
Standard Method of Test for Soil Suction

AASHTO Designation: T 273-86 (2022)

Technically Revised: 1986

Reviewed but Not Updated: 2022

Editorially Revised: 2022

Technical Subcommittee: 1a, Soil and Unbound Recycled Materials



**American Association of State Highway and Transportation Officials
555 12th Street NW, Suite 1000
Washington, DC 20004**

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1. SCOPE

- 1.1. This method covers the procedure for determining total soil suction force using thermocouple psychrometers. The test results of this method are to be used in conjunction with [T 258](#).
- 1.2. The thermocouple psychrometer measures the relative humidity in the soil by a technique called Peltier cooling. By causing a small direct current of approximately four to eight milliamperes to flow through the thermocouple junction for approximately 15 s in the correct direction, this junction will cool and water will condense on it when the dewpoint temperature is reached. Condensation of this water inhibits further cooling of the junction and the voltage difference developed between the thermocouple and the reference junctions can be measured using a microvoltmeter. With proper calibration, the thermocouple psychrometer output in microvolts can be converted directly to soil suction in convenient units of pressure. Typical thermocouple psychrometer output voltages vary from less than one microvolt for relative humidities close to 100 percent or total soil suction less than 95.76 kPa (1 tsf) to about 25 microvolts for relative humidities of about 95 percent or total soil suctions of about 5746 kPa (60 tsf).
- 1.3. The following applies to all specified limits in this standard: For the purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded off “to the nearest unit” in the last right-hand place of figures used in expressing the limiting value, in accordance with [ASTM E29](#).
- 1.4. The values stated in SI units are to be regarded as the standard.
- 1.5. *The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of [R 18](#) are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with [R 18](#) alone does not completely assure reliable results. Reliable results depend on many factors; following the suggestions of [R 18](#) or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.*
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2. REFERENCED DOCUMENTS

- 2.1. AASHTO Standards:
- [M 231](#), Weighing Devices Used in the Testing of Materials
 - [R 18](#), Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
 - [T 207](#), Thin-Walled Tube Sampling of Soils
 - [T 233](#), Density of Soil In-Place by Block, Chunk, or Core Sampling

- [T 258](#), Determining Expansive Soils

2.2. *ASTM Standard:*

- [E 29](#), Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

3. **TERMINOLOGY**

3.1. *Definitions:*

- 3.1.1. *matrix suction*—the matrix suction is the result of clay mineral surface attractive forces for water and cations (i.e., ion hydration) and the surface tension effects of water in soil. The matrix suction is both water content and surcharge pressure dependent.
- 3.1.2. *osmotic suction*—the osmotic suction arises from the presence of soluble salts in the pore water of the soil and is the result of the difference in the ion concentration between the pore water and the clay particles double-layer water. Osmotic suction is independent of water content and surcharge pressure.
- 3.1.3. *soil suction*—soil suction is a quantity that can be used to characterize the effect of moisture on the volume and strength properties of soils; that is, soil suction quantitatively describes the interaction between soil particles and water, which determines the physical behavior of the soil mass. Soil suction, expressed in units of pressure, is a measure of the pulling force exerted on water by the soil mass.
- 3.1.4. *total soil suction*—total soil suction, as determined by this method of test, is the force responsible for soil water retention and is the sum of the matrix and osmotic components.

4. **APPARATUS**

- 4.1. *Microvoltmeter*—Minimum range of 30 μV and readable to the nearest 0.01 μV .
- 4.2. *Milliammeter*—Minimum range of 0 to 25 mA.
- 4.3. *Thermocouple Psychrometers*—WESCOR Model PT 51-10, or equal.
- 4.4. *Polystyrene Thermal Containers*—Chest or box insulated with at least 38.1 mm (1.5 in.) of foamed polystyrene. One container approximately 304.8 mm by 304.8 mm by 381 mm (12 in. by 12 in. by 15 in.) will accommodate six samples.
- 4.5. *Sample Containers*—0.5-L (1-pt) metal sample containers with interior coated with melted wax to prevent corrosion. One-half-liter paint cans are satisfactory.
- 4.6. *Rubber Stoppers*—Size 13 $\frac{1}{2}$ rubber stoppers with an approximately 6-mm (0.25-in.) diameter hole through the center.
- 4.7. *Electrical Supplies*—Switch box, selector switches, electrical connectors, two 1.5-V dry cell batteries, and a 1 k ohm variable potentiometer.
- 4.8. *Calibration Standards*—Minimum of three WESCOR Osmolality Standards (290, 1000, and 1800 mOs/kg) (Note 1). Standard sodium chloride solutions of various molalities may be prepared in the laboratory.
- 4.9. *Stopwatch*.

- 4.10. *Tare Containers.*
- 4.11. *Specimen Cutting Equipment*—Wire saw, knife, bandsaw, etc.
- 4.12. *Balance*—The balance shall have sufficient capacity, be readable to 0.1 percent of the sample mass, or better, and conform to the requirements of [M 231](#).
- Note 1**—mOs/kg is the abbreviation for milliosmos per kilogram.

5. ASSEMBLING EQUIPMENT

- 5.1. The assembled apparatus is as shown in Figure 1. The apparatus should be assembled to accommodate multiple samples to be tested simultaneously. The wiring diagram shown in Figure 2 permits the testing of twelve samples simultaneously by utilizing a 12-position selector switch.

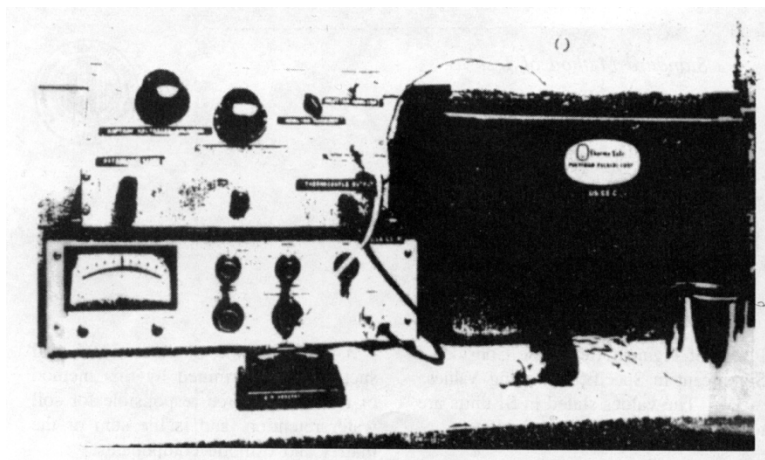


Figure 1—Soil Suction Apparatus