



Designation: C 876 – 91 (Reapproved 1999)

Standard Test Method for Half-Cell Potentials of Uncoated Reinforcing Steel in Concrete¹

This standard is issued under the fixed designation C 876; 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 estimation of the electrical half-cell potential of uncoated reinforcing steel in field and laboratory concrete, for the purpose of determining the corrosion activity of the reinforcing steel.

1.2 This test method is limited by electrical circuitry. A concrete surface that has dried to the extent that it is a dielectric and surfaces that are coated with a dielectric material will not provide an acceptable electrical circuit. The basic configuration of the electrical circuit is shown in Fig. 1.

1.3 The values stated in inch-pound units are to be regarded as the standard.

1.4 *This standard does not purport to address 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:*

G 3 Practice for Conventions Applicable to Electrochemical Measurements in Corrosion Testing²

3. Significance and Use

3.1 This test method is suitable for in-service evaluation and for use in research and development work.

3.2 This test method is applicable to members regardless of their size or the depth of concrete cover over the reinforcing steel.

3.3 This test method may be used at any time during the life of a concrete member.

3.4 The results obtained by the use of this test method shall not be considered as a means for estimating the structural properties of the steel or of the reinforced concrete member.

3.5 The potential measurements should be interpreted by engineers or technical specialists experienced in the fields of concrete materials and corrosion testing. It is often necessary to use other data such as chloride contents, depth of carbonation, delamination survey findings, rate of corrosion results, and environmental exposure conditions, in addition to half-cell potential measurements, to formulate conclusions concerning corrosion activity of embedded steel and its probable effect on the service life of a structure.

4. Apparatus

4.1 The testing apparatus consists of the following:

4.1.1 *Half Cell:*

4.1.1.1 A copper-copper sulfate half cell (**Note 1**) is shown in Fig. 2. It consists of a rigid tube or container composed of a dielectric material that is nonreactive with copper or copper sulfate, a porous wooden or plastic plug that remains wet by capillary action, and a copper rod that is immersed within the tube in a saturated solution of copper sulfate. The solution shall be prepared with reagent grade copper sulfate crystals dissolved in distilled or deionized water. The solution may be considered saturated when an excess of crystals (undissolved) lies at the bottom of the solution.

4.1.1.2 The rigid tube or container shall have an inside diameter of not less than 1 in. (25 mm); the diameter of the porous plug shall not be less than 1/2 in. (13 mm); the diameter of the immersed copper rod shall not be less than 1/4 in. (6 mm), and the length shall not be less than 2 in. (50 mm).

4.1.1.3 Present criteria based upon the half-cell reaction of $\text{Cu} \rightarrow \text{Cu}^{++} + 2\text{e}$ indicate that the potential of the saturated copper-copper sulfate half cell as referenced to the hydrogen electrode is -0.316 V at 72°F (22.2°C). The cell has a temperature coefficient of about 0.0005 V more negative per $^\circ\text{F}$ for the temperature range from 32 to 120°F (0 to 49°C).

NOTE 1—While this test method specifies only one type of half cell, that is, the copper-copper sulfate half cell, others having similar measurement range, accuracy, and precision characteristics may also be used. In addition to copper-copper sulfate cells, calomel cells have been used in laboratory studies. Potentials measured by other than copper-copper sulfate half cells should be converted to the copper-copper sulfate

¹ This test method is under the jurisdiction of ASTM Committee G01 on Corrosion of Metals and is the direct responsibility of Subcommittee G01.11 on Electrochemical Measurements in Corrosion Testing.

Current edition approved March 11, 1991. Published May 1991. Originally published as C 876 – 77. Last previous edition C 876 – 87.

² *Annual Book of ASTM Standards*, Vol 03.02.

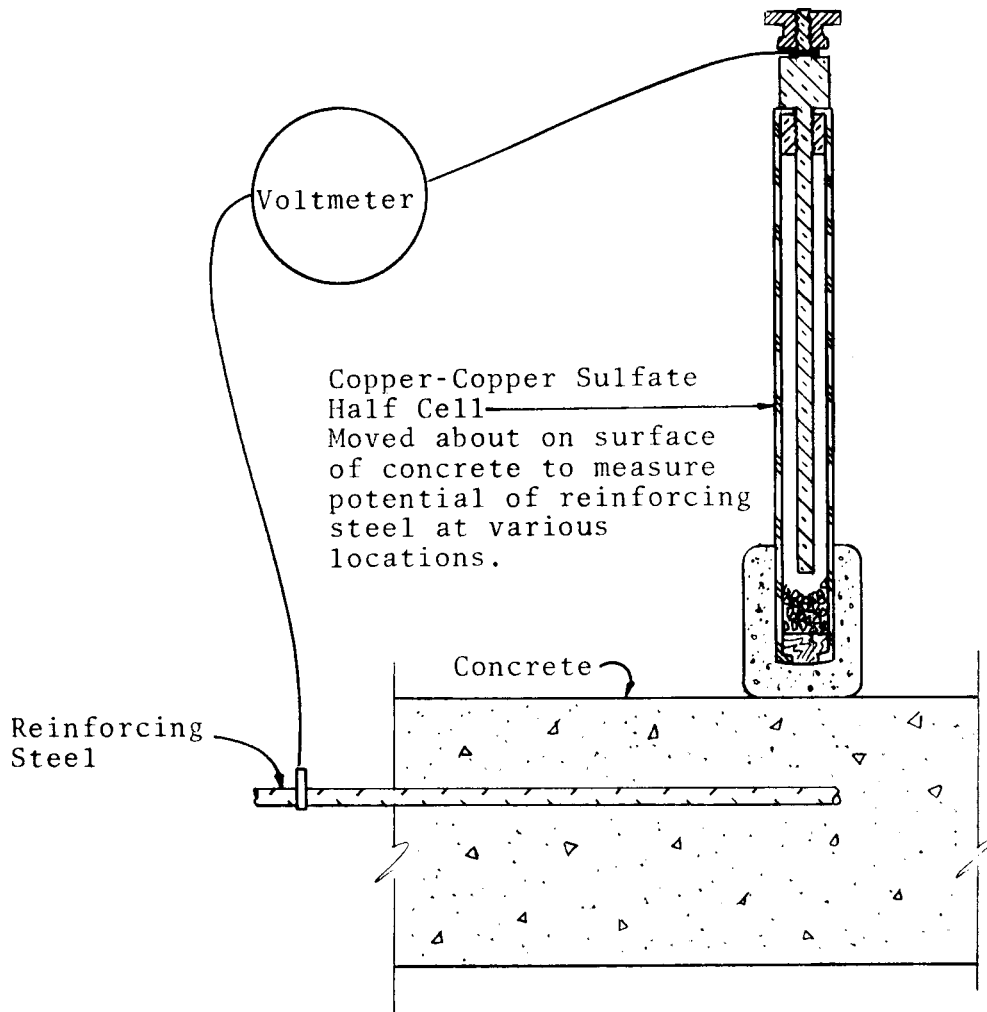


FIG. 1 Copper-Copper Sulfate Half Cell Circuitry

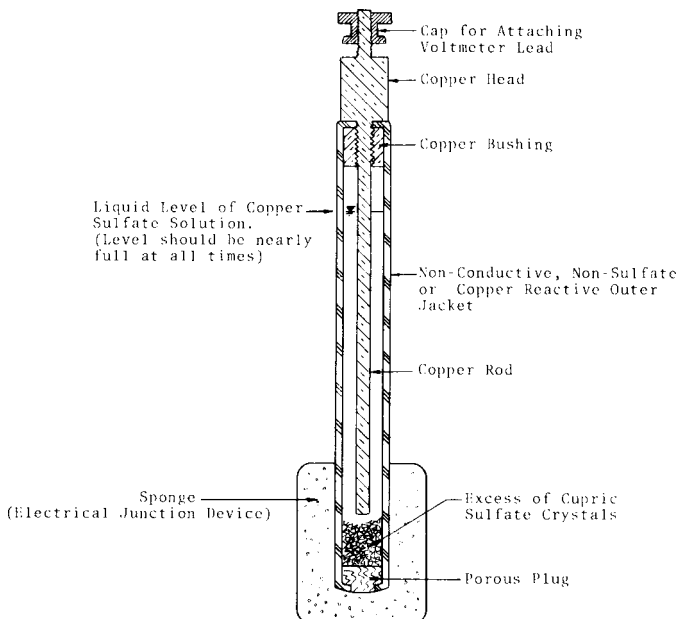


FIG. 2 Sectional View of a Copper-Copper Sulfate Half Cell

G 3 and it is also described in most physical chemistry or half-cell technology text books.

4.1.2 Electrical Junction Device—An electrical junction device shall be used to provide a low electrical resistance liquid bridge between the surface of the concrete and the half cell. It shall consist of a sponge or several sponges pre-wetted with a low electrical resistance contact solution. The sponge may be folded around and attached to the tip of the half cell so that it provides electrical continuity between the porous plug and the concrete member.

4.1.3 Electrical Contact Solution—In order to standardize the potential drop through the concrete portion of the circuit, an electrical contact solution shall be used to wet the electrical junction device. One such solution is composed of a mixture of 95 mL of wetting agent (commercially available wetting agent) or a liquid household detergent thoroughly mixed with 5 gal (19 L) of potable water. Under working temperatures of less than about 50°F (10°C), approximately 15 % by volume of either isopropyl or denatured alcohol must be added to prevent clouding of the electrical contact solution, since clouding may inhibit penetration of water into the concrete to be tested.

4.1.4 Voltmeter—The voltmeter shall have the capacity of being battery operated and have ± 3 % end of scale accuracy.

equivalent potential. The conversion technique can be found in Practice