The moisture sealing performance of short stroke O-ring seals.

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1. ABSTRACT

This paper presents an investigation into the moisture sealing performance of reciprocating FKM (Fluorocarbon Elastomer) O-rings. These O-rings are used in high-voltage oil insulated cable terminations to seal the cable exit. An effective and long-lasting seal is required to prevent moisture ingress degrading the insulating performance of the oil. In-service testing has revealed unexpectedly high moisture content in the oil of some terminations. The cable exit seal is a suspected failure point. The seal is a piston / cylinder type with the gland in the cylinder. Although designed to be static it has been hypothesised that slow movement caused by thermal expansion and contraction of the cable allows moisture to be transported past the seal.

A test rig has been developed to test seal reciprocation at an accelerated rate. The rig replicates the cable exit seal using parts from production cable terminations. The test seal is positioned in the top of a sealed air chamber. The outside of the seal is flooded by a water bath. A vertically orientated crank-slider mechanism reciprocates a conductor cable within the bore of the test seal. The stroke length can be adjusted between 0 and 10 mm and the cycle frequency between 0.15 and 2 Hz. A fan and sensor within the air chamber circulate the air and monitor the relative humidity and temperature. The chamber is fixed to a load cell to measure the seal friction.

Tests have investigated the effects of stroke length, cycle frequency and O-ring hardness on the rate of humidity increase in the chamber (i.e., the leak rate of the seal). Figures 1 and 2 show the effects of increasing stroke length and cycle rate during in two tests.

Results show that when the stoke is sufficiently short that the O-ring maintains continual ‘stick’ with the reciprocating surface, the seal is effective. However as soon as the stroke length induces slipping there is an immediate, and relatively rapid, increase in chamber humidity. It is concluded that any reciprocation approaching the O-ring cross-section diameter will compromise the seal. Further testing will investigate the effects of temperature, surface roughness, material types, and air-to-air (as opposed to water-to-air) sealing performance.

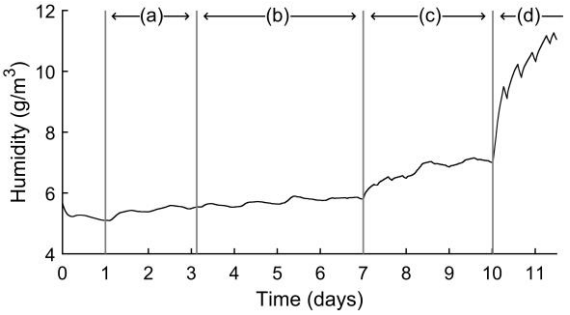

Figure 1. Effect of increasing stroke length on moisture ingress. Stroke length in mm (a) 0.3, (b) 0.7, (c) 1.4, (d) 2.8.

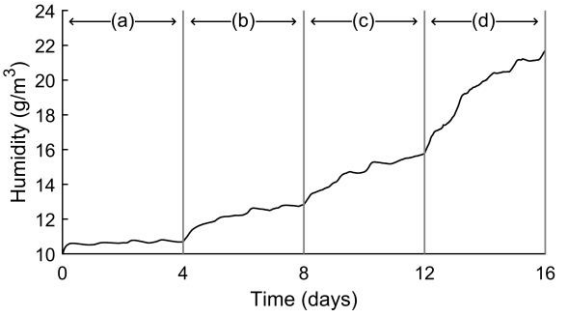

Figure 2. Effect of increasing frequency on moisture ingress. Frequency in Hz (a) 0, (b) 0.15, (c) 0.3, (d) 0.6.