~~Designation:D 6529–00~~ Designation: D6529 – 11

Standard Test Method for Operating Performance of Continuous Electrodeionization Systems on Feeds from 50–1000 µS/cm[1]

This standard is issued under the fixed designation D6529; 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 determination of the operating characteristics of continuous electrodeionization (CEDI) devices using synthetic feed solutions and is not necessarily applicable to natural waters. This test method is a procedure applicable to solutions with a conductivity range from approximately 50 to 1000 µS/cm.

1.2 This test method covers the determination of operating characteristics under standard test conditions of CEDI devices where the electrically active transfer media therein is predominantly unregenerated. This results in more rapid achievement of steady state and shorter test time than when performing a test which requires the active media be predominantly regenerated.

1.3 This test method is not necessarily indicative of the following:

1.3.1 Long-term performance on feed waters containing foulants or sparingly soluble solutes, or both,

1.3.2 Performance on feeds of brackish water, sea water, or other high-salinity feeds,

1.3.3 Performance on synthetic industrial feed solutions, pharmaceuticals, or process solutions of foods and beverages, or,

1.3.4 Performance on feed waters less than 50 µS/cm, particularly performance relating to organic solutes, colloidal or particulate matter, or biological or microbial matter.

1.4 This test method, subject to the limitations previously described, can be applied as either an aid to predict expected deionization performance for a given feed water quality, or as a test method to determine whether performance of a given device has changed over some period of time. It is ultimately, however, the user's responsibility to ensure the validity of this test method for their specific applications.

1.5 *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 or regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1125 Test Methods for Electrical Conductivity and Resistivity of Water

D1129 Terminology Relating to Water

D1193 Specification for Reagent Water

D1293 Test Methods for pH of Water

D2777 Practice for Determination of Precision and Bias of Applicable Test Methods of Committee D19 on Water

D4189 Test Method for Silt Density Index (SDI) of Water

3. Terminology

3.1 *Definitions*—For definitions of general terms used in this test method, refer to Terminology ~~D 1129~~D1129.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cell*—an independently fed ion-depleting chamber formed by two adjacent ion-exchange membranes, or by a membrane and an adjacent electrode.

3.2.2 *continuous electrodeionization (CEDI) device*—a device that removes ionized and ionizable species from liquids using electrically active media and using an electrical potential to influence ion transport, where the ionic transport properties of the active media are a primary sizing parameter. The CEDI devices typically comprise semipermeable ion-exchange membranes and

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[1] This test method is under the jurisdiction of ASTM Committee ~~D19.08~~ D19 on Water and is the direct responsibilities of Subcommittee D19.08 on Membranes and Ion Exchange 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.

permanently charged ion-exchange media. Examples include continuous deionization, electrodiaresis, and packed-bed or filled-cell electrodialysis.

3.2.3 *current efficiency*—the ratio, expressed in percent, of the net transfer of ionized and ionizable solutes per unit cell within a CEDI device, expressed in chemical equivalents transferred per unit time, to the number of coulombs transferred from an external dc power source to each electrode pair, expressed in faradays per unit time. Calculation of current efficiency is described in 9.2.

4. Summary of Test Method

4.1 This test method is used to determine performance capabilities of CEDI devices with regard to extent of ion removal, pressure/flow relationships and electrical power consumption at standard or nominal operating conditions, electrical current characteristics, and the relative ability of the device to remove ionized species when fed pretreated tap water. On this type of feed there is little water splitting or resin regeneration, thus only ionized species are removed. This test method is applicable to both new and used devices.

4.2 Pressure loss data is obtained. This information provides information relating to possible particulate plugging, fouling, or internal damage of the device. Deionization performance, concentrating stream pH, and electrical current transfer is monitored as a function of applied voltage. The initial ohmic (electrical) resistance, rate of change of ohmic resistance, and maximal ohmic resistance is determined. Also the electrical current efficiency as a function of deionization performance and voltage is determined. This information in combination with concentrating stream pH as a function of applied voltage provides basic design and performance information.

5. Significance and Use

5.1 The CEDI devices can be used to produce deionized water from feeds of pretreated water. This test method permits the relatively rapid measurement of key performance capabilities of CEDI devices using standard sets of conditions. The data obtained can be analyzed to provide information on whether changes may have occurred in operating characteristics of the device independently of any variability in feed water characteristics or operating conditions. Under specific circumstances, this test method may also provide sufficient information for plant design.

6. Apparatus

6.1 *Description*:

6.1.1 The test apparatus is schematically represented in Fig. 1. Feed water to the apparatus may be passed through a heat exchanger or other accessories, or both, to modify or control feed water temperature, or both, as desired. Alternately, data obtained from the operation of the apparatus may be normalized for temperature if normalization factors are known.

6.1.2 Feed water to the apparatus enters a holding tank (open or vented) of volume sufficient to maintain good control of water level and solute concentrations. The tank is unpressurized, ported to be capable of occasional cleanings or sanitizations, and incorporates needed safety features such as temperature and overflow protection. The tank also incorporates a drain valve. During operation of the apparatus, the drain valve may be used in combination with a valve controlling the rate of feed water to the apparatus to aid in control of solute concentrations, water level, and temperature within the tank. The tank supplies water to a recirculation pump designed to feed water to the CEDI device at a flow rate and pressure consistent with the ratings of the CEDI device. A recirculation line with a shut off valve from the pump discharge to the tank may be incorporated as required for proper pump operation.

6.1.3 The concentration and pH of the feed water to the CEDI device is controlled by metering pumps that meter a controlled flow of concentrated aqueous sodium chloride, and either sodium hydroxide or hydrochloric acid as needed into the feed water to maintain the desired feed water solute concentration and pH.

6.1.3.1 The concentrated reagents may be metered into the discharge line of the pump or alternately may be metered into the tank. In either case, mixing means are required to ensure that the feed water concentrations do not fluctuate. Metering pump assemblies and controllers should be designed with proper safety interlocks and controls configured so as to be "fail safe." Suitable instrumentation must be provided to monitor solute concentration (by means of electrical conductivity or resistivity, see Test Methods ~~D 1125~~D1125), pH (Test Methods ~~D 1293~~D1293), and temperature of the feed water to the CEDI device. Instrumentation may be in-line or alternately, appropriate sample taps may be incorporated to allow for determination off-line.

6.1.4 Feed water provided to the CEDI device should be plumbed as specified by the supplier, with appropriate flow and pressure controls, internal recirculations, drains, interlocks, safety controls, and other features as required. Pressure at the inlet and outlet and flow rates of each of the streams of interest must be monitored (for example, deionized water stream, concentrate stream, and electrode feed stream).

6.1.5 The CEDI device should be powered as specified by the supplier, with equipment and wiring to provide appropriate supply dc voltage and amperage, controls, interlocks, grounding, and safety features. Supply voltage and supply amperage to the CEDI device should be monitored at positions within the device or device assembly as specified by the supplier.

6.1.6 Streams leaving the CEDI device may be returned to the tank by means of return lines. Alternately, one or more of the streams may be sent either completely or partially to drain by means of appropriate valving if such operation provides easier control of desired feed water conditions. The outlet deionization stream is monitored for electrical conductivity or resistivity and optionally pH, and the outlet concentrating stream is monitored for pH and optionally electrical conductivity or resistivity. For

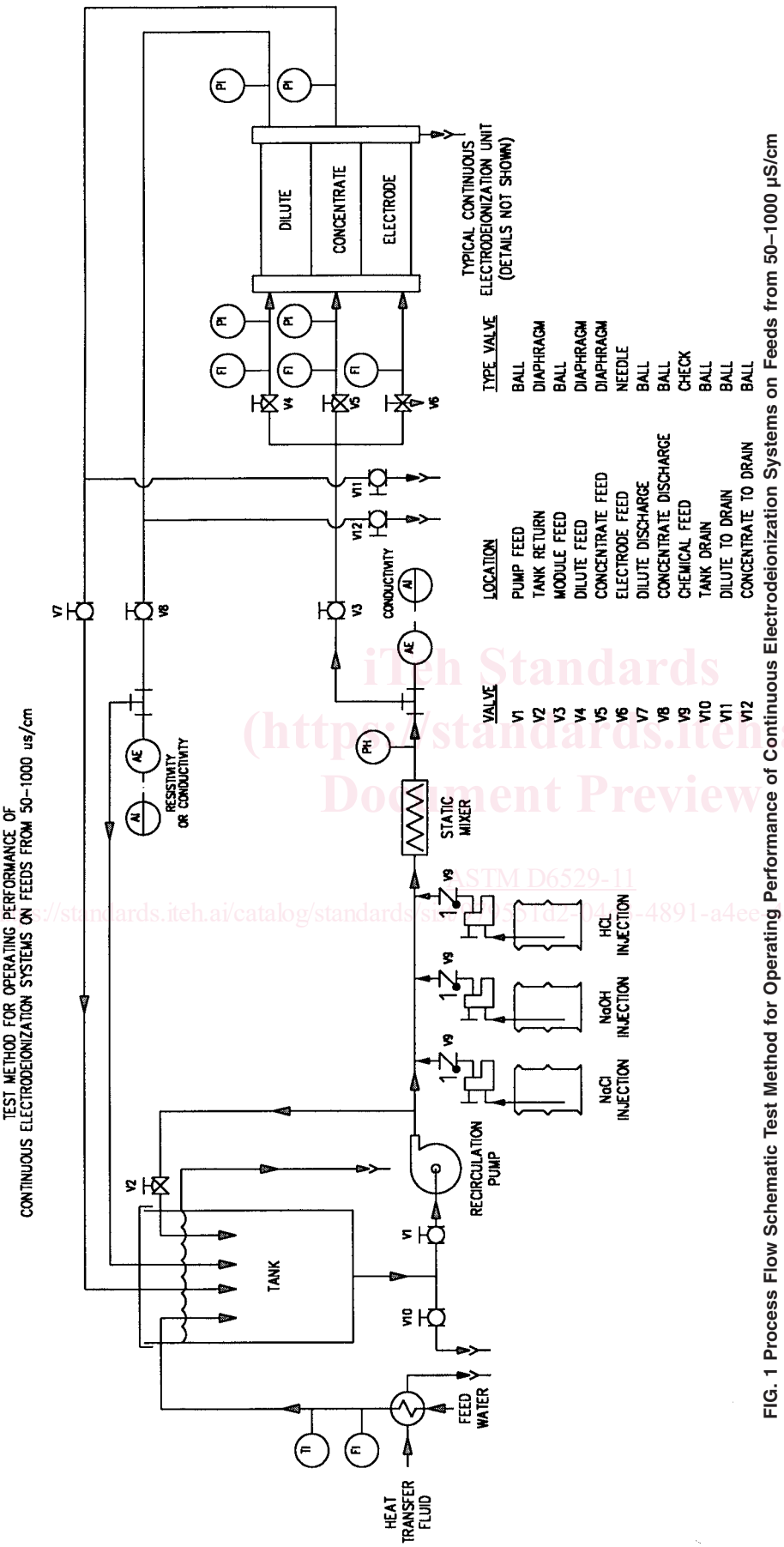

FIG. 1 Process Flow Schematic Test Method for Operating Performance of Continuous Electrodeionization Systems on Feeds from 50–1000 µS/cm