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Application News

No. MT-2201

Precision Universal Testing Machine

Tensile Testing of Rubber O-Rings According to ASTM D 1414

■ Introduction

O-rings are elastic seals with a circular cross section that are often used as gaskets to prevent gases or liquids from escaping connections between pipes, flanges, and pump components. In many applications, O-ring failures can have catastrophic consequences resulting in machinery damage or the release of hazardous substances. Potential causes of O-ring failure, include compression set (deformation of O-ring over time), abrasion, thermal degradation, and chemical exposure. Consequently, it is standard quality control protocol in the rubber industry to test the physical properties of O-rings and determine changes in properties due to aging and weathering. One such standard test is defined in ASTM D 1414 Standard Test Methods for Rubber O-Rings. This method describes procedures for evaluating the tensile and compression properties of O-rings as well as aging protocols, density measurement, and hardness measurement. The tensile testing of several O-rings according to ASTM D 1414 is described below.

O-rings are to be tested using grips consisting of ball-bearing spools. Stresses are minimized by either rotating one spool continuously or by lubricating the contact surface of the spools with oil to prevent the samples from breaking at the grips. The recommended spool diameter is 9 mm; however, other spools can be used to test smaller diameter O-rings. Consult the latest version of the standard for the most accurate details of the test.

Due to the unique dimensions of O-rings, the equations used to calculate stress and strain are different than in other tensile tests. Shimadzu's intuitive Trapezium-X and TrapeziumX-V software include convenient features specifically for O-ring specimen dimensions and the ability to input data constants and program custom data processing calculations.

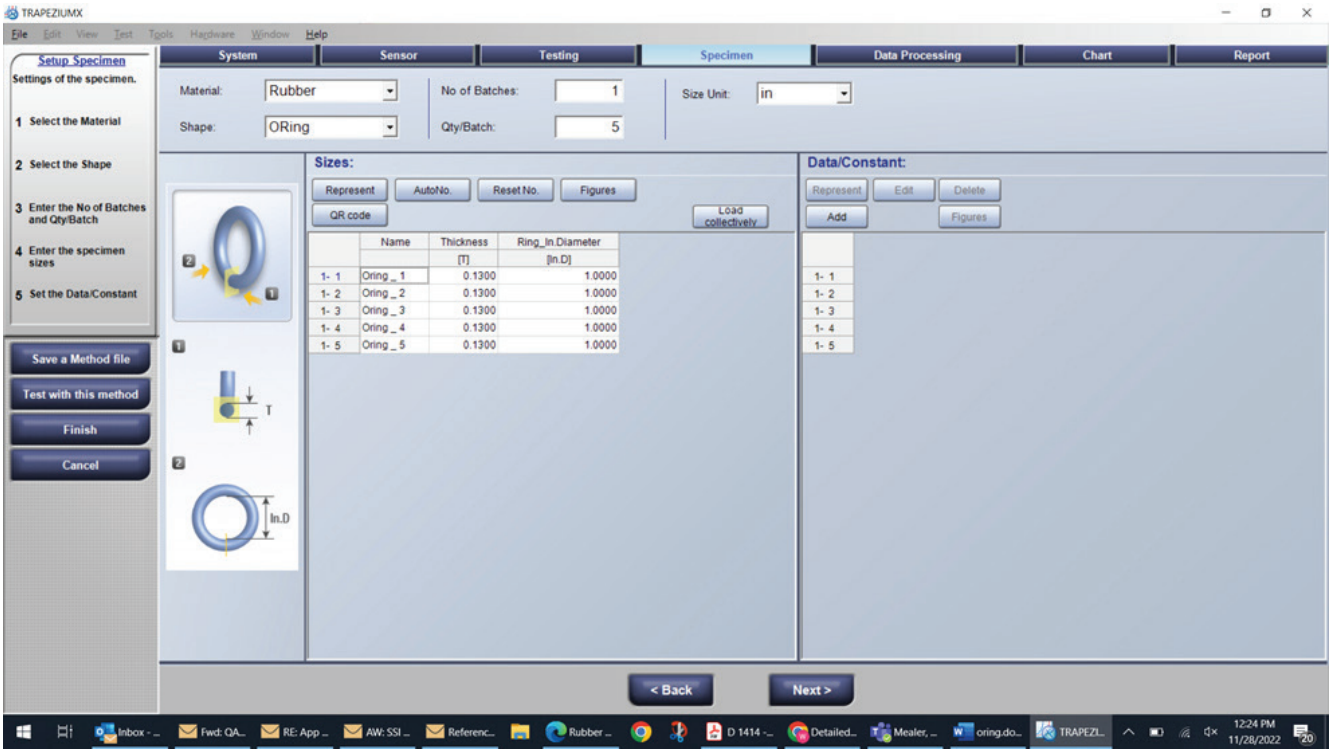

Figure 1: Shimadzu's test frame software makes it easy to enter in O-Ring specimen dimensions

■ Measurement System and Conditions

In this test, a Shimadzu AGS-X series precision universal testing machine was used. Three different O-rings were tested. Two nitrile rubber O-rings were tested, one with an inner diameter of 1 inch and thickness of 0.13 inches and the other with an inner diameter of 2 inches and thickness of 0.08 inches. A silicone O-ring with an inner diameter of 1 inch and thickness of 0.13 inches was tested. Samples were tested at 20 inches/minute until failure.

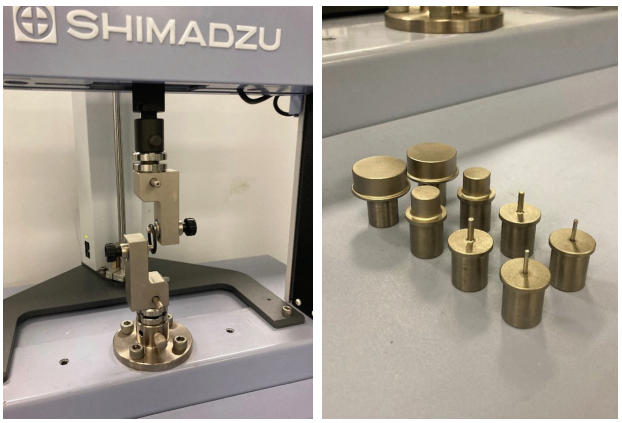

Figure 2: Shimadzu AGS-X Test Frame with Interchangeable Spool Grips

Table 1: Specification of Test System and Conditions

Instrument	AGS-X 1 kN
Grip	Spool Grips for O-rings with Custom Diameters
Software	TrapeziumX
Test Speed	20 inches/min
Break Detect	Sensitivity 10%
Data Processing	Max Stress and Max Strain
Specimen Materials	Nitrile and Silicone O-rings

■ Measurement Results

Figure 3 shows the measurement results on a stress-strain curve. All three specimens showed high elongation and sudden failures. The nitrile 1 inch O-ring had the highest tensile strength and strain. The 2-inch diameter, 0.08 thickness O-ring was the next strongest, but had lower strain at failure. The silicone O-ring failed at a significantly lower stress and strain than the nitrile O-ring of comparable size. This specific silicone O-ring is designed for high-temperature use, so though it has lower strength, it may be usable in certain more demanding applications.

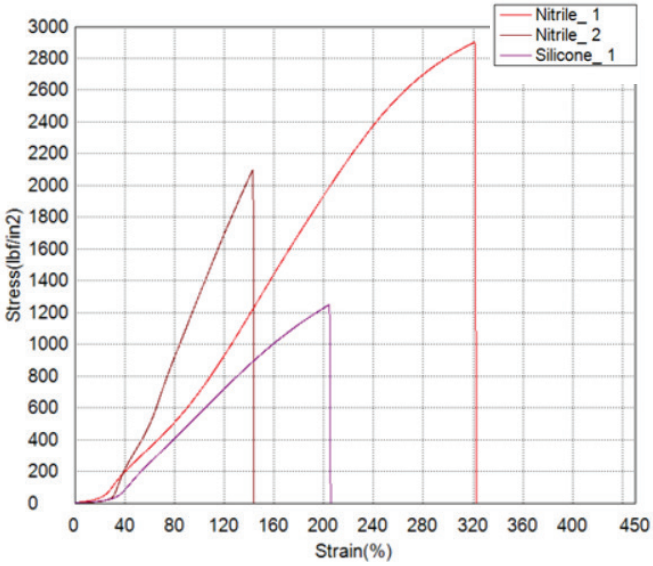

Figure 3: Stress-Strain Curve of Three O-ring Specimens

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