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O-Ring Tension Testing Calculations

RATIONALE

This document has been determined to contain basic and stable technology which is not dynamic in nature.

STABILIZED NOTICE

This document has been declared "Stabilized" by the SAE AMS CE Elastomers Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

1. SCOPE:

1.1 Purpose:

This document is intended to facilitate calculation of O-Ring tension testing values.

1.2 Application:

The calculation of the values for tensile strength, ultimate elongation, and modulus at 100% elongation from raw data obtained on O-Rings is outlined in its essentials in ASTM-D-1414. This document provides tables which simplify these calculations. Notations and symbols used herein are not identical to those used in ASTM D 1414.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publicatioans shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AS568 Aerospace Size Standard for O-Rings

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 1414 Rubber O-Rings

3. CALCULATIONS:

3.1 Elongation:

ASTM D 1414 provides the following equation for calculation of ultimate elongation.

$$\%E = \frac{(2d + G - C) \times 100}{C} \quad \text{(Eq. 1)}$$

Where

G = circumference of one spool,
C = original inside circumference of O-Ring,
d = spool center-to-center distance at time of rupture, and
E = elongation.

The raw data consists of the inside diameter of the O-Ring (denoted as D in the following), the spool diameter (S), and the spool center-to-center distance (d) at break. It should be noted that one spool must be driven and the other freely rotating in order that the stress be uniformly distributed around the entire ring. Use of nonrotating pins leaves the contact length(s) of the O-Ring substantially unstressed because of friction between O-Ring and pin(s), unless the O-Ring is suitably lubricated (silicone oil or castor oil is suggested) immediately prior to testing. Laboratories attempting to correlate data should agree upon spool or pin diameters and the particular lubricant to be used.

Equation (5) below is derived from equation (1) and, with Table 1, is directly and simply applicable to the calculation of percent elongation.

$$C = \pi D \quad \text{(Eq. 2)}$$

$$G = \pi S \quad \text{(Eq. 3)}$$

$$E = \frac{2d + \pi S - \pi D}{\pi D} \quad \text{(Eq. 4)}$$

$$E = \frac{2}{\pi D} d - \frac{D - S}{D} \quad \text{(Eq. 5)}$$

The terms $\frac{2}{\pi D}$ and $\frac{D - S}{D}$ are constants for any given O-Ring size and spool diameter. Tables 1 and 1A give values for these terms for AS568 dash numbers when tested on either the standard 0.500 inch diameter spools for ring sizes which will be accepted by them, or 0.250 inch diameter spools for smaller sizes. Similar tables for other spool diameters can be constructed by using equation (5) above. In using the table, multiply the spool center-to-center distance, (d), by the number in the column headed “multiply (d) by”, and subtract from the result the number in the column headed “and subtract”. This result must then be multiplied by 100 in order to obtain percent elongation. The calculated terms given are based on the mean value of the O-Ring inside diameter.