
**Fibre ropes — Electrostatic surface
potential measuring method**

*Cordages en fibres — Méthode de mesurage du potentiel
électrostatique de surface*

STANDARDSISO.COM : Click to view the full PDF of ISO 20615:2018



STANDARDSISO.COM : Click to view the full PDF of ISO 20615:2018



COPYRIGHT PROTECTED DOCUMENT

© ISO 2018

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

	Page
Foreword.....	iv
Introduction.....	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principle	1
5 Test atmosphere	1
6 Apparatus	2
7 Preparation of specimens	4
7.1 Specimen diameter.....	4
7.2 Cutting.....	4
7.3 Splicing rope specimen.....	4
7.4 Conditioning of specimen.....	5
8 Testing procedure	5
8.1 Rope specimen setting.....	5
8.2 Measurement of surface potential generated by tribocharging.....	5
9 Test report	6
Annex A (normative) Verification procedure and correction factor	7
Annex B (informative) Example of test results	10
Annex C (informative) Information on the effect of parameters	12
Annex D (informative) Interlaboratory test	14
Bibliography	17

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared jointly by Technical Committee ISO/TC 38, *Textiles*, and Technical Committee IEC/TC 101, *Electrostatics*. The draft was circulated for voting to the national bodies of both ISO and IEC.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Heavy duty ropes can be made from metal wire or synthetic fibre or a combination of these two. Historically, fibre ropes were commonly made of natural fibres such as cotton, flax, etc. Recently, synthetic fibres have been used to make heavy duty ropes. Synthetic fibre ropes are lighter and stronger than steel wire ropes and natural fibre ropes.

However, synthetic fibre can acquire electrostatic charge more easily compared to metal wire ropes or natural fibre ropes.

To overcome this disadvantage, different methods have been applied to the manufacture of synthetic fibre ropes, such as combining them with steel wire or blending with conductive yarn, etc. The development of such ropes has taken place without a standard procedure for evaluating their electrostatic propensity.

This document describes a test method that is used to determine tribocharging of fibre ropes by a specified charging mechanism.

This testing method may not be representative of all possible charging mechanisms that are found in use.

STANDARDSISO.COM : Click to view the full PDF of ISO 20615:2018

STANDARDSISO.COM : Click to view the full PDF of ISO 20615:2018

Fibre ropes — Electrostatic surface potential measuring method

1 Scope

This document specifies a method for determining the electrostatic charging propensity of fibre ropes by measuring the surface potential generated by tribocharging.

This document is not intended to be used to evaluate the safety of ropes for use in explosive atmospheres as safety also depends on application conditions.

The test method described in this document is only applicable to fibre ropes of diameter between 12 mm and 20 mm.

The result obtained using this test method is valid only for the charging mechanism and parameters described in the test method. Charging can be different in end-use applications.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 630-1, *Structural steels — Part 1: General technical delivery conditions for hot-rolled products*

ISO 1968, *Fibre ropes and cordage — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1968 apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

4 Principle

A fibre rope specimen is cut to a designated length and both ends spliced by the short splice method to make an endless loop. The rope specimen loop is mounted in a rope driving apparatus and passes around friction cylinders and a non-contacting electrostatic voltmeter. As the rope makes contact with the friction cylinders, rollers and pulleys, it becomes electrostatically charged. The resulting surface potential is measured by the non-contacting electrostatic voltmeter.

5 Test atmosphere

Unless otherwise agreed or specified, the atmosphere for conditioning and testing shall be a temperature of (23 ± 2) °C and a relative humidity of (25 ± 5) %.

A different temperature or relative humidity may be used as appropriate for different geographical regions, but in any case, the atmosphere for conditioning and testing shall include the lowest relative humidity expected in use.

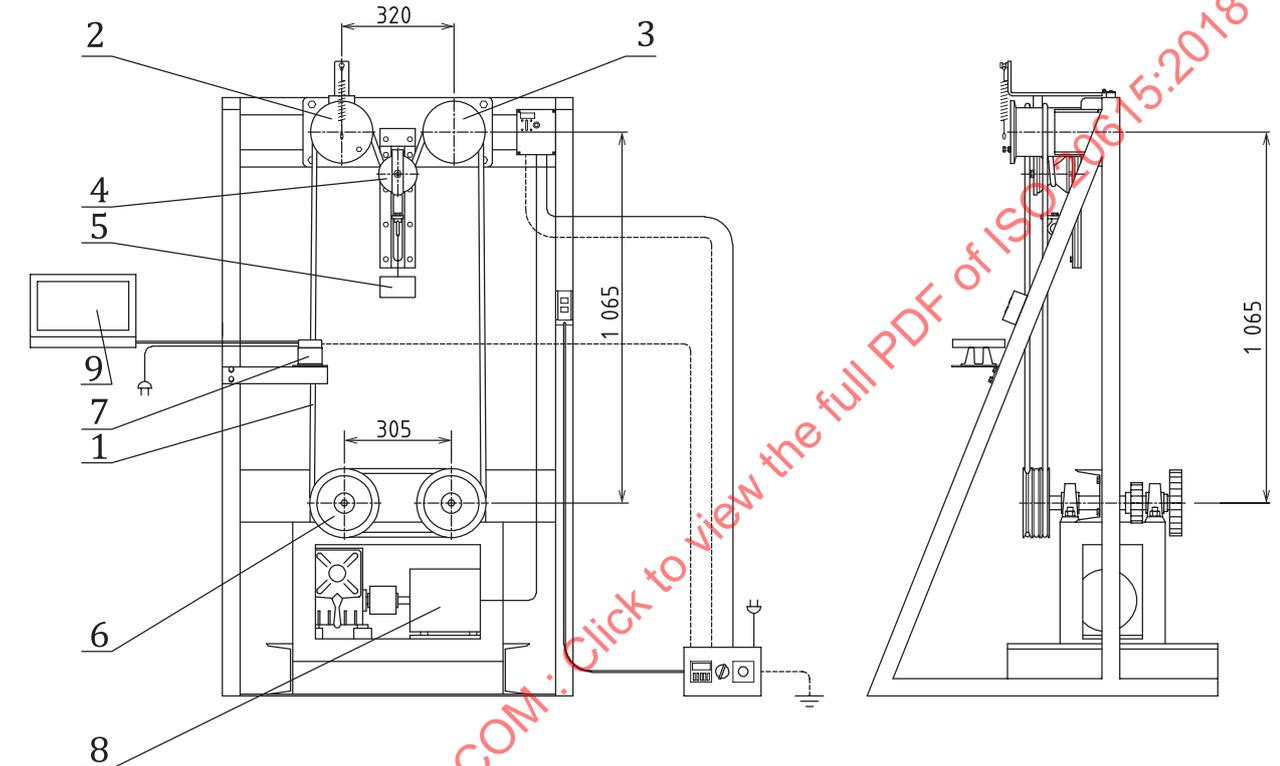
6 Apparatus

6.1 Apparatus for tribocharging and measuring surface potential

One possible test apparatus is shown in [Figure 1](#) as an example. Other apparatus capable of measuring surface potential generated by tribocharging and recording such measurements over a period of time may also be used after appropriate validation. For the validation, test a rope made of high modulus polyethylene (HMPE) and compare the data with the example shown in [Annex B](#).

The apparatus should be earthed. National electrical codes can be applicable.

Dimensions in millimetres with tolerance of $\pm 4,0$ mm



Key

- 1 rope specimen
- 2 friction cylinder (no rotation)
- 3 friction cylinder (no rotation)
- 4 loading roller
- 5 load
- 6 driving pulley
- 7 electrostatic voltmeter
- 8 motor
- 9 recording device

Figure 1 — Diagram of an example of the test apparatus

6.1.1 Friction cylinders, consisting of two friction cylinders (see [Figure 1](#), key items 2 and 3), which are fixed without rotation, and the rope specimen winds around the cylinders. The dimension of each

cylinder is $140 \text{ mm} \pm 3 \text{ mm}$ in diameter and $180 \text{ mm} \pm 3 \text{ mm}$ between flanges. The material is E275A prescribed in ISO 630-1 and polishing roughness is an arithmetic mean roughness of $6,3 \text{ }\mu\text{m}$.

E275A represents a typical material in many applications. However, there can be other materials in other applications that have different triboelectric charging characteristics.

If the application for ropes requires testing using other friction materials, such as polyamide resin for example, other material for the friction cylinders may be used and shall be recorded in the test report.

6.1.2 Loading roller, hanging freely in the rope path ([Figure 1](#), key item 4) and loaded with a mass of $2,4 \text{ kg} \pm 0,3 \text{ kg}$ ([Figure 1](#) key item 5). The diameter of the roller is $46 \text{ mm} \pm 3 \text{ mm}$. The material is the same as the friction cylinder material.

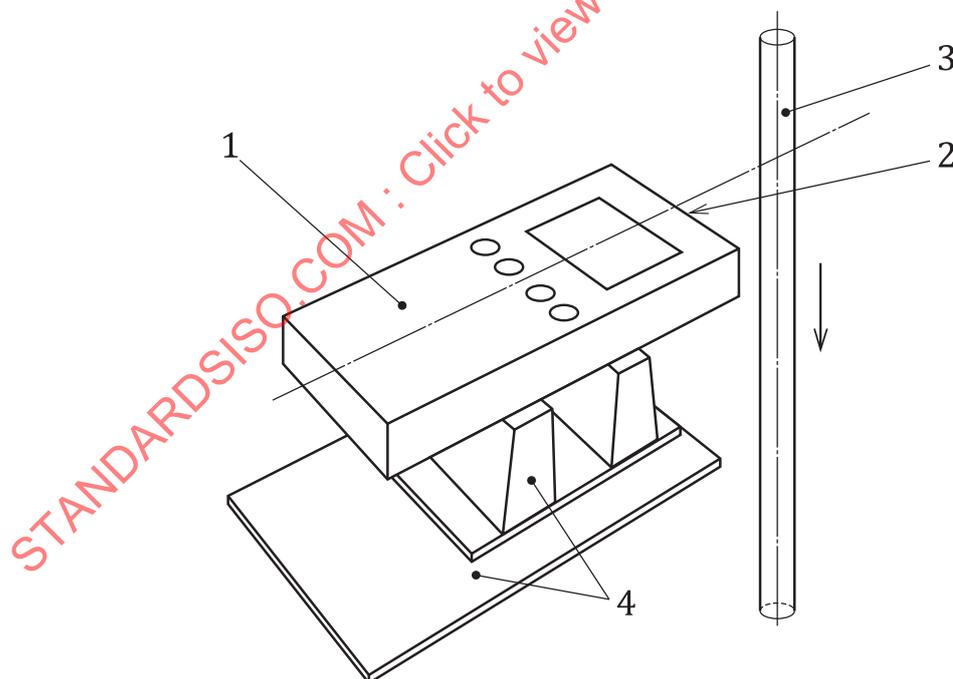
If a different load is used, record it in the test report.

6.1.3 Driving pulley, for driving the rope specimen in this testing apparatus along the rope path ([Figure 1](#), key item 6). The material is the same as the friction cylinder material.

6.1.4 Electrostatic potential measuring instrument, non-contacting electrostatic voltmeter as shown in [Figure 2](#), which may be either an electrostatic field meter calibrated to read surface voltage using a known target geometry, or a direct reading electrostatic voltmeter (e.g. vibrating reed type).

- Range: 0 kV to 20 kV, both positive and negative polarity.
- Response time (0 % to 90 % full scale): $\leq 10 \text{ ms}$.

Verification shall be performed, and the correction factors shall be calculated according to [Annex A](#).



Key

- 1 non-contacting electrostatic voltmeter
- 2 sensing point
- 3 rope specimen
- 4 mounting base

Figure 2 — Electrostatic voltmeter

6.1.5 Driving motor, with speed controlled by an inverter system. The rope running speed for this measurement is $0,6 \text{ m/s} \pm 0,1 \text{ m/s}$.

If a different rope speed is used, record it in the test report.

6.1.6 Recording device, data logger connected to a personal computer, or other suitable device for recording the output of the electrostatic voltmeter.

6.2 Neutralization apparatus, compressed gas or blown air ionizer, etc.

7 Preparation of specimens

7.1 Specimen diameter

The applicable diameter of ropes for this specific apparatus is from 12 mm to 20 mm. If the apparatus design is changed, a wider range of diameters can be measured.

The maximum value of the rope diameter is determined by the maximum groove diameter of the loading roller and the driving pulley, and the minimum diameter is determined by the field meter accuracy.

7.2 Cutting

Cut rope sample to $7\,300 \text{ mm} \pm 50 \text{ mm}$ in length.

7.3 Splicing rope specimen

Splice both ends together by the short splice method to make a loop as shown in [Figure 3](#).

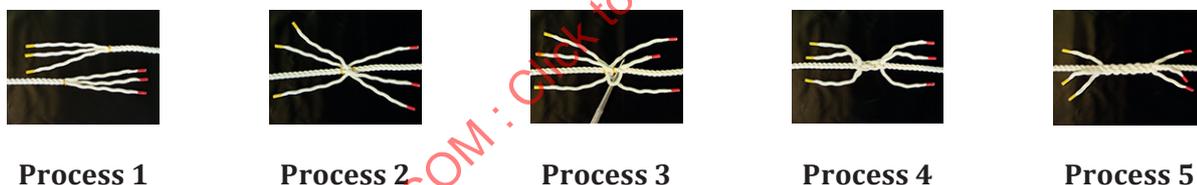


Figure 3 — Short splice method for connection of rope ends

Process 1: Unravel the both rope ends to strands and wind up tightly to create knot at the unravelled end position of ropes.

Process 2: Match the strands alternatively.

Process 3: Insert a strand into the rope as overlap one strand at the knotted position by using a knitting needle.

Process 4: Insert strands both sides reciprocally.

Process 5: Knit more than 3 times for both sides.

Wear gloves for handling of specimen to avoid contamination.

The surface of ropes can be contaminated by residual processing finishes, dirt or other substances that may affect to the test result. Contamination may be removed by washing. ISO 6330 specifies washing procedures that may be used for pre-treatment of rope samples.

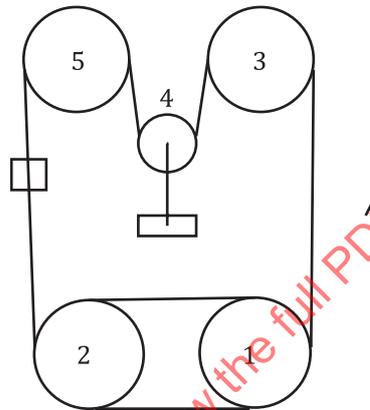
7.4 Conditioning of specimen

Condition specimens for a minimum of 24 hours under the conditions specified in [Clause 5](#) before testing under the same conditions.

8 Testing procedure

8.1 Rope specimen setting

- a) Hang the looped rope specimen as shown in [Figure 4](#). Wrap the rope twice around both driving pulleys in [Figure 4](#), 1 to 2 and 2 to 1, go to the first friction cylinder, 3, then the loading roller, 4, and wind around the second friction cylinder, 5, then pass the electrostatic voltmeter and return to driving pulley, 2.



NOTE The numerical values in the figure indicate the mounting order.

Figure 4 — Rope path explanation

- b) After hanging the rope specimen around the path, add a mass of $2,4 \text{ kg} \pm 0,3 \text{ kg}$ to the loading roller. Confirm that the loading roller position has not reached the lower end.
- c) Adjust the electrostatic voltmeter position so that it is equal to the distance used in verification, if a field meter is used, or as recommended by the measuring instrument manufacture if a direct reading electrostatic voltmeter is used. The distance between the measuring instrument and rope specimen shall be $50 \text{ mm} \pm 2 \text{ mm}$, or the distance determined in verification, and the centre of the sensing point shall be in line with the centre of the rope. Then, neutralize the measuring instrument and rope specimen by using an ionizer ([6.2](#)) and check that the surface potential of the rope specimen is in the range of $+100 \text{ V}$ to -100 V along its entire length. This check shall be done using a hand-held electrostatic potential measuring instrument (see [6.1.4](#)) scanned along the rope specimen.

8.2 Measurement of surface potential generated by tribocharging

- a) Connect the electrostatic voltmeter to the recording device.
- b) Check that the starting measured value of surface potentials in the range of $+100 \text{ V}$ to -100 V along the entire length of the rope specimen.
- c) Switch on the motor and run the rope specimen.
- d) Record data for at least 10 minutes or until a maximum plateau is observed.
- e) Measure 3 rope specimens.

- f) Calculate the average of the maximum surface potentials obtained from each measurement of the 3 rope specimens.
- g) Example of the test result is shown in [Annex B](#), [Annex C](#) and [Annex D](#).

9 Test report

Test report shall include at least the following information:

- a) a reference to this document, i.e. ISO/IEC 20615:2018;
- b) date and time of measurements;
- c) atmosphere for conditioning and testing if there is deviation from this document;
- d) cleansing method and condition, if used;
- e) specifications of tested rope (material of fibre, product type, diameter);
- f) test results;
- g) identification of instrumentation used;
- h) friction cylinder material used;
- i) any deviation from this document.

STANDARDSISO.COM : Click to view the full PDF of ISO 20615:2018

Annex A (normative)

Verification procedure and correction factor

A.1 Tools

Prepare 5 metal pipes 200 mm in length and with diameters of 12 mm, 14 mm, 16 mm, 18 mm and 20 mm.

A.2 Verification procedure

- a) With the pipe and other nearby conductors earthed, adjust the zero point of the measuring instrument.
- b) Apply 10 000 V DC to a 16 mm diameter metal pipe and adjust the electrostatic voltmeter so that the reading is 10 000 V.
- c) Apply 10 000 V DC to each pipe and measure the voltage for all pipes as V_{12} , V_{14} , V_{18} and V_{20} .

A.3 Correction factor

Correction factor is calculated by using [Formulae \(A.1\)](#) to [\(A.4\)](#):

$$Fc_{12} = 10\,000/V_{12} \tag{A.1}$$

$$Fc_{14} = 10\,000/V_{14} \tag{A.2}$$

$$Fc_{18} = 10\,000/V_{18} \tag{A.3}$$

$$Fc_{20} = 10\,000/V_{20} \tag{A.4}$$

where

Fc_{12} is correction factor for diameter 12 mm;

Fc_{14} is correction factor for diameter 14 mm;

Fc_{18} is correction factor for diameter 18 mm;

Fc_{20} is correction factor for diameter 20 mm;

V_{12} is the voltage measured according to [A.2](#) using the metal pipe with 12 mm diameter;

V_{14} is the voltage measured according to [A.2](#) by using the metal pipe with 14 mm diameter;

V_{18} is the voltage measured according to [A.2](#) by using the metal pipe with 18 mm diameter;

V_{20} is the voltage measured according to [A.2](#) by using the metal pipe with 20 mm diameter.

The correction factors for the diameters between the prepared pipes are interpolated from the obtained values.

A.4 Example of correction factors

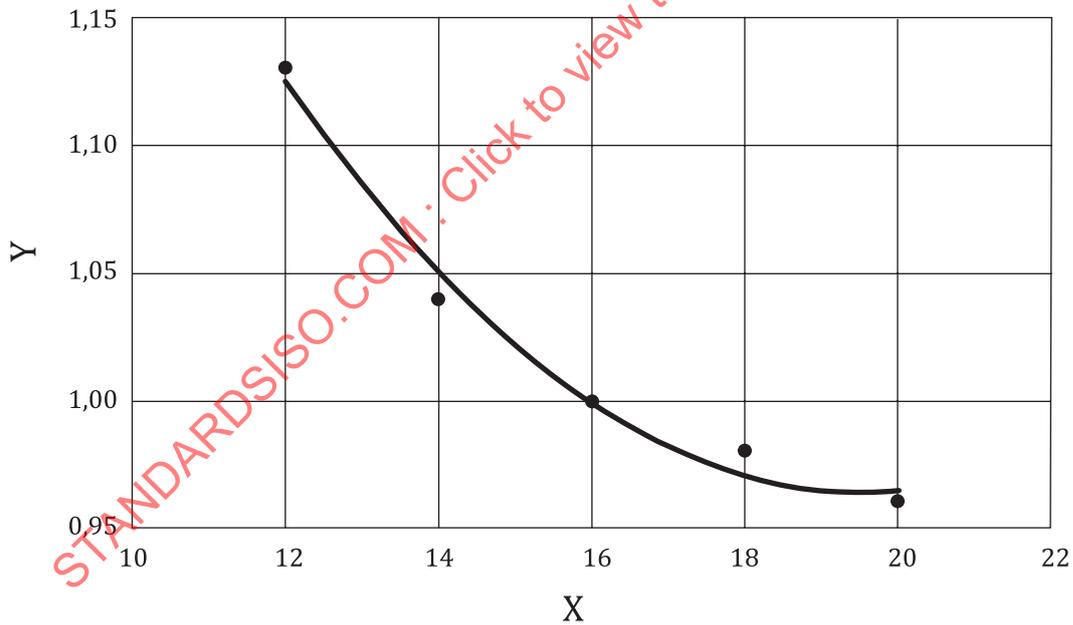
Table A.1 shows the verification on the pipe with a diameter of 16 mm and calculation of the correction factor to other diameters.

Table A.1 — Calculation of correction factors

Diameter mm	Measured voltage kV	Correction factor
12	8,84	1,13
13	—	1,09
14	9,65	1,04
15	—	1,02
16	10,00	1,00
17	—	0,99
18	10,24	0,98
19	—	0,97
20	10,39	0,96

The data of Table A.1 is described in Figure A.1 and the correlation factor is obtained as 0,986 1. The approximation formula is as described in Formula (A.5):

$$Y = 0,029x^2 - 0,114x + 2,050 6 \tag{A.5}$$



Key
 Y correction factor (N)
 X diameter (mm)

Figure A.1 — Example of correction factor

A.5 Alternative verification procedure

- a) Position one of the pipes near the measuring aperture of the measuring instrument.

- b) With the pipe and other nearby conductors earthed, adjust the zero point of the measuring instrument.
- c) Remove the earth connection from the pipe and apply 10 000 V DC to the pipe.
- d) Move the measuring instrument until the reading is 10 000 V DC.
- e) Record the distance between the measuring instrument and the pipe. This distance shall be used when testing ropes of the same diameter as the pipe.
- f) Apply 10 000 V DC to each of the other pipes and record the corresponding distance at which the measuring instrument reads 10 000 V.

STANDARDSISO.COM : Click to view the full PDF of ISO 20615:2018

Annex B (informative)

Example of test results

B.1 Fibre rope sample preparation

B.1.1 Sample A: A rope combining high modulus polyethylene (HMPE) and conductive fibre was prepared. The details of sample A is as following.

A conductive spun fibre of 1/34 metric count, which consists 50 % of conductive fibre and 50 % of synthetic fibre is combined by twisting in HMPE rope. The diameter of this rope is 14 mm.

B.1.2 Sample B: Regular rope, made of 100 % HMPE with 14 mm diameter.

B.2 Test condition

B.2.1 Friction cylinder material.

Metal E275A is used.

B.2.2 Washing.

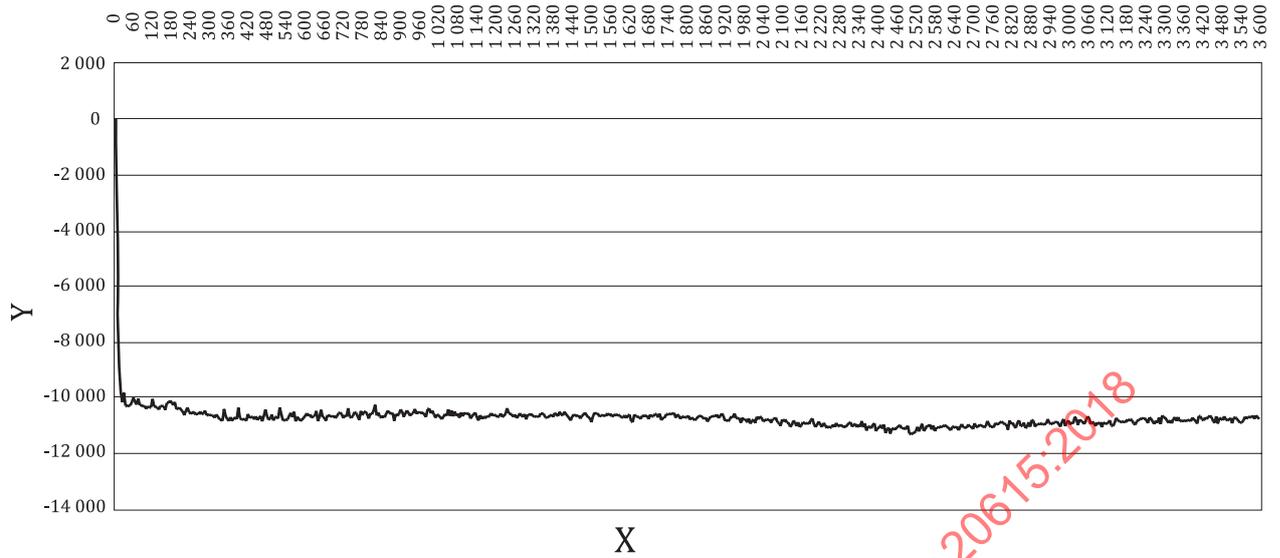
The washing method used is described in ISO 6330:2012 Table B.1, Procedure No. 4M: 3 cycles washed at 40 °C water for 10 min, then, dried naturally.

B.3 Test result

The test condition and measurement results are shown in [Table B.1](#). The results are the maximum values from the recorded output of the electrostatic voltmeter as shown in [Figure B.1](#) for HMPE fibre rope and [Figure B.2](#) for the combination rope of HMPE and conductive fibre.

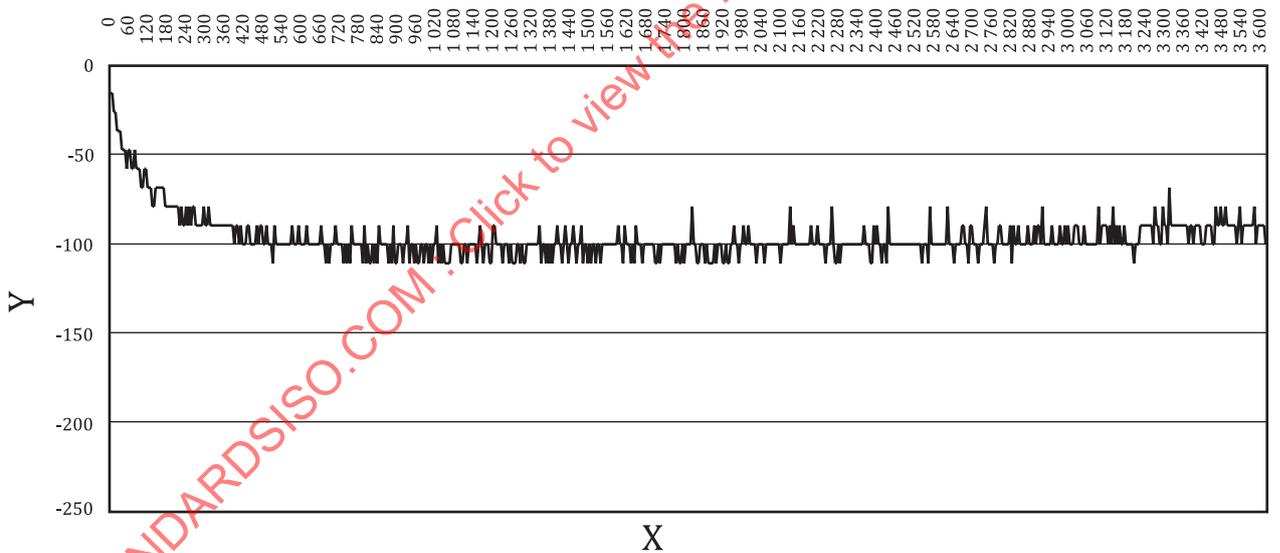
Table B.1 — Test result

	Sample A	Sample B
Temperature °C	21,2 to 21,4	
Relative humidity %RH	64,1 to 65,0	
Correction factor	1,04	
Maximum surface potential V	-114,4	-11 772,8



Key
 Y voltage (V)
 X passed time (sec)

Figure B.1 — Reference HMPE fibre rope (Sample B)



Key
 Y voltage (V)
 X passed time (sec)

Figure B.2 — HMPE and conductive fibre rope (Sample A)

Annex C (informative)

Information on the effect of parameters

C.1 General

Test results are shown to demonstrate the influence of changing some test parameters.

C.2 Sample preparation

The washing method used is ISO 6330:2012, Table B.1, Procedure No. 4M: 3 cycles washed at 40 °C water for 10 min, then, dried naturally.

C.3 Test condition

- Test conditions of different relative humidity (RH) were chosen for the tests.
- E275A was selected as the friction cylinder material in these tests.
- Rope wrapping on cylinder: 1,5 times
- Rope speed: 1,2 m/s.
- Load: 10 kg.

C.4 Test result

[Table C.1](#) shows the test result of different relative humidity.

Table C.1 — Effect of testing at different relative humidity

Diameter mm	12	
Correction factor	1,13	
Temperature °C	12,1 to 13,8	
Relative humidity % RH	36,6 to 37,0	46,8 to 47,9
HMPE rope V	-20 758,1	-20 193,1
HMPE+8 % conductive fibre rope V	-192,1	-203,4

[Table C.2](#) shows the result of different rope diameters.

Table C.2 — Effect of diameter of ropes under test

Temperature °C	11,6 to 13,9		
Relative humidity % RH	36,6 to 41,4		
Diameter mm	12	14	16
Correction factor	1,13	1,04	1,00
HMPE rope V	-20 758,1	Over-20 800	Over-20 000
HMPE + conductive fibre rope V	-192,1	-239,2	-340

Table C.3 shows the result on several kinds of rope products.

Table C.3 — Result on different kinds of rope materials

Temperature °C	11,3 to 13,8			
Relative humidity % RH	36,6 to 40,8			
Diameter mm	14		12	
Correction factor	1,04		1,13	
Kind of rope	HMPE	Polyarylate	HMPE	Polyester
Regular (no conductive fibre) V	over -20 800	over -20 800	-20 758,1	-16 147,7
Rope with conductive fibre V	-239,2	-634,4	-192,1	-372,9