Low Temperature testing of Parker V1289-75 O-rings

Summary

A sample of 3 V1289-75 O-rings were fitted to the pressure rig supplied and subjected to a cooling cycle to determine the temperature at which seal integrity was lost. For one of the three O-rings, the temperature was subsequently increased in order to determine the temperature at which an effective seal was restored. The results indicate that V1289 O-rings, runs 1 and 2, lost seal integrity at a temperature of approximately -50°C. The O-ring for run 3 lost seal integrity at around -54°C and re-sealed at around -52°C.

Materials and methods

Pressure test rig was supplied by our customer. Ref details as follows:
Test Rig drawing No. R8097-200/201 (Issue A), Vent Plug drawing No. R8097-203 (Issue A)

The reference details of the V1289-75 O-rings were as follows: Ceetak ref. 42870, Batch No. 80082263, Product code P2-117 V1289-75, Description 20.29 x 2.62, cure date 1Q08.

The reference details of the silicone O-rings were as follows: Ceetak ref. 42870, Batch No. 31002469, Product code P2-126 S383-70, Description 34.59 x 2.62 Silicone 70, cure date 1Q09.

All o-rings conformed to ISO 3601/1 tolerances and ISO 3601/3 Surface Imperfection control.

All instruments used e.g. pressure gauge, temperature sensors and torque wrench were calibrated before use.

A thermocouple was inserted down the centre of the test plug (marked P for pressure testing) and positioned with the thermocouple tip located within the vent port; as illustrated in Figure 1. The thermocouple was in close proximity to the inner o-ring.

A V1289-75 O-ring (black) was fitted in the inner groove and a Silicone 70 O-ring (red) was fitted in the outer groove, as illustrated in Figure 1. The plug was screwed into the test rig and tightened to a torque of 2kg.m.

The nominal section of the O-ring, in combination with the nominal depth of the vessel groove, resulted in a squeeze of 24%. This is deemed typical and conforms to typical sealing design guidelines.

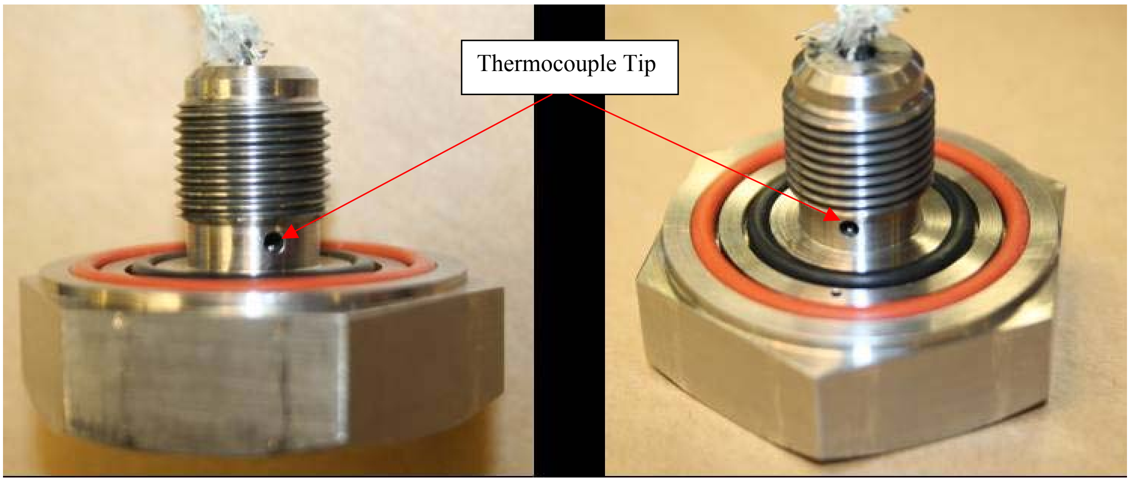

Figure 1 Position of thermocouple within plug fixture

Fittings were attached to enable the test rig to be pressurised and connected to a digital pressure meter. These are illustrated in Figure 2. The rig was placed within the test chamber (a modified Instron environmental test chamber) as illustrated in Figure 3. Gaseous CO_2 was used as the cooling medium and the chamber was connected to a CO_2 cylinder, as illustrated in Figure 4. The thermocouple was attached to a data-logging unit. The thermocouple, located within the test rig, was calibrated together with the data-logging unit prior to conducting studies with a pressurised system.

The digital pressure meter was attached to a T piece as illustrated in Figure 2. The system was pressurised to approximately 1 Bar using a hand pump attached to a section of rubber hose. The system was sealed with a clamp. The system was typically left for a period of at least 5 to 10 minutes, to check for system integrity, prior to chilling the test rig.

The target temperature of the control chamber was set to -55°C for the first run. The first run was used to provide an indication of the temperature range associated with loss of seal integrity. The second and third runs were more carefully controlled. They were intended to give more detailed information in the critical temperature range associated with loss of seal integrity.

The target temperature was initially set to -50°C for the second and third runs. This resulted in rapid cooling of the test rig. The target temperature was altered as the test proceeded, to reduce the rate of cooling of the rig as the temperature approached that associated with loss of seal integrity. The aim was to maintain the temperature at close to -45°C for a period of at least 20 minutes and to monitor for seal integrity at this temperature. The temperature was then lowered slowly to determine when seal integrity was lost. The temperature of the chamber was subsequently increased, following loss of seal integrity (for run 3), in order to determine the temperature at which an effective seal was restored.

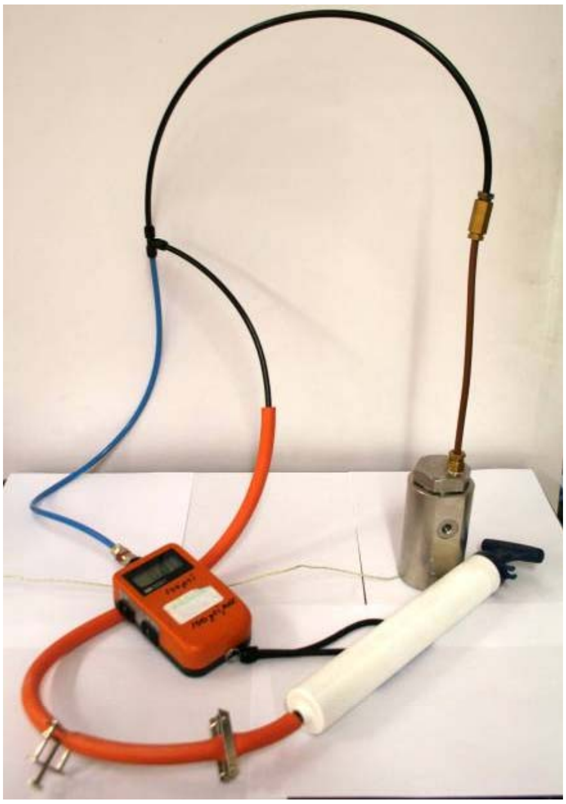

Figure 2 Test rig, pressurising system and digital pressure monitor

Figure 3 Close up of environmental test chamber

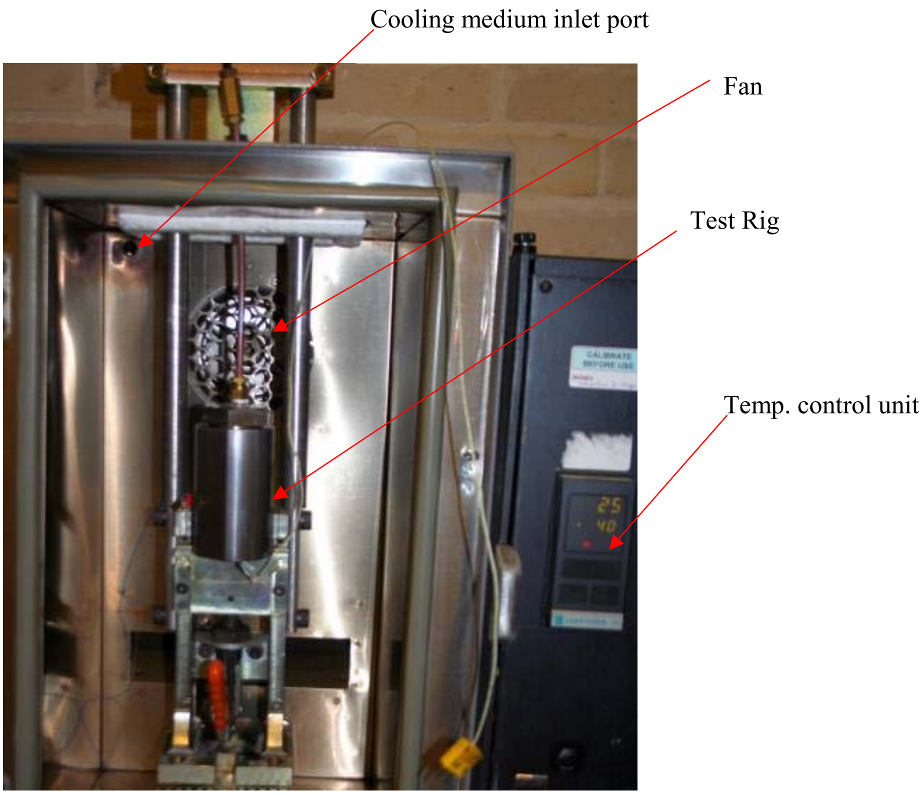

Figure 4 Test Chamber with CO_2 cylinder attached

Results

The results show that the V1289-75 O-rings lost seal integrity at temperature of –50 to -54°C. A sharp decrease in pressure, as illustrated in Figure 5, was recorded. On subsequently increasing the temperature, run 3, the temperature at which seal integrity was restored was -52°C.

A shallow decrease in pressure was noted during the initial cooling cycle, prior to loss of seal integrity. This was attributed to the air, within the pressurised system, obeying the gas laws; pressure decreasing with decreasing temperature. The small increase in pressure recorded for run 3, from 0.68 to 0.72 Bar, on heating the system would tend to support this.

The temperature and pressure profiles for the O-rings are included. These have been plotted as a function of elapsed time and are illustrated in figure 6 to 8. In addition to showing a sharp decrease in pressure at around -50°C, figures 6 and 7 also indicate that there was no loss in pressure over a 20 minute period at a temperature of around –45°C. The loss recorded for run 3 over the same region of the profile, 0.01 Bar was not significant.

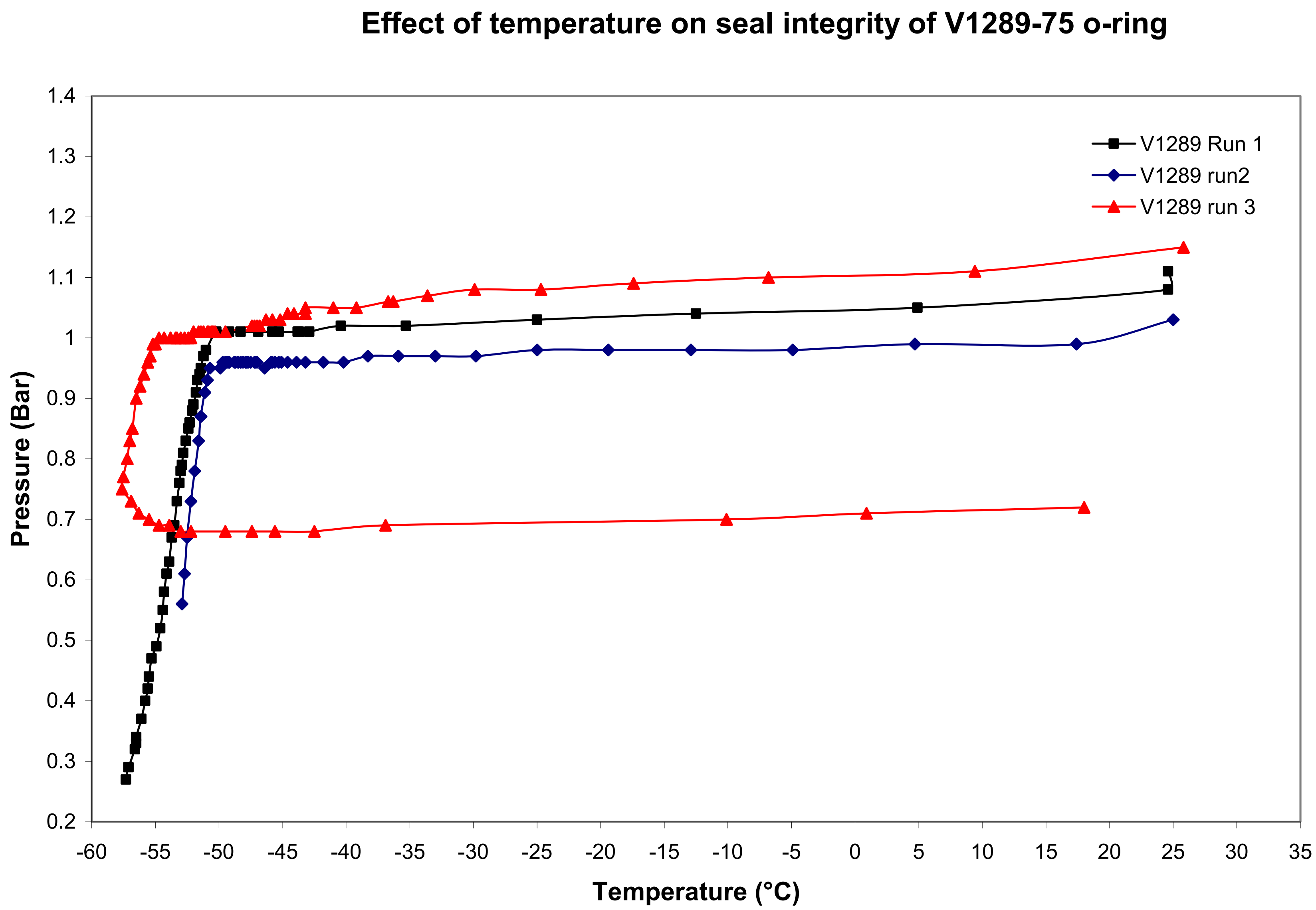

Figure 5 Effect of temperature on seal integrity of V1289-75 O-rings

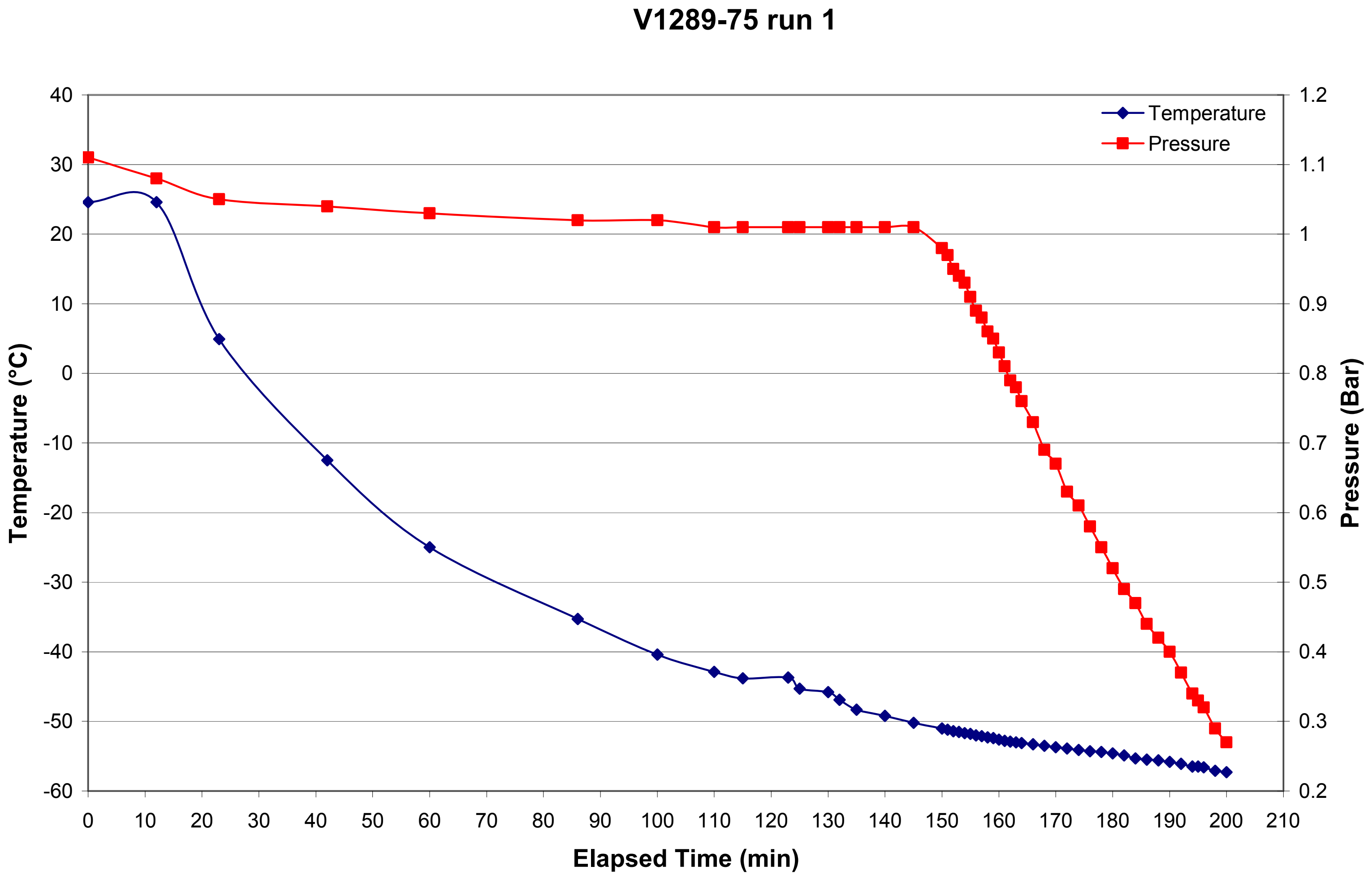

Figure 6 Temperature – Pressure profile for V1289-75 O-ring (Run 1)

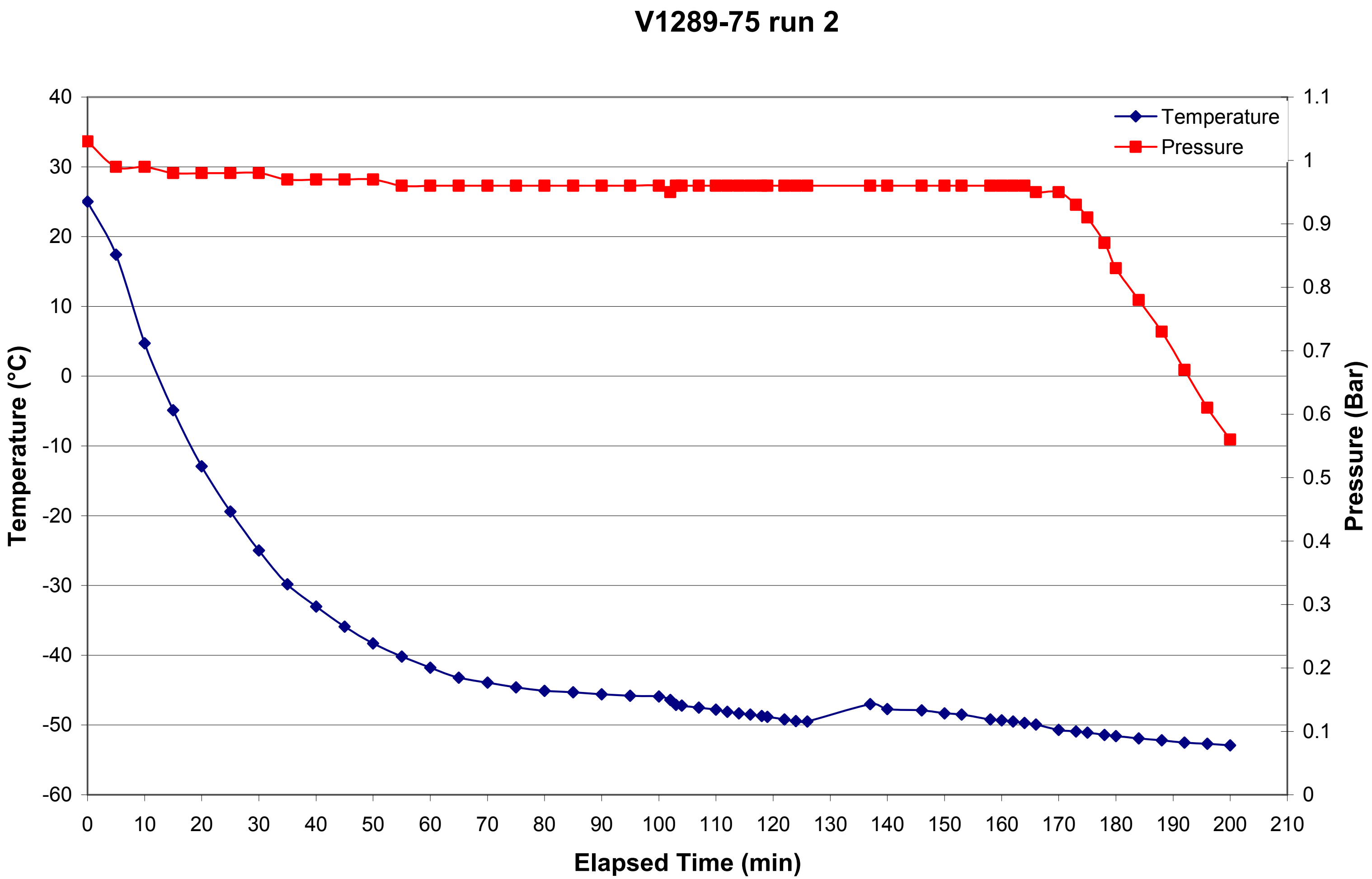

Figure 7 Temperature – Pressure profile for V1289-75 O-ring (Run 2)

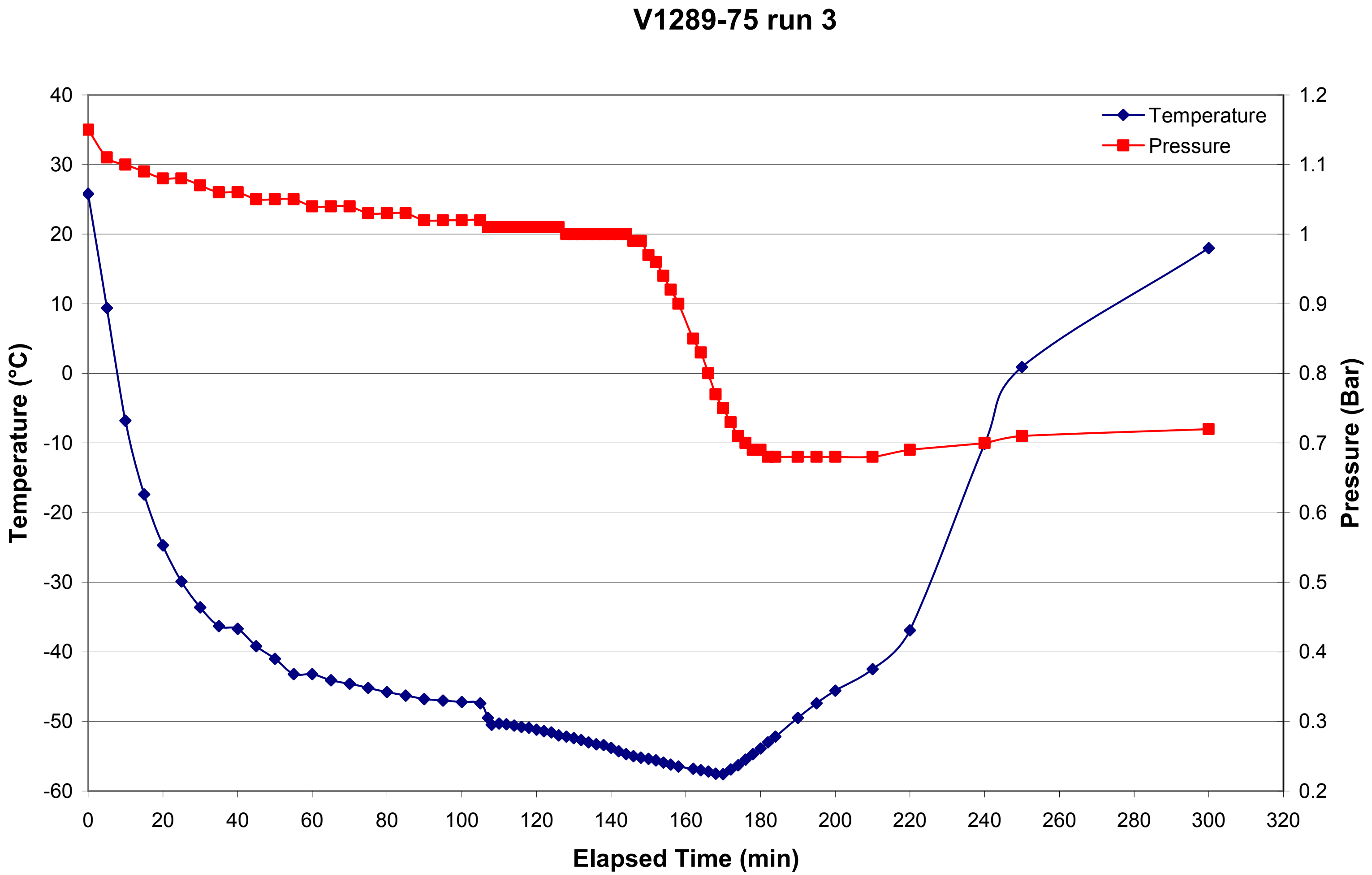

Figure 8 Temperature – Pressure profile for V1289-75 O-ring (Run 3)

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Signed: Tarsem Sandhu – Application Engineer

Signed: Chris Challis – Quality Manager

CEETAK LTD
Fraser Road
Priory Business Park
Bedford
MK44 3WH

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