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THE TREATMENT BY DIFFUSION OF THE CONICAL ACTIVE SURFACES OF THE DRIVER DISK FOR THE REVOLUTIONS SPEED VARIATOR

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ABSTRACT

The paper presents certain theoretical and practical aspects regarding the treatment of conical active surfaces of the driver disks for the mechanisms of the revolutions' continual speed variator by metallic settling through diffusion.

For increasing the friction coefficient between the active conical surfaces of the driver disks and lateral sides of the trapezoidal belt, the surfaces of the driver disks are treated by metallic settling through diffusion. The chromization of the variator disks made from OLC45 quality steel with 0.35-0.40 % C, was attempted at "Infratirea" factory from Oradea for the drilling machine with the speed variator named GV4.

1. INTRODUCTION

In the field machine construction certain mechanisms for continuous variation of speed are successfully used. Those mechanisms are placed between an electrical engine and an underdriven building block. The functioning of the speed variators is possible by modifying the drive disks diameter inversely laid with the conical parts on a channeled axis on which it can glide. Between the two disks there is a trapezoidal transmission belt and the transmission of the force is realized by contact between the lateral sides of the belt and the conic parts of the disks.

The oppression force of the disks on the edge of the belt is possible with the help of certain springs. Modifying the axial distance between the conical drive disks and automate washer the trapezoidal belt will have different positions on the conic side of the drive disks which lead to various diameters and, implicit, various gear ratio.

Due to certain differences that exist between the spring and that gliding construction of the disks, the oppression forces act dissimilar on those two disks. That aspect leads to belt creep when there are big loads on it.

This disadvantage is removed when the friction coefficient between the disks and the trapezoidal belt is increased. At "Infratirea" Oradea, by treatments with metallic settling through diffusion of the conic active surfaces of the driver disks, that disadvantage was solved. The treatment consists in the chromization in a solid environment of the variator disks. Disks are made by quality steel with 0.34 - 0.40 % C and pearlitic grey cast iron, Fc200.

2. THEORETICAL ASPECTS

The metallic covering through thermic diffusion is a method which enriches ceratin superficial structures of stable metals as far as the chemical and wear resistance are concerned.

One of the conditions for the thermic diffusion to take place is that the metallic support must form solid solutions with the metal.

Chromization represents the efficient thermic diffusion treatment of the steel and iron cast.

Metallic covering by diffusion of the parts made from hypoeutectoid steel and ledeburite cast iron is realized at high temperatures, in solid environments of poisonous substances (powders).

The thermic diffusion mechanisms depend on the type of the components, on the systems of metallic elements graining, atoms dimension.

The atomic diffusion depends on the kind of forces which develop in the enriched layer.

The fundamental rules of the physical phenomena of the thermic diffusion are Fick's laws.

The relation below represents the first law:

$$d_n = D \cdot \frac{dC}{dx} \cdot ds \cdot d\tau \qquad (1)$$

where D is the diffusion coefficient;
ds – the diffusion surface, in cm^2;
$\frac{dC}{dx}$ - the density variation;
$d\tau$ - the diffusion time variation;
dm – the diffusion variation.

The relation of the second law is:

$$\frac{dC}{dx} = D\frac{d^2C}{dx^2} \qquad (2)$$

with:

$$D = D_0 e^{-\frac{Q}{RT}} \qquad (3)$$

where: D_0 represents the pre exponential factor, in cm^2/s;
R – the general constant of gases, $R = 1.987$, cal/atom·grad·gramm;
Q – is the activation energy, in J/atom·grad;
D – represents the diffusion coefficient.

Depth variation of the diffusion layer according to the length of the process is revealed in the equation below:

$$x^2 = k \cdot t \qquad (4)$$

where x represents the diffusion layer depth in cm;
t is the length of the process in h;
k is the constant which depends on the kind of substance that diffuses.

Chromization, as a process that enriches the superficial layer with chrome, is based on chrome diffusion in Feα and Feγ.

In figure below a binary diagram Fe-Cr is shown.

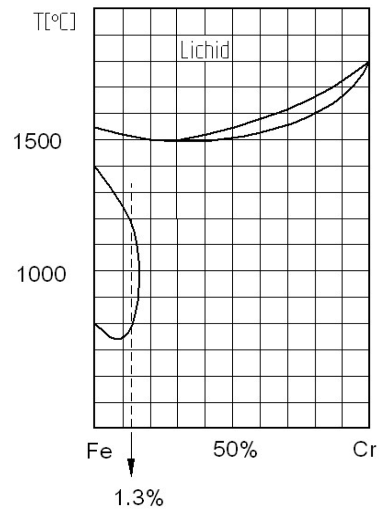

Fig. 1 Binary diagram Fe-Cr

The diffusion parameters of chrome in Feα and Feγ are: D_0=3 – 3,8·10^2 cm^2/sec; Q=82 kcal/atom·grad; Q=343,2 J/atom·grad.

The chrome is an alphagen element with a quicker diffusion in ferritical structure steels, causing the formation of the saturated α solid solution in chrome (fig. 1).

For a bigger concentration than 0.30% C steels, the structure of the chromized layer is formed from chrome mixed carbide with high hardness and wear resistance.

3. THE TREATMENT BY CHROMIZATION OF THE ACTIVE CONIC SURFACES OF THE DRIVE DISKS

In figure 2 is shown a side view with partial section of a speed variator.

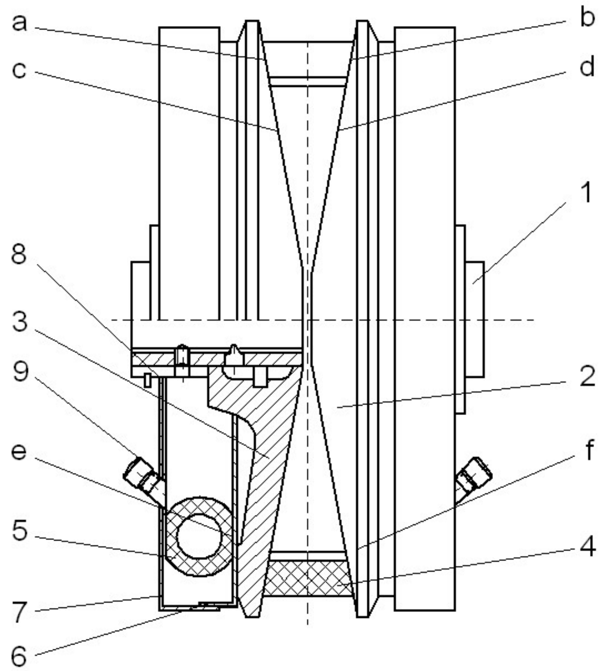

Fig. 2 Speed variator

The speed variator showed in figure 2 is composed from: 1 –grooved hub; 2, 3 – conic disks; 4 – trapezoidal belt; 5 – pneumatic room; 6, 7 – half housings; 8 – safety rings; 9 – valves; a, b – inclined parts of the belt; c, d – inclined parts of the disks; e, f – lateral sides of the conic disks.

The conic disks 2, 3 are made of quality rolled iron, OLC45 with over 0.35-0.40 %C. The inclined parts of the c and d disks are thermically treated by chromization. The drive disks are packed in boxes in powder mixtures formed from ferrochrome, china-clay or chamotte and ammonium chloride or hydrochloric acid. Packed pars are inserted in a horizontal furnace, heated by electrical resistance in a hydrogen or argon environment (fig.3).

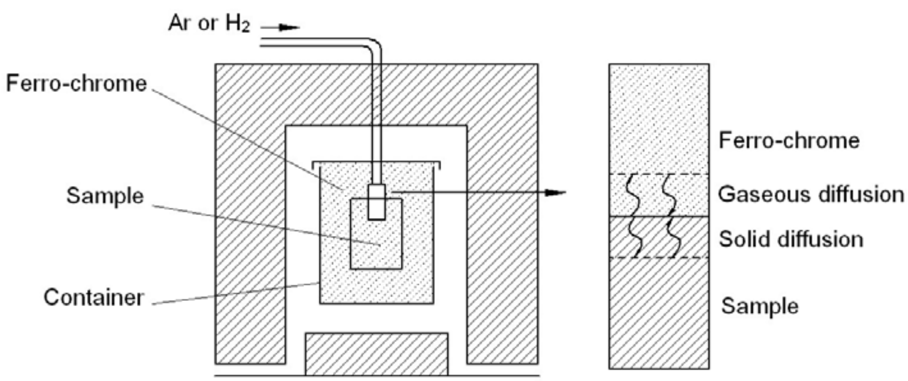

Fig. 3 Powder chromization process schema

The chromization temperature is 1100 – 1150 °C and the length of the process is about 10 – 15 hours.

I figure 4 the qualitative diagram of the chromization process is revealed. In the powder mixture, the china-clay or chamotte prevents the particles' sintering, being an inert addition. The ammonium chloride acts like a catalytic agent. Chrome trioxide (CrO_3) can be added in the powder mixture.

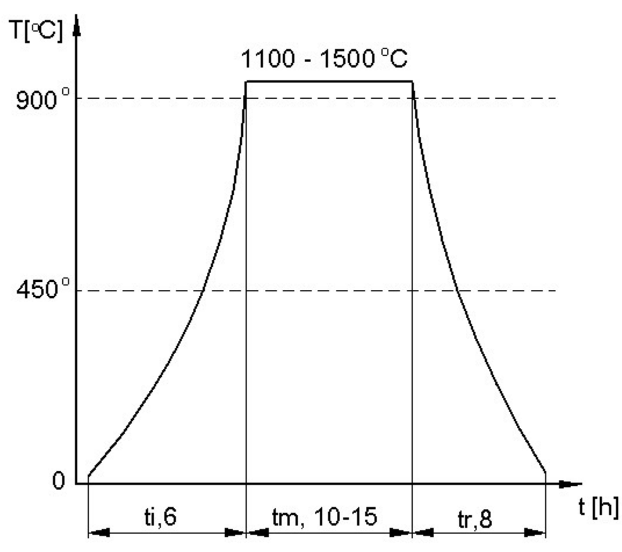

Fig. 4 Chromization treatment diagram

The structure of the chromization layer is formed from mixed chrome carbide and Fe-Cr alloy.

4. CONCLUSIONS

1. In the superficial layer the chrome atoms are mixed with those of the Feα and Feγ in the chromization diffusion process.
2. The diffusion of the chrome atoms in the binary solid solution Fe-Cr, in the superficial layer is an atomic diffusion with high concentration in chrome atoms, being an α solid solution oversaturated in chrome.
3. The chromized layer on the conic active surfaces of the conic drive disks made from OLC45 has a total depth of 12 – 15 μm with high wear resistance.
4. By the chromization treatment of the conic surfaces of the drive disks the friction coefficient between the active surfaces of the disks and the trapezoidal belt is increased.

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