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Short Communication

Effect of Heat Treatments on the Mechanical Properties of a Form Tool

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During the follow-up of the cutting tools in the production workshops, we noticed that the cutting tools operate in severe conditions, for this we thought to improve their mechanical characteristics and increase their yield. Two key factors influencing these tools, namely geometry and heat treatment. In this study we chose the heat treatment, from a basic fast steel form tool, after making the milling cutter in the tool shop we proceeded to a revenue treatment to remove austenite residues. The purpose of our work is to increase the machining quota of a Z80WCV 18-04-01 high speed steel mill, for this reason our study is based on the reduction of residual austenite by incomes. cumulated after prior quenching for different austenitization temperatures (1240, 1260 and 1270 °C)

Keywords: Fluoroperovskite, GGA approach, Quasiparticles, Exciton energy, Absorption spectrum.

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1. INTRODUCTION

Precision manufacturing of cutting tools is generally better than that of the manufacture of the current mechanical parts. Especially for the shape tools: such as the form milling, not only the dimensional accuracy terminal, but also the good geometric accuracy and the good heat treatment. Thus the quality of the machined parts depends directly on this precision [1].

During the shaping of these tools the residual austenite is transformed into secondary martensite and / or bainite, which increases the ductility [2]. Thus, the steel obtained has high mechanical properties.

The machining of "hard" steels is a new process that uses cutting tools performance and particular cutting geometries. This process was developed for replace very expensive operations, such as abrasion finishing, and to protect the environment by eliminating lubrication (use of dry machining) [3]

The objective of this work is focused on the study of the influence of heat treatments on a type Z80WCV 18-04-01 basic high speed steel milling cutter with specific addition of cobalt, which we proceeded to improve. Mechanical characteristics by increasing its hardness; the carbides of chromium, tungsten and vanadium thus precipitate, following the depletion of the residual austenite by raising the hardness of the tool: this corresponds, as it were, to a multiple income [4].

Heat treatment operations are commonly carried out in furnaces with special atmospheres or under vacuum. The processes used are: curing treatments (quenching, cementation ...). Modification of the internal structures of the tools is achieved by heating to the expected temperature, maintaining the temperature in a given time and cooling at a certain speed

2. EXPERIMENTAL PROCEDURE

2.1 Material Studied

The material studied is a basic steel bar type Z80WCV 18-04-01, with specific addition of cobalt (5 and 9 %) of dimension Ø95 x 85 mm, intended for the manufacture of a milling cutter (Fig. 1). This material has the following advantages:

- high hardness 65 HRC after heat treatment;
- density 8.67·103 Kg/m^3;
- coefficient of expansion $13.0 \cdot 10^{-6}$ K^{-1} between 20 and 400 °C.

The chemical composition is shown in Table 1.

In the receiving state, the steel studied has a globular ferritol pearlitic microstructure. (See Fig. 2).

Fig. 1 – Design of the shape cuter

Table 1 – Chemical composition of steel

Z80WCV18-04-01	wt. %
C	0.82
Cr	3.76
W	18.034
Mo	0.251
V	1.05
Co	0.109

These steels were then subjected to treatment of incomes between 550 and 600 °C. after prior quenching (in a Bacl2 salt bath) since the austenitization temperature of 1300 °C. Quenching is often followed by a tempering which triggers the transformation of the residual austenite into martensite and the hardening by precipitation of the carbides, after their dispersion, under the effect of the partial decomposition of the martensite. Knowing that a simple income only transforms a part of the residual austenite; so that the latter transforms itself entirely into secondary martensite, we most often use the step income whose duration of each operation is of the order of 60 minutes

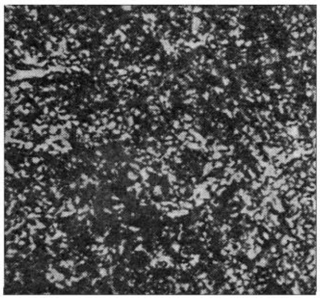

Fig. 2 – Steel Z80WCV18-04-01 Globular Perlite + Ferrite

3. RESULTS AND DISCUSSION

3.1 Influence of Cobalt on Hardness

We have tried to study the influence of cobalt on hardness, by varying the latter, we find that there is an increase in hardness when the content varies from 5 to 9%.

We have grouped the hardness curves in Fig. 3.

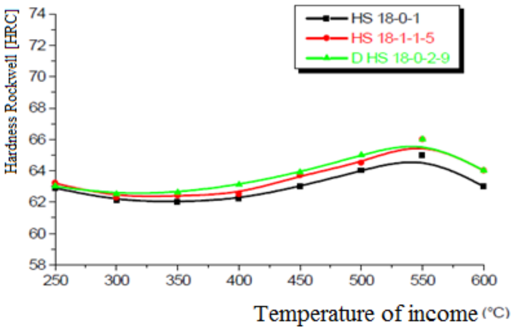

Fig 3 – Evolution of the hardness in function temperature for the three steels

Interpretation of the three curves.

In the case of an income, the evolutions involved depend clearly on the structural state developed after austenitization and quenching, the comparison of the results obtained during the heats from the various quenched states and by using various physical methods, allows us to propose the following interpretations:

a) For the first two stages of income between 200 and 400 °C., it is quite clear that they relate to the evolution of the martensitic phase; at these temperatures occurs first of all the elimination of internal stresses resulting from quenching; in addition, there is a rejection of some supersaturation elements in the martensitic phase essentially of carbon and chromium.

b) The structural evolution of the steel between 500-550 °C, the residual austenite begins to destabilize by rejecting some of these constituents which will precipitate in the form of carbides (most likely at the interfaces).

c) In the interval 500 to 600 °C the only phenomena likely to explain this peak are those which lead to the secondary hardening (indeed, the austenite is destabilized without being transformed and the supposed rejection of carbides by this phase can not that enhance the heat release associated with the precipitation of hardening carbides.Depending on the chemical composition of the three fast steels chosen, the percentage of tungsten is the same. This plays a big role in heat resistance. In the field of the three fast steels, one must know the hot hardness up to temperatures close to 600 °C.

In both cobalt steels the amount of cobalt makes it possible to quench at higher temperatures. Cobalt increases the hot hardness throughout the temperature range from ambient to 600 °C and delays the aging of the steel beyond secondary hardening. It also improves the resistance to catastrophic oxidation of steel when heating contents above 5% (Table 2).

Table 2 – Rockwell hardness according to the test temperature for the three steel

Temperature of income °[C]	250	300	350	400	450	500	550	600
Hardness Rockwell [HRC] HS 18-0-1	62.9	62.1	62	62.2	63	64	65	63
Hardness Rockwell[HRC]HS 18-1-1-5	63.2	62.3	62.4	62.5	63.7	64.5	66	64
Hardness Rockwell [HRC]HS 18-0-2-9	63	62.5	62.6	63.1	63.9	65	66	64

3.2 Evolution of Toughness According to Hardness

Fig. 4 shows the change in toughness as a function of the Rockwell hardness of HS 18-0-1 steel for temperatures (1200, 1220, 1240 and 1260 °C). We note that according to this figure when the hardness increases the material becomes fragile so the resistance to flexural fracture decreases for temperatures ranging from 1200 to 1260 °C (Table 3).

Table 3 – Evolution of Toughness According to Hardness

Hardness Rockwell (HRC)	62	63	64	65
Flexural strength (N)	6390	6290	5880	5140

3.3 Influence of Cobalt on Toughness

We have tried to study the influence of cobalt on the tenacity, by varying the latter between 5 and 9%. We notice that when the hardness increases with the latter the material becomes fragile and therefore the toughness decreased.

We have grouped the tenacity curves in the Fig. 5.

Interpretation of the three toughness curves.

Based on the toughness curves, we must choose the optimal heat treatments according to the conditions of use. This toughness property is defined as the possibility to withstand a high level of stress without sudden rupture. After carrying out the tests we find that the tempering temperature can vary only within narrow

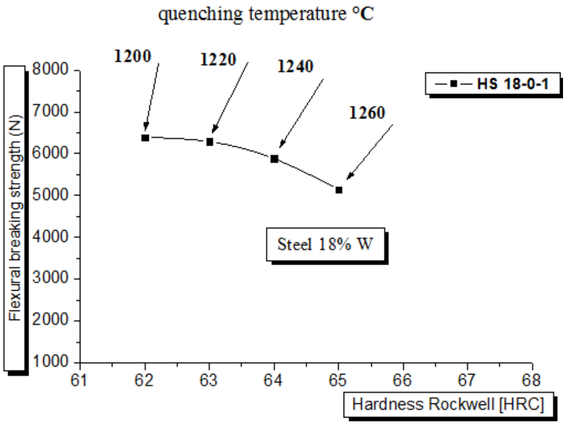

Fig. 4 – Evolution of toughness according to hardness

limits around 550 °C because the hardness drop as a function of the tempering temperature is too sensitive beyond 580 °C to choose the better compromise hardness-toughness, we play on the austenitization temperature.

4. CONCLUSIONS

After a cumulative income we eliminated a quantity of residual austenite and resulted in a very effective result that is to say elimination of the majority of residual austenite.

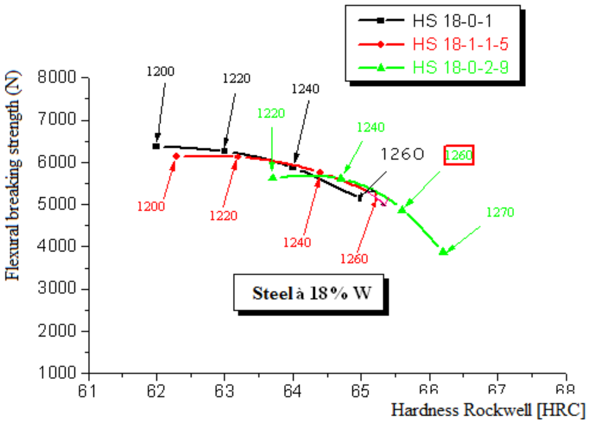

Fig. 5 – Volution of toughness versus hardness for the three steels

Confirmation with a conclusive test allowed us to increase the machining quota and to improve the hardness of the cutter and also to avoid regrinding until machining the number of parts prescribed in the machining range. The number of pieces machined by the cutter before the second income is 250 pieces, and after a cumulative income the number of machined parts 400. Finally an adequate heat treatment (cumulated income) gives a long duration for the shape cutter.

REFERENCES

1. A. Castel, *General Professional Technology* (Paris: 1980).
2. P. Jacques, Q. Fumément, A. Mtrens, F. Delannay, *Philosophical Magazine A*, 81 No. 7, 1789 (2001).
3. S. Benchiheub, *Etude de l'Interaction « Outil - Pièce » lors de l'Usinage des Matériaux Durcis* (Thèse Doctorat: Université d'Annaba: 2010).
4. R. Lévêque, *Digital Data on Tool Steels* (Engineering Technology: M332-24).