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A COMPARISON OF CARBON LAYER GRADIENT OBTAINED BY PACK CARBURISING PROCES WITH RESULTS OF A GLOW DISCARGE CARBURISING TECHNIQUES OF STEEL

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ABSTRACT
In the literature there are many paper about carbon concentration profiles obtained using the glow discharge apparatus and compared with the similar date for vacuum and gas carburizing. The published results showed that plasma carburising compares favourably with the alternative methods. This paper provides compared information and results of the investigation of the carbon layer gradient obtained by pack carburization of the 20MnCrB5 steel for carburization in the comparison with carbon concentration profiles obtained by plasma carburization process of the similar steel and date, published in the literature. The results obtained and the conclusions drawn from this investigations address the topic of the diffusion process of the carbon through the steel as limiting factor of carburization.
Keywords: glow discharge, carburization of steel, carbon layer gradient

1. INTRODUCTION
Plasma carburizing process was introduced about twenty years ago in Europe, after very long and extensive investigations. According literature's dates, ten years ago in Europe worked five big installations for plasma carburization process, for different uses. The most new installations were made on the lines for gears production at Germans automobile producers. These furnaces are accompanied by oil quenching devices or with comprised gas .
Process is controlled by special computer's program for responsible initial and boundaries condition, with goals optimization of time distribution between of the carburization period and diffusion. Forming of the uniform carburized layer with wonted surface hardness and proposed useful layer depth it is possible obtain by defined potential and electric field, by defined gas pressure and varying of process time. Process is new and special and is wary expensive getting details about them [1].
The rule of the carbon transfer over the pack –carburization in the compound CMD070 of the structural steel for carburization and direct quenching 20MnCrB5 is described in this work. Particular attention is given to the carbon diffusion process and the achieved carbon microstructure as well. This work confirmed the hypothesis that the limiting factor of the carburization process of this steel is the transport of carbon atoms through the material, but not the process on the boundary surface between the steel and the gaseous phase. Detailed up-to-date metallographic investigations of the carburized steel microstructure are also made. Results obtained bay investigation which are partially presented in this work , could be used as a base about carburization technological process optimization in the aim

of solving the existing dilemmas about chemical composition, type of microstructure and mechanical properties of the 20 MnCrB5 steel especially in the control process for motor's industry [2].

2. MAIN THEME

Specimens for pack carburisation of the 20MnCrB5 steel for carburisation and direct quenching were machined from Ø 32mm bar stock into carbon layer gradient samples sizes of Ø25x5mm. The specimens were carburised in the box of the steel plate, in the experimental electric furnace. Mediums for pack carburisation were charcoal and granular „Durferit 30" and the temperatures of the proces were: 940º C, 1050º C and 1100º C. After proces of carburisation, specimens for carbon layer gradient were direct quenched, tempered in oil with 60º C and tempered 10 minutes in the lead bath on the 650º C. Carburised specimens were machined in to millings (chip) in the paralel layer with the 0,125 mm depth to the distance 1 to 3 mm from the surface of tested specimens. In the millings were chemical analysed carbon content and obtained concentration are presented such as „carbon layer gradient curves" [2]. In order to determine carbon layer depth by metallographic investigation, samples were subjected to metallographic analysis (microhardness testing-HV10) [1].

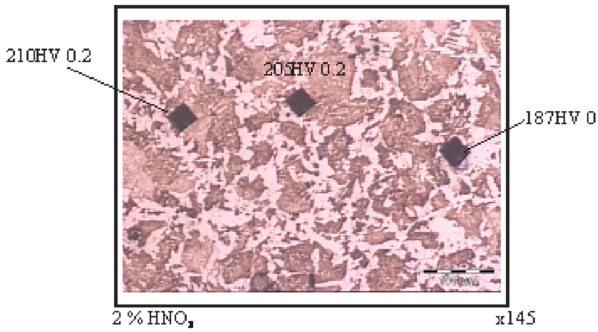

Figure 1. Microhardnes of the noncarburised steel [1]

The metallographic structures of the base steel were ferrit-perlit, figure1. Grain sizes and chemical composition of the investigated steel were in the standards garanted levels. The carbon layer structure of the examinated steel consists of the martensite, retained austenite and coarse martensite in the midle of the specimens, which provides good hardness of the surface and mechanical characteristic of the specimen's core. The following laboratory equipment was used:

- CUT machine Buehler Abrasiment-2 (Type 95-C-1800)
- Optical microscope Olympus PMG3 (20 to 2000x enlargement ratio)
- Stereo microscope Technival 2 (8 to 80x enlargement ratio)
- Vickers Micro hardnes testing device Zwick 3212 (measurement uncertainty $\leq \pm 0{,}5\%$)

3. RESULTS OF INVESTIGATIONS

3.1. Carbon layer gradient curve

Samples for the carbon layer gradient with size of Ø 25x5mm were machined in to millings (chip) in the paralel layer with the 0,125 mm depth to the distance 1 to 3 mm from the surface of tested specimens. In the millings were chemical analysed carbon content and obtained concentration are presented such as „carbon layer gradient curves", figures 2 and 3. Mean content of the carbon in the surface parts of carburised of the experimental obtained layers, over the carburisation in the power CMD070 , were about 1,1%C. Figure 4 present carbon concentration profiles conventional gas carburised and glow discharge carburised mild steel [3]. The gas carburising data menthioned on the figure 4 is taken from reference 14 [3].

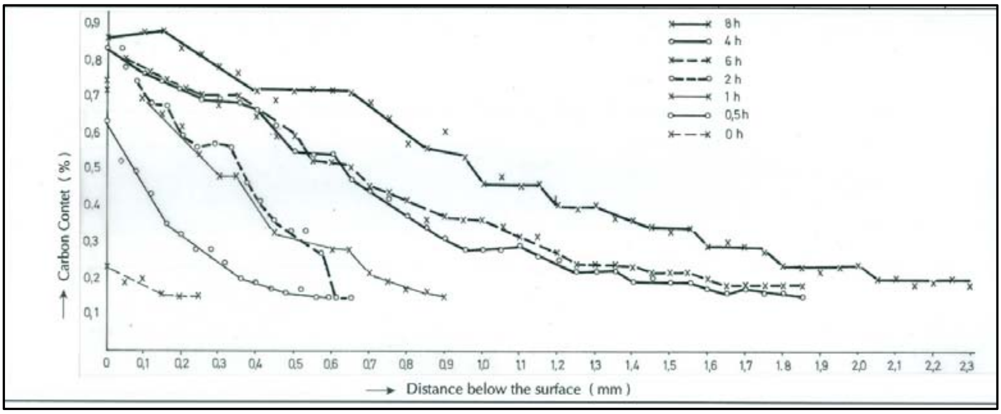

Figure 2. Pack-carburised carbon layer gradient curve obtained on the 940º C [2]

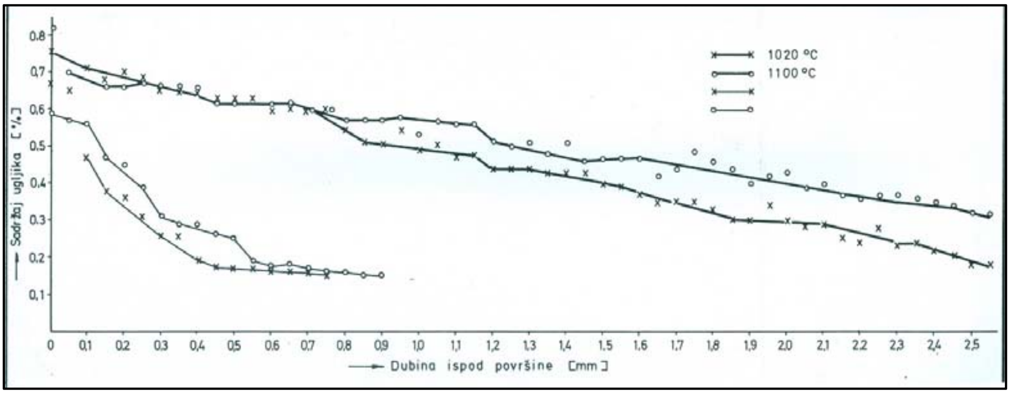

Figure 3. Pack-carburized carbon layer gradient curve obta ined on the 1020º C and 1100 º C [2]

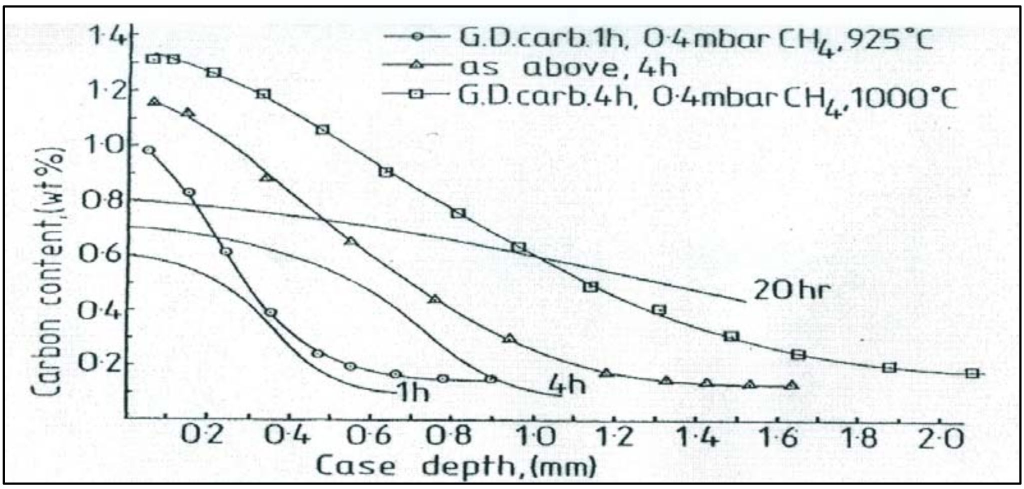

Figure 4.Plasma carburising process carbon layer gradient curve [3]

3.1. Microhardness testing

In order to determine carbon layer depth micro hardness testing was performed. Figure 5 shows location of micro hardness tests. All carburised specimens were tested on location with equal distance from the surface to the core [1].

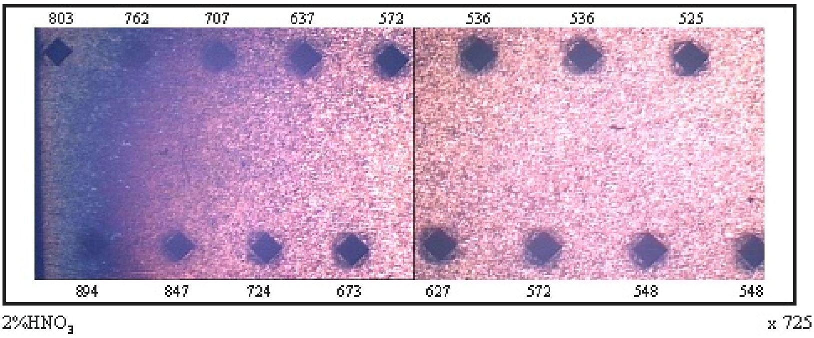

Figure 5. Microhardness values through carburised layer [1]

4. CONCLUSION

In the literature there are many paper about carbon concentration profiles obtained using the glow discharge apparatus and compared with the similar date for vacuum and gas carburizing. The published results showed that plasma carburising compares favourably with **the menthioned** alternative methods.

This paper provides compared information and results of the investigation of the carbon layer gradient obtained by pack-carburization of the 20MnCrB5 steel for carburization with carbon concentration profiles obtained by plasma carburization process of the similar steel and date, published in the literature.

This work confirmed the hypothesis that the limiting factor of the carburization process of this steel is the transport of carbon atoms through the material, but not the process on the boundary surface between the steel and the gaseous phase.

Results obtained bay investigation which are partially presented in this work, could be used as a base about carburization technological process optimization in the aim of solving the existing dilemmas about chemical composition, type of microstructure and mechanical properties of the 20 MnCrB5 steel especially in the control process for motor's industry.

5. REFERENCES

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