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EXPERIMENTAL RESEARCH REGARDING THE MANUFACTURING OF THE ANTI FRICTION MATERIALS USED IN AERONAUTIC CONSTRUCTIONS

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Abstract: *The designing of a product which must be fulfilled by the product, thus it is worth to mention the issue of selecting the material out of which that particular product will be made.*

The experimental researches are those concerning the assurance of high mechanical and physical characteristics under special regimes, where as the weight of the finished product must be minimized by diminishing the density of the samples.

This paper presents a few characteristics of materials used in the production of friction materials used in the aeronautic constructions.

Keywords: *manufacturing, material, friction bearings, aeronautic, construction.*

1. INTRODUCTION

The paper present some aspects regarding the experimental researches of the antifriction materials used in the aeronautic constructions:

AS20 – Steel Support Plated with Anti-Friction Material: 20% Tin, 1% Copper, the rest - Aluminum

and

CP10S10 – Steel Support with Anti-Friction Material Sintered from: 23% Lead, 10% Tin, the rest - Copper).

The anti-friction sample based on Cooper, Tin, Lead, sintered powders end not sintered, has a metallic structure, the relations established during the sintering process between the granules powders can be explained by the inter-atomic forces from the microstructure.

2. MATERIALS USED

At present, the main categories of metallic materials used in the production of friction (radial, axial and hydrostatic) are the following ones: [2, 4]

- alloy from the Lead-Tin system;
- cast piece or sintered Cooper-based alloy;
- Aluminium-based alloy;
- other alloys etc.

The tin based alloys (babbit – the composition 88% Sn, 8% Sb and 4% Cu). This alloy has rapidly become the most frequently used in the production of anti-friction materials. The white metals have capacity of incorporating the particles, which conferred them certain clear advantages in comparison with other anti-friction materials. But the white materials have lost ground in the production of friction materials because of the reduced mechanical resistance, especially at high temperatures.

Pb based alloys (especially the alloys with as content) are used in the world because of the advantages offered by the Pb which replaced Sn, the Pb which is not short. The hardness and the mechanical resistance, they are similar to the Tin-based alloys. These materials are inferior from the point of view of the fatigue strength.

Bronze alloy with Lead, on steel support – is applied by casting or sintering. The Cooper-Lead alloys sintered on steel support are more modern than those directly cast on steel strip or support. These materials have a charging capacity and a strength resistance which are 3-5 bigger, the high hardness of the copper-based alloys requires a higher pin hardness.

The Aluminium-based alloys – anti-friction materials have been cast, because are obtaining an alloy having a structure similar to the babbit, that is a hard stage alloy in a soft basal mass.

An disadvantage at the Al-Si alloys is the fact that, having constituents with high melting points, they do not present the advantages of those with low hardness. In order to replace the lack of conformability, other companies use the method of working surface galvanic coating of the Al-Si layer or the AlSn6 with an extra Pb-Sn layer thick of about 0.25 mm. This layer achieves a micro-conformability of the bushing working surface during exploitation, thus intertwining the qualities of the Al-Si and AlSn6 alloys (high buoying force lift, chemical stability etc.).

3. TECHNOLOGIES USED IN THE PRODUCTION

3.1. The Production Technology of the **AS20** material (Aluminium – Tin 20%) is made in the following stages:

- the preparation of the pre-alloys of Al-Ni, Al-Cu and raw material;
- the melting of the charging;
- the transfer of the material, degasification, de-oxidation and maintenance at the casting temperature;
- the casting.

The properties of the anti-friction material are greatly determined by its chemical composition. It decides the good behaviour following lamination operations in which the material suffers structural transformations. Except the basic elements Sn, Cu, Al, Ni, the other two elements Fe and Si are undesired impurities, thus they must be limited at the minimum value. [1, 4]

The temperature must reach 750-760°C. The temperature plays an important role must be transferred into the soaking furnace, period of time in which the temperature decreases.

This is followed by a heating over the best casting temperature leading to the excessive burning of Sn.

The casting of the anti-friction material represents a important operation which greatly determines the quality of the cast material.

The appreciation of the quality of the cast material is made according to the standards. There are rejected presenting gaseous inclusions, faults as “metallic beads”, cold welding or other casting faults. In order to get an ingot with great properties, deprived of casting faults, the ingot butt must be removed, that is the crop end proper.

The Production Technology of the Al-Sn material requires the use of the pre-alloy made up of Aluminium-Nickel and Aluminium-Cooper. Because of the huge differences between the melting temperatures of the alloying elements, the nickel and copper will not be introduced directly, he form of the pre-alloy Al-Cu and Al-Ni, respectively, which have low melting points.

The pre-alloy casting temperature is of 850-860°C.

The main operations for obtaining the double strips of Aluminium-Tin based anti-friction material are the following ones:

- pre-lamination of the AS20;
- annealing of the pre-laminated;
- plating the alloy ingots with Al foil;
- lamination of the plated;
- plating the steel strips with alloy strip;
- annealing the double strips.

The pre-lamination thicknesses of the alloy ingots are chosen according to the final thickness of the alloy from the double strip.

The annealing temperature of the pre-laminated ingots is made at the best of 355-360°C, and the best annealing time duration is of 150 minutes.

After plating the alloy ingot with the Al foil and laminating the plated ingots, after a series of secondary operations, the shift is towards plating the steel (support) strips with alloy strips, thus obtaining the double strips.

3.2. The stages of the Production Technology of the CP10S10 are the following ones:

- production of alloy powder;
- sintering of the powder on the steel support (obtaining the double strip based on sintered Cu-Pb).

The technological process of obtaining the alloy powder consists of the following operations: the preparation of the cold charging, melting, casting and production of powder. [2]

The best melting temperature ranges in between 1200°C and 1280°C.

The casting, the mode of action of the atomizers and which will form the powder from the melted alloy is monitored.

The powder should be highlighted certain parameters: the pressure of the filtered water, the water softening degree, the regeneration of the de-ionized water, the pressure of the de-ionized water at the atomizers, the moisture of the powder at the entrance of the drier, the temperature at the exit of the drier, neutral air supply in the drier, powder sieving manner, the sieve quality and in the end it can be noticed if the powder corresponds to the requirements. [3, 4]

The technological process of obtaining the double strip based on sintered Cooper-Lead consists of the following:

- the preparation of the strips for sintering;
- depositing the powder on the steel strip having in view the sintering;
- the sintering of the powder on the steel strip;
- lamination of the double strip.

The preparation of the steel coils on which the Cooper-Lead powder is sintered consists in executing certain operations aiming at assuring a continuous technological process: butt welding of the strips, straightening the curvatures and unevenness resulted after welding, washing at the 77-88°C with water mixed with a degreasing and washing, drying at the 95°C through infrared rays heating.

Depositing the powder for sintering on the steel strip is made by means of a complex plant: the plant for the strip speed control and adjustment, the depositing plant proper and the suction hood.

To avoid the oxidation the powder and the steel, a neutral atmosphere is in the furnace and the sintering speed will be established according to the heating curve of the furnace.

The sintering process ends with the strip cooling. The cooling takes place in a complex and closed plant, the same neutral atmosphere being maintained, just like in the sintering furnace.

The lamination of the sintered aims obtaining the density of the deposited powder.

The Cu-Pb based powder sintering on the steel support is made in the sintering furnace ($t_{sint.}$=900-950°C).

According to the hardness of the alloy layer as well as to the tolerance of the double strip thickness, it is recommended to deal with:

- a final sintering and lamination;

- two sinterings and two laminations (a lamination in between the sinterings and a final lamination).

The lamination reduction will be made so that not to appear the melting of the lead from the alloy.

4. EXPERIMENTAL RESEARCH

The materials used in the production of the friction pieces for which there have been used samples and have been carried out studies and experimental research are the following ones: [1, 3, 4]

- Al-Sn plated on the steel support;
- Cu-Pb sintered powders on steel support.

AS20 (Steel Support Plated with Anti-Friction Material: 20% Tin, 1% Copper, the rest - Aluminum).

CP10S10 (Steel Support with Anti-Friction Material Sintered from: 23% Lead, 10% Tin, the rest - Copper).

These samples are presented in Figure 1.

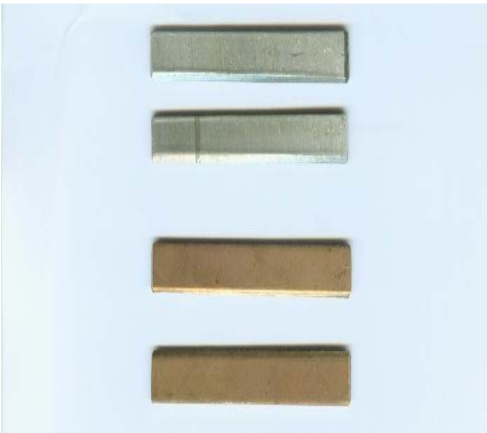


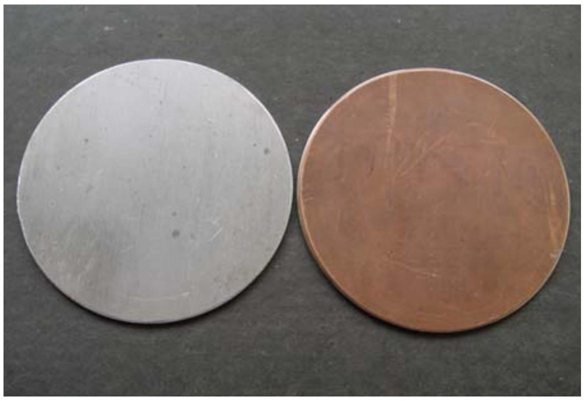
Fig. 1. Samples of Materials Used

Concerning these materials, there have been studied the following properties: chemical composition, micro-structure, resistance (hardness, stretching resistance, shearing, bending, adherence of the anti-friction layer), values of friction static quotients.

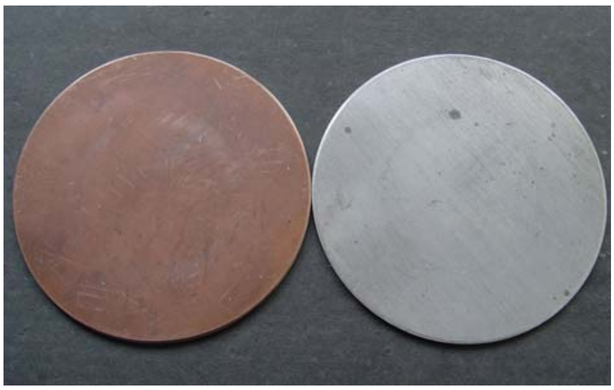
Experimental research studies have been made on a six couplings made out of different materials used when making the anti-friction materials: anti-friction material based on Aluminium-Tin (AS20) and steel OLC 45, anti friction material based on synthesized powders Cu-Pb (CP10S10) and steel OLC 45. These are presented in the figures 2 and 3.

Fig.2. The mobile semi coupling (steel OLC 45)

In figure 2 there are presented the four mobile semicuplings made out of steel OLC 45.



a



b

Fig.3. Fixed semi couplings (sintering materials)

In figure 3 (a, b) are presented the four fixed semi couplings (sintering antifriction material.

3. CONCLUSIONS

The anti friction material based on Cooper-Lead sintered powders has a metallic microstructure. During the sintering process between the granules can be explained the inter-atomic forces.

There is a metallic contact between the powder granules. This contact is seldom realized due to an oxide coating at the surface of the granules. The concentration of oxide cannot exceed the imposed value of 0.55% in the case of the powder under research, in order to preserve the metallic structure.

At the heat temperature from the sintering, the powder deposited on the steel suffers the phenomenon of surface and volume diffusion (in solid phase). This is explained by the fact that the atoms situated on the prominences of the powder granules move on the surface of the other granules, concentrating themselves in the surface unevenness. At the heat temperatures, the diffusion between the powder granules and those of the steel takes place. [4]

The factors which influence the Cooper-Lead powder sintering on the steel are: the sintering temperature, the heating speed, the cooling speed, the atmosphere, the size of the granules, diffusion, the powder.

The mixture of alumina and tin oxide is accepted only if the surface occupied by them doesn't exceed 80% of the interface length.

The sulphide inclusions, the foreign bodies inclusions and small cracks are accepted according to the adherence tests (chiselling, peeling).

The structures with superficial corrosion of tin melt at the alloy surface during annealing and inter-crystalline corrosion are unappropriate.

The double strips must not present a series of faults, such as: overlaps, surface slag imprints, oxide traces after pickling, foreign bodies inclusions, cracks.

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