POWER TO THE FUTURE

Flexitallic®

Innovative Sealing Materials for Corrosion mitigation

Vinay Tripurana

ICorr

October. 2022

Introduction

Background……..

Graphite – E.g., Spiral wound gaskets

- Long history (> 20 years)
- Widely used and specified (proven sealing platform)
- Fire safe
- Established installation procedures (torque etc)
- Low ‘product’ cost

The challenge…..

Graphite – E.g., Spiral wound gaskets

- Flange face corrosion – High ‘hidden’ cost (repairs & lost production)
- Emissions reduction – ‘Net Zero’ strategy

Introduction

Technical brief

A new material that…

- Mitigate flange face corrosion – electrically neutral and clean
- Significantly improve connection tightness (Net Zero)
- Be fully compliant with current gasket standards – ASME B16.20
- Meet industry service envelope requirements (-196 to 260^{o}C & B16.5 #150 thru #2500)
- Meet fire safe requirements
- Ease of use – require no change to established installation procedures
- Economically viable compared with graphite

The solution

Corriculite - Spiral wound gaskets

An electrically inert, high purity spiral wound gasket filler material with enhanced tightness properties, that is both fire safe and compliant with the requirements of ASME B16.20. A direct, and cost-effective, replacement for conventional, graphite filled gaskets.

Corrosion Mitigation

Flange face Corrosion

Galvanic action – Highly cathodic

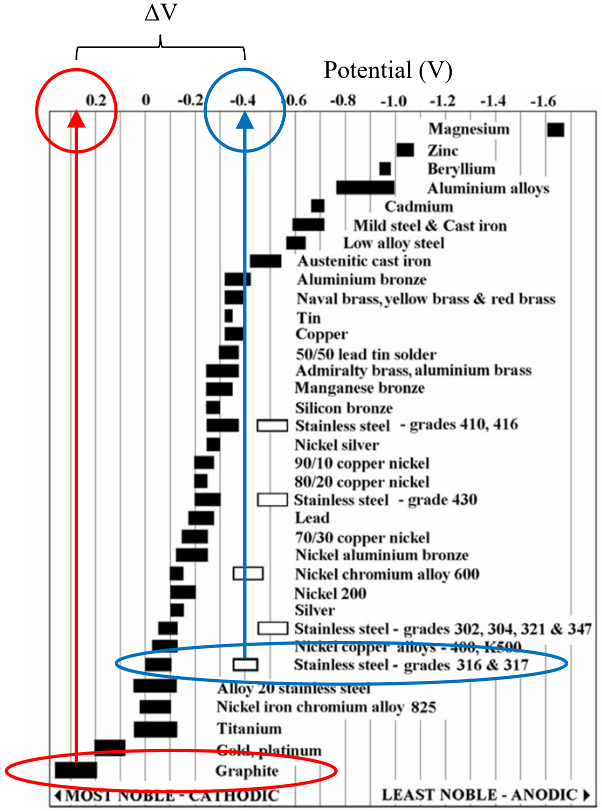
<u>Corrosion Testing – ISO 9227</u>

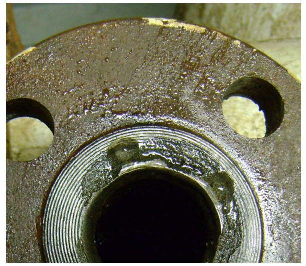
Assembly

Graphite

Innovative Sealing Material

Galvanic Series – Sea Water/SCE

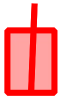


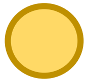


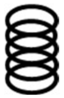
Corrosion Mitigation

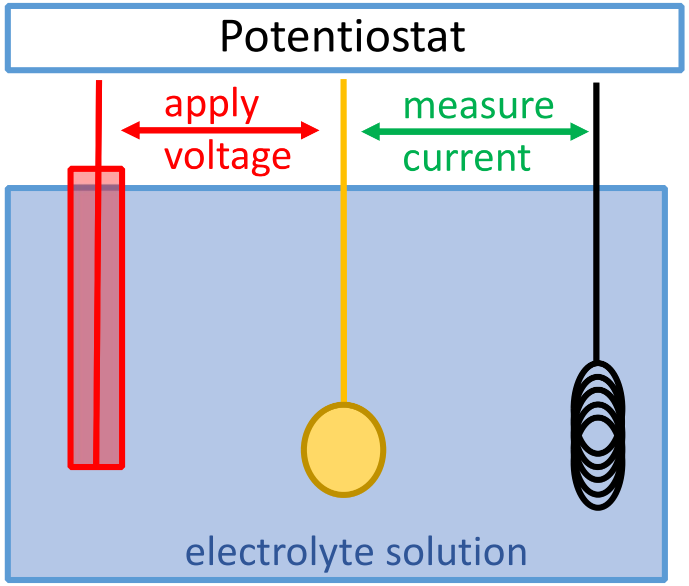
ELECTROCHEMICAL EVALUATION

Potentiostatic Polarisation

 Reference electrode (A_g/A_gCl_2)

 Working electrode or anode (Flange)

 Counter electrode or cathode



Electrochemical Reactions

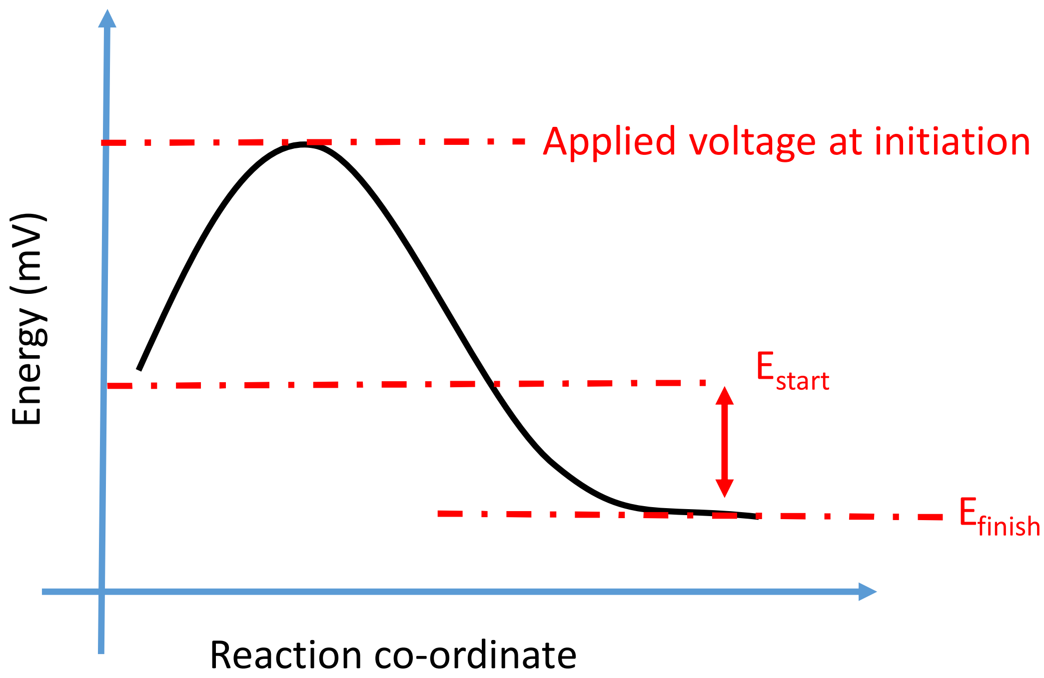
Anode surface: $M \rightarrow M^{2+} + 2e^-$ metal going into solution 'corrosion' also 'chemical oxidation'

Cathode surface: $2e^- + 2H_2O \rightarrow 2OH^- + H_2$ electrons reacting with electrolyte also 'reduction'

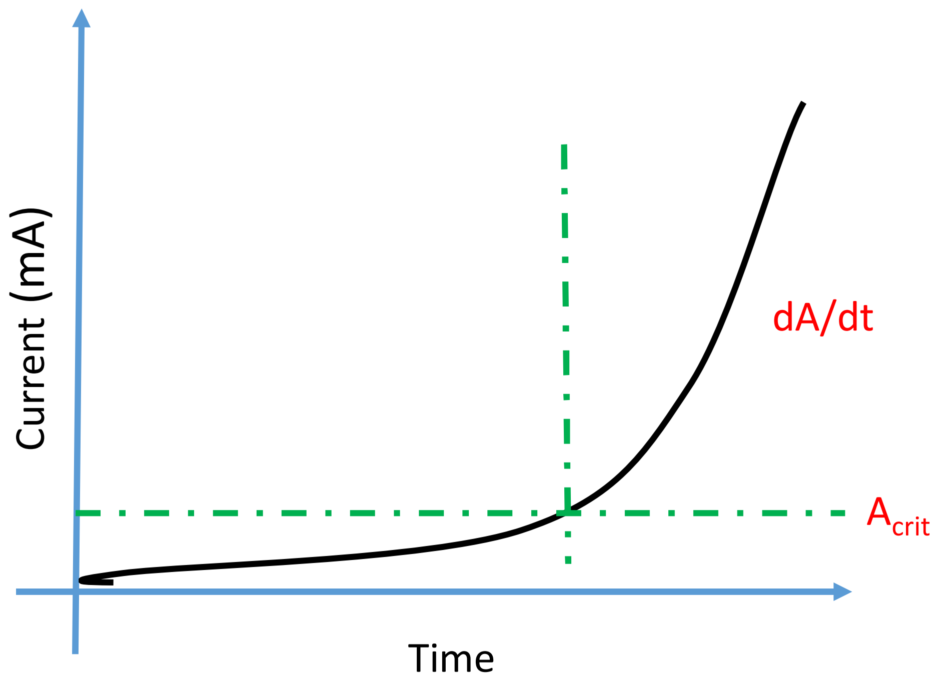
Electrolyte: $2OH^- + M^{2+} \rightarrow M(OH)_2$ ions reacting to form corrosion by products – metal hydroxide

Potentiostatic Polarisation

Reaction Thermodynamics – Initiation (applied potential)

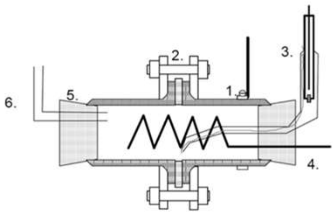


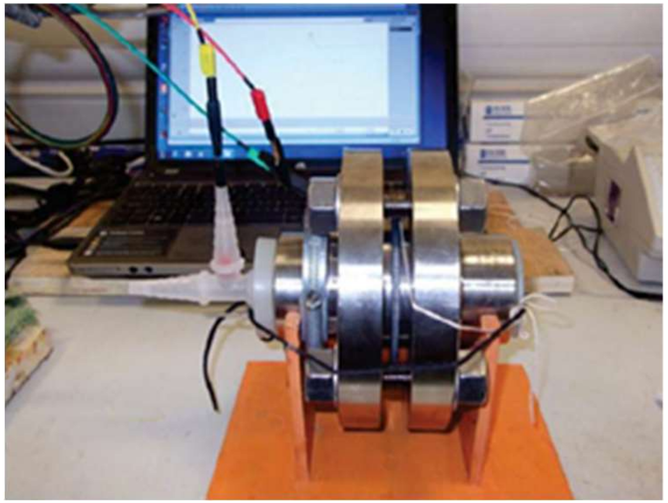
Reaction Kinetics – Propagation Current flow (A)

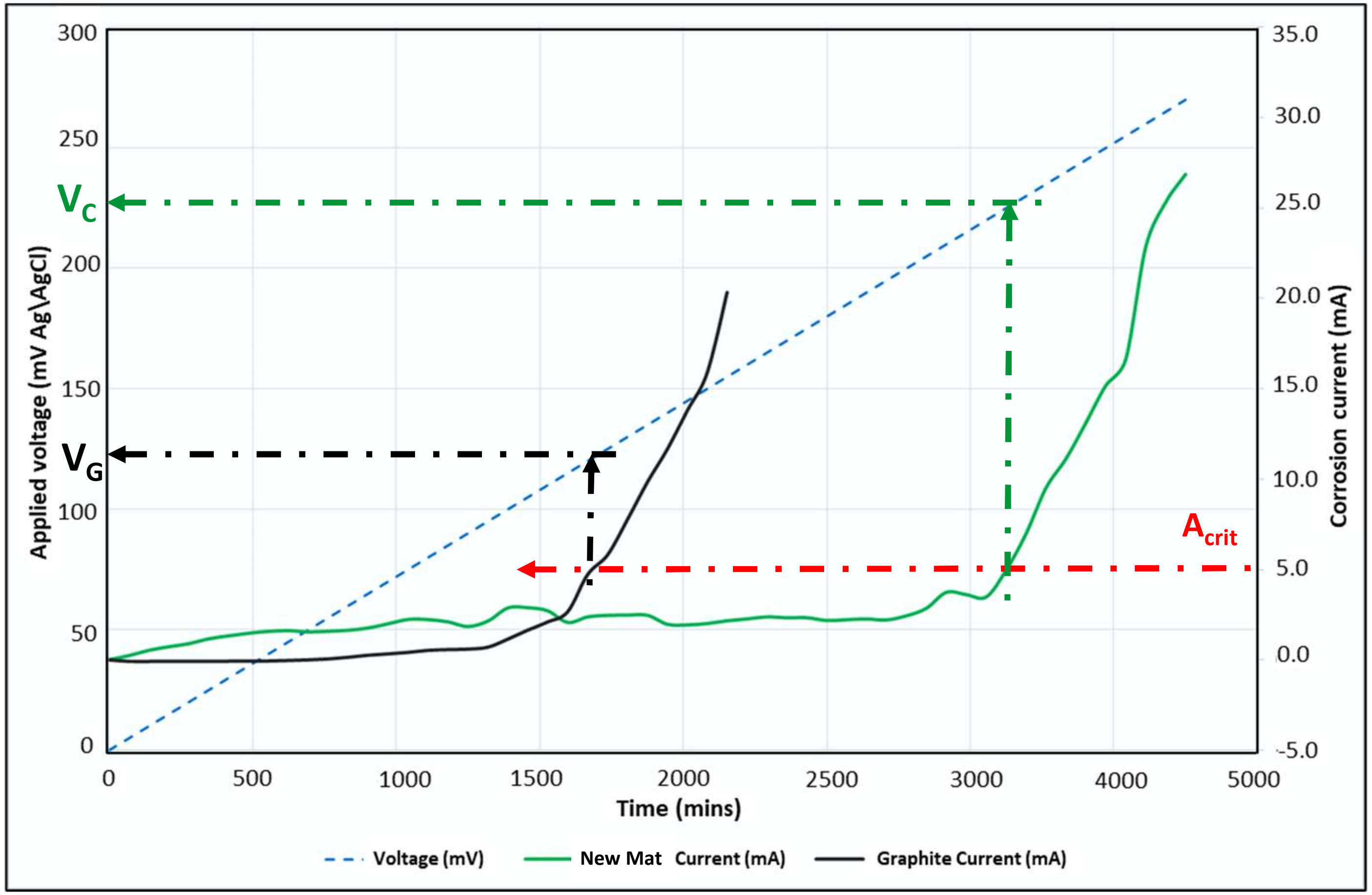


Corrosion Mitigation

Induced Corrosion Evaluation

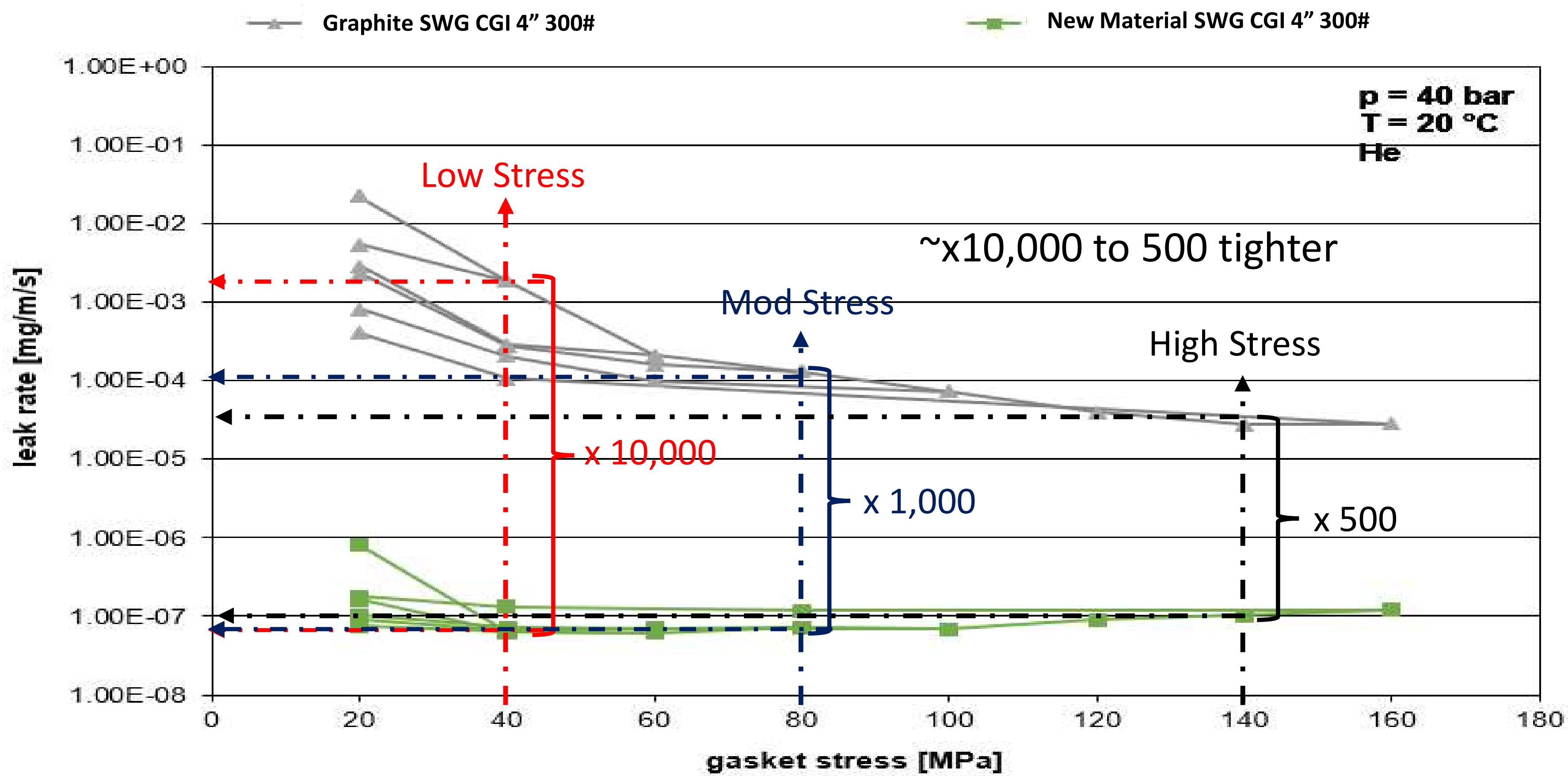






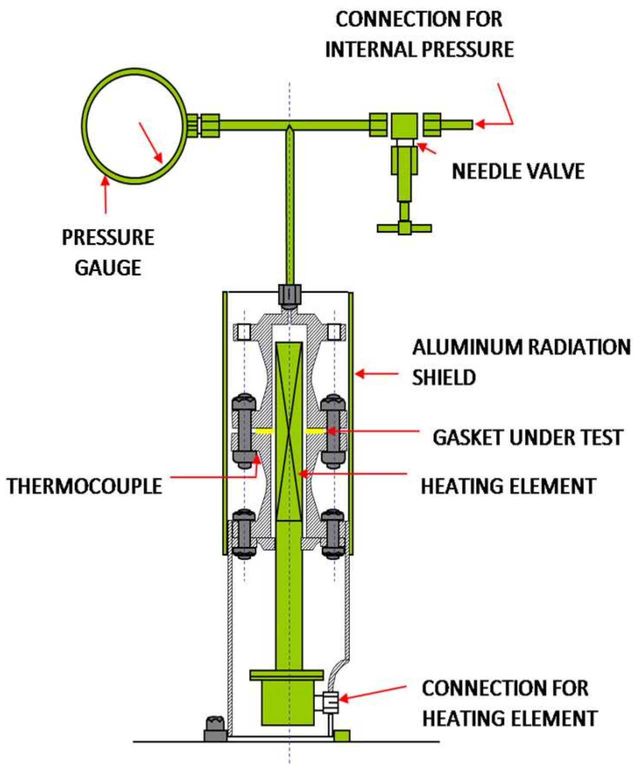
Flexitallic

Innovative Material v Graphite SWG – EN 13555 Q_{min} (Assembly) & Q_{smin} (Service)



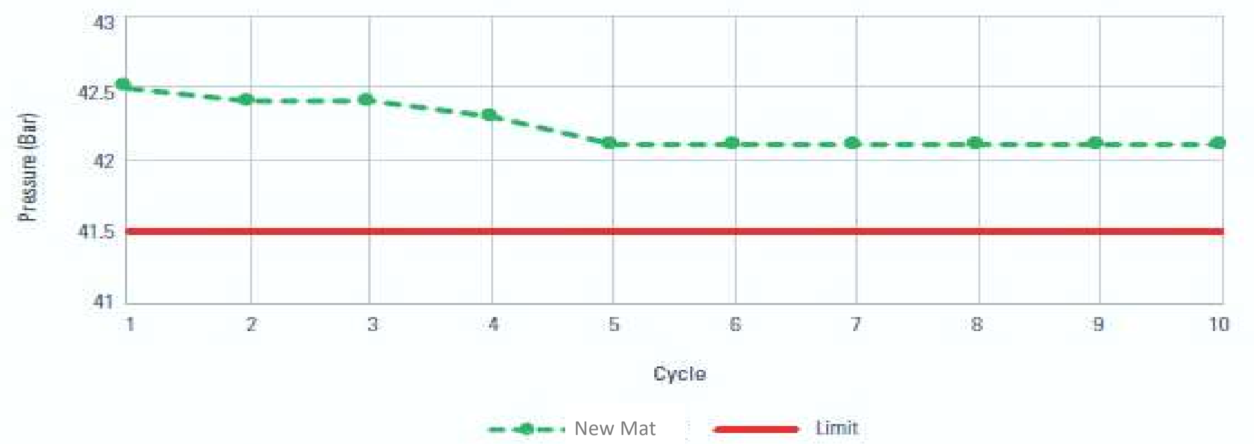
Corrosion Mitigation

Shell Thermal Cycle Test



- Product evaluated at ambient and elevated temperature (225°C)
- Ambient phase (51 bar)
- Thermal cycle phase (42.5 bar)

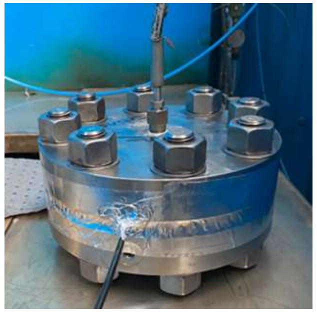
- Pressure drop is recorded at every cycle
- Total max pressure drop: 1 bar
- Corriculite evaluated over 10 cycles



- Maximum pressure drop allowed 1 bar
- New Material total pressure drop only 0.4 bar over 10 cycles

Corrosion Mitigation

Cryogenic Testing (Blow-down qualification)



Protocol:

- ASME Class 150 & 900 grp 2.2. Test pressure 19.7 & 147 barg
- Test medium: Helium
- Leak detection: Helium mass spectrometry
- Test cycle: ambient (20^{o}C)/-110^{o}C/-196^{o}C. Pressurise/hold 1 hr/leak test/de-pressurise
- Number of cycles: 3

Results (final leak rates):

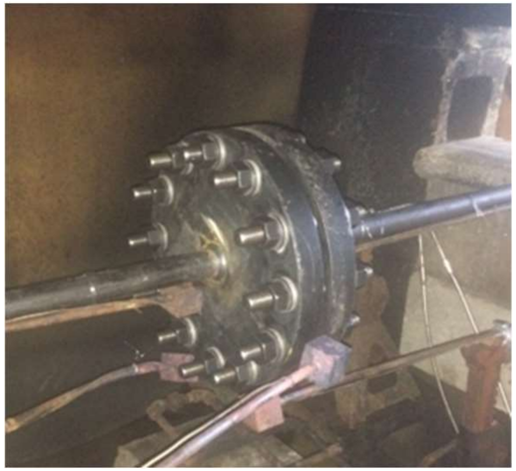
- Class 150: 7.8×10^{-6} mbar.l/s = 0.0086 ft^3/yr = 244 cm^3/yr
- Class 900: 5.8×10^{-6} mbar.l/s = 0.0064 ft^3/yr = 181 cm^3/yr

Corrosion Mitigation

Fire Safe

Protocol:

- Method: API 6FB (direct flame impingement)
- Test assembly: ASME 6” 300#
- Test medium: Water
- Test pressure: 75% MAWP (40 barg)
- Leak detection: Pressure decay reported as mL/inch/min
- Cycle: 650^{o}C/30 min/force cool/depressurize/re-pressurise



Result:

- Burn phase leak rate: Recorded 0.0; Allowable 1 mL/inch/min
- Re-pressurisation leak rate: Recorded 0.0; Allowable 1 mL/inch/min

Corrosion Mitigation Summary

Corriculite

An innovative spiral wound filler material that…

- Mitigates flange face corrosion in up-stream environments
- Significantly improves tightness (‘Net Zero’ philosophy)
- Is fully compliant with current gasket standards – ASME B16.20/EN 1514-2
- Meets industry service envelope requirements (-196 thru 260^{o}C and pressure classes/norms)
- Is fire safe complaint in accordance API 6FB
- Can be used as a direct replacement for graphite using existing assembly procedures
- Is a viable economic alternative to conventional graphite sealing technology

POWER TO THE FUTURE

Thank you!