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Termisk sprutning – Acceptanskontroll av utrustning för termisk sprutning –
Del 5: Lågt tryck och kontrollerad atmosfär

Thermal spraying – Acceptance inspection of thermal spraying equipment –
Part 5: Plasma spraying in chambers

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Europastandarden EN 1395-5:2018 gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av EN 1395-5:2018.

Denna standard ersätter SS-EN 1395-5:2007, utgåva 1.

The European Standard EN 1395-5:2018 has the status of a Swedish Standard. This document contains the official version of EN 1395-5:2018.

This standard supersedes the SS-EN 1395-5:2007, edition 1.

Upplysningar om sakinnehållet i standarden lämnas av SIS, Swedish Standards Institute, telefon 08-555 520 00. Standarder kan beställas hos SIS som även lämnar allmänna upplysningar om svensk och utländsk standard.

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Denna standard är framtagen av kommittén för AGS 448 Termisk sprutning, SIS/TK 134/AG 08.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1395-5

August 2018

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Supersedes EN 1395-5:2007

English Version

Thermal spraying - Acceptance inspection of thermal spraying equipment - Part 5: Plasma spraying in chambers

Projection thermique - Contrôle d'acceptation du matériel de projection thermique - Partie 5 : Projection au plasma en chambre

Thermisches Spritzen - Abnahmeprüfungen für Anlagen zum thermischen Spritzen - Teil 5: Plasmaspritzen in Kammern

This European Standard was approved by CEN on 9 April 2018.

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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 CEN-CENELEC Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (EN 1395-5:2018) has been prepared by Technical Committee CEN/TC 240 "Thermal spraying and thermally sprayed coatings", 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 February 2019, and conflicting national standards shall be withdrawn at the latest by February 2019.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1395-5:2007.

In comparison to the previous edition EN 1395-5:2007, the following technical changes have been made:

a) normative references were updated;

b) added a clause regarding the determination and the assessment of leakage rate;

c) added in Annex B an example for calculation of leakage rate

EN 1395 series consists of the following Parts, under the general title *Thermal spraying — Acceptance inspection of thermal spraying equipment*:

— *Part 1: General requirements;*

— *Part 2: Flame spraying including HVOF;*

— *Part 3: Arc spraying;*

— *Part 4: Plasma spraying;*

— *Part 5: Plasma spraying in chambers;*

— *Part 6: Manipulator systems;*

— *Part 7: Powder feed systems.*

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies requirements for the acceptance inspection of thermal spraying equipment, in this case the pressurized part only for low pressure and controlled atmosphere plasma spraying, used in spray jobs to produce thermally sprayed coatings of reproducible quality.

This part is intended to be used in conjunction with EN 1395-1, which includes general requirements and explanations of procedures.

The plasma spraying system itself is intended to be acceptance inspected according to EN 1395-4.

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.

EN ISO 14917, *Thermal spraying - Terminology, classification (ISO 14917)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 14917 and the following 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

3.1
final pressure
asymptotically approached value that the pressure reaches in a closed flanged vacuum pump system at usual operating conditions and without further gas inlet

3.2
degassing
gaseous de-sorption which can be accelerated by physical processes, e.g. by evacuation, heating

3.3
vapour de-sorption
spontaneous evaporation as the decreasing pressure depresses the boiling point to the ambient temperature

3.4
gas ballast of a vacuum pump
<vacuum pump> controlled admission of an amount of gas, in general into the compression room of a vacuum pump to avoid or minimise the condensate formation within the vacuum unit

3.5
gas load
total mass flow rate that is applied into the vacuum system

Note 1 to entry: Formula: $p \times V/t$. The unit is mbar l s^{-1}.

3.6
leak
leakiness within the system caused by material or processing faults or wrong handling of seals

Note 1 to entry: A leak can occur in the chamber or at joint elements.

3.7
leakage rate
Q_L
gas flow rate of a leak

Note 1 to entry: Formula: $p \times V/t$. Q_L depends on the pressure difference and the temperature. The unit is 1 Pa m^3 s^{-1} = 1 × 10 mbar l s^{-1}.

3.8
suction rate
flow rate of the gas pumped out of the system

Note 1 to entry: Formula: $p \times V/t$. The unit is 1 Pa m^3 s^{-1} = 1 × 10 mbar l s^{-1}.

3.9
controlled atmosphere
atmosphere inside the chamber used for thermal spraying where the pressure is maintained within small tolerances

4 Principles of acceptance inspection

4.1 General

5.1 to 5.4 reveal state of the art technology in thermal spraying equipment. The minimum requirements to achieve a stable parameter setting and maintenance are given in Annex A.

4.2 Typical components

A low pressure plasma spraying system contains the following components:

— vacuum pumping unit;

— vacuum chamber;

— manipulator systems;

— plasma spraying equipment.

5 Procedure for acceptance inspection of vacuum components

5.1 General

All values mentioned in 5.2 are valid for a new and clean system only.

The acceptance inspection of the low pressure system is divided into the acceptance test of the vacuum pumping unit and of the vacuum chamber.

5.2 Low pressure performance of the pump station

For the acceptance test of the vacuum pumps the pump system is to be separated from the chamber mechanically or locked by means of a vacuum slide valve.

The evacuation time from atmospheric pressure to 1 mbar is regarded as an acceptance criteria. This time period for the separated pumping unit shall not exceed 5 min. Subsequently the final vacuum of the pumping system is checked. With this, a value lower than 5×10^{-3} mbar (0,005 mbar) shall be reached, depending on the type of pump unit, within a period of 30 min if nothing else is specified among the contracting parties.

5.3 Low pressure performance of the chamber

5.3.1 Preparation

The chamber volume should be determined according to its internal geometric dimensions.

The complete system is consequently tested without the internal set-up inside the chamber (e.g. manipulator). In order to carry out the vacuum tests it is necessary to maintain the chamber in a condition that is free of dust and any contamination. Therefore, the system should be evacuated for a longer time period to minimize pollutions (e.g. removal of de-sorptions of steam and air molecules adsorpted on the chamber walls). Ventilation is recommended to flood the chamber with argon gas while pumping.

During the evacuation tests the chamber should be opened for a time period (5 min maximum) to simulate charging of parts to be sprayed. Then, the chamber door sealing is to be cleaned and the system is to be evacuated. The time period for evacuating from atmospheric pressure to 1 mbar should not exceed 15 min. This value is only valid for a chamber in the new condition. Any pollutants by spray material deposits can influence this value significantly. Subsequently the leakage rate of the complete system has to be determined.

5.3.2 Determination of the leakage rate (Q_L)

a) The chamber should be evacuated to less than 5×10^{-2} mbar (0,05 mbar). This should not take longer than 30 min.

b) The valve – if applicable – between the vacuum chamber and the vacuum pumping system shall be closed.

c) For determination of the leakage rate, the vacuum pump system shall be switched off and the pressure rise in the chamber, as well as in the pump system shall be measured.

d) For the determination of the leakage rate for a comparable value without the influence of gas pollution~~s~~ and de-sorption, it is recommended to start the leakage rate determination not earlier than 30 min after switching off the vacuum pumps.

e) The increase of the chamber pressure shall be measured in small time intervals (normally 10 s) over a longer period.

f) The time range of 60 min for the determination of the leakage rate is sufficient. The pressure drop should be observed and recorded by suitable means e.g. pressure gauge and stop watch (use of X/Y printer, PC control unit are recommended). For details, see Annex B.

g) The pressure rise per time (e.g. in Pa/s or mbar/s) is determined by the gradient of the received curve.

h) The leakage rate Q_L is determined by the multiplication of the pressure rise per time and the determined volume of the vacuum chamber, see Formula (1).

$$Q_L = (p_{90} - p_{30}) \times V / t \quad (1)$$

where

- p_{30} is the pressure in mbar 30 min after stopping the pump;
- p_{90} is the pressure in mbar 90 min after stopping the pump;
- V is the volume of chamber in litre;
- t is the time range 60 min = 3 600 s.

Annex B includes a diagram for the chronological sequence of the pressure change and an example for the calculation of the leakage rate.

5.3.3 Assessment of leakage rate

Depending on the type, size and number of vacuum flanges, pipe connections and valves each vacuum system has its own theoretical leakage rate. Also pressure and gas sensors as well as other measuring systems connected to the chamber interface cause a leakage rate. By summing the leakage rates of all these components, a total theoretical leakage rate can be calculated.

Furthermore, the types of seals shall be considered for the leakage rate. In the case of plasma arc spraying in vacuum chambers, the chambers often consist of stainless steel and appropriate seals shall be used.

This information allows assessment of the technically possible leak tightness of an apparatus after build-up of the vacuum system.

In particular cases it is recommended that the maximum allowed leakage rate of a vacuum system should be agreed by the contracting parties.

A system with a good leak tightness would have $Q_L < 1$ mbar l/s.

5.4 Function test

For the function test of the complete system with the internal set-up inside the chamber (e.g. manipulator) it has to be evacuated to a pressure of 5×10^{-2} mbar (0,05 mbar). This evacuation time typically does not exceed 30 min. Subsequently, the plasma spray system is started with argon gas after ventilation with argon to a suitable plasma pressure greater than 5 mbar.

To check the requirements concerning controlled atmosphere conditions the constant pressure regulation under spraying conditions are to be determined for 50 mbar, 100 mbar, 150 mbar, 200 mbar and 250 mbar chamber pressure experimentally.

The maximum deviations from the adjusted chamber pressure are as follows:

— 10 mbar to 200 mbar: ± 5 mbar;

— 200 mbar to 500 mbar: ± 10 mbar.

During acceptance inspection of the automatic chamber pressure control, the plasma gas flow rate through the gun shall be set to various values in order to check the function of the automatic pressure control system.