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Contact behavior analysis of elastomeric x-ring under uniform squeeze rate and internal pressure before and after forcing-out using the photoelastic experimental hybrid method†

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Abstract

Many different types of elastomeric rings have been developed to suit various needs in industry. The X-ring was introduced as a result of the limitations of O-rings that twist, especially during dynamic application. A better understanding of the behavior and the stress distribution of the X-ring under a uniform squeeze rate and internal pressure is needed. We analyzed the contact stresses and internal stresses developed in an X-ring before and after forcing-out by using the photoelastic experimental hybrid method, ascertained the packing ability of an X-ring, and studied the failure criterion of an X-ring under uniform squeeze rate and internal pressure. Forcing-out in the X-ring occurred when the internal pressure was 3.92 MPa. After forcing-out, at an internal pressure of 5.88 MPa, the two lobes on the upper contact surface merged one contact side of the upper side immensely. Even after extrusion of the X-ring, the X-ring can be used to effectively contain the fluid. This is because the effects of extrusion on the X-ring affected the stress distribution of only two lobes close to the assembly gap and the two lobes are merge into one lobe. In addition, our experimental results show that the maximum shear failure criterion is suitable for the prediction of failure in X-ring seals.

Keywords: Contact behavior; Contact stress; Contact length; Packing ability; X-ring; Squeeze rate; Internal pressure; Forcing-out; Photoelastic experimental hybrid method