Test bench development for Rapid Gas Decompression evaluation of valve elastomer seals

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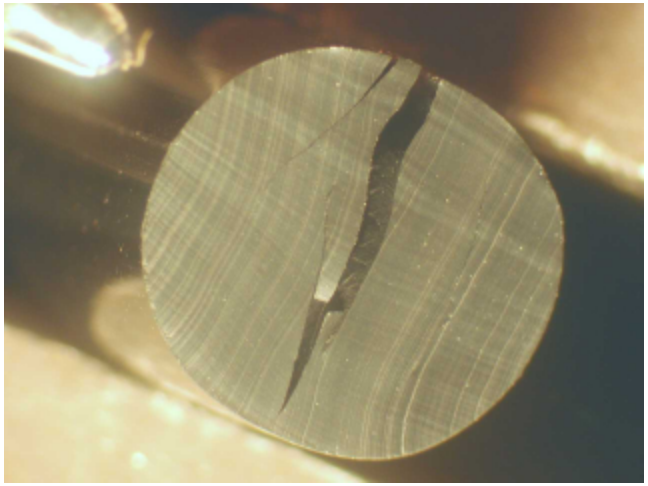
Rapid Gas Decompression (RGD)



- O-rings in Oil and Gas producing facilities are subjected to extreme pressure and temperature.
- Minute imperfections or faults in the O-rings allow gasses to permeate into the seals.
- In time, seals become saturated with the gasses. In the event of a sudden drop in system pressure
- Gas contained in seals may expand
  - ➲ O-ring damage (blisters, cracks)
- ***Aim*** : Conditions of exploration and production of gas are more extreme
  - ➲ need to test and qualify materials at higher pressure, temperature in sour gas.

Project overview

- In collaboration with **Total, Dresser Rand** and seal manufacturers (Dupont, Greene Tweed, Hutchinson, James Walker, PPE, Trelleborg)
- Definition of the new test conditions (pression, température, O-ring housing....)
- Development of a procedure and a test program
- Development of test installations
- Test on O-ring and analysis

Definition of the new test conditions

- The aims of the project are to
  - develop and carry out tests on the explosive decompression of elastomeric seals under more extreme conditions of :
    - pressure (400 bar),
    - temperature (from 90 to 120°C)
    - fluid (adding H2S in addition to the CO2+CH4 test mixture already used)

      ➲ one for CO2-CH4 and one for H2S-CO2-CH4

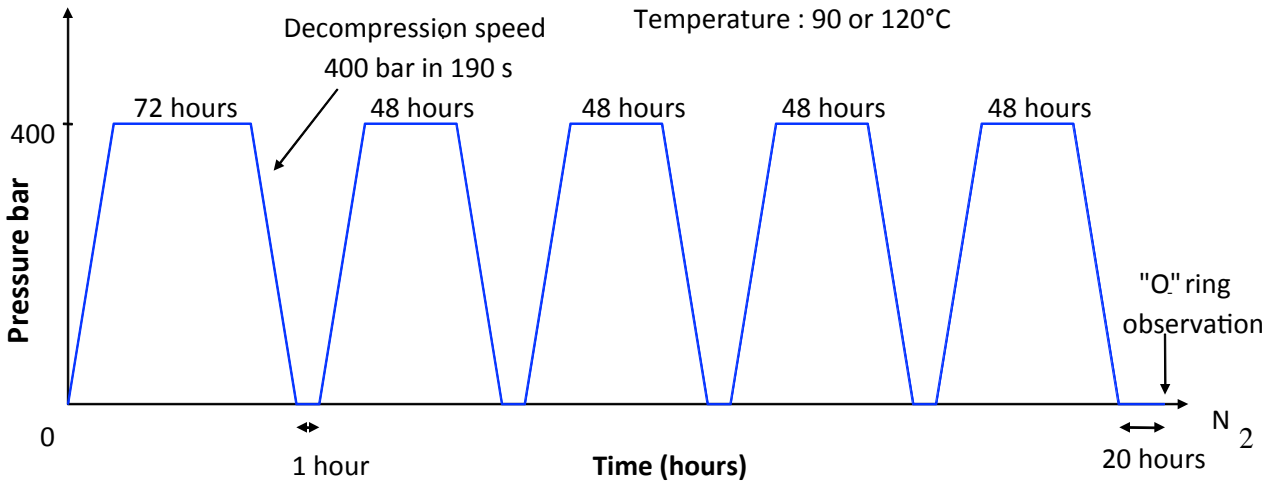
  - study the influence of production dispersions (formulation, mixture, manufacture, vulcanisation, etc.) on the behaviour of elastomeric O-rings during explosive decompression (not in this presentation)

Definition of the new test conditions

- Step 1: Definition of test conditions (T°, P, gas mixture)
  - Based on the test protocol of the **Total procedure GS EP PVV 142 rev. 8** and an inventory of the **configurations of Dresser Rand**, test conditions of this project are the following:
  - O-ring internal diameter: 113.67 mm
  - Cross section : 5.33 mm
  - Configuration : piston type
  - Radial compression : 13.7 %
  - Groove fill : 73 %
  - Pressure : 400 bar
  - Fluids: 20%CO2-80%CH4 first, and then 5%H2S-15%CO2-80%CH4
  - Temperature: 90 then 120°C
  - Decompression speed : 127 bar/min
  - Soaking periods : 72h +4x48h (one hour of waiting time between two soaking periods)

Development of a procedure and a test program

- Step 2: Definition of test procedure



- Before and after test:
  - Hardness
  - Dimensions
  - Tensile strength
  - Density
  - Optical microscope (cross sections)

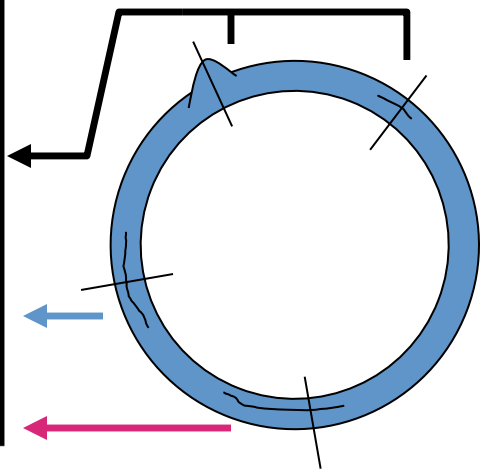
    ➲ Norsok rate

Development of a procedure and a test program

Estimation of Norsok M710 rev. 2 : Quantification of damage

Description	Rating #
No internal cracks, holes or blisters of any size	0
Less than 4 internal cracks, each shorter than 50% of cross section with a total crack length less than the cross section.	1
Less than 6 internal cracks, each shorter than 50% of the cross section, with a total crack length of less than 2,5 times the cross section.	2
Less than 9 internal cracks of which max. 2 cracks can have a length between 50% and 80 % of the cross section.	3
More than 8 internal cracks or one or more cracks longer than 80 % of the cross section.	4 *)
Crack(s) going through cross section or complete separation of the seal into fragments.	5 *)

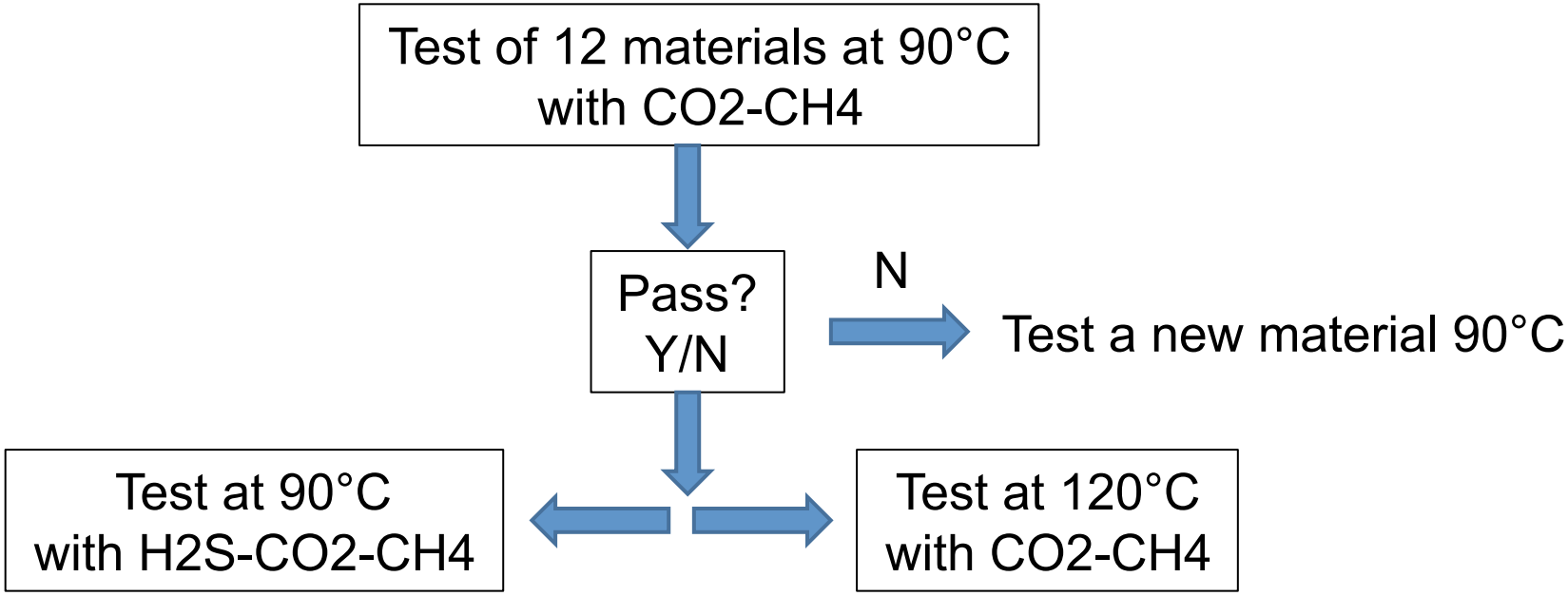
*): Seals with rating 4 or 5 are not acceptable.



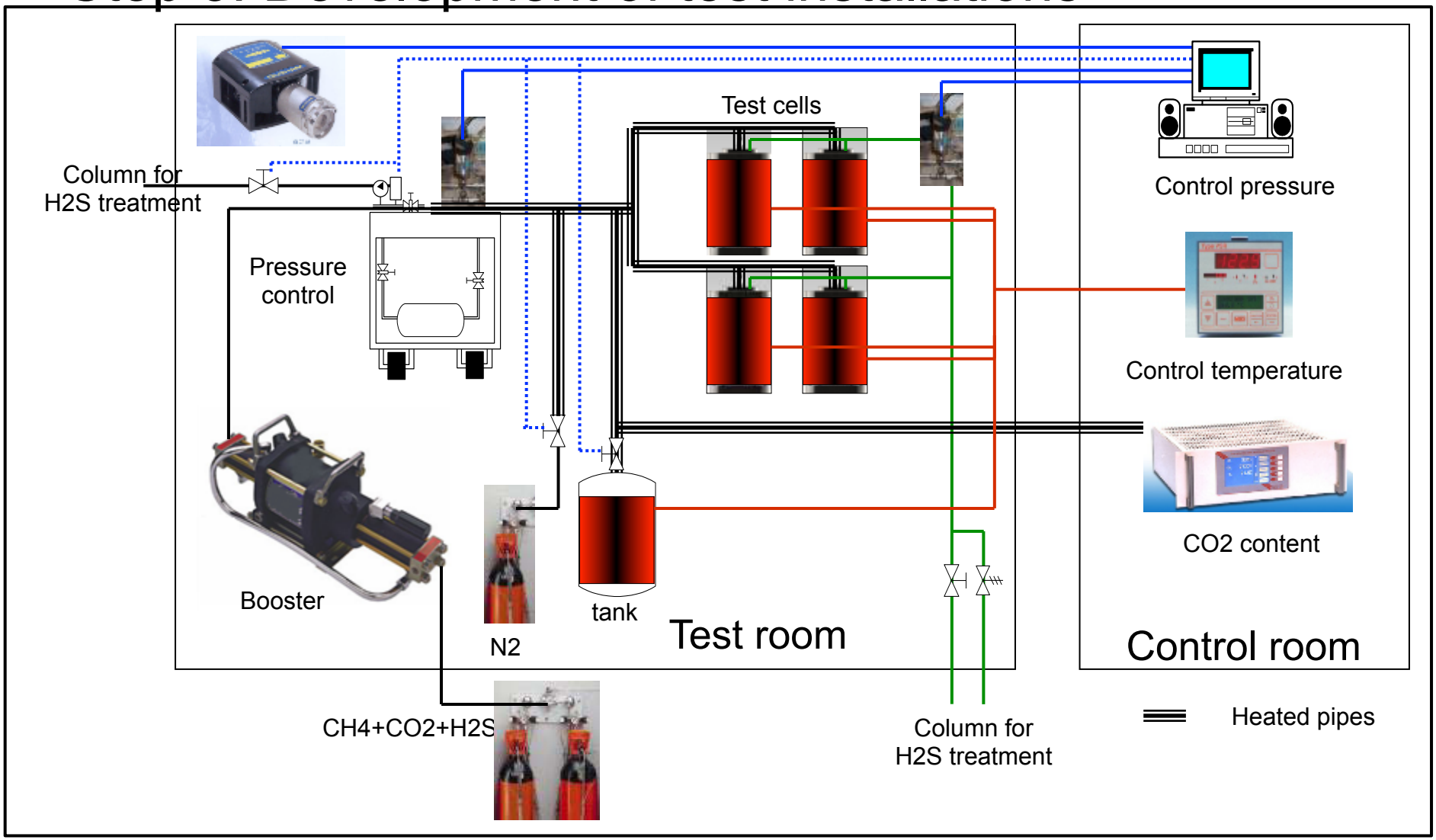
5422 would mean that

- one section had one or more cracks going through the seal cross-section,
- one section had more than 8 cracks or at least one longer than 80% of seal cross-section
- and the other two sections had less than 6 cracks, each of them was shorter than 50% of seal cross-section

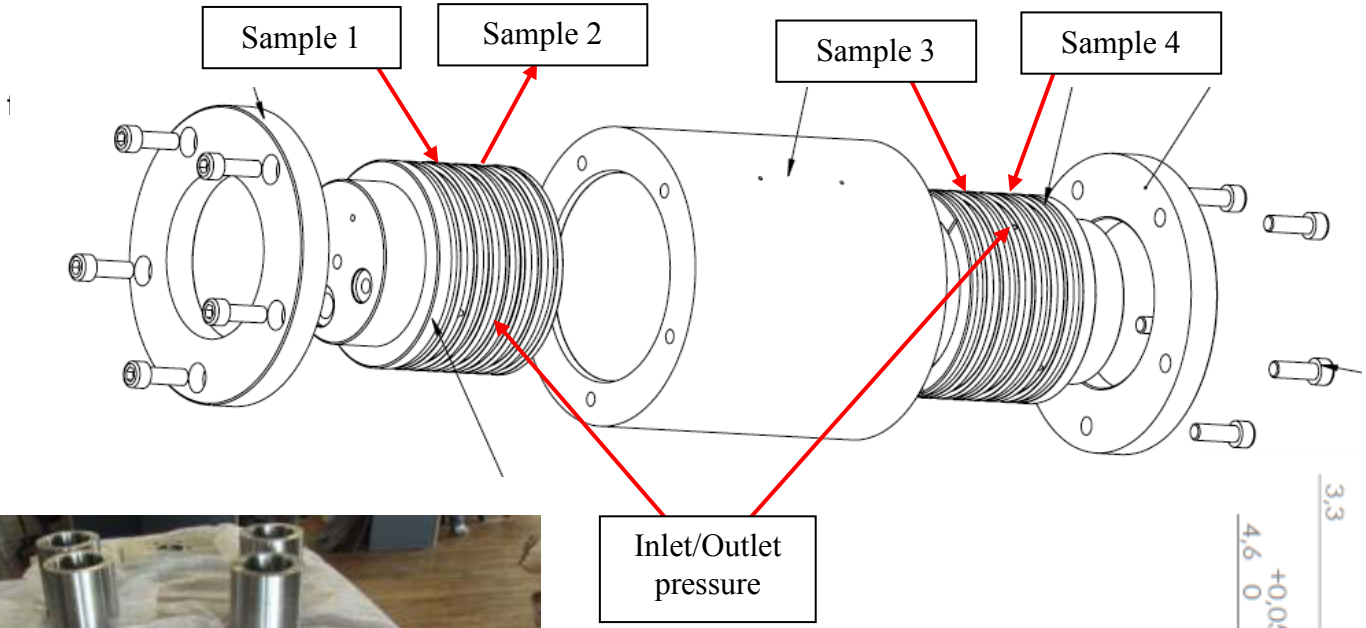
Test program

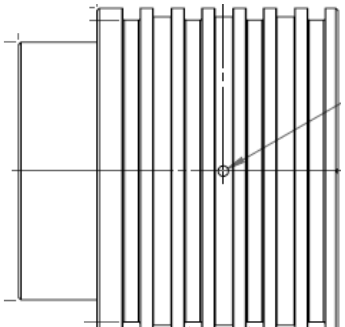


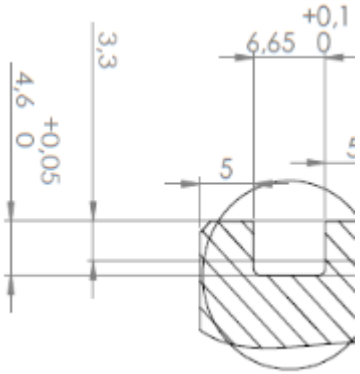
Step 3: Development of test installations

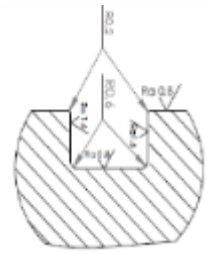


Definition of test cells

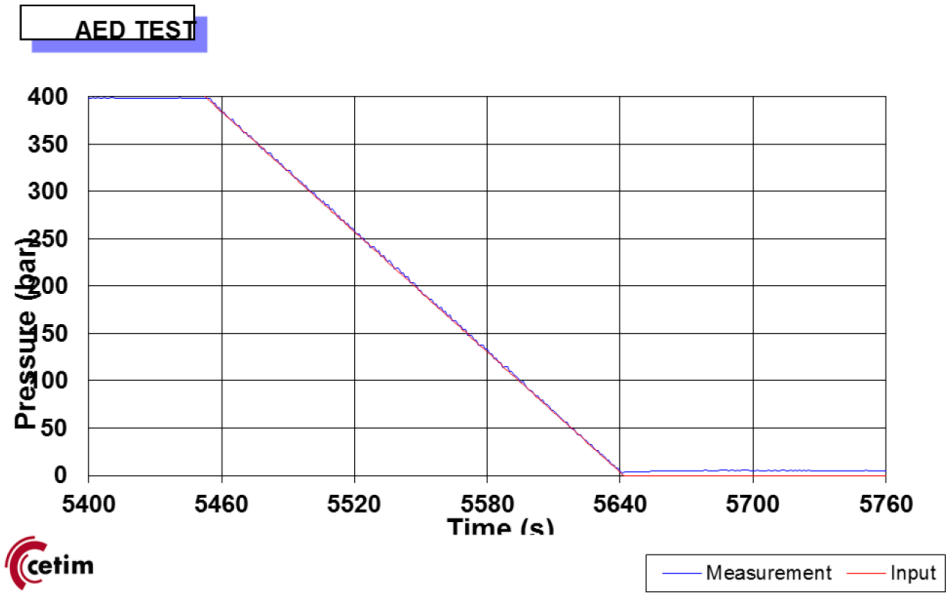


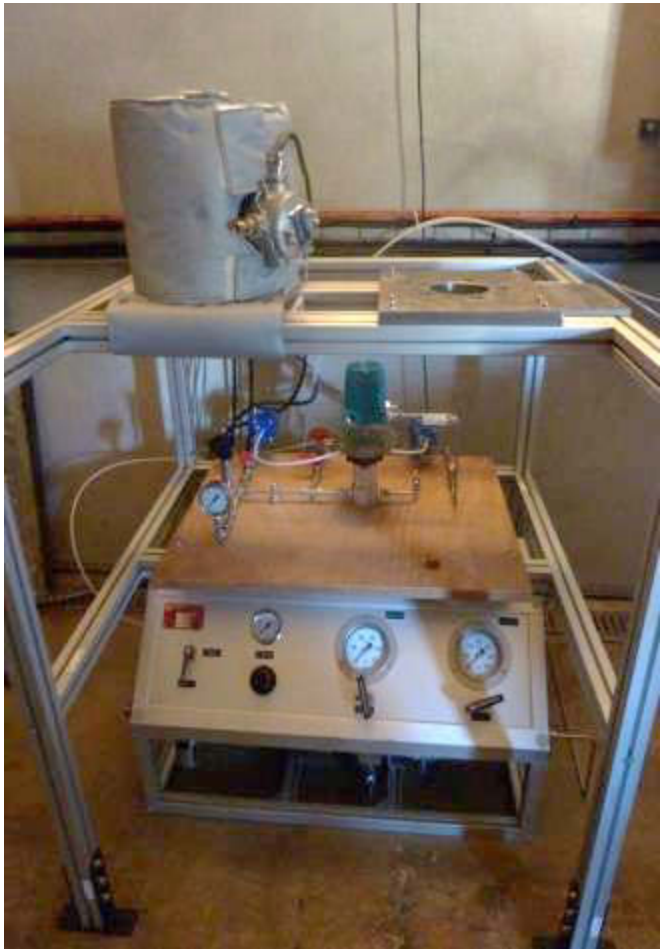






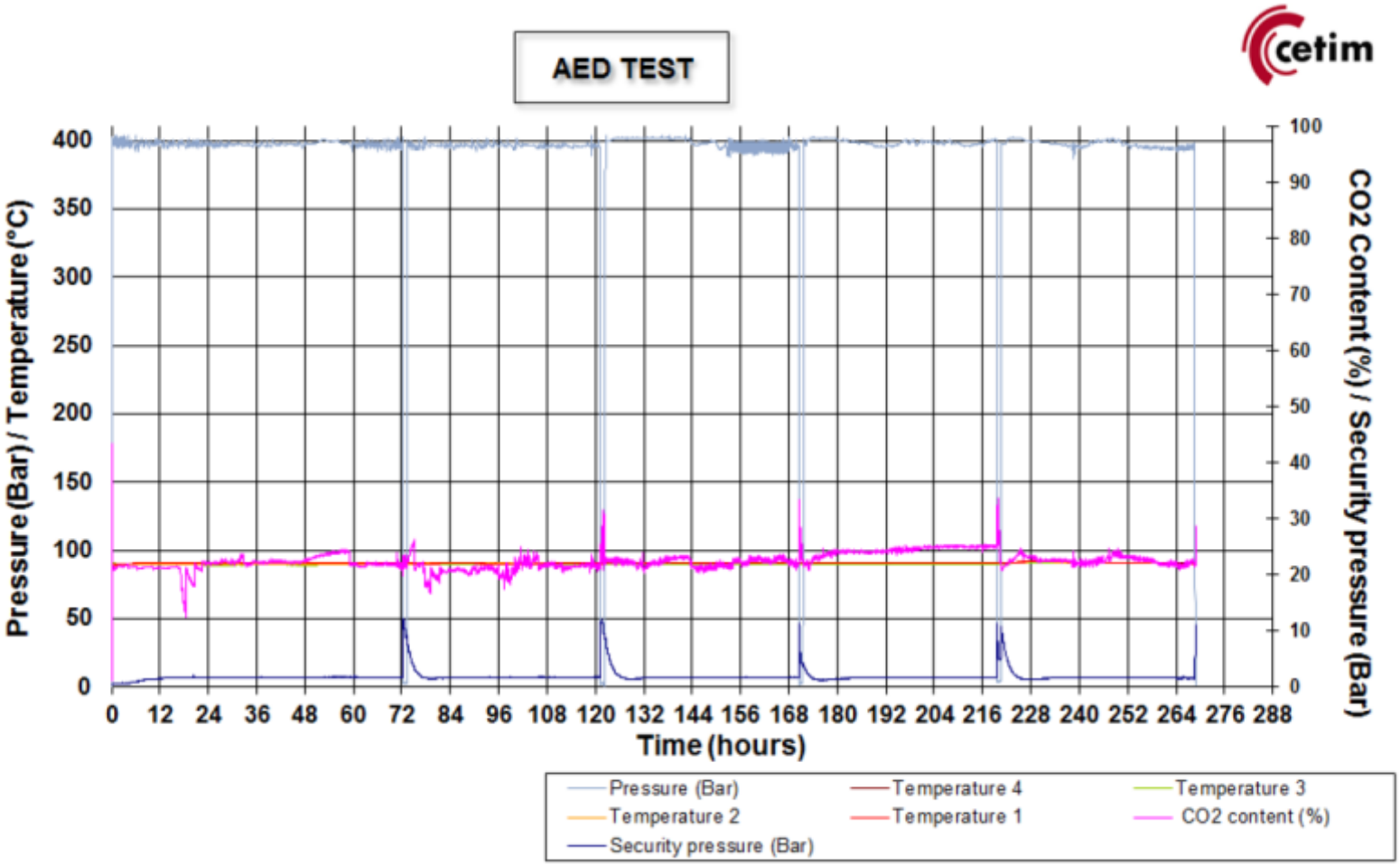
- Development of test installations
  - good control of decompression speed
  - good control of temperature (±2°C)
  - 4 cells
  - 4 O-rings per cell





Development of test installations

- Example of test record



Example of damage

extrusion
no blister, no crack
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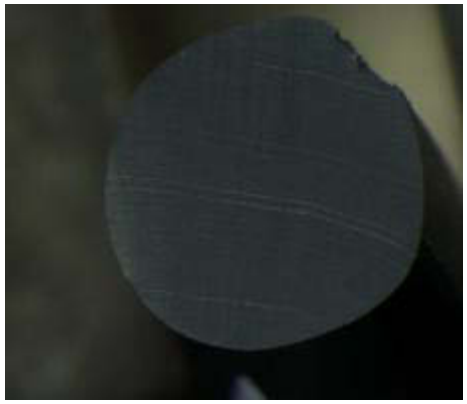
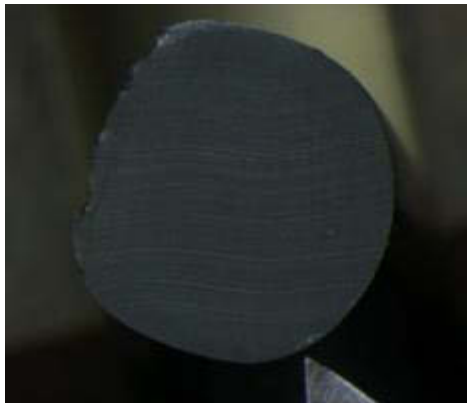

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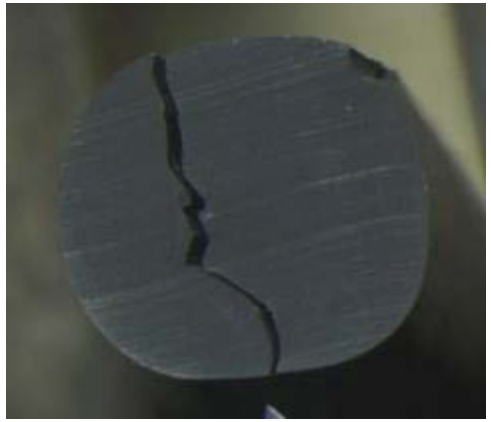
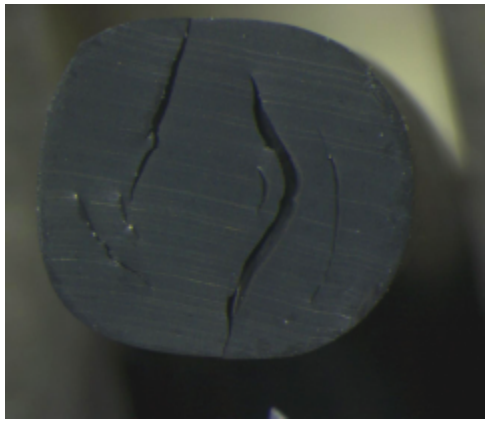
cracks going through cross section of 5 mm to 1 cm long
and extrusion
5555

Conclusion

- In collaboration with **Total, Dresser Rand and seal manufacturers** (Dupont, Greene Tweed, Hutchinson, James Walker, PPE, Trelleborg)
- Development of **new test installations** to perform RGD tests with extreme conditions: **400 bar, 120°C**, with a mixture of **H2S, CO2 and CH4**.
- This approach :
  - allows **to compare the behaviours** of various materials to explosive decompression (selection)
  - gives information on **influence of major parameters** (P, T, H2S)
  - is an helpful tool to **model explosive decompression** (good control of experimental parameters)