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STUDY OF THE PROCESSING BY HEAT TREATMENTS OF BIMETALLIC BUSHINGS FOR AUTOMOBILES

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[1]SC PROCOMIMPEX SRL IASI, [2]SC PRESUM PROIECT SA IASI

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Abstract. The heat treatment of the bimetallic bushings of the automobiles must be seen as a compromise that satisfy the requirements both of the base material MB (hypoeutectoid carbon steel) and of the deposited layer SD (bronze with aluminium) regarding the framing in the temperatures range in which the phase transformations take place. Conforming to the phase equilibrium diagram, the bronze layers deposited present a variation of the solubility with the temperature, which involves the possibility of the modification of the physical-mechanical properties by heat treatments. The heat treatments applied to the bimetallic assembly hypoeutectoid carbon steel – bronze with aluminium can be the salt hardening, the aging and the homogenization annealing.

1. Introduction

The improvement of the physical-mechanical properties of the bimetallic bushings of hypoeutectoid carbon steel – bronze with aluminium by heat treatments has to be achieved taking into consideration the following aspects [1]:

- the heat treatment has to have favorable effects on the both metallic layers;
- if the improvement effect is preponderant for one of the layers, than at least not to present big disadvantages on the second one and not to affect negatively the specific adherence between layers;
- the heat treatment has to achieve a compromise that satisfy the requirements both of the base material MB and of the deposited layer SD. That's why the possibilities of thermal processing of the bimetallic components for automobiles are much reduced, only certain treatments and between certain limits can be applied with proper results.

2. The salt hardening of the bimetallic bushings for automobiles

The heat treatment of salt hardening has in view [2]:

- conservation at ambient temperature, in a metastable supersaturated condition, of the solid solution existent at high temperature;
- the supersaturated solid solution is obtained by rash cooling from the temperature of meting in solution (the transformation by precipitation of certain components from the solid solution cannot take place), the deposited layer (bronze with aluminium) conserving its mono-phase structure of the high temperature;
- the technological parameters of the salt hardening have been established experimentally. The temperature and time of maintaining at salt hardening must ensure the dissolving of the inter-metallic components in solid solution, the homogeneity of the solid solution, the obtaining of a proper size of the crystalline grain.

Bimetal OLT35-CuAl9T: $T_{salt\ hard}$ = 850-900^{o}C, $t_{maintain}$ ~ 0,5h, water-cooling.

- the effect of this treatment on the base material MB hypoeutectoid carbon steel does not present big shortcomings because the cooling of the bimetallic bushing in water from 850°C does not have the effect of a hardening in its self due to the low content of C of the base material MB- OLT35;

- the size of the heating speed is conditioned only by the capacity of the deposited layer SD of non-cracking at sudden temperature variations (for the bronzes with aluminium this variation of temperature can be maximum → the bushings can be introduced in the furnace directly at the treatment temperature);
- following the salt hardening, the deposited layer presents o mono-phase structure constituted of a metastable supersaturated solid solution α (alloying elements substitute the Cu atoms or penetrate in the net interstices) having low physical and mechanical properties.

3. Ageing

The ageing heat treatment has in view the following aspects [3]:

- the heating of the metastable structure obtained by salt hardening in such a way that this one evolves towards the condition of physical-chemical equilibrium;
- if the metastable structure is supersaturated solid solution then the ageing hardens and if it is of martensite type then the ageing softens;
- this treatment supposes the heating under the curve of variation of the solubility with the temperature, maintaining and slow cooling;
- the supersaturated solid solution passes in equilibrium condition, separating from it by precipitation certain inter-metallic components depending on the nature of the alloying elements and the values of the treatment parameters;
- the technological parameters have been determined experimentally:

  Bimetal OLT35-CuAl9T: T_{temp} = 480-500°C, $t_{maintain}$ ~ 1,5h, air-cooling.
- for the base material MB this treatment is equivalent with a high tempering
- having as effect the improvement of the rough ferrite-perlite structure and the diminishing of the acicular presence of the ferrite;
- the effect of the precipitation of the chemical compounds consists in the important increase of the mechanical characteristics due to the creation of the segregation areas, of the particles of precipitates metastable coherent and half-coherent to the matrix and of the fields of stresses existing around these ones; all these constitute obstacles in the way of displacement by sliding of the dislocations;
- in the case of the deposited layer SD – CuAl9T the most probably the following inter-metallic compounds precipitate : Cu_3Al, Al_2Cu, AlNi, Al_3Ni.

4. Homogenization annealing of the bimetallic components for cars

The heat treatment of homogenization annealing has in view the following aspects [4]:

- elimination of the dendrite segregation (the chemical composition defects from the inside of the deposited layer SD crystals, that alters the properties creating phases out of equilibrium);
- re-heating at as higher temperature, maintaining a sufficient period of time for the proper distribution by diffusion of the components;
- the technological parameters of the annealing homogenization have been experimentally determined:

Bimetal OLT35-CuSn10: T_{ann} = 650-700°C, $t_{maintain}$ = 5-8min/mm thick. wall ~0,5h, cooling in quiet air.

Bimetal OLT35-CuSn4Zn4Pb17: T_{ann} = 650°C, $t_{maintain}$ = 0,5 h, cooling in quiet air.

- important modifications of the SD structure are produced (structure with dendrite segregations → homogeneous mono-phase or bi-phase structure);

- for MB this treatment is equivalent with a complete stress relieving annealing, the level of the remnant stresses decreasing at values under 5 daN/mm^2 concomitantly with hydrogen elimination.

In fig.1 the diagrams of the heat treatments experimented for the bimetallic hypoeutectoid carbon steel – bronze are shown.

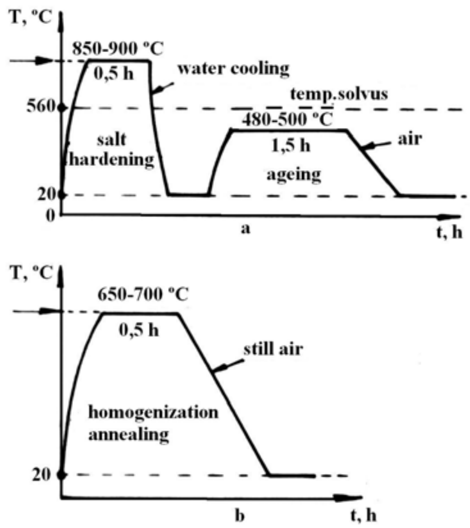

Fig.1. The heat treatment of the experimented bimetallic bushings for automobiles, made of hypoeutectoid carbon steel – bronze.
a. OLT35-CuAl9T → salt hardening + ageing;
b. OLT35- CuSn10, OLT 35- CuSn4Zn4Pb17 → homogenization annealing

5. Conclusions

The salt hardening induces in the bronze deposited layer a metastable mono-phase structure having low properties (the effect on the base material – hypoeutectoid carbon steel MB, does not present big disadvantages);

- Ageing leads to the evolution of metastable layers obtained by salt hardening to physical-chemical stability. If the metastable structure is of type supersaturated solid solution then the ageing hardens and if the metastable structure is of martensite type then the ageing softens the layers deposited on the base material;
- Homogenization annealing of the bimetallic components for automobiles has in view the elimination of the dendrite segregation that creates phases out of equilibrium leading to the reducing of the specific adherence between layers and to exfoliation.

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