



Designation: D7148 – 07(Reapproved 2011)

Standard Test Method for Determining the Ionic Resistivity (ER) of Alkaline Battery Separator Using a Carbon Electrode in an Electrolyte Bath Measuring System¹

This standard is issued under the fixed designation D7148; 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 test method covers the pretreatment, test conditions, apparatus, and procedure to determine the ionic resistivity, commonly referred to in the battery industry as electrical resistance (ER) of an alkaline battery separator immersed in an electrolyte of 40 % potassium hydroxide (KOH).

1.2 The values stated in SI units are to be regarded as the 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.*

2. Referenced Documents

2.1 *ASTM Standards:*²

D1711 Terminology Relating to Electrical Insulation

2.2 *Battery Council International:*

Standard Test Method for Determining the Electrical Resistance of a Battery Separator Using a Palico Measuring System, Section 3.3b³

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

¹ This test method is under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.19 on Dielectric Sheet and Roll Products.

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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 Battery Council International, 401 N. Michigan Ave., 24th Floor, Chicago, IL 60611-4267.

3.1.1 *barrier resistance (RB), n*—the resistance of the bath with a solid, nonporous sheet of alkaline resistant, electrical insulation that separates the electrodes.

3.1.2 *bath resistance (RC), n*—the resistance of the bath without the specimen (separator).

3.1.3 *bath resistance (RT), n*—the total electrical resistance of the bath and a separator specimen.

3.1.4 *battery separator, n*—an ion-permeable, nonconductive material that prevents electrical contact between electrodes of opposite polarity.

3.1.5 *electrolyte, n*—a 40 % potassium hydroxide solution.

3.1.6 *ionic resistivity (ER), n*—the product of a change in electrical resistance times an area.

3.1.6.1 *Discussion*—The area is the aperture area divided by the number of separators between the electrodes. The change in resistance is the difference, in ohms, of the electrical resistance with and without the separator(s). The SI units for ER are ohms-metre² but the customary practice in the battery industry is to report the ER in units of ohms-cm². It should be noted that this terminology is not in conflict with Terminology D1711.

3.2 *Symbols:*

3.2.1 ER—a symbol, peculiar to the battery industry, denoting that characteristic of a sheet material that is related to the rate of transfer of ions through the interstices of a porous sheet immersed between two carbon electrodes in an aqueous electrolyte.

4. Summary of Test Method

4.1 This test method detects small changes in ohmic resistance between carbon electrodes immersed in an alkaline electrolyte with and without separator material between the carbon electrodes. This change is related to the rate of transfer of ions through a separator material. The ER is calculated from the fixed aperture area. The sensitivity and resolution of the apparatus detects electrical resistance changes of ± 0.1 %.

5. Significance and Use

5.1 The ER of a battery separator is a standard measurement used by separator and battery manufacturers for quality control purposes and separator selection.

5.2 Separator ER and the separator's interaction with the electrolyte, that is resistance to wetting or flow, will contribute to the internal resistance of the battery and this can potentially limit the electrical output of a battery. The ER determination is a tool for battery manufacturers to use in design, material selection, and performance specifications.

5.3 The change in the bath electrical resistance imparted by a separator is affected by the porosity, thickness, and tortuosity of the pore structure of the separator, the wettability of the separator to the electrolyte, and the temperature and concentration of the electrolyte.

5.4 Incomplete wetting or saturation of the pore structure limits the lowest ER value obtainable from a separator structure. Separators are pretreated to assure that the specimen being tested has been adequately wetted out. A separator that is not fully wetted out (saturated) will give a higher ER.

5.5 This test method is intended to give a rapid and repeatable measurement that approximates the change in ER that could happen when the separator is used in a battery.

6. Apparatus

6.1 Stainless steel container or equivalent to accommodate the separator test samples.

6.2 Hot plate or other heating device suitable to boil water.

6.3 Stainless steel screen.

6.4 Glass or plastic separator tank for presoaking separators in battery electrolyte.

6.5 Interval timer.

6.6 Safety glasses.

6.7 Thermometer.

6.8 Alkaline resistant gloves, that is neoprene latex or polyethylene gloves.

6.9 Plastic tongs for handling KOH-wetted separators.

6.10 ER bath with a fixed aperture area (32 cm² is standard) that puts a uniform current flux through a fixed area of the separator sample for measurement. A drawing of an ER bath is included in [Annex A1](#).

6.11 A.C. resistance meter or bridge with sufficient sensitivity and resolution to measure ± 0.1 % change in the ER bath resistance in the presence of potentials generated in the ER bath.

7. Reagents and Materials

7.1 Distilled or deionized water.

7.2 Reagent grade KOH.

8. Hazards

8.1 Safety goggles and face shield, lab coat, and rubber apron and gloves must be worn during KOH dilution opera-

tions. Enclose the glass-mixing bottle in a plastic container of sufficient capacity to contain the solution in case of bottle breakage. To prevent excessive heating, add concentrated KOH slowly to water with adequate agitation to produce thorough mixing. The diluted KOH is sufficiently corrosive at both ambient and elevated temperatures that careful handling is necessary to prevent injury or damage.

8.2 The hazard associated with mixing KOH with water is that it generates a lot of heat as it dissolves; this has the potential to lead to spattering. A concentrated KOH solution will erode skin and eyes. Avoid these hazards by wearing safety glasses, face shield, and protective gloves, and immediately rinsing with water if any skin contact occurs. (If any eye contact occurs, flush the eyes with water for 15 min and then get medical attention.)

9. Sampling, Test Specimens, and Test Units

9.1 Select samples representative of the separator material to be tested.

9.2 Use a specimen size of at least 120 by 120 mm and no larger than what will fit in the bath.

9.3 If specimens require identification, use an alkaline resistant marker. Mark an area of the specimen that will not interfere with the ion transfer through the separator.

10. Preparation of Apparatus

10.1 Fill the ER bath with prepared battery electrolyte (40 ± 1 % KOH solution) to a level above the aperture opening (12 to 25 mm below the top of the ER bath). Adjust the bath's temperature to $25 \pm 5^\circ\text{C}$.

10.2 Connect the electrodes to the resistance meter control unit using alkali-resistant wire and hardware.

10.3 Turn on the resistance meter. Allow the equipment to stabilize for at least 20 min. If the meter includes a standard reference resistor (place in "Standby" mode and "Standard" scaling on the resistance meter control unit and set to the appropriate resistance range scale for a 0.200- Ω resistor reading). Unless the meter reading is within ± 0.1 % of the value of the resistor, service will be required.

10.4 If available, check the resistance standard for the system outlined in [11.4](#). If this agrees within ± 1 %, proceed to [Section 13](#).

10.5 Periodically, or when problems occur or changes are made to the system, test the stability, polarization, current leakage, and standardization using the maintenance procedures set forth in [Section 11](#).

11. Testing and Maintenance of Equipment

11.1 Stability of Equipment

11.1.1 Check the resistance of the ER bath (Place the meter in "Operate" mode and "Standard" scaling and press "Reset." Set the appropriate resistance range to give the maximum meter reading without going off scale.)