



Standard Test Method for Testing Nonmetallic Seal Materials by Immersion in a Simulated Geothermal Test Fluid¹

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1. Scope

1.1 This test method covers a procedure for a laboratory test for performing an initial evaluation (screening) of nonmetallic seal materials by immersion in a simulated geothermal test fluid.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements, see Section 6 and 11.7.

2. Referenced Documents

2.1 ASTM Standards:²

D395 Test Methods for Rubber Property—Compression Set

D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

D471 Test Method for Rubber Property—Effect of Liquids

D575 Test Methods for Rubber Properties in Compression

D1415 Test Method for Rubber Property—International Hardness

D2240 Test Method for Rubber Property—Durometer Hardness

2.2 ASME Standard:

Boiler and Pressure Vessel Code, Section VIII³

¹ This test method is under the jurisdiction of ASTM Committee E44 on Solar, Geothermal and Other Alternative Energy Sources and is the direct responsibility of Subcommittee E44.15 on Geothermal Field Development, Utilization and Materials.

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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 Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

3. Summary of Test Method

3.1 Separate sets of material specimens are subjected to both the test liquid and its vapor at saturation conditions at the test temperature.

3.2 Specimens exposed to the test fluid for a given test may be from a single material to prevent interaction between dissimilar materials.

3.3 The samples shall be unstressed during exposure to the test fluid.

3.4 Tests of mechanical and physical properties shall be performed on specimens before and after immersion testing.

4. Significance and Use

4.1 This test method is intended for laboratory screening of materials. Due to large differences in the composition, pressure, and temperature of geothermal fluids, this test method may not correlate with actual service conditions. It does not consider the effects of geothermal fluid combined with oxidizing environments, stress loading, or thermal cycling.

5. Apparatus

5.1 *Test Vessel*, shall be capable of containing the test fluid at the test pressure and temperature. It is suggested that reference be made to the ASME Boiler and Pressure Vessel Code, Section VIII.

5.2 *Specimen Supports*, shall be capable of holding specimens submerged in the liquid and specimens suspended in the vapor so that the specimens are unstressed and do not touch other specimens or the walls of the vessel.

5.3 The apparatus, as illustrated in Fig. 1, shall include a means of heating the test vessel to a controlled temperature as selected.

5.4 *Safety Devices and Controls*, should be provided to protect the vessel from overpressure and overheating.

5.5 All parts of the apparatus that shall be exposed to the test fluid or its vapor shall be constructed of materials that are non-reactive with the fluid. Corrosion by-products may affect test results.

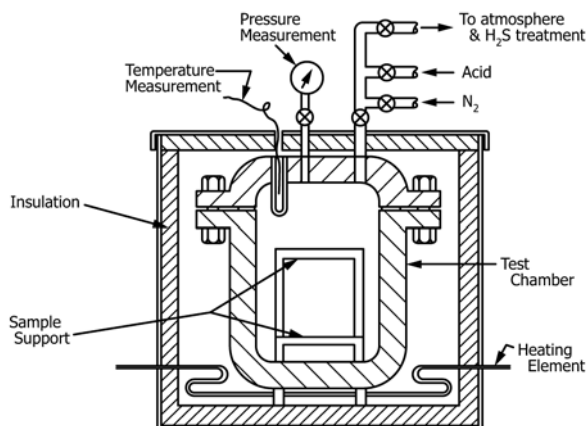


FIG. 1 Schematic of Test Apparatus

6. Precautions

6.1 Because of the extremely corrosive nature of this testing environment it is imperative that the vessel construction materials be corrosion resistant. Failure by weight loss corrosion or stress cracking can be catastrophic.

7. Test Fluid

7.1 The standard test fluid shall consist of the fluids specified in Table 1.

7.2 Other test fluids may be used. The composition or source must be described in the report.

7.3 The test fluid shall not be replenished during the test.

7.4 The test fluid volume shall be at least 100 times greater than the volume of the test specimens.

7.5 The standard test fluid shall be mixed according to the procedure defined in Section 11 of this test method.

8. Test Temperature

8.1 The test temperature shall be selected from Table 2.

9. Test Pressure

9.1 Pressure in the vessel shall be maintained at the vapor pressure of the test fluid at the test temperature.

10. Test Duration

10.1 The duration of the test shall be 570 h (approximately 24 days) for temperatures of 150°C or less. The duration for temperatures over 150°C shall be 70 h. The tolerances for test duration times shall be + 2 %, - 0 %.

11. Procedure

11.1 Place the specimen(s) into the apparatus vessel.

TABLE 1 Standard Test Fluid

Na ₂ S·9H ₂ O	5 g	±0.05 g
NaHCO ₃	5 g	±0.05 g
NaCl	57 g	±0.5 g
HCl (0.1 M)	1000 g	±5 g
Water (distilled)	1430 g	±5 g

TABLE 2 Standard Test Temperatures

°C		°F	
85	±2°C	185	±4°F
100	±2°C	212	±4°F
150	±2°C	302	±4°F
200	±2°C	392	±4°F
250	±2°C	482	±4°F
300	±5°C	572	±9°F
350	±5°C	662	±9°F

11.2 Place dry ingredients (Na₂S·9H₂O, NaCl, and NaHCO₃) into the apparatus vessel.

11.3 Seal and purge the vessel with nitrogen to remove air from the vessel.

11.4 Inject the liquid ingredients (HCl and H₂O). Note that hazardous gas (H₂S) will be evolved and pressure will develop when the acid is added. All the evolved gases shall be contained in the vessel as part of the test environment.

11.5 To ensure that the specimens are located in the proper phase, the volume at ambient temperature of the fluid shall be calculated to ensure proper liquid-to-vapor ratio in the test vessel at the test temperature for the volume ratio stated in 7.4.

11.6 Apply heat and raise to test temperature, at which time the test period shall begin.

11.7 After the test period, reduce the temperature to less than boiling temperature at atmospheric pressure and purge thoroughly with nitrogen before opening the test vessel. **CAUTION**—The nitrogen purge effluent may contain hazardous H₂S gas and must be disposed of in an approved manner.

12. Report

12.1 State that the test was conducted in accordance with ASTM Test Method E1068, and report the following:

12.1.1 Date of test report.

12.1.2 Description of new, unexposed specimens, including material type, batch identification, dimensions, appearance, and physical properties.

12.1.3 Dates and times of the various periods of exposure.

12.1.4 Volume of the test vessel.

12.1.5 Test liquid used, volume, and chemical analysis.

12.1.6 Temperature and pressure of exposure.

12.1.7 Exposure periods.

12.1.8 All observed and recorded data, to include the type of properties being reported.

12.1.9 Statement of condition of exposed specimens from visual and manual examination, and measured physical properties.

12.1.10 Statement identifying whether specimen was in vapor or liquid.

12.2 Physical properties may be determined from tests performed in accordance with Section 2.1 (Test Methods D395, D412, D471, D575, D1415, and D2240) of this standard.

13. Precision and Bias

13.1 This test method is for screening candidate materials for an intended application, so results in the report are to be evaluated for the specific application.

13.2 Candidate specimen materials that are judged adequately resistant to degradation by the test are subjected to further testing.

13.3 Descriptions of exposed specimens (12.1.9) are necessarily subjective in nature. Problems of precision and bias of the reported information should be judged as such.

14. Keywords

14.1 geothermal fluids; geothermal liquids; immersion test; nonmetallic seal; nonmetallic seal materials

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