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Standard Practice for Compression versus Load Properties of Gasket Materials[1]

This standard is issued under the fixed designation F3270/F3270M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice measures the compression properties of a gasket material by measuring gasket deflection while it is subjected to an increasing compressive load until a target load is reached. The load and change in thickness are recorded at a defined loading rate as a function of time for the duration of the test.

1.2 Suggested loading rates are 0.5 MPa/s [72.52 psi/s] for all types of gaskets except for expanded polytetrafluoroethylene (PTFE), elastomer, and cork/elastomer gaskets when 0.1 MPa/s [14.5 psi/s] is used.

1.3 The Part A test is performed that measures the compression properties of a gasket material by measuring gasket thickness while it is subjected to an increasing compressive load until a target load is reached. This test is performed at room temperature but may be performed at an elevated temperature if desired or when agreed upon by producer and user.

1.4 The Part B test may be performed that measures the compression properties of a gasket material by measuring gasket thickness while it is subjected to increasing compressive loads that includes a sequence or sequences in which the gasket is unloaded followed by a resumption of the compressive load until a target load is reached. The unloading rate is the same as the loading rate unless different loading and unloading rates are desired or when agreed upon by producer and user. This test is performed at room temperature but may be performed at an elevated temperature if desired or when agreed upon by producer and user.

1.5 The testing parameters for both Parts A and B including the gasket material type, gasket dimensions, platen type (RF or FF), target load, loading time, recording interval used during the test, loading and unloading rates, and temperature are to be reported with the results.

1.6 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2000 Classification System for Rubber Products in Automotive Applications

F104 Classification System for Nonmetallic Gasket Materials

F868 Classification for Laminated Composite Gasket Materials

3. Terminology

3.1 *Definitions:*

3.1.1 *final specimen thickness, T_2, n*—specimen thickness recorded at the target stress for the material type.

3.1.2 *initial specimen thickness, T_1, n*—initial specimen thickness recorded on testing device.

3.1.3 *original specimen thickness, T_0, n*—average of specimen thickness measured in three places 120° apart before placing specimen on the testing device.

3.2 *Symbols:*

3.2.1 T_{s0}—original calibration ring thickness.

3.2.2 T_{s1}—calibration ring thickness recorded on testing device after bringing platens together.

[1] This practice is under the jurisdiction of ASTM Committee F03 on Gaskets and is the direct responsibility of Subcommittee F03.20 on Mechanical Test Methods.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.2.3 T_{s2}—final calibration ring thickness recorded at test maximum load.

4. Summary of Practice

4.1 *Compression Curve*—The relationship of the thickness of a gasket material at a given surface pressure is an important property for both the evaluation of a gasket material or the development of new materials. Specimens cut from gasket materials are subjected at room temperature or an elevated temperature or both to an increasing load at a defined loading rate (see 1.2) perpendicular to the flat surface of the specimen until a specified load is attained. Material thickness and load should be recorded as a function of time for the duration of the test to evaluate the load versus thickness relationship for the material. When an elevated temperature test is performed it can be done at the specified load before the specified temperature is applied, or with the material at the specified temperature before the load is applied, as agreed upon by the user or producer or both. The specified temperature should be determined by the material being tested or as agreed upon by the user or producer or both. Reporting for an elevated temperature test should include the load at which the specified temperature is applied.

4.2 *Part A – Loading Sequence*—Specimens cut from gasket material are subjected at room temperature to an increasing load perpendicular to the flat surface of the specimen until a specified load is attained. Material thickness and load should be recorded as a function of time for the duration of the test to evaluate the load versus thickness relationship for the material.

4.3 *Part B – Loading/Unloading Sequence*—In addition to a loading sequence, the test may include an unloading sequence or sequences to measure the thickness as load is decreased. If unloading is included, the gasket thickness is measured both while it is subjected to increasing compressive loads and during a sequence or sequences in which the gasket is unloaded followed by a resumption of the compressive load until a target load is reached.

4.4 The testing parameters, including the gasket material type, gasket dimensions, platen type (RF or FF), the target load, loading and unloading rates, and temperature, are to be reported with the results.

5. Significance and Use

5.1 The load versus thickness properties of a gasket material are an important factor with regard to the selection of a given material for use in a particular sealing application. Additionally, compression/load behavior data are a common request from users. The test allows comparison of materials at room temperature or elevated temperatures or both. Additionally, properties can be evaluated while loading and unloading the material at room temperature or elevated temperatures or both. The significance of the test method is based, in part, on the assumption that, if a material exhibits too much compression at either room temperatures or elevated temperatures, it will no longer function as effectively as a seal. The results may be used in certain flange design methods to characterize properties for design such as finite element analysis (FEA). The results may be used to confirm adequate assembly loading based on measured gasket compression in the field. Two or more materials can be compared to determine differences in their compression properties. A sample of material can be compared to an established standard or previously determined characteristics on original lots of the same material for quality assurance purposes.

5.2 If desired, samples may be tested with a raised profile flange, insert, or calibration ring described in 6.3 and Fig. 1 so that the area (2042 mm^2 [3.18 $in.^2$]) remains constant during the test.

6. Apparatus

6.1 *Testing Machine,* for applying a known value of compressive stresses to specimens. The machine should be capable of applying a stress of up to the expected maximum loads for materials being tested to a specimen size described in 7.1 at room temperature, depending on the indent resistance of the steel platens and the means of reading the applied load.

6.2 *Hardened Steel Platens, Two (Rockwell of C35 to 40 or Equivalent),* circular shape, larger than the specimen diameter. The faces of the platens shall be plane parallel with a surface finish between 3.2 and 6.4 µm [125 and 250 µin.], serrated or machined. Fig. 1 shows a suitable arrangement of steel platens and test specimen. Other finishes as desired or agreed upon between the producer and the user may also be used.

6.3 *Hardened Steel Platens, Two (Rockwell of C35 to 40 or Equivalent),* circular shape, larger than the specimen diameter. If the platens will only be used with a raised face flange, insert, or calibration ring, the faces of the platens shall be plane parallel with a smooth finish. Otherwise, the faces of the platens shall be plane parallel with a surface finish between 3.2 and 6.4 µm [125 and 250 µin.], serrated or machined. Fig. 1 shows a suitable arrangement of steel platens and test specimen. Other finishes as desired or agreed upon between the producer and the user may also be used.

6.4 *Device for Applying Heat to Platens,* sufficient to achieve a desired temperature at interface with gasket material specimens. In some cases, the loading device itself may be heated, such as with a hot press. Any appropriate means is acceptable. The device shall be capable of increasing the temperature at a rate between 2 and 5°C [3 and 9°F] per minute. The temperature difference between the two platens shall not exceed 5°C [9°F] at any time. The maximum temperature limit can be determined by the user and their requirements for their equipment. Other heating rates may be used as desired or agreed upon between the producer and the user.

6.5 *Temperature Measuring Device,* for use at interface, such as a thermocouple assembly and a means for recording the voltage.

6.6 *Dial or Thickness Measuring Device,* an indicating dial, or dials, graduated in 0.025 mm [0.001 in.] or a digital device to show or record the thickness of the specimen during the test.

6.7 *Shield*—A safety shield for protection from severe outgassing that may occur during the test.