Designation: D5472/D5472M – 14

Standard Test Method for Determining Specific Capacity and Estimating Transmissivity at the Control Well[1]

This standard is issued under the fixed designation D5472/D5472M; 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 describes a procedure for conducting a specific capacity test, computing the specific capacity of a control well, and estimating the transmissivity in the vicinity of the control well. Specific capacity is the well yield per unit drawdown at an identified time after pumping started.

1.2 This test method is used in conjunction with Test Method D4050 for conducting withdrawal and injection well tests.

1.3 The method of determining transmissivity from specific capacity is a variation of the nonequilibrium method of Theis (**1**)[2] for determining transmissivity and storage coefficient of an aquifer. The Theis nonequilibrium method is given in Test Method D4106.

1.4 *Limitations*—The limitations of the technique for determining transmissivity are primarily related to the correspondence between the field situation and the simplifying assumptions of the Theis method.

1.5 The scope of this test method is limited by the capabilities of the apparatus.

1.6 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.6.1 The procedures used to specify how data are collected/recorded and calculated in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that should generally be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to commensurate with these considerations. It is beyond the scope of this standard to consider significant digits used in analysis methods for engineering design.

1.7 The values stated in SI units are to be regarded as standard. Rationalized inch-pound units also are used in this standard. Each system of units is to be regarded separately as standard.

1.8 This standard may involve hazardous materials, operations, and equipment. This standard does not address safety problems 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:*[3]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4050 Test Method for (Field Procedure) for Withdrawal and Injection Well Testing for Determining Hydraulic Properties of Aquifer Systems

D4106 Test Method for (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of Nonleaky Confined Aquifers by the Theis Nonequilibrium Method

D6026 Practice for Using Significant Digits in Geotechnical Data

3. Terminology

3.1 For common definitions of terms in this standard, refer to Terminology D653.

3.2 *Symbols and Dimensions:*

3.2.1 *K*—hydraulic conductivity [LT^{-1}]

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Groundwater and Vadose Zone Investigations.

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[2] The boldface numbers in parentheses refer to a list of references at the end of this standard.

[3] 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.

***A Summary of Changes section appears at the end of this standard**

3.2.2 m—saturated thickness [L]

3.2.3 Q—discharge [L^3T^{-1}]

3.2.4 Q/s—specific capacity [$(L^3T^{-1})L^{-1}$]

3.2.5 r—well radius [L]

3.2.6 s—drawdown [L]

3.2.7 S—storage coefficient [dimensionless]

3.2.8 T—transmissivity [L^2T^{-1}]

3.2.9 T'—provisional value of transmissivity [L^2T^{-1}]

3.2.10 t—elapsed time of pumping [T]

3.2.11 u—$r^2S/4Tt$ [dimensionless]

3.2.12 $W(u)$—well function of "u" [dimensionless]

3.2.13 c_1—$[W(u)/4\pi]$

4. Summary of Test Method

4.1 A control well is equipped with an accumulated water meter or other well yield measuring device and the static water level determined after conditioning.

4.2 After a conditioning pumpdown, the well is pumped continuously and measurements collected. Determination of the specific capacity and an estimate of the transmissivity of the well is then calculated.

5. Significance and Use

5.1 Assumptions of the Theis (**1**) equation affect specific capacity and transmissivity estimated from specific capacity. These assumptions are given below:

5.1.1 Aquifer is homogeneous and isotropic.

5.1.2 Aquifer is horizontal, of uniform thickness, and infinite in areal extent.

5.1.3 Aquifer is confined by impermeable strata on its upper and lower boundaries.

5.1.4 Density gradient in the flowing fluid must be negligible and the viscous resistance to flow must obey Darcy's Law.

5.1.5 Control well penetrates and receives water equally from the entire thickness of the aquifer.

5.1.6 Control well has an infinitesimal diameter.

5.1.7 Control well discharges at a constant rate.

5.1.8 Control well operates at 100 percent efficiency.

5.1.9 Aquifer remains saturated throughout the duration of pumping.

5.2 *Implications of Assumptions and Limitations of Method.*

5.2.1 The simplifying assumptions necessary for solution of the Theis equation and application of the method are never fully met in a field test situation. The satisfactory use of the method may depend upon the application of one or more empirical correction factors being applied to the field data.

5.2.2 Generally the values of transmissivity derived from specific capacity vary from those values determined from aquifer tests utilizing observation wells. These differences may reflect *1*) that specific-capacity represents the response of a small part of the aquifer near the well and may be greatly influenced by conditions near the well such as a gravel pack or graded material resulting from well development, and *2*) effects of well efficiency and partial penetration.

5.2.3 The values of transmissivity estimated from specific capacity data are considered less accurate than values obtained from analysis of drawdowns that are observed some distance from the pumped well.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

5.3 Withdrawal well test field procedures are used with appropriate analytical procedures in appropriate hydrogeological sites to determine transmissivity and storage coefficient of aquifers and hydraulic conductivity of confining beds.

6. Apparatus

6.1 Various types of equipment can be used to withdraw or inject water into the control well, measure withdrawal and injection rates, and measure water levels. The test procedure may be conducted with different types of equipment to achieve similar results. The objectives to be achieved by the use of the equipment are given in this section and in Sections 7 and 8. The selection of equipment and measuring apparatus will be evaluated to ensure that sufficient accuracy and sensitivity will be provided for the later evaluation of data by Test Method D4106.

6.2 *Control Well*—Discharge or injection well test methods require that water be withdrawn from or injected into a single well. This well, known as the control well, must be drilled and completed such that it transmits water to or from the aquifer (usually the entire thickness of the aquifer) at rates such that a measurable water level change will occur at observation wells. The control well should be as efficient as possible, to reduce the head loss between the aquifer and the well. Well development should be as complete as possible to eliminate additional production of sand or silt and consequent changes in well efficiency and pumping water levels during the test. The cuttings from the control well should be described and recorded according to Practice D2488. The analytical method selected for analysis of the data may specify certain dimensions of the control well such as screen length and depth of screen placement. Specific requirements for control wells may be given in standards for specific analytical methods (see, for example, Test Method D4106).

6.3 *Observation Wells or Piezometers*—Numbers of observation wells and their distance from the control well and their screened interval may be dependent upon the test method to be employed. Refer to the analytical test method to be used for specifications of observation wells (see, for example, Test Method D4106).

6.4 *Control Well Pump*—A pump capable of withdrawal of a constant or predetermined variable rate of water from the control well. The pump and motor should be adequately sized for the designed pumping rate and lift. The pump or motor must be equipped with a control mechanism to adjust discharge rate. In the case of diesel-, gasoline-, or natural-gas-fueled