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

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

Projection thermique - Contrôle d'acceptation du matériel de projection thermique - Partie 5: Projection plasma sous enceinte

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Foreword

This document (EN 1395-5:2007) 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of an identical text or by endorsement, at the latest by July 2007, and conflicting national standards shall be withdrawn at the latest by July 2007.

This document together with EN 1395-1, 1395-2, 1395-3, 1395-4, 1395-6 and 1395-7 supersedes EN 1395:1996.

EN 1395 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 organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

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

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

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

2 Normative references

The following referenced documents are indispensable for the application 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 657:2005, *Thermal spraying — Terminology, classification*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 657:2005 and the following apply.

3.1
final pressure
<vacuum pump> 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 $p \times Vlt$ flow that is applied to the vacuum system

NOTE The unit is mbar l s^{-1}.

3.6
leaks
leakiness within the system caused by material or processing faults or wrong handling of sealings

NOTE A leak can occur in the camber or at joint elements.

3.7
leakage rate
LR
$p \times Vlt$ flow for gas by a leak

NOTE LR 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 power
$p \times Vlt$ flow of the gas pumped out of the system

NOTE 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 kept constantly or in 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 and the minimum requirements concerning a stable parameter setting and maintenance 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 the following clause are valid for a new and clean system only. For the acceptance test period the filter elements shall be taken out.

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 set-up, 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 has to be determined according to internal geometrical 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 minimise 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.

Applying the evacuation tests the chamber should be opened for a time period of max. 5 min 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 onto 1 mbar should not exceed 15 min. This value is only valid to 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. Identical preparations are to be applied as for the acceptance test of the pumping unit.

5.3.2 Leakage rate

The chamber pressure should amount to at least 5×10^{-2} mbar (0,05 mbar) after 30 min evacuation time. For determination of the leakage rate, the vacuum pump system has to be switched off and the pressure rise in the chamber, as well as in the pump system shall be measured.

5.3.3 Determination of the leakage rate (LR)

For the determination of the leakage rate for a comparable value without the influence of the rest of the gas pollutions and de-sorption, it is recommended to start the leakage rate determination not before 30 min after switch off the vacuum pumps. The time range of 1 h 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).

$$LR = (p_{90} - p_{30}) \times C_{vol} / T \quad (1)$$

where

p_{30} is the pressure after 30 min pump stopping;

p_{90} is the pressure after 90 min pump stopping;

C_{vol} is the volume of chamber;

T is the time range 60 min = 3 600 s.

Subsequently, the complete system is tested, inclusive of all internal settings (e.g. manipulator, robot, gun), with regard to the evacuation times.

The leakage rate for the complete system including the internal settings and with the chamber locked from the pumping unit shall not exceed 6×10^{-3} mbar l s^{-1} (0,006 mbar l s^{-1}).

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 shall not exceed 30 min. Subsequently, the plasma system is started with argon gas after ventilation with argon to a suitable plasma start 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 deviation of the adjusted chamber pressure can be tolerated as follows:

— 10 mbar to 200 mbar: ± 5 mbar;

— 200 mbar to 500 mbar: ± 10 mbar.

Applying acceptance inspection of the automatic chamber pressure control the plasma gas flow through the gun is to vary specifically.

6 Designation

Acceptance inspection of the thermal spraying equipment for plasma spraying in cambers shall be designated as follows:

Acceptance inspection according to EN 1395-5.

7 Inspection report

An example for the inspection report is given in Annex A.