SIST

SLOVENSKI STANDARD
oSIST prEN ISO 11274:2018

01-april-2018

Kakovost tal - Določevanje karakteristik zadrževanja vode - Laboratorijske metode (ISO/DIS 11274:2018)

Soil quality - Determination of the water-retention characteristic - Laboratory methods (ISO/DIS 11274:2018)

Bodenbeschaffenheit - Bestimmung des Wasserrückhaltevermögens - Laborverfahren (ISO/DIS 11274:2018)

Qualité du sol - Détermination de la caractéristique de la rétention en eau - Méthodes de laboratoire (ISO/DIS 11274:2018)

Ta slovenski standard je istoveten z: **prEN ISO 11274 rev**

ICS:

13.080.40	Hidrološke lastnosti tal	Hydrological properties of soils

oSIST prEN ISO 11274:2018 **en,fr,de**

DRAFT INTERNATIONAL STANDARD
ISO/DIS 11274

ISO/TC **190**/SC **3** Secretariat: **DIN**

Voting begins on: **2018-03-15** Voting terminates on: **2018-06-07**

Soil quality — Determination of the water-retention characteristic — Laboratory methods

Qualité du sol — Détermination de la caractéristique de la rétention en eau — Méthodes de laboratoire

ICS: 13.080.40

This document is circulated as received from the committee secretariat.

ISO/CEN PARALLEL PROCESSING

Reference number
ISO/DIS 11274:2018(E)

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Published in Switzerland

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 190, *Soil quality*, Subcommittee SC 3, *Chemical methods and soil characteristics*.

This second edition cancels and replaces the first edition (ISO 11274:1998), which has been technically revised.

Introduction

Soil water content and matric pressure are related to each other and determine the water-retention characteristics of a soil. Soil water which is in equilibrium with free water is at zero matric pressure (or suction) and the soil is saturated. As the soil dries, matric pressure decreases (i.e. becomes more negative), and the largest pores empty of water. Progressive decreases in matric pressure will continue to empty finer pores until eventually water is held in only the finest pores. Not only is water removed from soil pores, but the films of water held around soil particles are reduced in thickness. Therefore a decreasing matric pressure is associated with a decreasing soil water content.[1],[2] Laboratory or field measurements of these two parameters can be made and the relationship plotted as a curve, called the soil water-retention characteristic. The relationship extends from saturated soil (approximately 0 kPa) to oven-dry soil (about -10^6 kPa).

The soil water-retention characteristic is different for each soil type. The shape and position of the curve relative to the axes depend on soil properties such as texture, density and hysteresis associated with the wetting and drying history. Individual points on the water-retention characteristic may be determined for specific purposes.

The results obtained using these methods can be used, for example:

— to provide an assessment of the equivalent pore size distribution (e.g. identification of macro- and micropores);

— to determine indices of plant-available water in the soil and to classify soil accordingly (e.g. for irrigation purposes);

— to determine the drainable pore space (e.g. for drainage design, pollution risk assessments);

— to monitor changes in the structure of a soil (caused by e.g. tillage, compaction or addition of organic matter or synthetic soil conditioners);

— to ascertain the relationship between the negative matric pressure and other soil physical properties (e.g. hydraulic conductivity, thermal conductivity);

— to determine water content at specific negative matric pressures (e.g. for microbiological degradation studies);

— to estimate other soil physical properties (e.g. hydraulic conductivity).

Soil quality — Determination of the water-retention characteristic — Laboratory methods

1 Scope

This document specifies laboratory methods for determination of the soil water-retention characteristic.

This International Standard applies only to measurements of the drying or desorption curve.

Four methods are described to cover the complete range of soil water pressures as follows:

a) method using sand, kaolin or ceramic suction tables for determination of matric pressures from 0 kPa to −50 kPa;

b) method using a porous plate and burette apparatus for determination of matric pressures from 0 kPa to −20 kPa;

c) method using a pressurized gas and a pressure plate extractor for determination of matric pressures from −5 kPa to −1 500 kPa;

d) method using a pressurized gas and pressure membrane cells for determination of matric pressures from −33 kPa to −1 500 kPa.

Guidelines are given to select the most suitable method in a particular case.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

2.1
soil water-retention characteristic
relation between soil water content and soil matric head of a given soil (sample)

2.2
pressure
pressure equivalent of soil water potential

2.3
matric pressure
amount of work that must be done in order to transport, reversibly and isothermally, an infinitesimal quantity of water, identical in composition to the soil water, from a pool at the elevation and the external gas pressure of the point under consideration, to the soil water at the point under consideration, divided by the volume of water transported

2.4
water content mass ratio
w
mass of water evaporating from the soil when dried to constant mass at 105 °C, divided by the dry mass of the soil (i.e. the ratio between the masses of water and solid particles within a soil sample)

2.5
water content volume fraction
q
volume of water evaporating from the soil when dried to constant mass at 105 °C, divided by the original bulk volume of the soil (i.e. the ratio between the volume of liquid water within a soil sample and the total volume including all pore space of that sample)

Note 1 to entry: The soil water-retention characteristic is identified in the scientific literature by various names including soil water release curve, soil water-retention curve, pF curve and the capillary pressure-saturation curve. Use of these terms is deprecated.

Note 2 to entry: The pascal is the standard unit of pressure but many other units are still in use. Table A.1 provides conversions for most units.

Note 3 to entry: Sometimes suction is used instead of pressure to avoid the use of negative signs (see Introduction). However, this term can cause confusion and is deprecated as an expression of the matric pressure.

Note 4 to entry: For swelling and shrinking soils, seek the advice of a specialist laboratory since interpretation of water-retention data will be affected by these properties.

3 Guidelines for choice of method

Guidelines are given below to help select the most suitable method in a particular case.

3.1 Sand, kaolin or ceramic suction tables for determination of pressures from 0 kPa to −50 kPa

The sand, kaolin and ceramic suction table methods are suitable for large numbers of determinations at high pressures on cores or aggregates of different shapes and sizes. Analyses on samples of a wide range of textures and organic matter contents can be carried out simultaneously since equilibration is determined separately for each core. The suction table methods are suitable for a laboratory carrying out analyses on a routine basis and where regular equipment maintenance procedures are implemented.

3.2 Porous plate and burette apparatus for determination of pressures from 0 kPa to −20 kPa

The porous plate and burette apparatus allows analysis of only one sample at a time, and several sets of equipment are therefore necessary to enable replication and full soil profile characterization. The method is particularly suited to soils with weak structures and sands which are susceptible to slumping or slaking, since minimal sample disturbance occurs. Capillary contact is not broken during the procedure and all samples, particularly soils with higher organic matter content or sandy textures, will equilibrate more rapidly using this technique. This is a simple technique suitable for small laboratories.

3.3 Pressure plate extractor for determination of pressures from −5 kPa to −1 500 kPa

The pressure plate method can be used for determinations of all pressures to −1 500 kPa. However, different specifications of pressure chambers and ceramic plates are required for the range of pressures, e.g. 0 kPa to −20 kPa, −20 kPa to −100 kPa and −100 kPa to −1 500 kPa. The method is, however, best suited to pressures of −33 kPa or lower, since air entrapment at high negative pressures can occur. It is preferable that soils with similar water-release properties are analysed together to ensure equilibration times are approximately the same, though in practice it may be difficult. Sample size is usually smaller than for the previous two methods and therefore the technique is less suitable for heterogeneous soil horizons, or for those with a strong structural composition. Analysis of disturbed soils is traditionally carried out using this method.

3.4 Pressure membrane cells for determination of pressures from −33 kPa to −1 500 kPa

The pressure membrane cell should only be used for pressures below −33 kPa. Capillary contact at higher pressures is not satisfactory for this method. The method is appropriate for all soil types though the use of double membranes is recommended for coarse (sandy) textured soils. Sample size can be selected (according to the size of the pressure cell) to take into account soil structure. Different textures can be equilibrated separately using a suite of cells linked to one pressure source.

4 Sampling

4.1 General requirements

It is essential that undisturbed soil samples are used for measurement at the high matric pressure range 0 kPa to −100 kPa, since soil structure has a strong influence on water-retention properties. Use either undisturbed cores or, if appropriate, individual peds for low matric pressure methods (< −100 kPa).

Soil cores shall be taken in a metal or plastic sleeve of a height and diameter such that they are representative of the natural soil variability and structure. The dimensions of samples taken in the field are dependent on the texture and structure of the soil and the test method which is to be used. Table 1 provides guidance on suitable sample sizes for the different methods and soil structure.

Take soil cores carefully to ensure minimal compaction and disturbance to structure, either by hand pressure in suitable material or by using a suitable soil corer. Take a minimum of three representative replicates for each freshly exposed soil horizon or layer; more replicates are required in stoney soils. Record the sampling date, sample grid reference, horizon and sampling depths. Dig out the sleeve carefully with a trowel, trim roughly the two faces of the cylinder with a knife and if necessary adjust the sample within the sleeve before fitting lids to each end, and label the top clearly with the sample grid reference, the direction of the sampling (horizontal or vertical), horizon number and sample depth.

Wrap the samples (e.g. in plastic bags) to prevent drying. Wrap aggregates (e.g.in aluminium foil or plastic film) to retain structure and prevent drying. Alternatively, excavate blocks measuring approximately 30 cm cube of undisturbed soil in the field, wrap in metal foil, wax (to retain structure and prevent drying) and take to the laboratory for subdivision. Store the samples at 1 °C to 2 °C to reduce water loss and suppress biological activity until they are required for analyses. Treat samples having obvious macrofaunal activity with a suitable biocide, e.g. 0,05 % copper sulfate solution.

Other relevant site information should be noted, e.g. soil water status, topsoil/surface conditions, etc. (see 5.6).

Table 1 — Recommended sample sizes (height × diameter) for the different test methods

Dimensions in millimetres

Test method	Structure		
	Coarse	**Medium**	**Fine**
Suction table	50 × 100	40 × 76	24 × 50
Porous plate	50 × 76	40 × 76	20 × 36
Pressure plate	-	10 × 76	10 × 50
Pressure membrane	-	20 × 76	10 × 50

NOTE 1 The points mentioned here are specific to water-retention analyses. Reference is made to ISO 10381-1 in which general advice on sampling and problems encountered is given.

NOTE 2 In moist conditions, soil is easier to sample and in shrink/swell soils the bulk density under natural conditions is lowest. It is therefore preferable to take samples in the wet season when soil matric pressures are at or near −5 kPa. Especially clayey soils, are difficult to core when dry and they contract and swell with varying water content. Samples of swelling and shrinking soils can be taken in cores only under completely saturated conditions, i.e. under the water table and in the full capillary zone. In all other circumstances peds should be taken.