ESTABLISHMENT OF PROCESS PARAMETERS AND TECHNOLOGY WORKING ELECTRIC ARC THERMAL SPRAYING OF COMPOSITE MATERIALS

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Abstract

The paper, based on experimental data and results presents the reconditioning technology throw thermal spray of plane bearings and trees from the composition of different parts, using composite materials (Steel + SiO₂).

Keywords: coating, technological stages, requirements

1. GENERAL CONSIDERATIONS FOR MAKING COATING

The research presented in the literature on achieving a coating of high quality aimed to quantifying the individual and collective influences of process of thermal metal spraying arc technological parameters on adhesion and cohesion of layers. Practical application of research concerned from literature was the friction couplings of Class III - camps, similar application to own subject researches, which aimed to determine optimal conditions arc thermal spraying of a composite alloy layer (Steel + SiO₂) supported on steel for general use mark 35.

2. GRIP PARAMETRICS STRENGTH

Technological parameters of the operation of electric arc thermal spraying on which we can intervene and thus ensure the completion of prerequisites of layers adherent to the underlying are:

- Electrical parameters of the arc: the intensity (I) and voltage (U);
- Spray-agent-air pressure (p);
- Distance between the spray gun and the target (substrate surface h).

By adjusting these parameters, consistent with theories of adhesion layers to support and particle cohesion within layer’s interior is intended to ensure the following goals:

- as high temperature powder particles (greater degree of overheating as compared with the melting temperature of the material sprayed) because at the impact with the surface or other particles already in contact with the surface can take place physic-chemical interaction to generate support their attachments;
- high speed for powder particles thus the interact with the environment in which they move – air, to be minimized and the kinetic energy of particles as large;
- high flow of powder particles because in this way it’s ensured a yield of surface coverage as high as possible and also uniformity of obtained spray coating;
- minimized losses caused by burning elements throw excessive overheating of powder particles.

Analysis of the effects of technological changes in various parameters leads to the conclusion that it requires an extremely rigorous scrutiny of their choosing their optimal values are strictly correlated with the nature of the sprayed material.
A particularly delicate issue is the choice of technological parameters ranges studied (Independent parameters) due to their antagonistic effects in different areas of values. So:

- **Electrical parameters of the arc (I, U)** melts the wire (material to be spraying) that occurs between the arcs and a hot melt to a certain desired value.

An excessive increase in current intensity may cause an amplification rate of evaporation of material under spraying, and lower limit voltage is dependent on the material submitted spraying.

Low intensity of electric arc below a certain minimum value, dependent on nature of the material sprayed, would create disturbances (turbulence) in the consistency of powdered material flow.

It follows that the upper limit of variation of electric arc’s parameters will be determined by the need to avoid evaporation phenomenon of sprayed alloy or burning of certain elements of their and the lower limit by the need to melt the alloy being concerned to spray, and to ensure consistency and continuity of particle jet.

- **Spray agent pressure (air pressure-p)** determined the sprayed particle sizes and their acceleration to target (subject area spraying). Pressure of spraying agent must be so chosen as to obtain large particles strong accelerated to target. It is good that these particles have large dimensions as this will ensure a limitation loss of elements by evaporation or combustion.

It is good to strongly accelerate this particles thus the particle gains high kinetic energy and “sticks” easily to support or other particles that previously anchored on it. On the other hand is limited while the potential interaction with the environment.

- **Distance between spray gun and the target (h)** affects if a poor election performance of the spraying process and the uniformity of deposit. When it’s lowered, there is a decrease in ground surface, but an excessive increase recorded a decrease in powder particle energy (reduction in both thermal and kinetic energy). Increasing time of particles in stationary environment, it’s recorded an increase of inherent and environmental interaction effects with particles overheated and a saturation of their gas. Increasing the spray distance, where justified (for example, in case of chemically active materials that need metallic and thermal reactions completion, and by increasing the spray distance, flow of particles may reach maximum values of enthalpy) can and should be compensated throw a corresponding increase in current spray and also throw but a strict correlation with blood and spray pressure.

Sometimes antagonistic nature of the variation’s effects of various technological parameters complained, before setting ranges therefore, conduct a series of preliminary experiments. Thus, the choice of technological parameters of arc spraying process leading to a maximum level of adhesion layer support (strength parameters) constant and equal to 180 A (usual average power plant).

**Note:** Adhesion changes in proportion with the increase of coating over current fixed minimum (I = 180 A), reaches a maximum, then it’s reduced about 80%. Maximum current intensity of spraying to which its characteristic is the maximum adhesion depends mainly on the absorption power and heat dissipation of the molten particles before impact support and is in strict correlation with mass, size and shape of the piece under load.

Determining minimum spray pressure ($U_{\text{min}}$) was carried by making sprays on a steel plate under the hood spray facility. Spraying began with a voltage of 34 V after which decreased continuously. At $U_{\text{min}} = 24$ V, the constancy of flow disturbances occurred, regardless of the current adopted spray. According to literature, stress field spray indicated for testing adhesion is $U_{\text{min}}+(2-6)$ V. It was adopted range 26-30 V recommended appropriate domain $U_{\text{min}}+2V - U_{\text{min}}+6V$. 
3. ESTABLISHMENT OF COVERAGE TECHNOLOGY

In determining coating technology have been considered working conditions and applications operating of shaft and bearings and technical possibilities of rebuilding their beneficial execution. Technology provides the execution conditions reception and delivery shafts and bearings repacked using Steel + SiO₂ composite material.

3.1. Chemical composition of Steel + SiO₂ composite material

The chemical composition of steel from Steel + SiO₂ composite material is: C =0,35 -0,44%; Si =max.0,6 %; Mn =max.0,6%; Cr=12...14% and SiO₂ powder grain size must be 40-60 μm.

3.2. Areas of use.

Steel + SiO₂ composite material is used to preventive cover or refurbishing of shaft and bearings. Has increased resistance to abrasion wear, friction and wear, and can successfully replace conventional materials used in similar working conditions. It can be used to manufacture new parts (preventive coverage) or retrofitting of rolling stock worn or any facility or equipment working under conditions of abrasive wear and friction wear (or combination thereof). Metallization layers deposited by don’t resist dots or linear loads.

3.3. Working technology

3.3.1. Specific equipment. Steel + SiO₂ composite material shall be deposited by metallization only with metallization facility specially built for this purpose. SiO₂ powder bath is introduced into the arc formed between the two steel wires, mix them with molten and the mixture is pulverized and screened on track uploaded. Deposit is applied to a surface specially prepared by machining and blasting, basic material is active because of these chemically operations. Because of this issue, between the blasting operation and operation of metal must not go more than 60 minutes.

3.3.1. Technological stages

To cover by metallization the work surface of shaft and bearings with composite material Steel+SiO₂ is apply a process consisting of the following: a). Preliminary analysis of the part and surface to be metalized; b). Surface cleaning; c). Control; d). Surface preparation for metallization; e). Preheating (if applicable); f) Metallization; g).Machining; h). Final control.

d). Surface preparation for metallization. Best adhesion of coating to be deposited with the metallization is achieved by applying mechanical preparation methods (especially threading), followed by sanding.

d.1). Mechanical surface preparation. Mechanical surface preparation has three purposes: Bring the worn surface of simple geometric shapes: cylindrical or flat (for the usual wear is not uniform over the entire piece). Operation is by machining (turning, grinding, milling, planing, etc.); Achieving the minimum required thickness of metallic layer that will remain after processing; Metallization processes "cold" as arc metallization and require a minimum thickness of the layer is deposited; Creating a "bed anchor" for material to be submitted to the metallization. The operation aims to avoid the separation layer metallic edges. Turning the operation parameters (speed, advance, geometry of cutting tools) are based on material of the song that is loaded by metallization.

d.2). Blasting. Blasting is run by cleaning facilities with compressed air, by pressure blasting system using electro Corydon grain of 1.25-1.5 mm, which, due to high hardness, achieves the highest roughness. Cleaning should be performed until the surface gets blasted gray look gray, dull without bright spots (areas that are incorrect or no blasted). Also, must be avoid overblasting phenomenon because, in this
case, roughness created on a normal blast are smoothed by sanding over and no longer as good for anchoring material to be submitted to the metallization. Blasting operation phases are: Preparation of the operation which consists in siting the blasting agent to remove dust or other impurities and filling the tank working pressure blasting agent; Cover areas not to be blasted by rubber masks; Compressed air pressure regulating work flow at 5.5 bar and it is chosen according to the size of the nozzle exit 6 mm nozzle, the flow is adjusted to 1.5 m³ / min; The tank is empty it will be depressurized in order to enter the blasting agent; Blasting which is positioning gun blast to 60-80 mm of surface blasting and maneuvering so that the whole surface should be sanded metalized. During blasting gun blasting operation will be tilted at an angle of 10-15°, and guns blasted through absorption, because the particles that will attack the surface to prevent the particles bounced off of it; Control of blasting which is visually or with control samples aiming at the surface roughness to be necessary or not blasted bright areas, in which case it blasted these areas.

e). Preheating. Apply to interior surfaces (bearings) and the plans aims to avoid the separation layer deposited at the edges of the metallization due to cooling and internal stresses, tends to pile up and fall off. Preheating is about 180-200 ° C. Preheating may be in heat treatment furnaces or oxyacetylene flame with condition that the flame does not act directly on the surface sanded.

f). Metallization. Metallization technology work to include the following phases: a)Adjusting the parameters of compressed air: pressure and flow. The adjustment is made at the control panel by adjusting the compressed air spray devices that control: pressure regulator and flow meter; b)Adjusting the working parameters of the arc: voltage and current.

Operation is made from spraying, but spraying the empty set at the minimum tension in the arc is stable and intensity depending on the wire feed rate of metal; c)Spray adhesive layer is made only with metal injection material and taking the gun to around 60-80 mm of metal surface and its movement speed by printing more (about 80 m / min), aiming at the whole area . To avoid any particles bounced the gun takes 10-15° tilted perpendicular to the loading area; e)Load sprayed layer of metal material and ceramic material contribution is made in the same manner and with the same parameters, but increasing the spraying distance of 170-180 mm and printing of metal gun movement speed of about 40 m / min. During the operations of metal bearings or flat surfaces to be pre-heated will follow that their temperatures do not exceed 200 - 220°C. If it is found above this temperature deposition by metallization process is stopped and tracks will cool with stream of air; f)Seeking verification control metallization adhesion and thickness of deposited layer, if it finds areas without adhesion or poor adhesion, metallization process resumes the operation of blasting (or cleaning operation if it finds that the lack of adhesion is due presence of traces of oil). Control is by hitting sound coating and product analysis: if broken means that no adhesion or adhesion layer is weak and if the sound is full, the adhesion is good.

g). Metallic layer processing. It will make the mechanical processing of cutting force is relatively constant, such as turning and grinding, but these will be made with specific parameters for processing metallic layers. On turning lathe knife blade geometry will not give material processing chips continuous flow, but breaking chips, short and crumbly. The knife will have a negative rake angle so that the normal component of the cutting surface to have meaning to the work piece, ie to 'Press' chip. Otherwise it will stick to the work piece and it will break the lines caused by micro points. To rectification will choose a soft abrasive disc mass to take hard particles removed by processing and thus not be "clogged". The other working parameters: cutting speed, feed, cutting depth and number of passes is determined according to the material that is processed and provided added processing. Processing begins with debarring metallic layer which is the phase in which the metallic layer removes peaks and material deposited on the metalized surface adjacent areas. Processing begins in the middle to the edges of the metallic surface. After removing the peaks and obtaining a metallic layer with a uniform thickness, it is working class, as in normal processing, the usual material, non-metallic.
**h). Ultimate control.** Final check will follow: adhesion material deposited metallic layer and the geometric dimensions of the piece. Adhesion of material deposited by metallization easiest check by gently hitting with a hammer and the sound interpretation: if the sound is hollow, adherence is poor, and if the sound is full adhesion is good. Thickness and physical construction of the metallic layer is checked with micrometer or gauge (depending on size and surface machining metallic).

4. **PROBE FOR CHECKING PROPERTIES METALLIC LAYER**

Metallic layer properties that are essential for the proper functioning of the part in service are: adherence, porosity and hardness.

**REFERENCES**