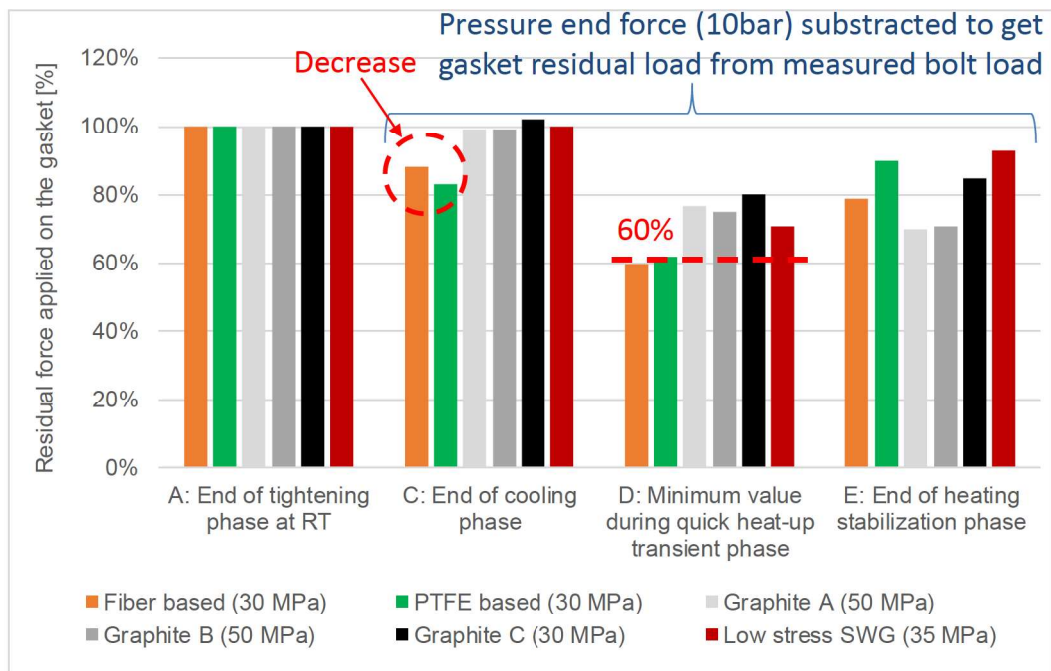


Bolt load results



BFJ exposed to quick heat-up after low temperature exposure

Test results on the different tested gasket types

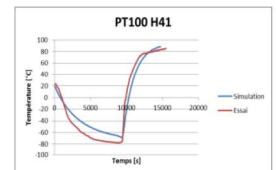
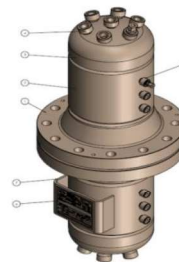
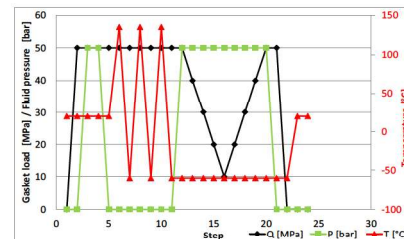
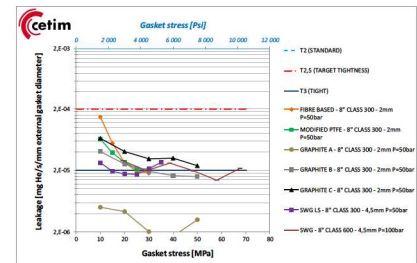


[to leakage tests](#)

Conclusion

Project outcomes (concerning flange gaskets):

- ▶ The selected commercial references can safely be used in arctic conditions by the sponsors
- ▶ Developed procedures and facilities are available for tests on other references
- ▶ Tests on instrumented BFJ for quick heat-up after low temperature exposure gave data for FEA thermo-mechanical model development (in progress)



Thank you to our sponsors !!



TOTAL

Schlumberger



Any questions ?