STUDIES AND SURVEYS ON METHODS OF OBTAINING METALLIC SUPPORT MATERIAL AND CHARACTERIZATION OF SURFACE-LAYER SUPPORT AT ARC THERMAL SPRAYING

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***Abstract**: This paper presents methods for processing of layers due to analysis results towards hydrodynamic collisions spherical liquid particles to solid media. The process of thermal arc metalizing establish procedures for processing and working parameters of different operations to achieve a uniform coating on dimensions and obtain required mechanical properties.*
***Keywords**: metallic material support*

1. GENERAL CONSIDERATIONS

In reconditioning bearings (bearings) and cover the metallization of new bearings, raw material to obtain a support metallic materials are worn and new bearings.
Spent pads are subjected to processing methods, used to remove bearing material and their surface preparation for metallization, thus becoming metallic material support. Technological process applied for the reuse of material support includes the following:
- Removed by machining (turning) of bearing material originally
- Machining of the surface (inner surface threaded execution)
- Preheat to remove oil from the pores
- Degreasing to remove traces of grease or fat and oil combustion products resulting from pores.

Following this technical process support are metallic materials suitable for application of technological process of metal. A special case is the refurbishing of the bronze bearings which consists of the following:
- Turning inside to remove traces of wear and bring to a simple geometric shape (cylinder)
- Achieving anchorage bed
- Preheating for removing oil from pores
- Degreasing for removing grease, oil and products resulting from preheating.

In case of new bearings, technological process for obtaining a metallic material support depends on their thickness and dimensions. New bearings are classified:
- Bearing of a piece;
- Shells of two or more pieces.
- Processing bearings from a piece

Bearings support for the achievement of a piece is obtained as a result of machining. As a first operation, is carried out a deepening operation and beveling on the hole. It's used as a basis for fixing the outer cylindrical surface (Figure 1).

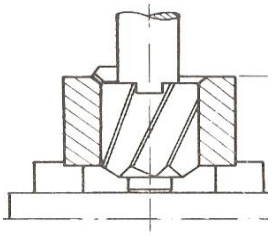

Fig. 1. And deepening hole beveling

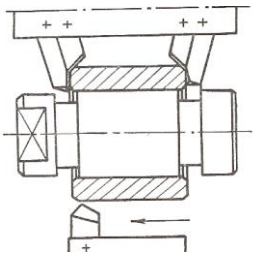

Fig. 2. Turning bushings mounted on mandrel

At operation 2, are finished by stitching the inner surface of the hole. Penetration of the brooches is on the part with beveling.
Bushing on the mandrel is fixed (Figure 2). It turn outer cylindrical surface and bevels. Outer cylindrical surface is corrected. It is removed the mandrel, being prepared in this way the support and it is applied the technological process metallization coating.

Processing two-piece bearings
In this sense, can be distinguished a difference between bearings, if it taking into account the wall thickness. Thus, they can be grouped into two categories:
- Thick-walled shells
- Thin-walled shells.

Blanks for pads thick-walled can be cast iron, steel, bronze, etc.., or can be forged.

Processing of thick-walled shells

Processing of thick-walled shells begin milling processing (Fig. 3) or stitching (fig.4) of flat surface of separation and, if necessary, lateral flat surface.

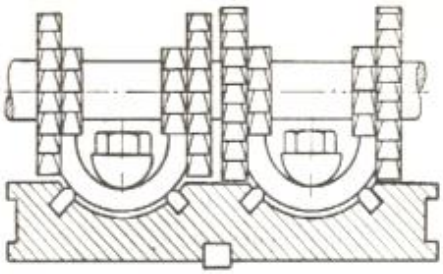

Figure 3. Machining

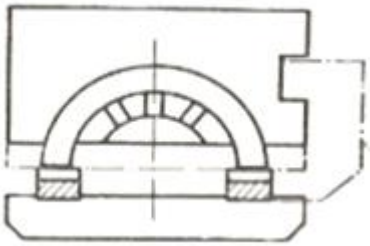

Figure 4. Processing by stitching

In iron and steel pads, after processing it's assembled two sides of the bearing shell in a processing device for interior surfaces, of front surface and channels bearing casting material. When installing the device, often shall be added between the separation plan, to enable adjustment of the game in the assembly bushings. After casting material bearing, runs roughing turning the inner cylindrical surface and frontal areas, to give bearing shell the required size. The last operation consists of drilling holes and lubrication channels. Thin wall pads have a slightly different technology. Thus, after having pressed steel sheet using a press molding, processing operation of frontal surfaces is executed, channels are then milled oil, the interface are processed by stitching after final processing of the inner surface. Last correction processing operation is the inner surface.

2. CHARACTERIZATION OF SUBSTRATES INTERFACES

Interface is the area of the base material (support) and material to be deposited by metallization and will be a metal or metal-ceramic coating on it. Interface or area of separation and contact between the two materials plays a decisive role in the functioning and operational behavior of parts loaded by metallization. In terms of operational behavior would be desirable that this interface would be missing or material is submitted to disseminate basic material and create a perfect connection with basic material. Since composite materials are deposited by electric arc metalizing process which belongs to the category of metal processes "cold" in which the base material temperature does not exceed 80-1000C during submission, can be no mixing of basic material with filler material or filler material diffusion in the base material. Links that may be obtained by spraying a metal material or metal-ceramic on a metal surface is largely mechanical connections, with a small part of links between particles created by micro powder and base material. Interface material base material should be directed by mechanical phenomenon, chemical or electrochemical deposited layer connection with the basic material to be as better.

Two surfaces meet at the interface:

- Surface support that will make a composite layer;
- The surface composite layer.

2.1. Surface characterization support

Arc thermal spraying is the submission of applications of composite materials with appropriate characteristics of surface mining on parts and machine parts, which will provide them with resistance properties and applications of the composite material chosen (forced, in fact, requests to which part subject to service)

Specifically, on the working surface of a piece is deposited a layer of composite material, by electric arc metallization process. It will establish the existence of areas of separation between the material support and the metallization layer that is deposited. This area is actually deposited layer-substrate interface. Not every area can interface at deposition of metallic materials throw metallization. To become the interface substrate surface must be prepared with a stream of technological operations designed to assure its qualities necessary to ensure the material deposited by as much grip metallization. Further flow of technological operations are presented by a metal surface can become the technological process of metal interface. Phenomena occurring at the interface, how they are managed and controlled, have particular importance in terms of operational behavior of the song that was made by metallization composite material. Support area is the area that is deposited composite material to increase wear resistance of abrasion and wear of friction. Because these composite materials made to face the demands of operating the complex underlying surface - composite material should act, possibly as a unitary material. This means that the link between the composite material made by metallization and surface support must be as strong.

To meet this criterion of functionality, both material and support material is submitted, it must satisfy certain conditions, namely: metalized surface must be clean and chemically active and particles sprayed on the have surface temperature and the kinetic energy necessary to create as many points to give the final layer micro obtained by metallization as much grip.

For a surface metallization to be deposited by a composite material, it must be subject to specific operations to be able to receive and retain the composite material to form one piece with it to fulfill the required characteristics operating requests. Conditions above the surface of metallic substrate layer is obtained only by

applying the specific technological operations, further described in detail.

a). Dry cleaning.

The production and processing of metals, cleaning metal surfaces is part of the production process. In most cases cleaning metal surfaces is not made aesthetic reasons, but rather as a preparatory stage for the next stage of production. Even the final cleaning processes are both the purpose and ensure appropriate level of corrosion protection. Cleaning metal surfaces is part of the production process and often integrated into production lines. In all industrial cleaning processes are used mechanical equipment or as lines of immersion, either in the form of encapsulated blower equipment.

Metal Surface cleaning is done only by professional staff and is strictly regulated, both at European and national level. Quality coatings sprayed is characterized by coating's structure, distribution and size of phases, pores, oxides, inclusions of different materials, segregation, cracks. These variables are difficult to measure quantitatively, assessment being carried out by comparison with different reference range of metallic coatings. Lot consists mainly external characteristics of unevenness, roughness or surface texture, color and appearance differences. Coating properties are significantly influenced by the presence of cracks, exfoliation, peeling and thickness.

A major factor affecting binding and formation of deposited layer should be considered to achieve thermal spray materials, that is the cleanliness of the area, which highlights that the cleaning operation is an important technological step for substrate preparation, which ensure a more active area of physical and chemical characteristics required for good fixation, a clean profile of substrates without contamination from dirt, oils and fats ensure a good mechanical gearing hard metallic particles. Decontamination can be achieved both chemically and mechanically, depending on their nature.

Chemical cleaning substrate surface (degreasing) is made to the following conditions:

- Apply chemical cleaning of all surfaces to be metalized.
- Chemical cleaning is done using specific materials.
- Chemical cleaning is done in special places.
- Dry cleaning is based on the degree of finish surface.
- Chemical cleaning is done carefully to obtain clean surfaces.

Mechanical cleaning of surfaces support refers to remove from the surface to be adherent metalized depositions that could not be removed by dry cleaning: spray welding, oxides adherents' adherent mineral deposits, etc

a) Mechanical cleaning is done by grinding carefully, using devices and specific material, the nature of the surface.
b) Mechanical cleaning is done in special places / the workstation.
c) Apply mechanical cleaning of all surfaces to be metalized.
d) Mechanical cleaning is done taking into account the quality and characteristics of the substrates to be metalized.
e) Mechanical cleaning is the nature of the materials to be used for metallization.
f) Mechanical cleaning is done taking into account the requirements prescribed in technological documentation.
g) Surface areas will not be protected metalized with metal or rubber masks.

b). Pre-initial.

Parts that have worked thoroughly with oil lubrication conditions, especially those made of bronze or iron, and to be covered by metallization, will undergo preheating operations to remove oil from the pores features cast materials. Is different from that of bypass surgery, which applies to flat or cylindrical interior parts to be metalized, the operation aiming at the elimination of internal stresses in metallic layer or directing them to a better adhesion material to spray metallization. Bypass operation to eliminate oil from the pores of the parts to be metalized is 200-2500C and is followed by a chemical cleaning to remove products from the combustion of oil and grease from the pores. Figure 5 presents a surface that has been preheated to remove oil from pores. This area has been applied to technology whole loading process metallization and at the end of metallic coating applied to peeling. Because of this separation was as follows: due to high temperature powder particles, pores oil went to interface and prevented material deposited by metallization to adhere to the surface of basic material.

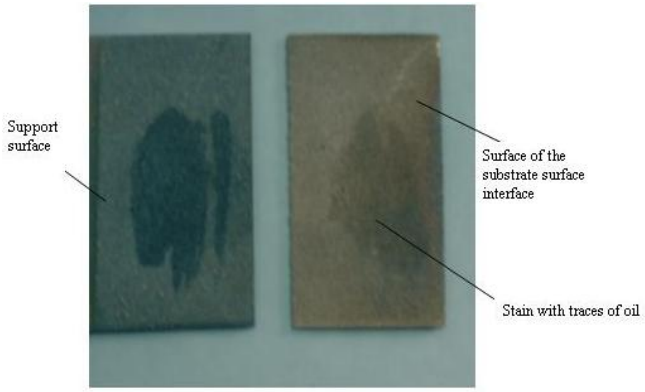

Figure 5. Spraying an area that was not preheated to burn oil

c). *Mechanical surface preparation*

Metallic layer is composed of fine particles in the state from a metal bath a jet spray of compressed air. Surface impact loading, particles are plastic (ie have sufficiently high temperature). Because these particles sticking to the metallic surface and form a metallic layer, the support surface must be prepared that metal layer so create by metallization have a maximum strength, not to lose its operation and can be processed throw classical mechanical methods of processing. If the input material

that is submitting the piece to determine the behavior of mining applications is so important, adhesion is one of the most important qualities of a coating as strength and durability makes the whole layer deposited by metallization and the degree of protection that part is applied (for corrosion protection). It is important to note that the metallization is applied differently depending on the shape and position of surfaces on which the deposit is made. Thus, flat surface metallization technology is completely different from the outer cylindrical surface metallization as metallization is different from interior surfaces of metal cylindrical outer surfaces and flat surfaces, each case having features of application and surface preparation for metallization features to must be strictly observed to the success of the operation.

c.1). Outer cylindrical surface preparation

The operation aiming to apply for the following:

- Removal of trace scratches and wear;
- Working surface for applying a simple geometric form;
- Working to ensure anchoring metallic layers.

c.1.a). Remove traces of wear

Remove traces of wear surface is achieved together ith the processing for applying a simple geometric form. Operation is necessary because it ensures a uniform thickness of the layer deposited by metallization, eliminating the possibility of areas with low thickness and risk of flaking. Experiments showed that if not removed scratches and traces of wear, there is a danger that material is submitted to the metallization and not to cover gaps in the layer by layer with the danger of breaking in these places, as shown in Figure 6.

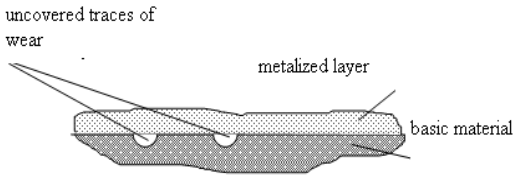

Figure 6. Layer deposited over traces of wear

c.1.b). Working to ensure an efficient anchoring and mooring bed achievement

Experiments have shown that to prevent relative movement between the metallic layer and base material are necessary machining of metallic surface for metallic layer to be placed in so-called "anchor bed. Geometry processing and "bed anchor" must be followed to have a deposit guarantee quality.

Meet two conditions:

a) the metallic layer is in the middle area, by technology deposit will secure a berth anchorage, as shown in Fig. 7.

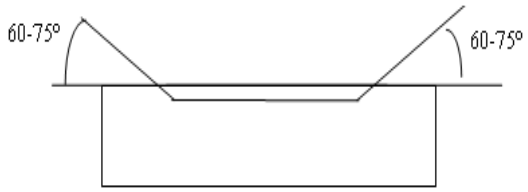

Figure 7. Anchorage bed in the middle area

Experiments showed that if is a dovetail processing, as indicated in some works of literature (which would ensure the best anchor) can not submit material swallow tail angles and gaps remain in danger of breaking or break during operation, as seen in Figure 8.

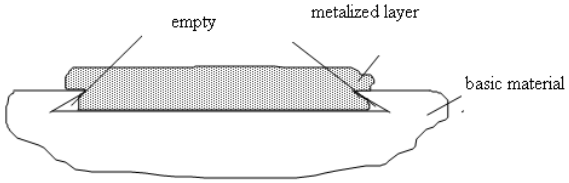

Figure 8. Processing dovetail anchoring

b) if the metallic layer is at the end piece. In this case, experiments have shown that deposit metal layers without proper preparation of heads lead to detachment layer. To avoid detachment of the head, their processing is mandatory, as is shown in Figure 9.

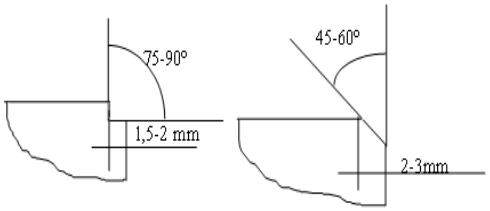

Figure 9. How to prepare the head support

After performing "anchor bed" as figures 8 and 9, mechanical processing are necessary to ensure maximum adhesion, which means tapping thread operating on the surface of the metallic layer to be deposited.

Types of threads executed surfaces possible to anchor inside the input material to be submitted to the metallization are shown in Figure 10. Square thread will run only if rebuilding parts with an inside diameter greater than 500 mm, the jet of metal can be directed perpendicular to the metallic surface. Up to 500 mm thread will only run with trapezoidal or triangular profile.

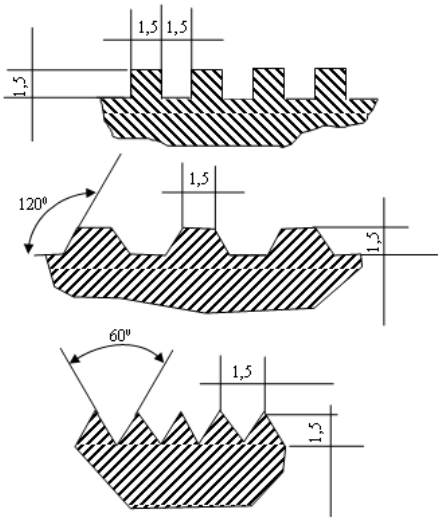

Figure 10. Working to increase adhesion

The processes are made without using coolant. The most common thread type is triangular. Note that threads used to ensure effective anchoring of the material submitted to the metallization does not run like normal threads. Threads executed in the metallization must be rough, being carried out in a passage with a lathe tool with tip angle of 600, placed under the work piece diameter 1-2 mm. To obtain maximum roughness of thread, knife will be turned overhang (free length of the blade to support the blade) higher than for conventional processing of threads. Thus, during processing of the knife will come into vibrations that lead to pull splinters of material processed and to obtain a large roughness.
Figure 11 presents a thread executed on a piece to be metalized as recommended above.

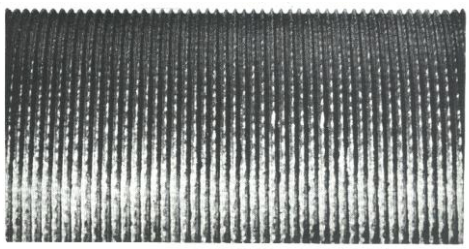

Fig hness

C.2). Inner cylindrical surface preparation
As for external cylindrical surface preparation, the operation aims to apply for the following purposes:
- Removal of trace scratches and wear;
- Working surface for applying a simple geometric form;
- Working to ensure anchoring metallic layers.
The choice of processing and cutting regime is the nature of the basic material in an effort to remove traces of wear (scratch, ditches, etc) effective anchoring of the species and ensure the minimum thickness required for metallic layer.
c.2.a) - remove traces of wear (and bring to a simple geometric form) is required for rebuilding the inner cylindrical surface mining waste.
Operation is turned on and seeks regular and continuous surface layer for which shall be deposited to have a uniform thickness throughout the area that will metalize.
c.2.b) - Securing effective means creating an "anchor bed" area, to avoid the phenomenon of detachment of head metallic layer.
Processing module is shown in Figure 12.

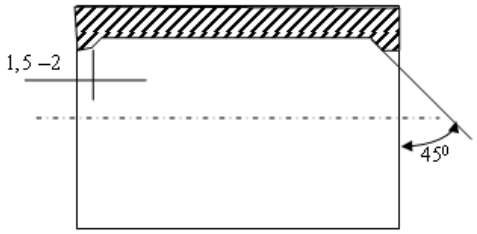

Figure 12. How to make bed anchorage interior surfaces

To obtain an effective anchoring it can run threads on the bed surface but only threads triangular anchor (with geometry shown in the outer cylindrical surface preparation) or with geometry shown in figura13. In this case, processing is made without using coolant.

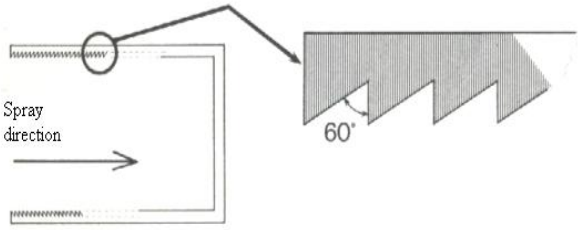

Figure 13. Thread execution for interior surfaces

A special case is the reconditioning bearings. Anchorage bed is practiced and camps with two or more pieces and axial bearings and cylindrical threads can run or plane (if axial bearing), most recommended threads were triangular or trapezoidal. Fringe elements of the camp to camp or direction directing the action of the forces of contraction is the purpose of raising the bearing surface and not as detachment from the surface.
If the case is one piece cylindrical bearings to ensure processing anchorage bed, where two or more bearings and bearing components axial edges processing problem becomes more important. If a radial bearing two pieces often the case in camps with more than 100 mm in diameter, should be made compulsory fringe two elements. Figure 14 Fringe are two elements that make up camp.

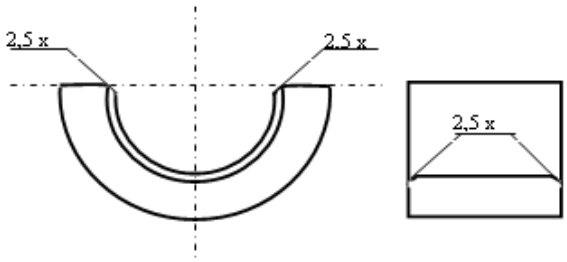

Figure 14. Fringe camps diameter greater than 100 mm.

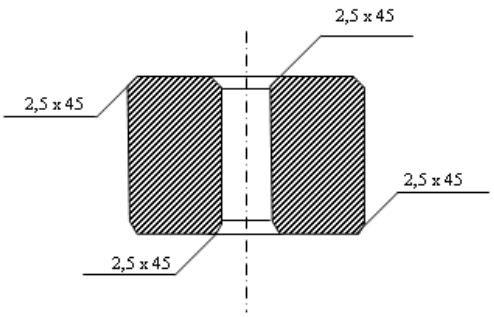

Figure 15. Processing elements with axial bearings

If bearings consist of several elements, each element is TESI edges 2.5 x 450, and when running the same axial bearing bevels the edges of the camp, as shown in Figure

15. A special case is the camps that were set pockets (channels) for oil, either tangential or along the generating (when radial bearings) or radial (for axial bearing). For metallization of these camps are two possibilities:
- Cover with metal or rubber masks pockets for non metallic
- Metallization and processing them into new pockets metallic layer.
It can be applied the both ways, but taking into account the size of these camps and their access to these pockets.
C.3). Preparing mechanical flat surface
To ensure a better grip and metallic layer, after processing for applying continuous flat form (after removal of traces of wear) can be made on the surface grooves with different shapes: square, triangular, trapezoidal, etc..
Note that such processing can be of any shape and size provided the power not to introduce concentrators in basic material to decrease its mechanical strength, as shown in Figure 16.

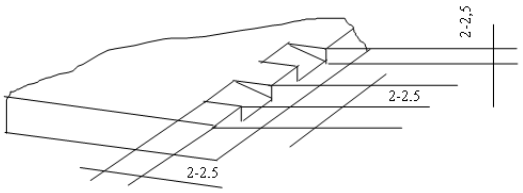

Figure 16. Processing ends flat surfaces

A principle that should be considered to carry out the task of processing for mechanical anchoring is: will not be working in the dark corners may enter the stream of powder particles and will not live metalize edges.
Another basic principle, particularly in refurbishing the flat surface is: if the surface does not wear a uniform may be working to bring the plane to form a specific local area, not having to process all the dimensions of the surface deeper removal of small traces of wear (which would mean higher consumption of labor, materials and energy. From the experiments made in this operation resulted in rebuilding its importance especially in flat pieces that are no longer produces the effect of relieving the deposited layer, the outer cylindrical surface for metallization.
d). Working to increase the surface roughness
Most widely used process for creating micro irregularities on the metallic surface is sanding process.
Cleaning is a technological process by which a blasting agent is designed with high hardness high speed on a surface that must be removed and adherent oxide deposits. In addition, blasting apply for metallization, to ensure a certain surface roughness to help anchor the metal particles to be deposited with the metallization.
Following studies highlights the practical aspects of implementation following blast:
- Blasting served more time leads to flattening of the peak roughness created in the first phase of blasting which leads to decrease adhesion material submitted to metallization;
- Blasting agent made with our screening lead to the sandblasted surface roughness of different areas will have different adhesion of the material deposited by metallization;
- Blasting nozzle made with blasting waste (increased diameter due to wear by blasting agent), makes the mixture pressure compressed air + blasting agent designed to reduce surface particles of blasting will be less kinetic energy, producing a roughness below it, and thus material deposited will have weaker grip.
Technological issues that need to be pursued for the successful operation are:
- Tracking and sifting grain blasting agent to remove particles of dust and broken;
- Particle velocity on impact with the blast area to be sandblasted to ensure it a kinetic energy sufficient to deform the plastic material blasted. Since the particle velocity is given by the compressed air pressure and blasting nozzle section, be pursued as it is not worn in carrying out blasting.
Blasting purposes is to ensure maximum adhesion of the metal to be deposited with the metallization, a blasting done correctly and legally appropriate metallization of the application must ensure that material is applied, a roughness of 15-20. For the deposition of a metallization layer on the surface bearing, bearings are subjected to mechanical stress and thermal operation, the process is indicated for blasting them with compressed air blasting and blasting system is under pressure.
Working parameters of the blast are: compressed air pressure, distance and speed blasting the blasting work.
- Compressed air pressure is very great influence in terms of particle velocity blast of the impact of sandblasted surface, so in terms of particle kinetic energy. Optimum blasting pressure 4, 5-4, 8 bar is indicated.
- Blasting distance is also very large influence on the rate and kinetic energy particle blasting agent;
- Speed of the gun blast has influence on the amount of particles striking unit area per unit time, so the quality of blasting.

Note: speeds of blasting shall be specifically for each area separately, depending on its condition, degree of oxidation, surface material, so there may be a required movement speed gun.

The material used for blasting is best corundum grain of 1, 25-1, 5 mm, due to high hardness, achieved the highest roughness. Cleaning runs until Sable area becomes gray look, dull without bright spots (areas that are incorrect or no sanded). Blasting gun should be positioned inclined to the surface normal sandblasted and maintained that position until the end of blasting.
e). Preheat to metallization
Operation is applicable to all cases of metal surfaces and flat or especially in the inner bearings, intended: to avoid

detachment of the layer caused by internal tensions caused by differences in temperature between it and the material support that is submitted. The tests and experiments for couples filing material or material bearing on bearing characteristics of the sample plane and bodies, it is advisable to make pre about 180-200°C oven for heat treatment. Next operation parts handling application was done with gloves and tongs to avoid accidents.

2.2. Characterization of deposited material interface support

On the substrate surface, now interface metallization process, the metallization layer in composite material is applied. Deposited particles form a composite layer of a certain thickness, the characteristics and their physic-chemical properties different from the substrate material. Between two different materials basically in terms of chemical composition, structure and chemical properties are forming a boundary interface for both one and other. Interface layer is actually made by metallization layer anchor (Strength) which in turn has properties very different chemically from the rest of metallic layer. Usually it is considered that the particle produced by thermal spraying layer presents purely mechanical connection between them. Frequently finds that bridges between particles are created through mutual melting or links formed by the action of van der Waals forces. Average particle moving superheated gas, their surface is oxidized. Each particle is covered with an oxide film which will be found on the limits of particle and metallic layer. The link layer obtained by thermal spraying of particles ensures both a mechanical attachment and via oxide. The contact points between particles can melt metal particles creating micro points between them. Layer obtained by coating itself is a laminate composed of molten particles that during training each layer is heat influence. Mutual interaction between particles can occur in two cases:

a) - particles come into contact with the spray before the spray was not fully crystallized;

b) - spray particle in contact with a particle already completely solidified but Nerac, which has a temperature higher than the substrate temperature.

The first variant is virtually impossible, that is not covered by layer of powder particles, placed on particles have not yet crystallized. From the experiments conducted, growth opportunities and quality of resistance are the pre-media layer or powder particle overheating, rising temperature of contact between particles and the medium on which they are deposited. Thermal spray coatings to achieve practical and experimental data indicate that the connection strength is determined not only sprayed particle temperature and contact area during interaction, but also the particle velocity. Particle displacement velocity differences advertising unevenness structure and properties obtained by thermal spraying layer. Although the influence of particle velocity spray deposited layer properties is clear, the mechanism underlying this influence on its value and quantitative data are very limited. Experimentally there is a direct link between speed and quality particle layer made: the growing amount of adhesion of particles with speed increase and also support the growing layer of resistance itself. Layer structure obtained by spraying small particles, accelerator, is very dense and uniform.

Metallographic investigations showed that the particles are characterized by low average size placed more compactly and more durable links between them and the layer, only coarse particles. Noteworthy is shown good correlation between the influence of speed on adhesion to the substrate and layer's compactness respectively. Experimental research results lead to the conclusion that to achieve adequate resistance layer, particle velocity must be the order of several hundred m / s. At such speed, kinetic energy of particles is close in size to the stored energy by heating.(Obs.: powder particles at speeds of up to 100 m / s is reduced and their kinetic energy is $mv^2/2 \cong 3.10^{-3}$ eV / atom value lower than the average thermal energy atoms k .T $\cong$ 0,1 eV). Therefore, under these conditions the spray material interaction in the contact area is achieved mainly by thermal activation. For particle velocity of 600 m / s and higher its kinetic energy of particles increased to 0.1 eV / atom becomes comparable with thermal activation energy, so the mechanism of interaction in the contact area will change. By increasing the particle velocity and hence pressure in the contact area. Activation energy of interaction is reduced and consequently raises strong interaction speed. If the contact pressure is zero or very close to this size, activation energy, of course, will have maximum value. Setting process by forming stable connections between particles and support is bound to appear, the dissociation of the weakest link of the base metal. Dissociation of such connections is active and providing reconstruction support surface chemical link between the particle and the atoms of the substrate in the contact area, leading to the formation of resistant bridges.

Due to the very short time in the deployment of contact and processes primarily due to rapid decrease of temperature in these areas can not reveal displacement of self-diffusion processes, hetero diffusion, and formation of new phases. Due to stable chemical linkages between the training and support particle diffusion becomes possible to initiate processes through dislocations and limit both particles and grains in support. To ensure appropriate links with support accelerated powder particles, their speed is necessary that the impact to be a value-dependent nature of the material sprayed, the quality of support, etc. Variation of spray distance (distance between source and target spray) involves a significant change in speed of movement of particles sprayed. High speed thermal spray particle displacement (hundreds of meters per second) generates high levels of pressure inherent in contact with the target.

Associated with a high temperature in contact with the media, the high pressure in turn dictates an expansion of

power of such physic-chemical interactions with material support, the consequence of such interactions is the formation of stable and strong links between thermal sprayed particles and support.
Understanding the processes of powder particle collision becomes possible as a result of the analysis results on the hydrodynamics of liquid spherical particle collisions solid media. The collisions with the support surface due to their kinetic energy particles are strongly deformed. Particle pressure on the support area of impact has two components: a dynamic component and a component of shock, both components of the hydraulic effect due to the collision. Shock component is called component of momentum due to short time or action.
Fast recordings of particle collisions liquid solid surfaces revealed that the first moment of impact elastic fluid deforms and then, after 10-10-10-9 seconds, the impact zone forms a flat layer of fluid led large liquid particles on the surface of the target. The formation of this layer is explained by the appearance of flat effects of elastic compression in the impact zone. Later, under the effect of component impulse (shock pressure) liquid film on the surface bears a strong extension support.

3. CONCLUSIONS

Material deposited by metallization interface interacts with the substrate surface is submitted by the pressure generated by particle impact with the surface but especially through heat and chemical action between the particle and substrate material in contact with him (which belongs to the interface material deposited particle).
To increase adhesion of the material submitted must support the interface to interact with chemically active metallic particles and create micro-welding points with them.

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