BEHAVIOR OF 1% Cr STEELS AT FLUIDIZED BED NITROCARBURIZING

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ABSTRACT

Paper is based by nitrocarburizing experiments made on pilot installation. For experiments were used different samples of steel at different nitrocarburizing regimes. Influence factors were: temperature and ammonia concentration. Treatment time had a constant value 2h30min. Influences of factors were investigated by: samples mass modifications, surface structure (micrograph), layer depth to all samples and hardness HV5 on the surface. The results confirm possibility to use fluidized med like nitrocarburizing media and good behavior of steel.

KEYWORDS: Nitrocarburizing, fluidized bed, steel

1. Introduction

After nitriding, nitrocarburizing became the most usual treatments for pieces at lower temperature. Nitrocarburizing and oxynitrocarburizing became alternative technologies for parts of car industries. After this thermochemical treatment a surface layer with properties approaching at nitriding treatment is obtained, [2]. If a post oxidation is used to obtaining a Fe_3O_4 superficial a porous layer, which increases corrosion resistance of parts. Porous layer offer a good adherence for different sealant that conduce to one order increasing for a corrosion resistance. For efficiency of nitrocarburizing treatment evolution shows tendencies for quality and low costs. A complex processes are performed in fluidized bed. Gasses (ammonia and methane in different proportion) in active zone, near over separation plaque, are thermal decomposing in contact with hot solid granular.

The homogeneous reactions are possible to continue on the high of bed, but equilibrium is established at higher uniform regimes temperatures. A secondary stage is for heterogeneous reactions at surface samples, with adsorption of nitrogen and carbon atoms. As results of these two stage of reactions chemical compositions of gasses having major modifying: hydrogen and nitrogen and rests of methane and ammonia. These gasses produced normal fluidizations in bed and that maintaining a normal and a constant gas dynamics for constant properties of fluidized bed. A fluidized bed technology (FBT) for heat and thermo chemical treatments offers a low costs for investments and an acceptable quality [3]. The most important characteristics of fluidized bed are influenced by: chemical compositions of fluidization gas through physical gas properties and the solid granular properties (physical characteristics, shape, dimension)

High values for heat and mass transfer coefficient conduce to shorter treatment time and this technology may have applications for small enterprises and for small series of pieces.

2. Experimental conditions

Nitrocarburizing was made on the pilot conditions (

Fig. 1). The fluidized bed furnace has minimal conditions for nitrocarburizing. The furnace working up to 1000°C and a various gas mixtures is possible to use for different heat and thermochemical treatments. Fluidized beds are made from burned clay and a gas mixture by methane and ammonia, with different proportion of methane. Nitrocarburizing in fluidized bed is based by repeatability of process, [4]. The nitrocarburizing media was made in fluidized bed. In this case the internal and external properties of fluidized bed are important for treatment, because a large exchange surface is formed between fluidized bed and parts (samples). After fluidization, at outlet from furnace, gases were burned.

For nitrocarburizing experiments three steels with 1%Cr were used: 21TiMnCr12, 18MnCr10 and 40Cr10 (Romanian standards). Chemical compositions are showing in Tab. 1. The critical points for transformation for all steels are showing in Tab. 2. For all steels nitrocarburizing are a sub critical treatments, that's have not influence over core structure and properties.

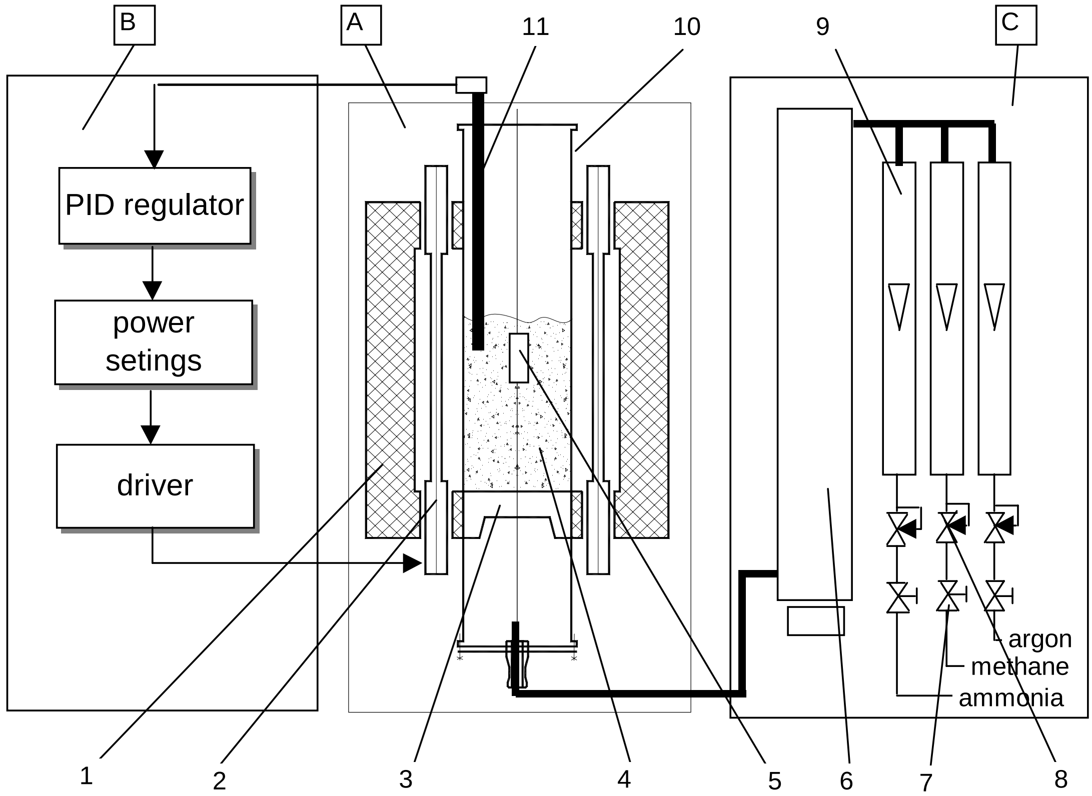

***Fig. 1**. Schematic representation of fluidized bed furnace: B-automatization unit, A- furnace unit, C-gas unit, 1-isolation, 2-resistors, 3-fluidiszation plaque, 4-fluidized bed, 5-samples, 6-silicogel column, 7-valves, 8-gas regulators, 9-rotameters, 10-fluidized bed furnace, 11-K thermocouple*

***Tab. 1.** Chemical composition for steel used in experiments*

Steel	Chemical composition,%.							
	C	Mn	Si	P	S	Cu	Cr	Ti
21TiMnCr12	0,20	0,95	0,28	0,014	0,016	-	1,05	0,06
18MnCr10	0,18	1,05	0,22	0,035	0,035	-	1,05	-
40Cr10	0,40	0,65	0,27	-	-	-	1,00	-

***Tab. 2.** Critical points for steels used in experiments*

No.	Steel	Ac1	Ac3
m.u.	-	°C	°C
1	21TiMnCr12	740	840
2	18MnCr10	765	838
3	40Cr10	743	782

Tab. 3. *Nitrocarburising in fluidized bed regimes*

No.	Temperature	Time	gas composition
	°C	h, min	%
1	550	2h30min	25% ammonia + 75% methane
2			15% ammonia + 85% methane
3			5% ammonia + 95% methane

Tab. 4. *Hardness measurements on the nitrocarburizing surface*

steel	ammonia contents (rest methane)	HV_5
m.u.	%	kgf/mm^2
21TiMnCr12	5	667
	15	752
	25	655
18MnCr10	5	524
	15	623
	25	549
40Cr10	5	655
	15	713
	25	677

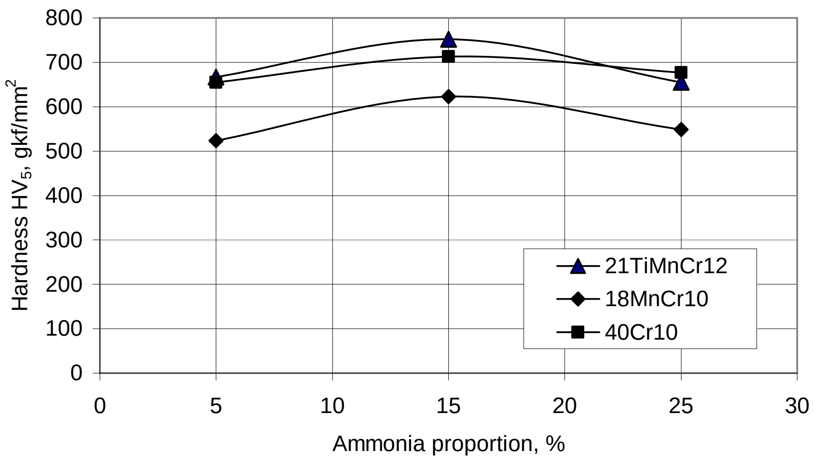

Fig. 2. *Hardness on the nitrocarburizing surface.*

Because ammonia is more expensive gas the proportion was varied between 5 and 25%, and the influence of ammonia proportion over experiments was studied (Tab. 3).

3. Results

The hardness on the surfaces is the technological properties that are usual determined. All steel having in chemical compositions approximate 1%Cr. That conduced to hard combinations at temperature and nitrogen presence in surface. As a normal result for all samples hardness (HV5) having higher values (***Tab. 4***, **Fig. 2**). For 15% ammonia contents in gas mixture for fluidization a maximum values were obtaining for all samples. Measurements of layer thickness for all nitrocarburizing samples are showing in **Fig. 3**. A normal increasing of layer depth by ammonia proportion is presence to all steel samples, but having different behaviour. The structure and properties of nitrocarburizing layer is determined by chemical compositions that conduced to particular behaviour of each steel samples.

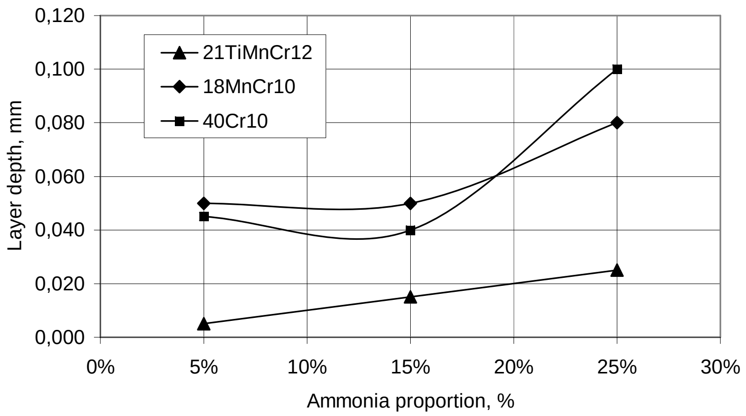

Fig. 3. *Nitrocarburizing layer variation with ammonia proportion*

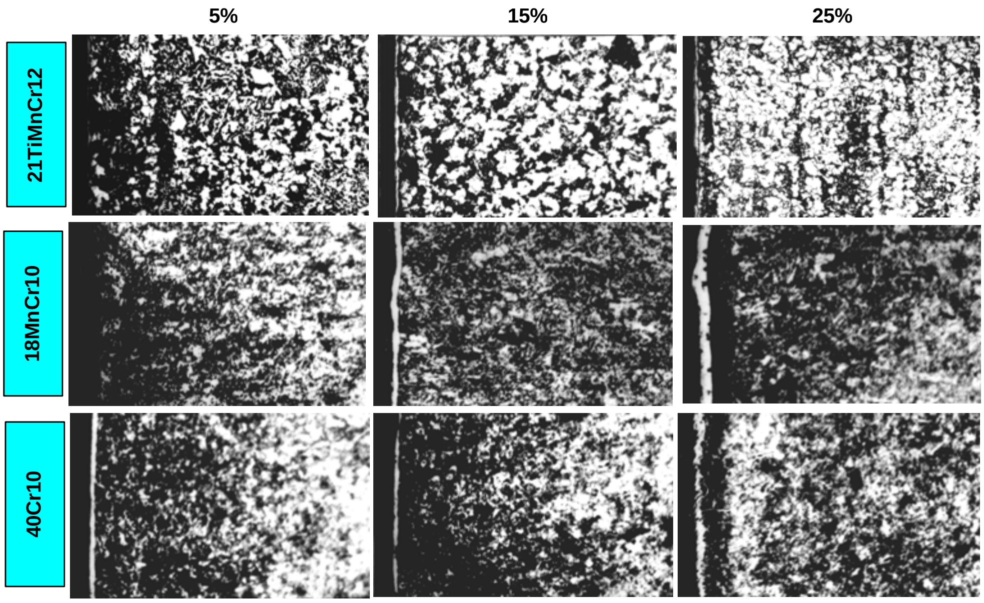

Fig. 4. *Representative microstructure for nitrocarburizing in fluidized bed layers*

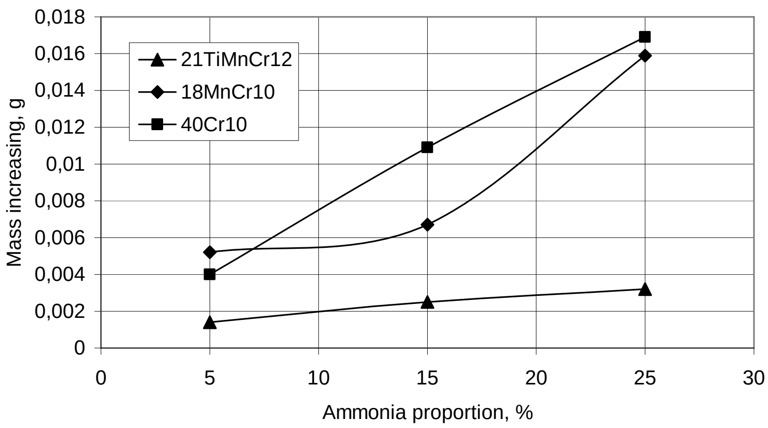

Fig. 5. *Mass increasing of nitrocarburizing samples*

For all steel samples representative microstructures are showing in **Fig. 4**. Combination layer has a normal increasing with ammonia proportion. Mass increasing for all steel samples was calculated by difference between final mass an initial mass, when the samples having identical shape and identical dimensions. The results are showing in **Fig. 5** Increasing of ammonia proportions in initial fluidization gas mixture conduced to mass increasing to all samples

4. Conclusions

Nitrocarburizing experiments made in fluidized bed over the samples from 1% Cr steels confirm fluidized bed capacity for mass transfer at higher temperature. Nitrocarburizing layer was formed for all regimes, and structures and properties of layer is depending by ammonia proportion in initial gas mixture. A maximum values for hardness is in 720…750 kgf/mm^2 interval, which is higher values for 150min nitrocarburizing time at 550°C temperature. A shorter treatment time is the most important characteristics of fluidized be d technology.

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