

## METHOD 101E

SALT ATMOSPHERE (CORROSION)  
(formerly Salt Spray (Corrosion))

1. **PURPOSE.** The salt-spray test, in which specimens are subjected to a fine mist of salt solution, has several useful purposes when utilized with full recognition of its deficiencies and limitations. Originally proposed as an accelerated laboratory corrosion test simulating the effects of seacoast atmospheres on metals, with or without protective coatings, this test has been erroneously considered by many as an all-purpose accelerated corrosion test, which if "withstood successfully" will guarantee that metals or protective coatings will prove satisfactory under any corrosive condition. Experience has since shown that there is seldom a direct relationship between resistance to salt atmosphere corrosion and resistance to corrosion in other media, even in so-called "marine" atmospheres and seawater. However, some idea of the relative service life and behavior of different samples of the same (or closely related) metals or of protective coating-base metal combinations in marine and exposed seacoast locations can be gained by means of the salt atmosphere test, provided accumulated data from correlated field service tests and laboratory salt atmosphere tests show that such a relationship does exist, as in the case of aluminum alloys. (Such correlation tests are also necessary to show the degree of acceleration, if any, produced by the laboratory test). The salt atmosphere test is generally considered unreliable for comparing the general corrosion resistance of different kinds of metals or coating-metal combinations, or for predicting their comparative service life. The salt atmosphere test has received its widest acceptance as a test for evaluating the uniformity (specifically, thickness and degree of porosity) of protective coatings, metallic and nonmetallic, and has served this purpose with varying amounts of success. In this connection, the test is useful for evaluating different lots of the same product, once some standard level of performance has been established. The salt atmosphere test is especially helpful as a screening test for revealing particularly inferior coatings. When used to check the porosity of metallic coatings, the test is more dependable when applied to coatings that are cathodic rather than anodic toward the basic metal. This test can also be used to detect the presence of free iron contaminating the surface of another metal, by inspection of the corrosion products.

2. **APPARATUS.** Apparatus used in the salt atmosphere test shall include the following:

- a. Exposure chamber with racks or fixtures for supporting specimens.
- b. Salt-solution reservoir with means for monitoring an adequate level of solution.
- c. Means for atomizing the salt solution, including suitable nozzles and compressed air supply.
- d. Chamber-heating means and controls.
- e. Means for humidifying the air at a temperature above the chamber temperature.

2.1 **Chamber.** The chamber and all accessories shall be made of material that will not affect the corrosiveness of the salt atmosphere, such as glass, hard rubber, or plastic. All parts of the test setup that come in contact with test specimens shall be of materials that will not cause electrolytic corrosion. The chamber and accessories shall be so constructed and arranged that there is no direct impinging of the spray or dripping of the condensate on the specimens, so that the atmosphere circulates freely about all specimens to the same degree, and so that no liquid which has come in contact with the test specimens returns to the salt-solution reservoir. The chamber shall be properly vented to prevent pressure build up and allow uniform distribution of salt spray. The chamber shall have a suitable means of heating and maintaining the required test temperature.

2.2 **Salt solution reservoir.** The salt solution reservoir shall be made of material that is non-reactive with the salt solution, e.g., glass, hard rubber, or plastic. The reservoir shall be adequately protected from the surrounding environment and shall have a means to monitor the solution level. The reservoir shall include a means to filter the salt solution in the supply line to the atomizers. When long duration test conditions are specified (e.g. test condition D), the reservoir may be refilled via auxiliary reservoirs so that the test cycle shall not be interrupted.

2.3 Air supply. The compressed air entering the atomizers shall be free from all impurities such as oil and dirt. Means shall be provided to humidify and warm the compressed air as required to meet the operating conditions. The air pressure shall be suitable to produce a finely divided dense fog with the atomizer(s) used. To insure against clogging the atomizers by salt deposition, the air should have a relative humidity of 95 to 98 percent at the point of release from the nozzle. A satisfactory method is to pass the air in very fine bubbles through a tower containing heated water. The temperature of the water should be 95°F (35°C) or higher. The permissible temperature increases with increasing volume of air and with decreasing heat insulation of the chamber and temperature of its surroundings. It should not exceed a value above which an excess of moisture is introduced into the chamber (e.g. 110°F (43.3°C) at an air pressure of 12 pounds psi), or a value that makes it impossible to meet the requirement for operating temperature.

3. SALT SOLUTION. The salt used shall be sodium chloride (NaCl) containing on the dry basis not more than 0.1 percent of sodium iodide, and not more than 0.5 percent of total impurities. Do not use sodium chloride (NaCl) containing anti-caking agents because such agents may act as corrosion inhibitors. Unless otherwise specified, the salt solution concentration shall be  $5 \pm 1$  percent. The 5 percent solution shall be prepared by dissolving  $5 \pm 1$  parts by weight of salt in 95 parts by weight of distilled or deionized water. Water used in the preparation of solutions shall contain not more than 200 parts per million of total solids. The salt solution shall be kept free from solids by filtration. The solution shall be adjusted to and maintained at a specific gravity in accordance with figure 101-1. The pH shall be maintained between 6.5 and 7.2 when measured at a temperature of 95°F  $\pm 5$ °F (35°C  $\pm 3$ °C). Only dilute cp grade hydrochloric acid or sodium hydroxide shall be used to adjust the pH.

4. PREPARATION OF SPECIMENS. Specimens shall be given a minimum of handling, particularly on the significant surfaces, and shall be prepared for test immediately before exposure. Unless otherwise specified, uncoated metallic or metallic-coated specimens shall be thoroughly cleaned of oil, dirt, and grease as necessary until the surface is free from water break. The cleaning methods shall not include the use of corrosive solvents nor solvents which deposit either corrosive or protective films, nor the use of abrasives other than a paste of pure magnesium oxide. Specimens having an organic coating shall not be solvent cleaned. Those portions of specimens which come in contact with the support and, unless otherwise specified in the case of coated specimens or samples, cut edges and surfaces not required to be coated, shall be protected with a suitable coating of wax or similar substance impervious to moisture.

#### 5. PROCEDURE.

5.1 Maintenance and conditioning of test chamber. The chamber shall be cleaned each time the salt solution in the reservoir has been used up to assure that all materials that could adversely affect the results of subsequent tests are removed. However, no test shall be interrupted for the purpose of chamber cleaning. After the cleaning cycle, upon restarting the chamber, the reservoir shall be filled with salt solution and the chamber shall be stabilized by operating it until the temperature comes to equilibrium, see 5.3. Intermittent operation of the chamber is acceptable, provided the pH and concentration of the salt solution are kept within limits, see 3.

5.2 Location of specimens. Unless otherwise specified, flat specimens and, where practicable, other specimens shall be supported in such a position that the significant surface is approximately 15 degrees from the vertical and parallel to the principal direction of horizontal flow of the fog through the chamber. Other specimens shall be positioned so as to insure most uniform exposure. Whenever practicable, the specimens shall be supported from the bottom or from the side. When specimens are suspended from the top, suspension shall be by means of glass or plastic hooks or wax string; if plastic hooks are used, they shall be fabricated of material that is non-reactive to the salt solution such as lucite. The use of metal hooks is not permitted. Specimens shall be positioned so that they do not contact each other, so that they do not shield each other from the freely settling fog, and so that corrosion products and condensate from one specimen do not fall upon another.

5.3 Chamber operation. A salt fog having a temperature of 95°F minimum (35°C minimum) shall be passed through the chamber for the specified test duration (see 5.4). The exposure zone of the chamber shall be maintained at a temperature of 95°F ±5°F (35°C ±3°C). The conditions maintained in all parts of the exposure zone shall be such that a suitable receptacle placed at any point in the exposure zone will collect from 0.5 to 3.0 milliliters of solution per hour for each 80 square centimeters (0.5-3ml/hr/80cm<sup>2</sup>) of horizontal collecting area (10 centimeters diameter). At least two clean fog-collecting receptacles shall be used; one placed at the perimeter of the test specimens nearest to the (any) nozzle, and the other at the perimeter of the test specimens farthest from the nozzle(s). Receptacles shall be fastened in such a manner that they are not shielded by specimens and so that no drops of solution from specimens or other sources will be collected. The 5 percent solution thus collected shall have a sodium chloride (NaCl) content of from 4 to 6 percent (specific gravity in accordance with figure 101-1) when measured at a temperature of 95°F ±5°F (35°C ±3°C). The specific gravity and quantity of the solution collected shall be checked following each salt atmosphere test. Suitable atomization has been obtained in boxes having a volume of less than 12 cubic feet with the following conditions:

- a. Nozzle pressure of from 12 to 18 pounds psi.
- b. Orifices of from 0.02 to 0.03 inch in diameter.
- c. Atomization of approximately 3 quarts of the salt solution per 10 cubic feet of box volume for each 24 hour period of test.

When using large-size boxes having a volume considerably in excess of 12 cubic feet, the above conditions may have to be modified in order to meet the requirements for operating conditions.

5.4 Length of test. The length of the salt atmosphere test shall be that indicated in one of the following test conditions, as specified:

<u>Test condition</u>	<u>Length of test</u>
A -----	96 hours
B -----	48 hours
C -----	24 hours
D -----	240 hours

Unless otherwise specified, the test shall be run continuously for the time indicated or until definite indication of failure is observed, with no interruption except for adjustment of the apparatus and inspection of the specimen.

6. MEASUREMENTS. Upon completion of the salt exposure, the test specimens shall be immediately washed with free flowing deionized water (not warmer than 100°F (38°C)) for at least 5 minutes to remove salt deposits from their surface after which they shall be dried with air or inert gas. As an option, the test specimens may be subjected to a gentle wash or dip in running water (not warmer than 100°F (38°C)) and a light brushing, using a soft hair brush or plastic bristle brush, after which they shall be dried with air or inert gas. The test specimens shall then be subjected to the inspections specified.

7. SUMMARY. The following details are to be specified in the individual specification:

- a. Special mounting and details, if applicable (see 5.2).
- b. Test condition letter (see 5.4).
- c. Measurements after exposure (see 6).

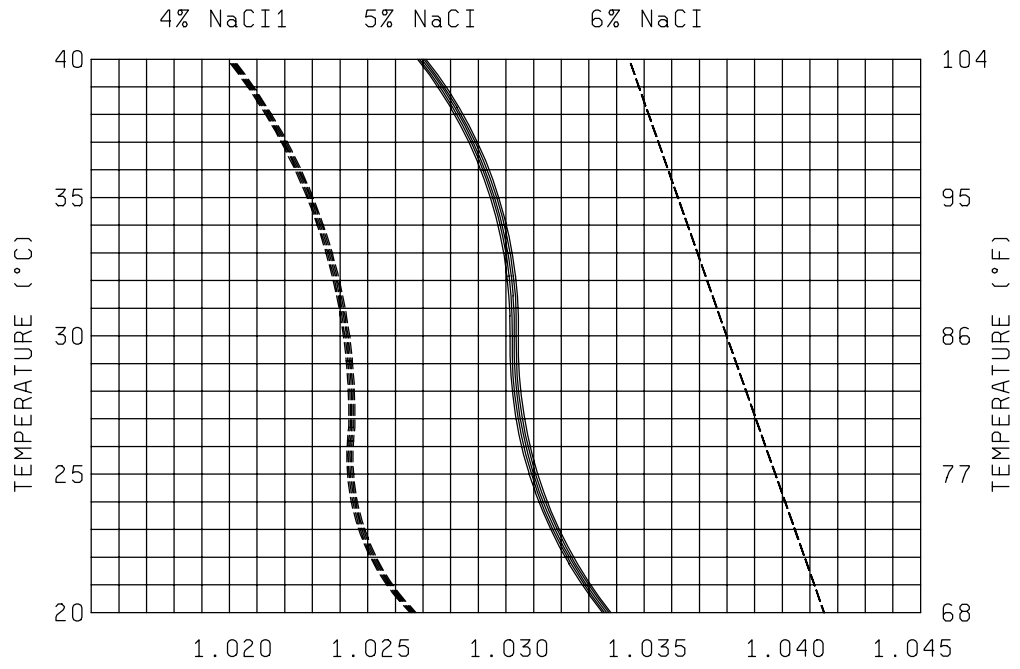


FIGURE 101-1. Variations of specific gravity of salt (NaCl) solution with temperature.