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Indian Standard

DETERMINATION OF THE SPECIFIC ELECTRICAL CONDUCTIVITY OF SOILS — METHOD OF TEST

ICS 13.080

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Price Group 2

Soil Quality and Improvement Sectional Committee, FAD 27

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Soil Quality and Improvement Sectional Committee had been approved by the Food and Agriculture Division Council.

The electrical conductivity of water extract of soil is proportional to its salt concentration. There is no Indian Standard procedure available for determination of electrical conductivity in various types of soils. Hence need was felt to provide uniform method for determination of electrical conductivity of soils.

In the preparation of this standard, assistance has been derived from ISO 11265:1994 'Soil quality — Determination of the specific electrical conductivity'. Because of the typical national agro-climatic conditions it has not been possible to align with the above mentioned International Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2:1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

DETERMINATION OF THE SPECIFIC ELECTRICAL CONDUCTIVITY OF SOILS — METHOD OF TEST

1 SCOPE

This standard specifies an instrumental method for the routine determination of the specific electrical conductivity in an aqueous extract of soil. The determination is carried out to obtain an indication of the content of water-soluble electrolytes in a soil.

This standard is applicable to all types of air-dried soil samples.

2 REFERENCE

The Indian Standard listed below contains provisions which through reference in this text, constitutes provision of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below:

IS No.	*Title*
1070:1992	Reagent grade water (*third revision*)

3 PRINCIPLE

Air-dried soil is extracted with water at 25°C ± 1°C at an extraction ratio of 1:2 (*m/v*), to dissolve the electrolytes. The specific electrical conductivity of the suspension extract is measured and the result is corrected to a temperature of 25°C.

4 QUALITY OF REAGENTS

4.1 Unless specified otherwise, pure chemicals and distilled water (*see* IS 1070) shall be employed in tests.

NOTE — 'Pure chemicals' shall mean chemicals that do not contain impurities which affect the results of analysis.

4.2 Potassium Chloride Solution — [C(KCl) 0.1 mol/l].

Dissolve 7.456 g of potassium chloride, previously dried for 24 h at 220°C ± 10°C in water (**4.1**), and dilute to 1 000 ml. The specific electrical conductivity of this solution is 1 290 mS/m.

4.3 Potassium Chloride Solution — [C (KCl) 0.020 mol/l].

Pour 200,0 ml of the potassium chloride solution (**4.2**) into a 1 000 ml volumetric flask and dilute to volume with water. The specific electrical conductivity of this solution is 277 mS/m.

4.4 Potassium Chloride Solution — [C (KCl) 0.010 0 mol/l].

Pour 100,0 ml of the potassium chloride solution (**4.2**) into a 1 000 ml volumetric flask and dilute to volume with water at 20°C. The specific electrical conductivity of this solution is 141 mS/m at 25°C.

All the potassium chloride solutions (**4.2**, **4.3** and above) used for calibration shall be stored in tightly sealed bottles which do not release sufficient alkali or alkali-earth cations to affect the electrical conductivity of the solutions.

NOTES

1 Plastics bottles may be suitable.

2 For bottles containing potassium chloride solutions, plastics seals are recommended as glass will weld to the bottle.

3 The use of commercially available conductivity standards is permitted.

5 APPARATUS AND GLASSWARE

5.1 Conductivity Meter

Fitted with a conductivity cell, equipped with an adjustable measuring range setting and (automatic) temperature correction and having an accuracy of 1 mS/m at 25°C. Preferably, the conductivity meter should also be equipped with a cell-constant control.

5.2 Analytical Balance

With an accuracy of at least 0.01g for soil and 0.000 1 g for KCl.

5.3 Thermometer

Capable of measuring to the nearest 0.1 °C.

5.4 Shaking Machine

Intermittant stirring with the glass rod for 30 min. Placed in a environment where the temperature adjusted is maintained.

6 LABORATORY SAMPLE

Use the fraction of particles smaller than 2 mm of air-dried pretreated soil samples.

7 PROCEDURE

7.1 Extraction

Weigh 20,00 g of the laboratory sample and transfer

in to 100 ml beaker. Add 40 ml of water (2:1) ratio at 25°C ± 1°C. Close the bottle and place it in a horizontal position in the shaking machine (5.4). Shake for 30 min. Transfer the soil-water suspension into a 100 ml beaker. Carry out a blank determination in the same way. The value of the blank shall not exceed 1 mS/m. If the value of the blank exceeds this, repeat the suspension. The result will be observed in follows.

7.2 Checking of the Cell Constant

7.2.1 Measure the conductivity (x) of the potassium chloride solutions (4.2 to 4.4) according to the instruction manual of the instrument.

7.2.2 Calculate, for each potassium chloride solution, a cell constant according to

$$K = \frac{x_s}{x_m}$$

where

K = cell constant, in reciprocal metres;

x_s = specific electrical conductivity of one of the potassium chloride solutions, in millisiemens per metre (known); and

x_m = measured electrical conductivity of the same potassium chloride solution, in millisiemens per metre.

Use the average of the calculated values as the cell constant of the instrument.

The calculated cell constant shall not differ by more than 5 percent from the value given by the manufacturer.

7.2.3 Adjust the cell constant of the conductivity meter.

7.3 Measurement of the Electrical Conductivity of the Suspension

Measure the electrical conductivity of the suspension (x_{sample}) according to the instructions provided by the manufacturer of the conductivity meter (5.1). Carry out the measurements with the temperature corrected to 25°C. Alternatively, in manual note the actual temperature on correct value by temperature correction factor (Table 1) already referred to.

8 INTERFERENCES

8.1 The measured values of the electrical conductivity can be influenced by contamination of the electrodes.

This type of interference is very difficult to recognize. Degenaration of the electrodes may change the cell constant, and this can be perceived by measuring the conductivity of the potassium chloride solutions. Platinization should be achieved from time to time by platinum chloride solution.

8.2 Air bubbles on the electrodes, for example formed during warming of the extracts, perturb the measurements.

8.3 Measurements of electrical conductivities less than 1 mS/m are influenced by carbon dioxide and ammonia from the atmosphere. In these cases, measurements shall be carried out in an adapted measuring cell. Such measurements are outside the scope of this Indian Standard.

9 REPEATABILITY

The repeatability of the electrical conductivity measurements in two separately prepared suspension shall satisfy the requirements of Table 2.

10 TEST REPORT

The test report shall contain the following information:

a) A reference to this Indian Standard;

b) All information necessary for complete identification of the sample;

c) The results of the determination in whole numbers, express in millisiemens per metre; and

d) Details of any operations not specified in this Indian Standard or regarded as optional, and any other factors which may have affected the results.

Table 1 Temperature Factors (f_t) for Correcting Resistance and Conductivity Data on Soil Extracts to the Standard Temperature

$EC_{25} = EC_t \times f_t$; $EC_{25} = (k/R_t) \times f_t$; $R_{25} = R_t/f_t$

(*Clause* 7.3)

3.0	37.4	1.709	22.0	71.6	1.064	29.0	84.2	0.925
4.0	39.2	1.660	22.2	72.0	1.060	29.2	84.6	0.921
5.0	41.0	1.613	22.4	72.3	1.055	29.4	84.9	0.918
6.0	42.8	1.569	22.6	72.7	1.051	29.6	85.3	0.914
7.0	44.6	1.258	22.8	73.0	1.047	29.8	85.6	0.911
8.0	46.4	1.488	23.0	73.4	1.043	30.0	86.0	0.907
9.0	48.2	1.448	23.2	73.8	1.038	30.2	86.4	0.904
10.0	50.0	1.411	23.4	74.1	1.034	30.4	86.7	0.901
11.0	51.8	1.375	23.6	74.5	1.029	30.6	87.1	0.897
12.0	53.6	1.341	23.8	74.8	1.025	30.8	87.4	0.894
13.0	55.4	1.309	24.0	75.2	1.020	31.0	87.8	0.890
14.0	57.2	1.277	24.2	75.6	1.016	31.2	88.2	0.887
15.0	59.0	1.247	24.4	75.9	1.012	31.4	88.5	0.884
16.0	60.8	1.218	24.6	76.3	1.008	31.6	88.9	0.880
17.0	62.6	1.189	24.8	76.6	1.004	31.8	89.2	0.877
18.0	64.4	1.163	25.0	77.0	1.000	32.0	89.6	0.873
18.2	64.8	1.157	25.2	77.4	0.996	32.2	90.0	0.870
18.4	65.1	1.152	25.4	77.7	0.992	32.4	90.3	0.867
18.6	65.5	1.147	25.6	78.1	0.988	32.6	90.7	0.864
18.8	65.8	1.142	25.8	78.5	0.983	32.8	91.0	0.861
19.0	66.2	1.136	26.0	78.8	0.979	33.0	91.4	0.854
19.2	66.6	1.131	26.2	79.2	0.975	34.0	93.2	0.843
19.4	66.9	1.127	26.4	79.5	0.971	35.0	95.0	0.829
19.6	67.3	1.122	26.6	79.9	0.967	36.0	96.8	0.816
19.8	67.6	1.117	26.8	80.2	0.964	37.0	98.6	0.801
20.0	68.0	1.112	27.0	80.6	0.960	38.0	100.2	0.785
20.2	68.4	1.107	27.2	81.0	0.956	39.0	102.2	0.775
20.4	68.7	1.102	27.4	81.3	0.953	40.0	104.0	0.763
20.6	69.1	1.097	27.6	81.7	0.950	41.0	105.8	0.752
20.8	69.4	1.092	27.8	82.0	0.947	42.0	107.6	0.751
21.0	69.8	1.087	28.0	82.4	0.943	43.0	109.4	0.731
21.2	70.2	1.082	28.2	82.8	0.940	44.0	111.2	0.711
21.4	70.5	1.078	28.4	83.1	0.936	45.0	113.0	0.705
21.6	70.9	1.073	28.6	83.5	0.932	46.0	114.8	0.604
21.8	71.2	1.068	28.8	83.8	0.929	47.0	116.6	0.603

Table 2 Repeatability

(*Clause* 9)

Sl No.	Electrial Conductivity mS/s at 25°C	Accepted Variation
(1)	(2)	(3)
i)	0 to 50	5 mS/m
ii)	>50 to 200	20 mS/m
iii)	> 200	10 percent

ANNEX A

RESULTS OF AN INTERLABORATORY TRIAL FOR THE DETERMINATION OF THE SPECIFIC ELECTRICAL CONDUCTIVITY OF SOILS

A-1 In 1991, an interlaboratory trial was organized by the Wageningen Agricultural University to test the procedure specified in this Indian Standard.

A-2 For this interlaboratory trial, the determination of the specific electrical conductivity of five soils was carried out by 26 laboratories.

A-3 The summary of the results of the interlaboratory trials is presented in Table 3.

A-4 Samples 1 and 4 mentioned in Table 3 were collected in salt-affected areas in Hungary. The fifth sample originates from the Netherlands.

A-5 The repeatability, r, and the reproducibility, R, given in Table 3 were calculated by the Precision of test methods — Determination of repeatability and reproducibility for a standard test method by inter-laboratory tests.

Table 3 Results of an Interlaboratory Trial for the Determination of the Specific Electrical Conductivity
(*Clauses* A-3, A-4 *and* A-5)

Sl No.	Tests	Sample Number				
		1	2	3	4	5
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Number of laboratories retained after eliminating outliers	26	26	26	25	26
ii)	Number of outliers (laboratories)	–	–	–	1	–
iii)	Number of accepted results	52	52	52	50	52
iv)	Mean value (mS/m)	34.931	117.075	142.673	655.506	31.077
v)	Repeatability standard deviation (S_r)	0.874	3.012	1.717	11.153	1.063
vi)	Repeatability relative standard deviation (%)	2.501	2.573	1.203	1.701	3.420
vii)	Repeatability limit ($r = 2.8 \times S_r$)	2.446	8.434	4.806	31.229	2.976
viii)	Reproducibility standard deviation (S_R)	7.889	9.021	13.340	62.439	4.116
ix)	Reproducibility relative standard deviation (%)	22.583	7.705	9.350	9.525	13.244
x)	Reproducibility limit ($R = 2.8 \times S_R$)	22.088	25.259	37.352	174.828	11.524

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