Technical Report

DuPont™ Vespel® Parts and Shapes

Ageing and RGD Tests in Supercritical CO_2 (sCO_2)

Carbon dioxide (CO_2) at high pressure is often found in oil and gas upstream applications and in carbon capture utilization and storage (CCUS) in downstream applications such as refineries, steel or cement plants. These refineries and plants often feature equipment such as valves, compressors, pipes and vessels.

Above 31 °C and 73 bar, CO_2 changes phase and becomes a supercritical fluid with mixed properties of both liquid and gas phases. Vespel® polyimide products are used as soft seats in valves or for stem sealing in ball valves applications, as well as in bushings, seal rings, packing rings and rider bands for compressors. The increasing market demand in CCUS necessitates more data on plastics and elastomers in super critical CO_2 applications to develop suitable specifications.

Therefore, an initial test has been conducted on several Vespel® grades to assess the impact of sCO_2 over the mechanical properties and the surface aspect.

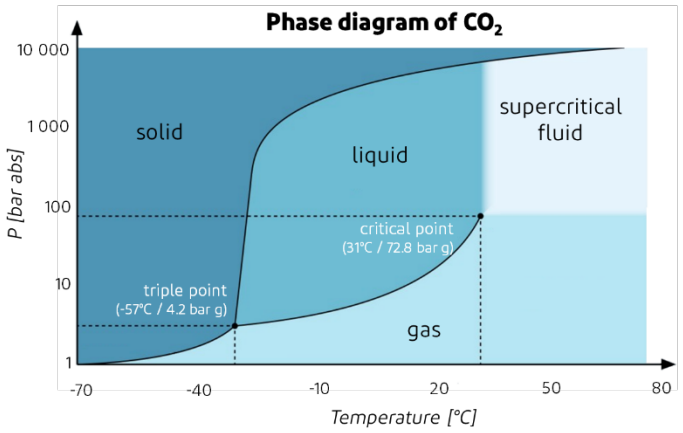
1 Objectives

The target of the test is to evaluate the rapid gas decompression (RGD) performance of various Vespel® grades and to determine the compatibility with pure CO_2 in super critical state (sCO2).

Both ageing and RGD will be applied to the specimens. This is an initial scouting test to primarily assess the overall performance of Vespel® families in CO_2 combined with rapid gas decompression.

What is super critical fluid CO_2?
Supercritical carbon dioxide (sCO_2) is a fluid state of carbon dioxide where it is held at or above its critical temperature and critical pressure.

The following phase diagram shows the various states and phases of carbon dioxide. The critical point or triple point is at the edges of liquid, critical fluid, and gas phase of CO_2:



2 Specimens and testing

Vespel® grades and specimens	
Vespel® SP-1	ISO 527-1BA tensile bars
Vespel® SP-21	
Vespel® SCP–50094	

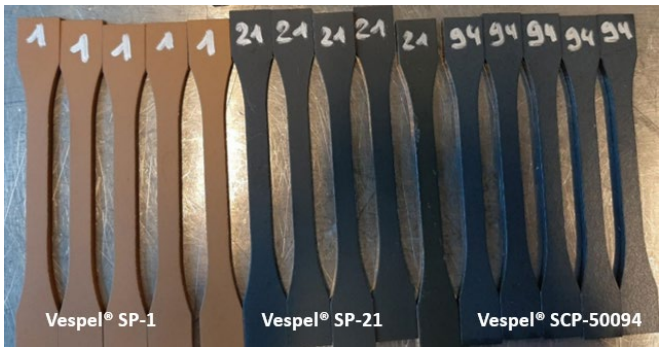
First test conditions	
20 hours ageing in sCO_2	150 °C / 200 bars (2,900 psi)
Followed by a RGD event	At 120 bars/min

Second test conditions	
100 hours ageing in sCO_2	150 °C / 200 bars (2,900 psi)
Followed by a RGD event	At 120 bars/min

The two above tests are followed by a visual inspection and tensile testing to assess the impact over the mechanical properties of the various Vespel® grades.

3 Test results

Surface aspect after ageing and RGD

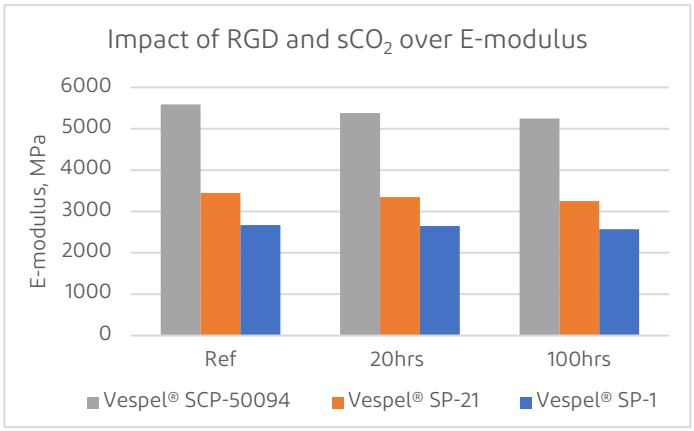


Aspect after 100 hours ageing in sCO_2 + RGD

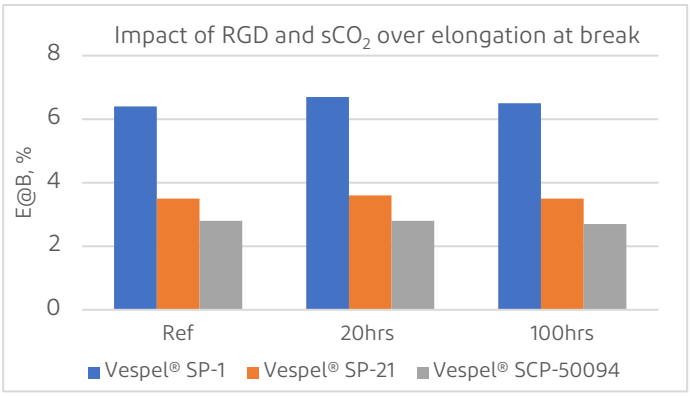
No visual defects or dimensional changes are observed on the Vespel® tensile specimens after 20 hours and 100 hours ageing followed by the rapid gas decompression event.

Tensile properties

Based on the tensile testing, the ageing and RGD had no impact on the E-modulus of the various Vespel® grades:



Based on the tensile testing, the ageing and RGD have not impacted the elongation at break of the various Vespel® grades:



4 Conclusion

The ageing at 200 bars (20 MPa, 2,900 psi) and 150 °C (302 °F) in pure carbon dioxide did not have any significant impact over Vespel® SP and SCP tested. Moreover, the pure CO_2 was in the supercritical phase which is supposed to be the most aggressive.

At the end of the ageing phase a decompression cycle took place. The decompression rate used for the RGD was high. The standard decompression rate recommended by ISO 23936-2 (former Norsok M-710) is 2MPa/min and in this case a decompression rate of 12MPa/min was selected which is six times higher than the former mentioned. The decompression rate of 12MPa/min had no significant impact over Vespel® mechanical properties, dimensions or aspect.

Overall, Vespel® PI is suitable for service in sCO_2 applications such as for valve seats or compressor parts.

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