BRITISH STANDARD

BS EN
13966-1:2003

Determination of the transfer efficiency of atomising and spraying equipment for liquid coating materials —

Part 1: Flat panels

The European Standard EN 13966-1:2003 has the status of a British Standard

ICS 87.100

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 13966-1:2003.

The UK participation in its preparation was entrusted by Technical Committee MCE/3, Safeguarding of machinery, to Subcommittee MCE/3/8, Thermoprocessing equipment — Safety, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Additional information

The UK voted against the acceptance of this European Standard at Formal Vote stage for the following reasons.

- The direction of the spray-booth air-flow direction given in **6.4.1** is different to the direction commonly used for testing in the UK.
- The UK believe that **6.10** does not contain the information necessary to determine the mass of coating material delivered by the atomizer for method 1 gravimetrically.
- The UK also drew attention to the fact that the measurement accuracy tolerance given in Annex A for the weighing of the coating material deposit is, in their view, too large.
- Finally, the UK consider that the contents of Annex C do not allow for the correct recording of test results.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

This British Standard, was published under the authority of the Standards Policy and Strategy Committee on 10 October 2003

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 20, an inside back cover and a back cover.

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EUROPEAN STANDARD

NORME EUROPÉENNE

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EN 13966-1

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English version

Determination of the transfer efficiency of atomising and spraying equipment for liquid coating materials - Part 1: Flat panels

Détermination de l'efficacité de transfert des équipements d'atomisation/pulvérisation pour produits de revêtement liquides - Partie 1: Panneaux plans

Bestimmung des Auftragswirkungsgrades von Spritz- und Sprühgeräten für Beschichtungsstoffe - Teil 1: Flächenbeschichtung

This European Standard was approved by CEN on 28 November 2002.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This document (EN 13966:2003) has been prepared by Technical Committee CEN/TC 271, "Surface treatment equipment - Safety", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2003, and conflicting national standards shall be withdrawn at the latest by October 2003.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

Transfer efficiency is a performance parameter that is used to express the effectiveness of spraying or atomising equipment in transferring a coating material to the surface of an object.

Transfer efficiency is defined as the ratio of coating solids laid down on the surface of an object and forming the dry film to the total solid content of the coating material delivered by the atomising and spraying equipment, expressed as a percentage.

The use of atomising and spraying equipment with a high transfer efficiency therefore has economic and environmental benefits.

A standard and reproducible procedure for determining the transfer efficiency is required to:

- enable a reliable comparison of atomising and spraying equipment through transfer efficiency data quoted by manufacturers;
- provide data to show that the atomising and spraying equipment meets minimum values stipulated in health, safety and environmental legislation.

1 Scope

This European Standard specifies a laboratory procedure for determining the transfer efficiency of atomising and spraying equipment for the application of liquid coating materials onto flat panels. A second part (to be prepared) will cover coating material application to other substrate geometries and provide a method for the determination of transfer efficiency for atomising and spraying equipment with electrostatic support.

This standard applies to the determination of the transfer efficiency of atomising and spraying equipment, such as, but not limited to:

- conventional air atomiser (high air pressure);
- HVLP-atomiser (high volume low pressure);
- LVLP-atomiser (low volume low pressure);
- airless atomiser (hydraulic pressure);
- air assisted airless atomiser;
- vibratory or rotary atomiser (bells);
- electrostatic supported atomiser.

Two methods of determination are included in the standard.

The transfer efficiency value resulting from the application of this standard procedure expresses the potential performance of atomising and spraying equipment for comparison of different types or models. The value may or may not be attained in use, where the working conditions and operator practice are likely to differ from those of the standard test method.

The determined transfer efficiency is valid only in conjunction with the parameters shown in the test summary form, see annex C.

2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to the European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies (including amendments).

EN 971-1, *Paints and varnishes: Terms and definitions for coating materials. Part 1: General terms*

EN 1953, *Atomising and Spraying Equipment for Coating Materials - Safety requirements*

prEN 12215, *Coating plants - Spray booths for application of organic liquid coating materials - Safety requirements*

prEN 13355, *Coating plants - Combined booth – Safety requirements*

EN 21512, *Paints and Varnishes: Sampling of products in liquid or paste form*

EN ISO 1513, *Paints and Varnishes - Examination and preparation of samples for testing.*(ISO 1513:1992*)*

EN ISO 2431, *Paints and varnishes - Determination of flow time by use of flow cups* (ISO 2431:1993, including Technical Corrigendum 1:1994).

EN ISO 3219, *Plastics - Polymers/resins in the liquid state or as emulsions or dispersions - Determination of viscosity using a rotational viscometer with defined shear rate* (ISO 3219:1993*)*

EN ISO 3251, *Paints and varnishes - Determination of non-volatile matter of paints, varnishes and binders for paints and varnishes* (ISO 3251:1993*)*

ISO 2811-1, *Paints and varnishes - Determination of density - Part 1: Pyknometer method*

ISO 2811-2, *Paints and varnishes - Determination of density - Part 2: Immersed body (plummet) method*

ISO 2811-3, *Paints and varnishes - Determination of density - Part 3: Oscillation method*

ISO 2811-4, *Paints and varnishes - Determination of density - Part 4: Pressure cup method*

ISO 2884, *Paints and varnishes - Determination of viscosity using rotary viscometer*

ISO 9944, *Plastics; phenolic resins; determination of electrical conductivity of resins extracts*

3 Terms and definitions

For the purposes of this standard, the terms and definitions given in EN 971-1 apply. For the purposes of this standard, the following terms and definitions also apply:

3.1
application time
time during which coating material is applied to the test sheet during the transfer efficiency test

3.2
atomising and spraying equipment
any type of device which can be used to atomise coating materials. Atomising may be achieved by air, hydromechanically (airless) with or without air assistance, or by centrifugal forces such as rotating bells or discs, as defined in EN 1953

3.3
background panel
rigid plate placed behind the test sheet to support it and enable a flat surface to be obtained

3.4
coating material
liquid product, pigmented or non pigmented, applied to a substrate, as defined in EN 971-1

3.5
coating film
film possessing protective, decorative and/or other specific properties on a substrate, as defined in EN 971-1

3.6
solid content
non volatile portion of a coating material, as defined in EN 971-1

3.7
spray pattern
visual pattern width of the coating deposit on a vertical panel

3.8
stroke speed
velocity of spray pattern traverse across the face of the test sheet. This is equivalent to the velocity of travel of the atomiser relative to the test sheet. Either the atomiser or the test sheet can be moved

3.9
test rig
structure for supporting the background panel and maintaining the atomiser - test sheet distance constant

3.10
test sheet
flat sheet of aluminium foil to which coating material is applied for the determination of the transfer efficiency

3.11
test method 1
indirect method in which the mass of coating material delivered by the atomiser is determined from the fluid flow volume. It can be done by measurement with a fluid flow meter or by calculation from gravimetric measurement. The atomiser spray pattern is fully developed before it reaches the edge of the test sheet and is maintained constant over the test width

3.12
test method 2
direct method in which the mass of coating material delivered by the atomiser within the test sheet dimensions, is determined gravimetrically (by weighing). The atomiser is triggered on and off within the test sheet dimensions

3.13
transfer efficiency
defined as the ratio of the mass of coating material solids deposited on an object to the mass of coating material solids atomised, expressed as a percentage

4 Principle of test

The transfer efficiency of atomising and spraying equipment is determined by measuring directly or indirectly the mass of coating material solids delivered by the atomiser and the mass of dry coating material deposited on the test sheet.

5 Test procedure

The test procedure defines the steps to be carried out in the determination and the conditions under which the test is conducted as well as the minimum reporting requirements.

A transfer efficiency determination for a particular atomiser consists of at least three independent and consecutive tests of the transfer efficiency under the same conditions.

The atomiser transfer efficiency, under the prevailing conditions, is reported as the mean of the values obtained. If an individual test result differs from the mean value by more than +/- 1% the cause of the variation should be investigated and the determination repeated.

Step	Action	Reference
1	Record details of atomising and spraying equipment to be tested.	Use the form structure in annex C for recording data.
2	Record details of coating material to be used for transfer efficiency test.	see 6.2.1
3	Sample coating material for the test, thin and/or mix according to coating material manufacturer specification. Record preparation details.	see 6.2.2
4	Determine and record coating material solids content, viscosity and density.	see 6.2.2
5	Set up the test rig to configure the atomiser, panel and sheet.	see 6.4
6	Set atomising and spraying equipment to required settings.	see 6.5.2
7	Determine and record atomising and spraying equipment dynamic parameters and coating material characteristics. Measure the coating material flow rate and spray characteristics. Record coating material and air flow rate, atomiser stroke or test sheet traverse speed, to obtain required film thickness and the minimum/maximum dimensions of the spray pattern.	see 6.5, 6.6 and 6.7.
8	Clean, dry and weigh the test sheets. Indelibly label test sheets and record identification numbers and weights.	see 6.3
9	Measure and record test environmental conditions.	see 6.1
10	Re-determine coating properties (as necessary).	
11	Clean atomising and spraying equipment. Charge with coating material and measure coating material temperature. Set equipment parameters and mount in the test rig.	
11a	Method 1: Determine fluid flow rate	see 6.5.3
11b	Method 2: Measure and record initial weight of atomiser and coating material.	see 6.10
12	Mount test sheet on background panel and assemble in the test rig.	see 6.3 and 6.4
13	Apply coating material to the test sheet. Record coating material temperature, application period for each test sheet and the distance between fluid outlet and test sheet.	see 6.6
14	Remove the test sheet from the background panel taking care to avoid loss of coating material.	
15	Dry/stove the applied coating film. Record drying/curing temperature and time.	see 6.8
16	Allow the test sheet to cool to ambient temperature under clean dry conditions. Weigh the dry coated test sheet and record weight. The mass of deposited solids is the difference in the weights of the coated and uncoated test sheet.	
17a	Method 1: Check coating material flow rate	see 6.5.3
17b	Method 2: Weigh atomising and spraying equipment.	see 6.10

	Record the weight.	
18	Check spray pattern uniformity. Record observations and film thickness.	
19	Repeat steps 11 to 16 twice.	
20	Re-measure test environmental conditions and atomiser settings. Record variations from initial conditions. Repeat test if conditions are outside parameter tolerance.	
21	Measure and record properties of coating used for the test. Repeat test if conditions are outside parameter tolerance.	
22	Calculate transfer efficiency for each test.	see clause 7 and annex B.
23	Prepare test report.	see annex C.

6 Test and measurement methods

6.1 Test environment

The transfer efficiency determination shall be made with temperature and relative humidity measured and recorded, observing any coating materiel manufacturer recommendations.

All materials and equipment used shall be equilibrated at the test conditions.

The following internal spray booth conditions shall be measured and recorded in the test report.

¾ air temperature,

¾ barometric pressure,

¾ relative humidity,

¾ air velocity and direction measured halfway along the axis of the atomiser fluid flow between the atomiser and test sheet.

6.2 Determination of coating material physical properties

6.2.1 Manufacturers data

The details of the coating material used in the test shall be recorded in the test report, such as, but not limited to:

¾ manufacturer / supplier,

¾ function (e.g. primer, basecoat, clearcoat etc.),

¾ type (e.g. 1-k, 2-k, UV-lacquer etc.),

¾ suppliers description, code number, batch number, colour;

¾ at multi-component lacquer additional mixing ratio and pot life.

6.2.2 Measured data

All properties identified in the following clauses shall be reported in the test report.

6.2.2.1 General

Samples of the coating material to be used for transfer efficiency testing shall be obtained and prepared in the manner set out in EN ISO 1513 and EN 21512.

6.2.2.2 Preparation and mixing

The coating material used in the test shall be prepared and mixed in the manner specified by the coating material manufacturer. All test coating materials shall be stored in sealed containers. The coating material(s) shall be well mixed and equilibrated at the ambient temperature specified in 6.1.

The age of a mixed multi-component coating material used for the test purpose shall not exceed 50% of the shelf life.

6.2.2.3 Solid content

The solid content of the coating material shall be determined according to EN ISO 3251, using test conditions as appropriate for the coating material under test.

A coating material manufacturers stoving (drying) schedule is permitted where the EN ISO 3251 temperature/time is inappropriate. Where a coating material manufacturer's schedule is used this shall be recorded in the test report.

6.2.2.4 Coating density, where applicable

Coating material density shall be determined according to ISO 2811.

6.2.2.5 Coating viscosity, where applicable

Coating material viscosity shall be determined according to EN ISO 2431 (flow cup), ISO 2884 (cone and plate) or EN ISO 3219 (rotary viscometer).

6.2.2.6 Coating material conductivity / resistivity, where applicable

The coating material conductivity / resistivity is to be determined according to ISO 9944.

6.3 Test sheet and background panel

6.3.1 Dimensions and preparation

The test sheet is a piece of aluminium foil (proposed thickness gauge 25 to 50 m). The length l of the test sheet shall be at least 1.5 times the spray fan pattern with the atomiser to test sheet distance set at the manufacturer's recommendation.

The test sheet shall be free of grease, oil, moisture and dirt. Cleaning can be achieved by methods, such as, but not limited to, solvent wipe or tack rag, ultrasonic wash bath or thermal treatment. The test sheet shall be equilibrated at the test temperature before conducting the test.

Method 1:

The minimum dimensions of the test sheet are 400 mm x 1200 mm (width b x length l). The width B of the background panel shall be 1600 mm minimum longer than the test sheet and in minimum the same length L as the test sheet.

Method 2:

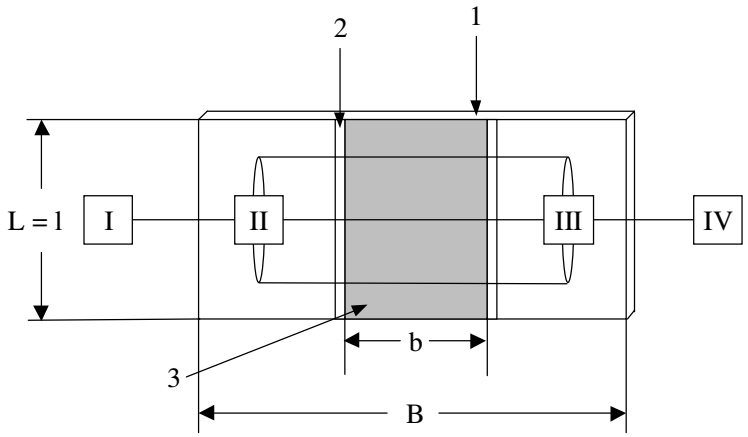
The minimum dimensions of the test sheet are 800 mm x 300 mm (width b x length l). The background panel shall have the same size as the test sheet.

6.3.2 Test sheet mounting

The test sheet shall be mounted on a rigid, conductive and grounded background panel such that it is flat and free from wrinkles.

Method 1:

The test sheet shall be attached to the background panel using adhesive tape in such manner that no gap exists between the test sheet and the background panel, and that the test sheet is centred on the background panel, see figure 1.



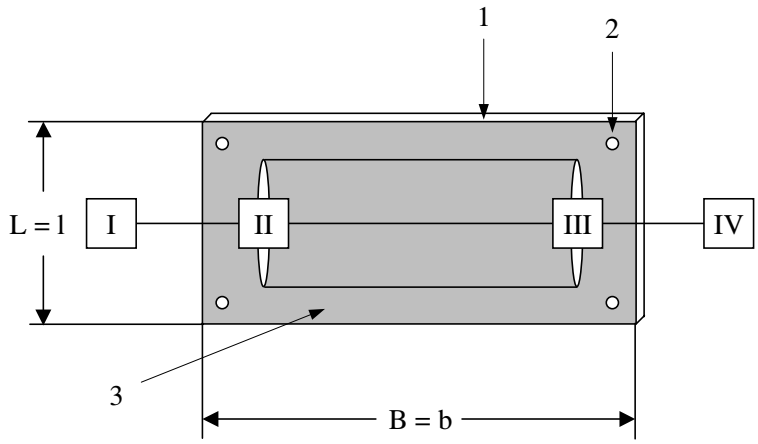
Key

1 Background Panel
2 Adhesive Tape
3 Test sheet

I = Atomiser starts moving
II = Atomiser starts spraying
III = Atomiser stops spraying
IV = Atomiser stops moving

Figure 1 —Test Method 1

Method 2:
The test sheet is held on the background panel by spring clips or magnets, see figure 2.



Key

1 Background Panel
2 Magnetic clip
3 Test sheet

I = Atomiser starts moving
II = Atomiser starts spraying
III = Atomiser stops spraying
IV = Atomiser stops moving

Figure 2 —Test Method 2

6.4 Test rig configuration

6.4.1 Test rig location

The transfer efficiency test shall be carried out in a totally enclosed spray booth conforming to the air velocity values set out in prEN 12215 and prEN 13355.

The test rig shall position the test sheet face vertically, centred in the spray booth with minimum distances of 1 m of spray booth walls, floor and ceiling. The air flow direction shall be parallel to the test sheet surface.

6.4.2 Atomiser - Test piece orientation and separation distance

The axis of the atomiser fluid flow shall be maintained perpendicular to the face of the test sheet. The distance between the atomiser fluid outlet and the face of the test sheet shall be maintained at the atomiser manufacturer's recommended target distance.

Method 1:

Coating material application to the test sheet shall be carried out using an automatic device with constant stroke speed for either the atomiser or the test sheet.

Method 2:

Coating material application to the test sheet can be carried out by manually moving the atomiser over the test sheet face or by using an automatic device moving either the atomiser or the test sheet.

6.5 Atomiser characteristics

6.5.1 General

The following atomising and spraying equipment details shall be presented in the test report:

- manufacturer,
- model / serial number,
- atomiser type (pneumatic, HVLP, airless, air assisted airless),
- nozzle size, where applicable,
- air cap designation, where applicable,
- inlet air pressures respectively inlet air flow volumes, where applicable,
- fluid flow rate,
- fluid pressure, where applicable,
- distance between atomiser fluid outlet and test sheet,
- coating material and atomising air temperatures measured at the inlet of the atomising and spraying equipment if these differ from ambient temperature,
- rotation speed and pattern shaping air flow, where applicable,
- electrostatic control method and the applied voltage and current, where applicable.

All these parameters shall be measured under application conditions.

6.5.2 Atomiser set up

The atomiser shall be set up according to the coating material and atomiser manufacturer's stated instructions for the coating material being applied or those otherwise specified for the test. The settings shall be those required to give an acceptable coating finish quality, see 6.7.

6.5.3 Determination of coating material flow rate (method 1)

The coating material flow rate shall be determined with the atomiser set up for the transfer efficiency test. The flow rate shall be determined before and after the transfer efficiency test. The flow rate shall be determined gravimetrically or volumetrically as appropriate.

- Gravimetric determination:
  Weigh the atomiser and coating material container to 0.01 g. Trigger the atomiser for 15 s. Re-weigh the atomiser and container. Record the weight and by difference determine the mass delivered in the 15 s period. The flow rate in g/min is obtained by multiplying the mass by four (4). Repeat the test. The atomiser flow rate is the mean of the two values.

- Volumetric determination:
  The flow rate or mass flow rate is read directly when using a calibrated in line fluid flow meter (for precision required see Annexe A). The flow rate is taken when a steady reading is obtained and the atomiser fan pattern is fully developed. The spray gun shall have the same settings as for spraying the test sheet.

6.6 Application of the coating material to the test sheet

Method 1:
Coating material shall be applied to the test sheet in a single stroke along the horizontal centre line of the test sheet. The atomiser spray pattern shall be fully developed before it reaches the edge of the test sheet and shall be maintained constant over the sheet width.

The application time is determined by dividing the test sheet width by the travel speed.

Method 2:
Coating material shall be applied to the test sheet in a single stroke along the horizontal centre line of the test sheet. The atomiser shall be triggered on and off within the sheet dimensions.

6.7 Coating finish quality and performance

The coating material shall be applied to a standard of finish acceptable to the industry sector in which the atomising or spraying equipment is to be used.

6.8 Coating film drying / curing

Following application of coating material to the test sheet the coating material shall be dried/stoved under the same time/temperature conditions as used for the determination of solid content, see 6.2.2.3.

The drying schedule used for the test shall be recorded.

The oven shall be a size suitable to accommodate the test sheet and to meet the performance requirements of EN ISO 3251.

6.9 Determination of coating material mass

The mass of un-coated and coated test sheets shall be determined using a balance with a resolution of 0,001 g.

The coating material mass is the mass difference between un-coated and dried coated test sheets.

6.10 Determination of mass of coating material delivered by the atomiser

Volumetric method:

For a volumetric flowmeter the mass of coating material delivered by the atomiser is determined from the product of the coating material flow rate (6.5.3), the material density and the application (stroke) time (6.6)

For a mass flow meter the mass of coating material delivered by the atomiser is determined from the product of the coating material mass flow rate (6.5.3) and the application (stroke) time (6.6)

Gravimetric method:

The mass of coating material sprayed by the atomiser can be obtained directly by weighing the atomiser, its container and contents prior to the spray test and substracting the weight of the same items after the test.

7 Calculation

The transfer efficiency is defined as:

$$_{TE} = \frac{m_{d}}{m_{a}} \quad 100 \quad \% \qquad (1)$$

where:

$_{TE}$ transfer efficiency, %
m_a coating solids atomised, g
m_d coating solids deposited on the substrate, g

Method 1:
The mass of coating material solids atomised is determined from the mass flow of the coating material:

$$m_a = \dot{m}_c \quad t_t \quad \frac{S_w}{100} \qquad (2)$$

$\dot{m}_c$ mass flow of coating, g/s

$\dot{m}_c = \dot{V}_c$

where:

$\dot{V}_c$ coating volume flow, ml/s

coating density, g/ml

S_w is the solids content of coating, wt%

t coating application (test) time, s

$$t = \frac{b}{r}$$

where:

v_r speed of stroke, mm/s

b width of test sheet, mm

The mass of coating solids deposited m_d is determined by weighing the dry film applied to the test sheet.

$m_d = m_{d2} \quad m_{d1} \qquad (3)$

M_{d1} mass of test sheet, g

M_{d2} mass of test sheet and dried coating material, g

The transfer efficiency is given by:

$$TE = \frac{(m_{d2} \quad m_{d1}) \quad 10000}{\dot{m}_c \quad t \quad S_w} \qquad (4)$$

From the above equations 1 - 4 the transfer efficiency is calculated from:

$$TE = \frac{(m_{d2} \quad m_{d1}) \quad r \quad 10000}{\dot{m}_c \quad b \quad S_w} = \frac{(m_{d2} \quad m_{d1}) \quad r \quad 10000}{\dot{V}_c \quad b \quad S_w}$$

Method 2:

The mass of coating material solids atomised is determined weighing initial and final mass of the coating material container:

$$m_a = (m_1 \quad m_2) \quad \frac{S_w}{100} \qquad (2a)$$

where:

m_1 = Initial mass of container and coating material, g

m_2 = Final mass of container and coating material, g

S_w = solids content of the coating material, wt %

The mass of coating material solids deposited m_s is determined by weighing the dry film applied to the test sheet:

$$m_d = m_{d2} \quad m_{d1} \qquad (3a)$$

where:

m_{d1} mass of test sheet, g

m_{d2} mass of test sheet and dried coating material, g

From the above equations 2a –3a the transfer efficiency is calculated from:

$$TE = \frac{(m_{d2} \quad m_{d1}) \quad 10000}{(m_1 \quad m_2) \quad S_w} \qquad (4a)$$

8 Test report

To comply with this European standard a quoted value of transfer efficiency should be supported by a test report. The report shall contain the following information:

¾ the method, by which the transfer efficiency was determined (method 1 or method 2);

¾ the transfer efficiency value and the test / intermediate data used in its determination;

¾ a full description of the atomiser tested to include the settings under which the test was made and performance tests conducted on them;

¾ a full description of the coating materials used in the test and the results of the tests performed on them;

¾ a full description of the coating material application conditions including the results of tests to determine them;

¾ a description of any variations from the standard test procedure and the reasons for such variations.

Forms for recording the test data to be included in the report are presented in annex C.

9 Accuracy

The estimated systematic error of method 1 (indirect method) is 5% of the quoted percentage transfer efficiency.

The estimated error of method 2 (direct method) is 2% of the quoted percentage efficiency.

This takes into account the accuracy of the single steps as indicated in annex A as well as all indirect parameter measurements (volume flows of air etc.).

Annex A
(normative)

Measurement tolerances

Parameter	Precision	Applicable to test method
Solid content of coating material: weighing	1%	1 and 2
Drying / curing temperature : time	± 2° C : ±1 min.	1 and 2
Coating material mass flow rate	± 2%	1
Mass of coating material solids atomised	± 0.01g	1 and 2
Time of application	± 1% of specified value	1
Coating material deposit: weighing	± 0.01g	1 and 2
Angular positioning of atomiser axis to test sheet	$90^0 \pm 2^o$	1 and 2
Test sheet width	± 1 mm	1 only
Gun to test sheet distance	± 1mm	1 and 2
Atomiser air volume flow	± 5% of specified value	1 and 2
Fluid pressure (hydraulic atomiser) measured at the gun inlet	± 5% of specified value	1 and 2
Speed of movement (gun mover, robot or conveyor)	± 1% of specified value	1 only
Rotation speed	± 1% of specified value	1 and 2
Electrostatic voltage or current	± 5% of specified value	1 and 2

Annex B
(informative)

Example calculations

Method 1:

Mass of un-coated foil m_{d1}	70,86 g
Mass of coated and cured foil m_{d2}	76,26 g
Solids deposit m_d	5,4 g
Speed of stroke v_r	200 mm/s
Width of test sheet *b*	400 mm
Application time *t*	2s
Volume flow of coating material $\dot{V}_c$	7,5 ml/s
Density of coating material	1,303 g/ml
Mass flow of coating material $\dot{m}_c$	9,7 g/min
Solid contents S_w	44%

$$_{TE} = \frac{(m_{d2} \quad m_{d1}) \quad _r \quad 10000}{\dot{m}_c \quad b \quad S_w} = \frac{(m_{d2} \quad m_{d1}) \quad _r \quad 10000}{\dot{V}_1 \quad b \quad S_w} = \frac{(76{,}26 \quad 70{,}86) \quad 200 \quad 10000}{7.5 \quad 1.303 \quad 400 \quad 44}$$

Transfer efficiency $_{TE}$ 62,7 % 5 (i.e. 59,57 - 65,84

Method 2:

Mass of un-coated foil m_{d1}	142,20 g
Mass of coated and cured foil m_{d2}	155,69 g
Solids deposit m_d	13,49 g
Initial coating material container mass m_1	313,63 g
Final coating material container mass m_2	265,00 g
Solid contents S_w	44%

$$_{TE} = \frac{(m_{d\,2} \quad m_{d\,1}) \quad 10000}{(m_1 \quad m_2) \quad Sw} = \frac{(155{,}69 \quad 142{,}20) \quad 10000}{(313{,}63 \quad 265{,}00) \quad 44}$$

Transfer efficiency $_{TE}$ 63 % 2% (i.e. 61,64 – 64,26)

Annex C
(content and structure normative; lay-out informative)
Test summary form for flat panel coating

Determination of the transfer efficiency according		EN 13966-1:2003 (E) used Method 1	Method 2
Spray booth conditions:	see 6.1	**Atomiser characteristics:**	see 6.5.1
Air temperature	° C	Manufacturer	
Barometric pressare	kPa	Model	
Relative humidity	%	Type	
Test sheet dimension	mm	Serial number	
Air velocity	m/s	Nozzle size	
Air direction		Air cap designation	
Coating physical properties:	see 6.2.1	Inlet air pressure (gauge)	kPa
		respectively inlet air volume flows	l/min
Manufacturer/supplier		Fluid flow rate	ml/min
Type		Fluid pressure (gauge)	kPa
Batch number		Inlet coating material temperature	°C
Colour		Inlet atomising air temperature	°C
Base		Distance between atomiser fluid outlet and test sheet	mm
Thinner		Stroke speed	mm/s
Hardener		**Rotating Atomiser:**	
Mixing ratio		Rotation speed	rpm
Density	g/cm^3	Diameter bell	mm
Viscosity		**Electrostatic supported Atomiser:**	
Solids content	mass %	Electrostatic high voltage/current	V/mA
Coating material temperature	° C	Constant voltage	Constant current
Resistance or conductivity	or 1/	Type: nozzle bell high rotation	

Determination of coating material atomised			
a) Gravimetric determination:		b) Volumetric determination:	
Weight of atomiser[1)]	g	Weight of the empty container	g
Weight of coating material container [1)]	g	Re-weight of the container after spraying	g
Re-weight of atomiser	g	Flow rate	ml/min
Re-weight of coating material container	g	or:	
Mass difference of atomiser	g	Measured flow rate by flow meter	ml/min
Mass difference of coating material container	g	Accuracy class of flow meter	%
Coating drying/curing:			
Drying temperature	° C		
Drying time	min		

Transfer efficiency: $_{TE}$ = _____ %

1) See 6.10

Bibliography

prEN ISO 2808, *Paints and varnishes - Determination of film thickness.* (ISO 2808:1997)

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