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Thermal spraying - Recommendations for constructional design of components with thermally sprayed coatings

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Thermal spraying - Recommendations for constructional design of components with thermally sprayed coatings

Projection thermique - Recommandations sur la conception des assemblages d'éléments comportant un revêtement déposé par projection thermique

Thermisches Spritzen - Empfehlungen zum konstruktiven Gestalten von Bauteilen mit thermisch gespritzten Schichten

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

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Foreword

This document (prEN 15520:2006) has been prepared by Technical Committee CEN/TC 240 “Thermal spraying and thermally sprayed coatings”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

Introduction

Thermal spraying is applied to improve the surface properties of work pieces in order to for example to increase the wear resistance, the electrical conductivity or the electrical resistance, to achieve corrosion resistance for the pertinent service conditions, to improve sliding behaviour or, to provide heat insulation a. o. Recommendations for thermal spraying are contained in EN 14616.

1 Scope

This European Standard applies for thermal spray coatings. It contains basic recommendations for the design of components, which have to be completely or partially coated. The recommendations apply for new manufacturing as well as for repair of worn components. The coating may be of metallic, metal-ceramic, oxide-ceramic or plastics.

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 14665, *Thermal spraying — Thermally sprayed coatings — Symbolic representation on drawings*

prEN 15311, *Thermal spraying — Components with thermally sprayed coatings — Technical supply conditions*

EN ISO 12944-3, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 3: Design considerations*

EN ISO 14920, *Thermal spraying — Spraying and fusing of self-fluxing alloys*

EN ISO 14921, *Thermal spraying — Procedures for the application of thermally sprayed coatings for engineering components*

EN ISO 14924, *Thermal spraying — Post-treatment and finishing of thermally sprayed coatings*

3 Applications and specific properties of thermally sprayed coatings

Due to their structure, thermally sprayed coatings possess properties which markedly distinguish them from solid materials. An appropriate basic structural design and a suitable parent metal have to bear the loading. Usually, thermally sprayed coatings do not increase the strength of the parent work piece.

Some process related specialities and specific properties of thermally sprayed coatings are summarised in Table 1.

Table 1 — Process related specialities and specific properties of thermally sprayed coatings

Process related specialities	Specific properties of thermally sprayed coating
Components made of nearly every material can be coated by thermal spraying.	Not each spraying procedure can be used rich in meaning for all applications.
—	If the coating is not post heat treated the bond strength only depends on adhesive properties.
Coatings with properties completely different to the parent metal are possible.	—
Coatings can be sprayed with different spray materials side by side, one upon another, or flowing into one another (graded coatings).	The residual stress in the coating rises with increasing coating thickness.
The heat input caused by spraying is so low, that no structural transformation or deformation will occur.	The heat input by fusing self-fluxing alloys or diffusion annealing may cause structural transformation or deformation.
The ability to apply the spray process is practically independent of the size of the component.	Limits exist regarding geometrical dimensions, e. g. in case of inner side coatings or holes with too small an inner diameter.
Components with complicated forms can be coated, if appropriate spray equipment is used.	Spray coatings are susceptible to edge loading, point and line loading and impact stresses if not thermally post treated.
Areas of a component, which shall be free of sprayed material can be protected, e. g. by masking.	—
The untreated surface of the coating provides a good basis for painting or sealing.	—
Several thermal spray processes can be applied in a workshop or on site.	—
Spray coatings can be carried out with the desired porosity for thermal barrier coatings.	Sprayed coatings are micro porous.

4 Basic rules for design of components with thermally sprayed coatings

If, certain prerequisites are considered regarding constructional design for thermally sprayed coatings, adequate bond strength values, the desired coating structure, mechanical, chemical, physical or electrical properties of the spray coating can be achieved.

All arguments mentioned for thermal spraying shall also apply for pre-treatment, blasting, post-treatment, and visual testing in comparable sense.

Further design instructions for specific applications are contained in EN ISO 14921 and EN ISO 17834 and for protection of steel structures against corrosion EN ISO 12944-3 and EN ISO 14713 and EN ISO 2063 which deals with evaluation of coating material, processing, testing and gives recommendations for coating thickness for several corrosive conditions.

The most important rules for the design are summarised in Table 2.

Table 2 — Basic rules and arguments

Basic rules	Arguments — Explanations
Sufficient accessibility of the area to be coated.	Procedure, spray gun with its electrical and/or gas connections, required spray distance and spray angle shall be considered.
Area to be coated shall be visible and attainable.	Visible and within reach for the practitioner or the manipulator.
Sharp edges are to be avoided.	Usually they cannot be sufficiently coated, with a sufficient and uniform coating thickness. Coatings may be damaged on sharp edges. Sharp edges on holes and along of cut edges shall be chamfered or rounded.
Small radii are to be avoided.	Turbulence of the spray jet, unfavourable angles of incidence, and irregular rebounding spray particles will occur which will lead to insufficient bond strength and density.
Spray coatings in narrow holes or in blind holes are to be avoided.	Turbulence and spray particles which are insufficiently adherent to the wall may occur.
The spray jet should hit the surface right-angled. The angle of incidence may not undergo 45° at all.	Insufficient spray angles impair bond strength, efficiency, and coating structure. See Figures 4a and 4b.
To avoid spalling of the coating.	The coating shall be pulled around rounded or chamfered edges. See Figures 6a and 6b.
To minimise the risk of damaging the coating.	A support edge or pocket (e. g. per Figure 9 detail X) may be employed.
Welds to be coated shall be free of splatters, undercuts and pores.	Smoothing of such irregularities shall be required.

5 Design for preparation of components and work pieces for pre-treatment for thermal spraying

When components or work pieces shall be coated partially only and the coating shall be chip cut afterwards the most important part of the machining to finished size shall be carried out after spraying the coating. When manufacturing rotationally symmetrical components the blank should be pre-machined only in the area to be sprayed to the diameter appropriate for the coating thickness. One example is shown in Figure 8.

In case of thermal spraying of finish-machined parts or repair of parts by coating, areas which shall not be coated may be protected by appropriate measures (e. g. masking) for blasting and thermal spraying. See Figure 5.

6 Chip cutting and post-treatment of thermally sprayed coatings

The strongly different properties of thermally sprayed coatings compared to solid materials shall be considered in chip cutting process. Particulars for proceeding of chip cutting, thermal post-treatment, or sealing of spray coatings are indicated in EN ISO 14924 and in EN ISO 14920. Impairment of the parent metal by any thermal post-treatment shall be considered. Details see EN ISO 14920.

7 Instructions for design - Symbolic representation of the spray coating on drawings - Test instructions in the parts list

The symbolic representation of a spray coating on a drawing has to be carried out by means of marking the area to be coated according to EN 14665. If the symbolic representation does not cover the requirements for the coating, the coating specification shall be indicated in the pertinent parts list.

The coating specification shall contain the type of the coating, pre-treatments, test procedures, required values for e. g. tensile adhesive strength, hardness, etc. relevant for this component, and if applicable, spraying procedure and post treatments.

An example is given in clause 8 of this standard in Table 4 and Figure 9.

Instructions that define tests and scope of tests shall be indicated in the parts list. Tests at the component and tests on accompanying test specimens have to be indicated separately. See Figure 9 and Table 4.

If further tests like corrosion or wear tests are required, test procedures and required results have to be agreed upon between contracting parties.

It is recommended to indicate the general supply conditions per prEN 15311 in the pertinent parts list to specify requirements concerning quality management of the manufacturer and specific instructions for manufacturing and testing.

8 Examples for design suitable for spraying

8.1 Plane surfaces

Examples shown in Figure 1. Further examples, especially for coatings for protection against corrosion of welded structures, are presented in EN ISO 12944-3.

8.2 Rotationally symmetrical parts

Restrictions of geometrical dimensions exist when coating inner surfaces. Specific conditions of the spray procedure like spray distance and size of spray spot have to be considered. Customary minimum dimensions on thermal spraying are contained in Table 3 (see also Figures 2 and 3). The actual dimensions depend on the procedure, equipment, and spray material. Examples of how to round or chamfer edges or carry out support edges or pockets are shown in Figures 6 and 9.