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Indian Standard

METHOD FOR DETERMINATION OF SOIL RESISTANCE AND SOIL RELEASE EFFICIENCY OF FINISHED TEXTILE FABRICS

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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(*Continued on page* 11)

Indian Standard

METHOD FOR DETERMINATION OF SOIL RESISTANCE AND SOIL RELEASE EFFICIENCY OF FINISHED TEXTILE FABRICS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 15 October 1986, after the draft finalized by the Chemical Methods of Test Sectional Committee had been approved by the Textile Division Council.

0.2 The soiling of textile fabrics is one of the most difficult problems associated with their use. Cotton and cellulosic fabrics do not pose a severe problem of soiling because of their high moisture regain. Nevertheless, the resin finished cellulosic fabrics and fabrics rich in synthetic fibres pose a severe problem of soiling during their usage. The soiling of fabrics is due to: (a) interfacial attraction or Van der Wall forces, (b) electrostatic attraction, (c) mechanical forces, and (d) hydrophobicity of the fibres.

0.3 The soil is mainly of two types, namely, dry or particulate soil and oily or greasy soil. The former which includes particles of dust, sand, earth, soot, metallic oxides and carbon with tarry substances may be hydrophilic (metallic oxides) or hydrophobic (carbon) in nature. The latter includes glycerides, long chain fatty acids and alcohols, lubricating oil, etc, which are mostly hydrophobic.

0.4 This Indian Standard prescribes a method for determination of soil resistance and soil release efficiency of finished textile fabrics and garments for both types of soil as mentioned above. In normal use, both types of soils may be present on the fabric. It is, therefore, advisable to test the fabric for both types of soil before use.

0.5 For evluation of soil resistance and soil release efficiency of the fabric, synthetic soils are used for soiling purpose. Ferric oxide and carbon black in fine powder form are employed as particulate soil whereas used lubricating oil SAE 40 is employed as oily soil. In the absence of a standard used lubricating oil, it is recommended to use a standard oil and add to it 10 percent of carbon black particles of standard mesh size of 20 to 25 nm.

The latter is hydrocarbon based and is similar to natural soiling encountered in actual usage as it contains carbon particles dispersed in oil phase. The properties of these soils are given in Table 1 (*see* **5.1**).

0.6 In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, expressing the result of a test, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard prescribes a method for determining soil resistance and soil release efficiency of finished textile fabrics and garments.

1.2 The method can also be used to assess the relative washing efficiency of surfactant auxiliaries.

2. PRINCIPLE

2.1 A specimen of the fabric under test is soiled with synthetic soil, washed under prescribed conditions and dried. Simultaneously, a control specimen and a control washed specimen are taken from the fabric under test. The soil resistance and soil release efficiency of the fabric is determined as described in **7.3**.

3. SAMPLING

3.1 Lot — The quantity of one definite type and quality of a fabric or garment delivered to a buyer against one despatch note shall constitute a lot.

3.2 Sample shall be drawn so as to be representative of the lot.

3.3 Sample drawn in compliance with the material specifications or as agreed to between the buyer and the seller to evaluate soil resistance and soil release efficiency of the textile fabric in the lot shall be held to be representative of the lot.

4. APPARATUS

4.1 An accelerotor consisting of a rotor capable of rotating at 1 600 rpm. The rotor consists of motor to which a shaft is attached. The shaft carries two arms at the end which are enclosed in a circular chamber having a door. A hole is provided on the upper part of this chamber for pouring particulate soil.

*Rules for rounding off numerical values (*revised*).

NOTE — Accelerotor type AB 7 of Atlas Electric Device Co, Chicago, USA may be used without the liner. Other similar instruments capable of producing consistent results may also be used. This type of instrument can be fabricated with little efforts.

4.2 A gas tight micrometer syringe to apply oily soil on the fabric with an accuracy of 0·01 ml.

4.3 A launderometer for washing the specimen.

4.4 A drying oven in which temperature can be maintained at 70 ± 5°C.

4.5 A spectrophotometer used in colour matching systems.

4.6 A white plate coated with barium sulphate.

5. QUALITY OF REAGENTS

5.0 Unless otherwise specified, pure reagents shall be employed in the tests. Distilled water (*see* IS : 1070 - 1977*), where the use of water as a reagent is intended, shall be used.

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

5.1 Soil — Ferric oxide or carbon black in fine powder form is used as particulate soil, whereas lubricating oil SAE 40 conforming to IS : 496 - 1982† or IS : 10356 - 1982‡ after it turns black during usage, or any other equivalent oil is employed as oily soil. The details of dry particulate and oily soils are given in Table 1.

TABLE 1 PROPERTIES OF SOILS TO BE USED

(*Clauses* 0.5, 5.1 *and* 7.1.2.2)

Sl No.	Property	Used Lubricating Oil	Ferric Oxide	Carbon Black
i)	Physical nature	Liquid	Powder	Powder
ii)	Chemical nature	Hydrophobic	Hydrophilic	Hydrophobic
iii)	Colour	Black	Red	Black
iv)	Density (g/cm³)	0·91 ± 0·01	—	—
v)	Viscosity (cps)	275	—	—
vi)	Particle size (microns)	—	0·3 to 1·6	2 to 4

*Specification for water for general laboratory use (*second revision*).

†Specification for automotive internal combustion engine lubricating oils (*fourth revision*).

‡Specification for automotive internal combustion engine lubricating oils from base stocks of mixed crudes.

5.2 A non-ionic detergent based on ethylene oxide condensate for washing, conforming to Type 2 of IS : 9458 - 1980*.

NOTE — The detergent selected should be capable of working at 50 ± 5°C satisfactorily.

5.3 Carboxymethyl Cellulose (CMC) — Sodium salt to prevent redeposition of soil during washing.

5.3.1 CMC normally used in sizing and printing of textiles is suitable.

6. PREPARATION OF SPECIMEN

6.1 From the sample as selected in **3.2**, cut twelve specimens of 10 × 10 cm size.

6.2 Take four of the twelve specimens as obtained in **6.1** and mark them as control specimens. Mark the other eight specimens as test specimens.

7. PROCEDURE

7.1 Soiling of the Specimens

7.1.1 *Method for Particulate Soil*

7.1.1.1 Take four test specimens (*see* **6.2**) and weigh each of them nearest to one mg.

7.1.1.2 Weigh the particulate soil exactly 5 percent on the bone dry mass of the two test specimens.

7.1.1.3 Keep the arms of the accelerotor in horizontal position and place the two test specimens one on each arm.

7.1.1.4 Secure the door of the chamber tightly and pour the calculated and weighed amount of soil (*see* **7.1.1.2**) inside the chamber through a hole situated in the upper part of the chamber.

7.1.1.5 Switch on the rotor and maintain its speed at 1 600 rpm for one minute. This simulates deposition of airborne soil on the test specimens. Take out the uniformly soiled test specimens and keep them aside for spectrophotometric measurement and washing.

7.1.1.6 Repeat the procedure from **7.1.1.2** to **7.1.1.5** for remaining two test specimens as obtained in **7.1.1.1** (*see* Note 1 under **7.1.2.6**).

*Specification for synthetic detergents for washing woollen and other delicate fabrics.

7.1.2 *Method for Oily Soil*

7.1.2.1 Take the other two test specimens (*see* **6.2**) and weigh each of them nearest to one mg.

7.1.2.2 Calculate the amount of 'used lubricating oil' (*see* **5.1**) 45 percent on the mass of the test specimens and convert it into ml taking into account the density of the oil (*see* Table 1).

7.1.2.3 Pour exactly half of the calculated amount on each test specimen with the help of a gas micrometer syringe and place them on each arm of the rotor of the accelerotor.

7.1.2.4 Secure tightly the door of the chamber, switch on the motor and maintain its speed at 1 600 rpm for three minutes. Take out the uniformly soiled test specimens and keep them aside for spectrophotometric measurement and washing.

7.1.2.5 The uniformly soiled test specimens shall not have maximum reflectance variation of more than ± 5 percent. In case, the test specimens as soiled in **7.1.2.4** do not meet this requirement, two fresh test specimens shall be cut from the sample and treated as given in **7.1.2.1** to **7.1.2.4** till they meet the requirement given in **7.1.2.5**.

7.1.2.6 Repeat the procedure given in **7.1.2.1** to **7.1.2.5** for the remaining two test specimens (*see* **6.2**).

NOTE 1 — The chamber should be cleaned in between two successive soiling operations.

NOTE 2 — Alternatively the sample is fixed on an embroidery ring and secured tight. The exact amount of soil is poured in the middle of the sample and allowed to wick for 16 to 20 hours. Each sample is processed similarly.

7.2 Washing

7.2.1 Wash two of the control specimens (*see* **6.2**) and four soiled test specimens, two each as obtained in **7.1.1.5** and **7.1.2.5** in a launderometer in separate baths each containing 3·5 g/l of a non-ionic detergent (*see* **5.2**) and 1g/l carboxymethyl cellulose (*see* **5.3**) at 50°C for 30 minutes at a liquor ratio of 1 : 50.

NOTE — The specimens should be fully exposed to the wash liquor from both the sides.

7.2.2 Rinse the washed specimens with tap water for 10 minutes and again rinse them with distilled water.

7.2.3 Dry the washed specimens in an electric oven at 70 ± 5°C for 20 minutes.

7.3 Assessment of Soil on Fabrics

7.3.1 Calibrate the spectrophotometer against a standard white plate of barium sulphate as per the method given in Appendix A.

7.3.2 Find out the minimum percent reflectance on the spectrophometer and note down the corresponding wave length for two specimens soiled with particulate soil — ferric oxide as obtained in **7.1.1.6** and that of two particulate — soiled and washed specimens at the same wavelength as above, as obtained in **7.2.3** at four different places on each side for each specimen and calculate the average value from these sixteen readings— eight for each specimen for both the sets, soiled and soiled-washed separately. Repeat the exercise for one control and one control-washed specimen at the same wavelength as above and calculate the average of eight readings for each separately.

7.3.3 Find out percent reflectance on a spectrophotometer at 450 and 650 nm for the two specimens soiled with oily soil as obtained in **7.1.2.6** at four different places on each side for each specimen and calculate the average of 32 readings. Perform similar exercise on two oily soiled and washed specimens as obtained in **7.2.3**, and one control and one control-washed specimen and calculate the average reflectance separately for oily soiled, soiled-washed, control; and control-washed specimens.

7.3.4 Calculate the Kubelka-Munk ratio $\left(\frac{K}{S}\right)$ for soiled, soiled-washed, control and control-washed specimens separately as obtained in **7.3.2** and **7.3.3** for both types of soil using the following formula:

$$\frac{K}{S} = \frac{(1-R)^2}{2R}$$

where

K = Absorption coefficient,

S = Scattering coefficient, and

R = Average percent reflectance as measured in **7.3.2** or **7.3.3**.

7.3.5 *Determination of Soil Resistance*

7.3.5.0 This can be done correctly only in case of particulate soil.

7.3.5.1 Find out $\frac{K}{S}$ value for the soiled and control sample and determine the soil resistance as follows:

Soil Resistance, $s = \left(\frac{K}{S}\right)_P - \left(\frac{K}{S}\right)_C$

where

$\left(\frac{K}{S}\right)_P$ = Kubelka-Munk ratio for particulate soiled sample, and

$\left(\frac{K}{S}\right)_C$ = Kubelka-Munk ratio for control sample.

7.3.6 *Determination of Soil Release Efficiency*

7.3.6.1 Calculate the degree of soil retained on the fabric specimen separately for particulate soil and oily soil using the formula:

$$D_{SR} = \frac{\left(\frac{K}{S}\right)_W - \left(\frac{K}{S}\right)_U}{\left(\frac{K}{S}\right)_S - \left(\frac{K}{S}\right)_C}$$

where

D_{SR} = Degree of soil retained on the fabric specimen,

$\left(\frac{K}{S}\right)_W$ = Kubelka-Munk ratio for soiled-washed specimen,

$\left(\frac{K}{S}\right)_U$ = Kubelka-Munk ratio for control-washed specimen,

$\left(\frac{K}{S}\right)_S$ = Kubelka-Munk ratio for soiled unwashed specimen, and

$\left(\frac{K}{S}\right)_C$ = Kubelka-Munk ratio for control unwashed specimen.

7.3.6.2 Calculate the percent soil retained on the fabric separately for both types of soil by multiplying D_{SR} by 100, that is, percent soil retained = $D_{SR} \times 100$.

7.3.6.3 Calculate the percent soil removed during washing for both types of soil by the formula.

Percent soil removed during washing or soil release efficiency = $100 (1 - D_{SR})$ where D_{SR} is the value obtained in **7.3.6.1**.

8. REPORT

8.1 The report shall include the following information:

a) Nature, type and constructional details of fabric being tested;

b) Nature and type of finish given to the fabric;

c) Percent soil retained on the fabric after washing separately for the particulate and the oily soil;

d) Soil release efficiency separately for the particulate and the oily soil; and

e) Soil resistance of the fabric or garment for particulate soil only.

APPENDIX A

(*Clause* 7.3.1)

METHOD FOR CALIBRATION OF SPECTROPHOTOMETER

A-1. Keep the spectrophotometer in an air-conditioned chamber at 27 ± 2°C.

A-2. Switch on the instrument about 90 minutes before use.

A-3. Set the arbitrary value, given with the instrument, on the panel.

A-4. Keep the white plate coated with barium sulphate below the sensor and calibrate the instrument at an interval of 10 nm. Set the reading to 100 ± 0·5 on the digital panel, each time.

A-5. Calibrate the instrument for the full range of wavelength from 380 to 760 nm. The instrument is now ready for recording the measurements.

(*Continued from page* 2)

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INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	Unit	Symbol
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	Unit	Symbol	Definition
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2