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BEHAVIOR OF Rp3-HIGH SPEED STEEL ON SHORT TIME NITRIDING IN FLUIDIZED BED

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ABSTRACT

For steel nitriding, treatment time is a important factor. Gas and plasma nitriding are usual method to increase surface properties by nitriding. A close retort is used. Total time for treatment are higher because are necessary transition time for heating and cooling. Fluidized bed offer a short time for heating and cooling because furnace having an open retort. Work paper is based by nitriding experiments by experimental fluidized bed furnace. A gas mixture of ammonia and nitrogen was used. For samples were used HHS (Rp3) . Results were investigated micrographic, surface hardness test (HV5) and micro hardness (HV0,05)..

KEYWORDS: Nitriding, fluidized bed, HSS, Rp3, short cycle

1.Introduction

High speed steel (HSS) having a good properties for cutting tools (resistance, hardness, wear resistance, thermal stability) and these properties is determined by chemical compositions (high quantity of alloying elements) and specific heat treatments. A carbon presence in chemical compositions of steel is necessary to a high quantity of complex metallic carbides dispersed in metallic matrix. For these properties HSS are actually used for many other applications: tools for die press forging, extrusion tools and hydraulic parts. For all tools is important hardness over surfaces and surface porosity to maintaining wear agent for a long time that increasing using time of tool. Some thermochemical treatments are used for increased hardness and surface profile control (nitrocarburizing, nitriding). The paper is based by nitriding in fluidized bed experiments. Some goals are following by thermochemical treatments:

higher values of superficial hardness
stability at high working temperature
corrosion resistance
decreasing values for friction coefficient
increasing durability.

Nitriding treatments of HSS is based by subcritical values of treatment temperature that conduced to low values of inside transformation in material. The treatments is localised at surfaces and a new hard complex with fine distribution is possible to appear before nitrogen diffused in material and alloying elements. Using a fluidized bed technology a short time for nitriding treatment is obtaining and a supplementary hardness appear because secondary brittle by Fe_4N fine dispersed in metallic grain is avoided.

2.Experiments

1. Base of experiments are intense chemical activity of fluidized bed made by granular solid (0,10…0,16mm, burned clay) and mixed gas from ammonia (33%) and nitrogen, 0. Working with open chamber make a reduced total nitriding time because samples is take off after nitriding time (1h, 2h and 3h) and was cooling in air. That procedure has a normal benefits by reducing total time of treatments and by eliminate a Fe_4N precipitates that decreasing hardness, 0. Nitriding in fluidized bed experiments were made on laboratory conditions and nitriding furnace is showing in

2. Fig. 1. For experiments was used samples from Rp3 steel (

Tab. 1). For all experiments a constant debit for mixed gases was used.

Tab. 1. *Chemical composition for Rp3 (HSS - T1-AISI, STAS 7382/90).*

C	Mn	Si	Cr	W	Mo	V	Co
0,7…0,8	max.0,45	0,30…0,40	3,62…4,40	17,5…19,5	max.0,60	1,0…1,4	-

Fig. 1. *Fluidized bed laboratory installation.*

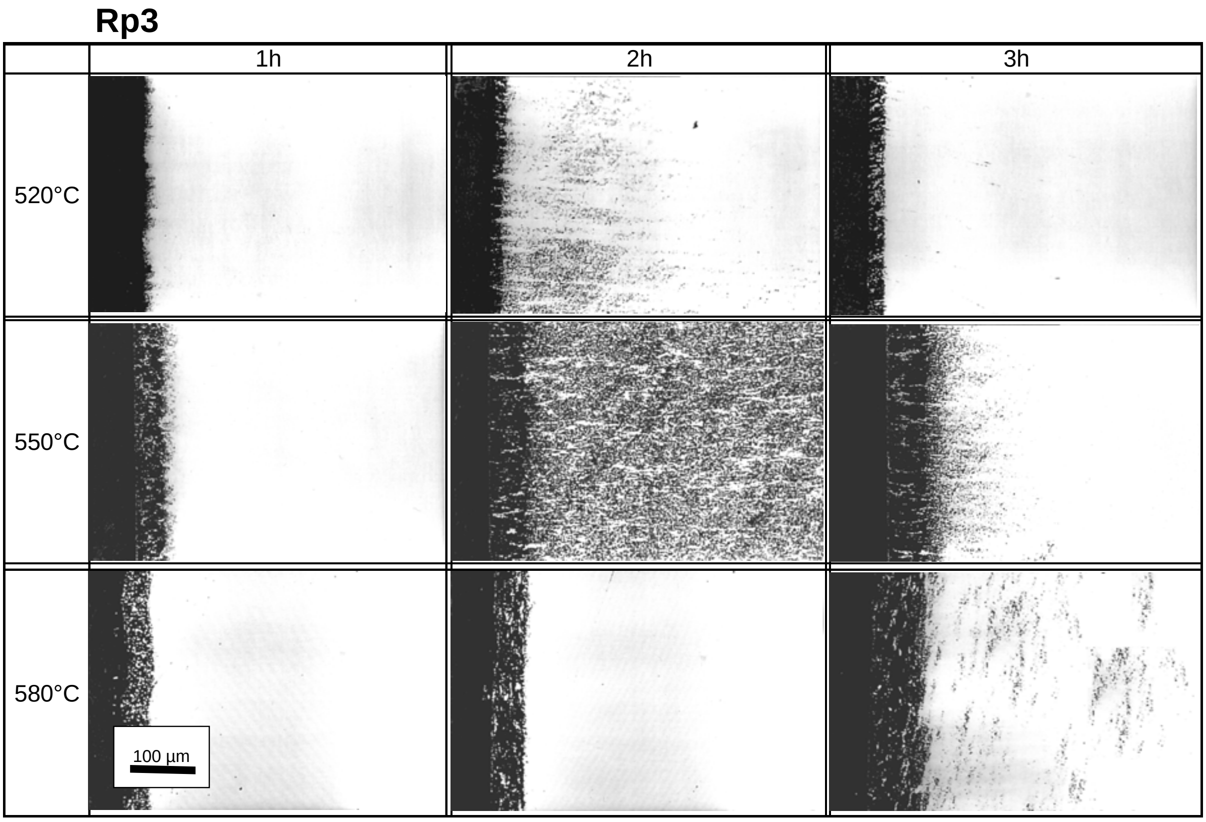

Fig. 2. *Micrographs for Rp3 steel samples after fluidized bed nitriding.*

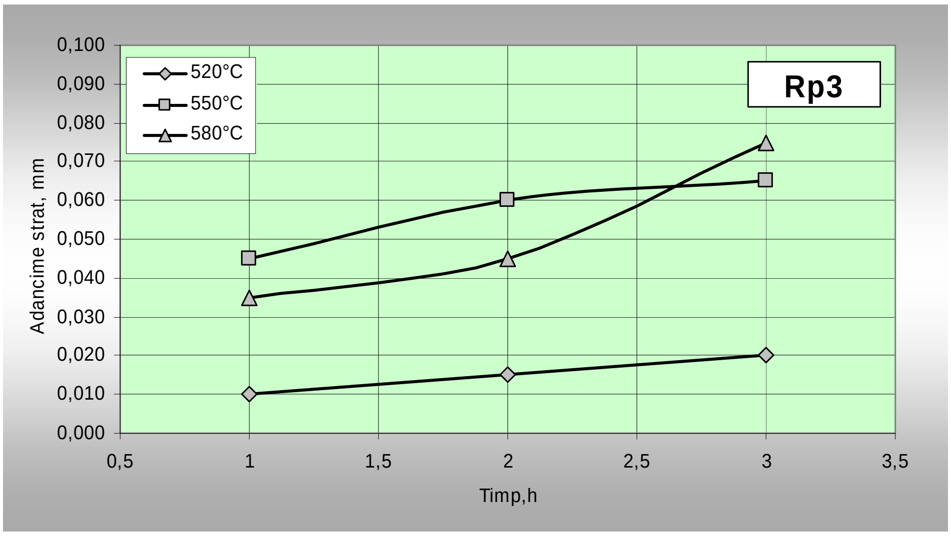

Fig. 3. *Nitriding layer depth variations with nitriding time and nitriding temperature.*

4.Results and discussion

For Rp3 steel samples micrographic analysis is showing in Fig. 2. For etching was used *royal water*. Micrographs showing a nitriding layers for all regimes, that are depending with nitriding time and nitriding temperature. Depth layer measurements on micrographs is showing in

Fig. **3**. Hardness measured on the nitriding surface is the most important properties after nitriding treatments.

3. The hardness after nitriding in fluidized bed is showing in Fig. 4 (measured by Vickers TPP-2, CIS, with load 5kgf). Hardness increasing with high values for nitriding temperature 550° C and 580°C, and for short time nitriding time (maximum 3h). Chemical and thermal activity of fluidized bed media are important for reducing time of treatments. After treatment the samples (parts or tools) was immediately take of that conduced to maintaining a hardness at high values, eliminated a secondary embrittlement of nitriding layer by Fe_4N (γ') acicular separation. Microhardness (Fig. 5, Fig. 6 and Fig. 7) was measured by nitriding section (metallographic samples) PMT-3 (CIS) microhardness tester with 50g load (0,050kgf). A cross section profile of hardness was determined using microhardness and this profile is in concordance with superficial hardness and micrographs.

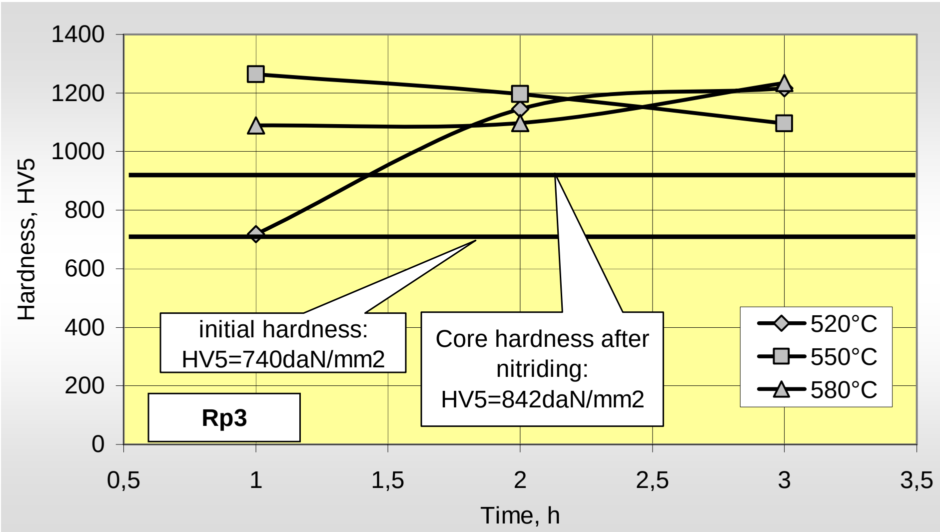

Fig. 4. *Hardness HV_5 after fluidized bed nitriding in function of nitriding temperature and nitriding time.*

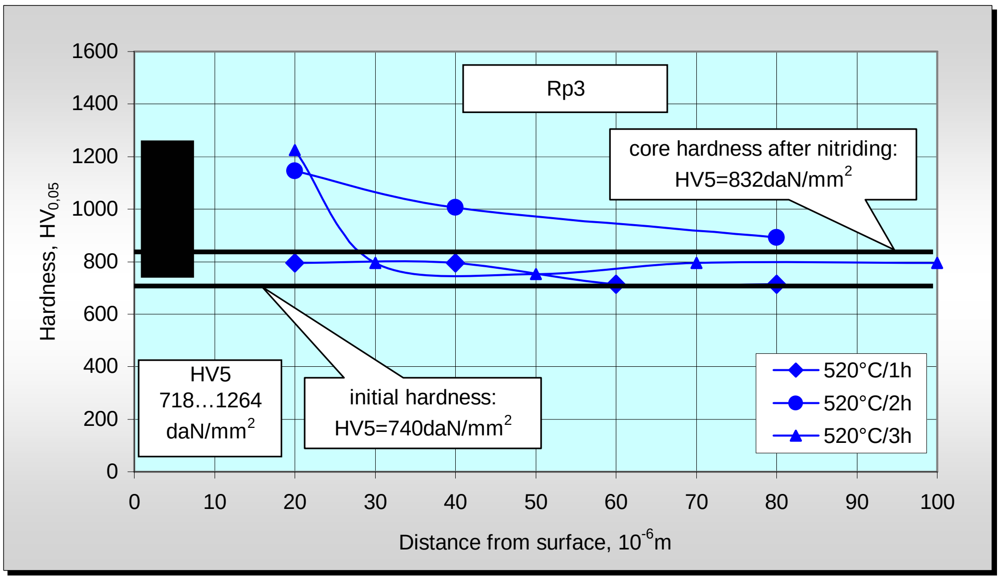

Fig. 5. *Micro hardness for Rp3 samples after fluidized bed nitriding at 520°C.*

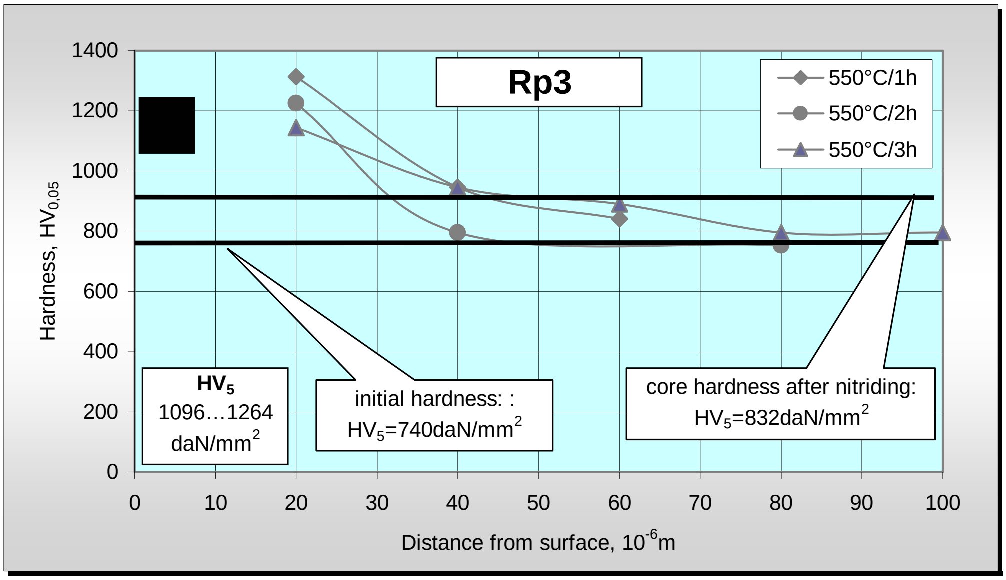

Fig. 6. *Micro hardness for Rp3 samples after fluidized bed nitriding at 550°C.*

Microhardness was measured by nitriding section (metallographic samples) PMT-3 (CIS) microhardness tester with 50g load (0,050kgf). A cross section profile of hardness was determined using microhardness and this profile is in concordance with superficial hardness and micrographs.

5.Conclusions

The Rp3 steel (HSS) having high quantity of alloying elements in chemical compositions. A very hardness metallic carbides dispersed in base matrix material. By nitriding a supplementary quantity of hard an thermal stable nitrures were dispersed by nitrogen diffused from nitriding media and by alloying elements from steel. A supplementary hardness increasing is associated by a superficial porosity increasing, and all conduced to a good behaviour of tools in cutting process. After nitriding in fluidized bed superficial hardness increasing with 250…400daN/mm^2.

The most higher value of hardness, 1234daN/mm^2 is obtaining at 580°C nitriding temperature and 3h for nitriding time. Microhardness ($HV_{0,05}$- 50 grams load) measured by metallographic sections showing a decreasing profile for hardness in sections. A secondary increasing of hardness is present in core of samples. Micrographs showing a structure with only a diffusion layer. An oxide layer is present on the surface of samples. Is appears because the samples is take out in air from fluidized bed at nitriding temperature and oxidation is present.

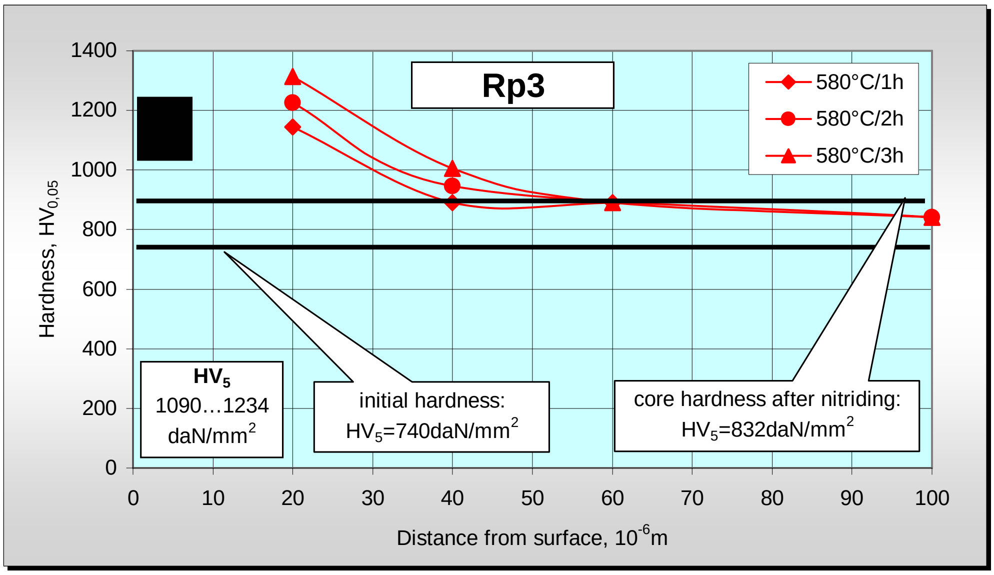

Fig. 7. *Micro hardness for Rp3 samples after fluidized bed nitriding at 580°C.*

The depth layer measured metallographic is depending by time and temperature. In fluidized bed conditions the total time of treatments is decreasing.
The furnace is at working temperature and is simple to introducing another parts to nitriding. The total efficiency of installations increasing when compare with ion nitriding and gas nitriding where heating and cooling represents higher values of time in correlation with effective nitriding time.

Fluidized bed nitriding is a favourable applications of internal and external fluidizations properties. High values of thermal conductivity an acceptable values of mass diffusivity are internal properties that determine high values for mass and thermal global coefficient of transfer. The nitriding surface having an apart gray nuance of colour because a thin ferrous oxide layer is present after nitriding when samples is cooling in air at atmosphere temperature.

Applications of fluidized nitriding thermochemical treatments for Rp3 steel is recommended to be at third tempering regimes for material.

References

[1]. Bâclea,A., *Some aspects concerning fluidized bed nitriding*, Proceeding of the MOC'40 Seminar, Odessa, 26-27 April 2001, pg.145;

[2]. Kunii,D., Levenspiel,O, *Fluidization engineering,* John Wiley & Sons, Inc., New York, 1969;

[3]. Bâclea.A., Drugescu.E., Cazacu.N., Dobrovici.S., *Some aspects concerning the nitriding steels in fluidized bed,* International Conference On Advances in Material and Processing Technologies, AMPT01, Leganes, Madrid, Spania, 18-21 Septembrie, 2001, Proceedings of The International Conference on Advanced Processing Technologies AMPT'01, vol. I, pag.131.

[4]. Ivanuş Gh, Todea I., Pop Al, Nicola S, Damian Gh, *Ingineria fluidizării,* Editura Tehnică, Bucureşti, 1996;

[5]. Drugescu E, Udvuleanu A, *Metalurgie fizică şi tratamente termice*, Lucrări de laborator, Universitatea din Galaţi, 1981;

[6]. Drugescu E, Udvuleanu A, Dobrovici S, *Tratamente termice. Lucrări de laborato*r, Universitatea din Galaţi, 1985;

[7]. Carţiş,I .Gh.,Tratamente termice. Tehnologie şi utilaje, Editura Facla, Timişoara,1982

[8]. Florian, E., Dulamiţă,T., *Tratamente termice şi termochimice*, Editura Didactică şi Pedagogică, Bucureşti,1982

[9]. Murry Guy, *Une nouvelle norme europeenne "Acier pour nitruration"*, Traitement Thermique, nr.339, mai 2002, pag.30

[10]. Dulamiţă. T., *Producerea si utilizarea atmosferelor controlate pentru tratamente termice*, Editura Tehnica, Bucureşti 1976;
Revista Tratamente termice şi ingineria suprafeţelor (ATTIS), Vol II, nr.1/2002, pag 39…40

[11]. Vermeşan,G., *Tratamente termice. Indrumător,* pag.167÷180, Editura Dacia Cluj Napoca, 1987.