ZIBELINE INTERNATIONAL PUBLISHING
ISSN: 1024-1752
CODEN : JERDFO

Journal of Mechanical Engineering Research and Developments (JMERD)
DOI : ??.????/????.????.????.????

RESEARCH ARTICLE

THE ATMOSPHERE CONSTITUENTS FOR GAS CARBONITRIDING ANCHORAGE WEDGE

Le Thi Chieu[1], Nguyen Duong Nam[2*]

[1]Hanoi University of Science and Technology
[2]Vietnam Maritime University, Haiphong city, Vietnam
[*]Corresponding Author E-mail: namnd.khcs@vimaru.edu.vn

ARTICLE DETAILS

Article History:

Received 10 July 2019
Accepted 12 August 2019
Available online 20 August 2019

ABSTRACT

Carbonitriding is a case-hardening process sin which carbon and nitrogen are increased in the surface layer of a low-carbon parts at a temperature sufficient to render austenitenic steel. The followed by quenching and tempering to form martensite microstructure. In the comparison with carburizing, Carbonitriding is carried out at a lower temperature, for a shorter time and resultion finer microstructure. However, in our Industry, this method is not developed. The reason that the carbonitriding atmosphere is constituent unreasonably. On this paper, carbonitriding is prepared by mixture of Industrial gas, CO_2; N_2, NH_3, with different ratio. The reasonable ratios is selected. Microstructure, microhardness are tested. This atmosphere is applied for carbonitriding for anchorage wedges, shows good result.

KEYWORDS

carbonating process, anchorage wedges, Microstructure, martensitic microstructure.

1. INTRODUCTION

The carbonitriding process is a method of simultaneously increasing both carbon and nitrogen elements on the surface of a low carbon steel surface while the substrate composition remains constant. The surface will have high rigidity while the substrate still retains the required toughness. Carbon and nitrogen are carried out by placing details in environments with much higher concentrations of carbon and nitrogen than those in the steel substrate. Atomic carbon and nitrogen from the environment diffusion into the surface of detail, together with iron and alloying elements to create compounds with high hardness on the surface, creating high anti-wear properties. The detailed surface is of the highest quality when the total carbon and nitrogen content is about 0.9-1.3%. [1]. The total content of these two elements is smaller, the surface hardness will be lower, and if larger, it will lead to soot or create defect to worsen the physical properties [2]. Compared to carburizing, carbon-nitrogen permeability is carried out at lower temperatures, creating a finer, smaller organization that can be applied to many details such as gears, camshafts, paper cutters

In the world today, in traditional equipment, carbon-nitrogen permeability environments include gases that generate atomic carbon, usually natural gas (CH4), atomic nitrogen source (NH3) and other Padded gas has the effect of diluting the absorbent medium with the aim of maintaining a reasonable amount of carbon and nitrogen on the surface. In addition, air filters also have the effect of pushing the permeability process. In the United States, Russia is a pervasive endo gas, a gas made with special equipment. The ratio between gas and filler ranges from 1/30 to 1/8 of each type of gas and depends on the country as shown in Table 1.

Table 1: Temperament composition of Russia and America

Gas	Composition					
	CO	C_nH_{2n+2}	CO_2	N_2	H_2	other gas
Endogas	23	3,8	0,4	45,7	30	0,9 H_2O
Exothermic	10,5	0,5	5,0	71,5	12,5	
Endothermic	20,7	0,8	-	39,8	38,7	

From Table 1, it is found in permeability environment there are gases: CH4; CO; CO2; NH3: H2; N2. In which CH4; CO CO2 is a gas capable of atomic carbon, a source of carbon, a supply of nitrogen is NH3: H2, N2 is a diluted gas. The permeability reactions will occur:

$$CO + H2 \rightarrow [C] + H2O \quad (1)$$

[C] diffuses into the surface of the detail, along with the elements and alloy elements that make up the carbide

$$2NH3 \rightarrow 2\,(Nnt) + 6H \quad (2)$$

Similar to carbon, nitrogen reacts with elements in the background;

$$2NH3 + Fe \rightarrow Fe\,(N) + 3H2 \quad (3)$$

$$2NH3 + 8Fe \rightarrow 2Fe4N + 3H2 \quad (4)$$

In our country, because it has not produced gas, many companies have to import absorbent gas very expensive and troublesome. There is a permeability environment company that only includes gas sources (gas and NH3), very low permeability quality, does not promote the advantages of the C-N permeability method.

For the purpose of establishing a fully permeable CN environment on the basis of domestic materials for heat treatment of prestressed concrete cable core cores (Figure 1), we have done the research presented in the article. this. Anchor core works in harsh conditions: Being subjected to friction on the surface requires a high hardness surface (60-63HRC), both compressive and high toughness

Figure 1: Prestressed concrete cable anchorage core

The source gas used in industrial gas and NH3. CO2 gas is introduced to react with the gas to form carbon atoms. N2 and H2 are in love with the role

2. EXPERIMENTAL PROCEDURE

The infiltration process is carried out in the equipment system as described in the diagram on Figure 2

Diagram of seepage system

Figure 2: Absorbent furnace has an experimental scale

The air supply system is adjusted by the flowmeter designed and installed by workshop staff. Adjust the air volume of the stirring fan by changing the voltage applied to the motor. The permeability temperature is 840oC, the permeability time is 3 hours. Seepage details are SCM420 steel anchor core, which requires surface hardness of 60-63HRC, foundation hardness of 40HRC.

Absorbent mixture including industrial gas (50% C3H8, 50% C4H10); Co2 gas; N2; NH3

Gas / CO2 ratio varies from 0.5 to 1.8.

N2 gas is actively introduced after choosing the ratio of carbon and atomic nitrogen

Table 2: composition of carbonitriding

Flowing	Gas (%)	CO_2 (%)	NH_3 (%)	N_2 (%)	T°(C)
C1	10	18	10	62	840
C2	15	18	10	57	840
C3	20	17	10	53	840
C4	30	15	10	45	840

Reaction temperatures occur:

$$C3\ H8 + 3\ CO2 \rightarrow 6\ CO + 4\ H2 \quad (5)$$

$$CO + H2 \rightarrow [C] + H2O \quad (6)$$

$$And: 2NH3 \rightarrow 2\ (Nnt) + 6H \quad (7)$$

Thus, after the reaction, the environmental component will include gases: gas, CO2; N2; NH3. Chemical equilibrium calculations show that the ratio between gases equivalent to the permeability medium using endo gas, or else, the endo gas has formed itself in the furnace. Changing the rate of gases, studying the permeability quality can find the carbon function on the surface of the permeable layer, thus finding a reasonable rate of gas.

Since Vietnamese gas including C3H8 (propane), C4H10) (íobutan) has a higher C / H ratio than the gas used by other countries (CH4), it should be at the same temperature and time, Vietnam gas. when decomposing produces a larger amount of atomic carbon. That leads to the ability to create soot that interferes with permeability or creating defects. Therefore it is necessary to dilute the gas to reduce the amount of atomic carbon by increasing the rate of filler in the permeable gas mixture. In addition, C3H8 (propane), C4H10) gas (isobutane) are heavy gases compared to other components, so when putting into the oven, it is necessary to use stirring fans and should not be brought from the bottom of the oven.

The sample used is the anchor core made from SCM420 steel (component on table 3). After each batch of absorbent, details are cleaned of oil, cut and ground to check the microscopic organization with microscope Axiorvert 25 and Axiorvert 100, perform magnification 50, 100, 200, 500 and 1000 times. Microhardness is measured on the Duramin machine. The distance to hold the piercing nose is 50 µm, the load is 200g. The measured value is Vickers converted to HRC. Anchor core is tried to pull the Institute of Science - Technology, Ministry of Transport.

Table 3: Composition of anchorage core steel

% C	% Si	% Mn	%P	%S	% Cr	% Ni	% Mo
0,18	0,2	0,65	0,01	0,01	1,2	0,08	0,15

3. RESULTS AND DISCUSSION

3.1 The composition C1

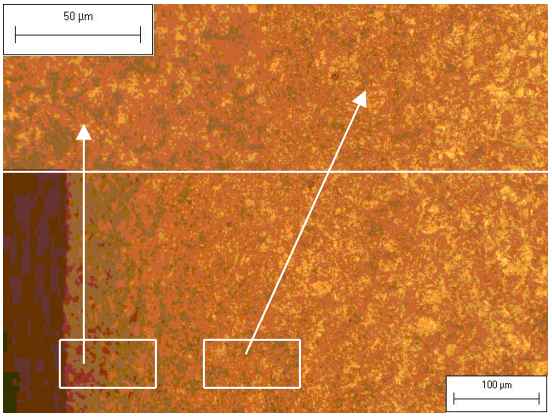

Figure 3: Microstructure with C1 composition

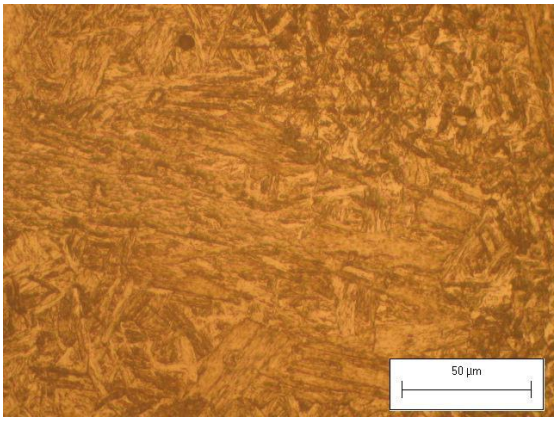

Figure 4: Microstructure the base of steel after carbonitriding and quenching

Microstruce in Figure 3 shows: grain size is fine. The magnification of 200 times shows the difference of different regions of the permeability layer. With a magnification of 500 times, the carbides and nitrite phases can be seen (hardness of 64.8 HRC in Figure 5), the next region has a martensite structure. Steel substrate after quenching have a low carbon martensite structure, has 45HRC hardness (Figure 4)

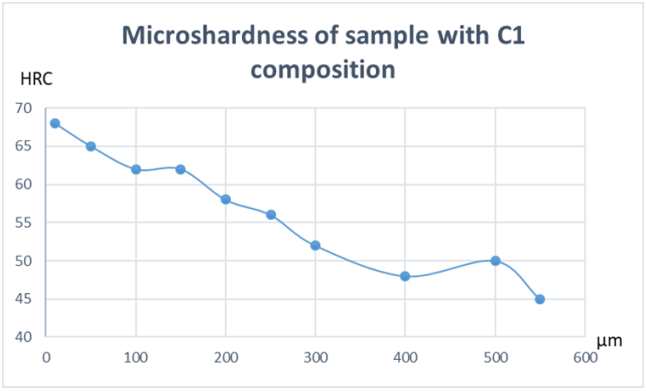

Figure 5: Microhardness of sample with C1 composition

3.2 The composition C2

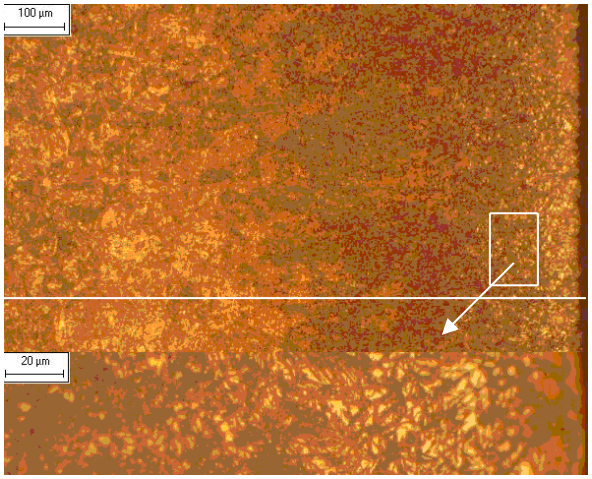

Figure 6: Microstructure with C2 composition

Microstructure in Figure 6 shows: Structure has fine grain, With 200 times magnification (upper part of Figure 6), it is possible to see different areas of permeability layer. When magnified 500 times (lower part), see the martensite structure (black needle) and light-colored austenite. The presence of residual austenite makes the surface hardness slightly lower (58.8HRC) as shown on the hardness distribution line as shown in Figure 7.

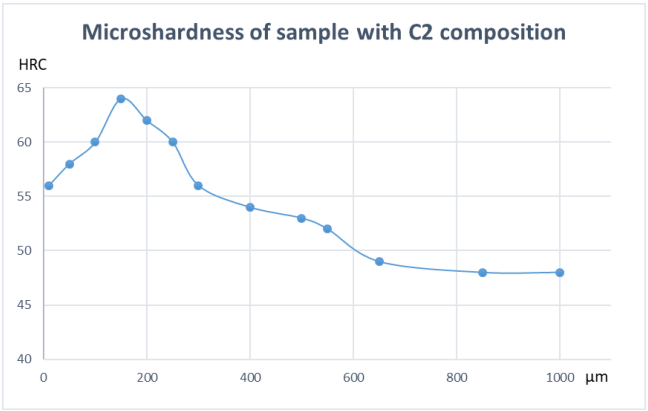

Figure 7: Microhardness of sample with C2 composition

The surface hardness is relatively low compared to the hardness of component C1 (58.8HRC). May be due to the presence of residual austenite. The hardness from the surface to the substrate varies in a harmonious way.

3.3 The composition C3

Component C3 has a relatively small CO2 / gas ratio, high carbon content, high surface hardness

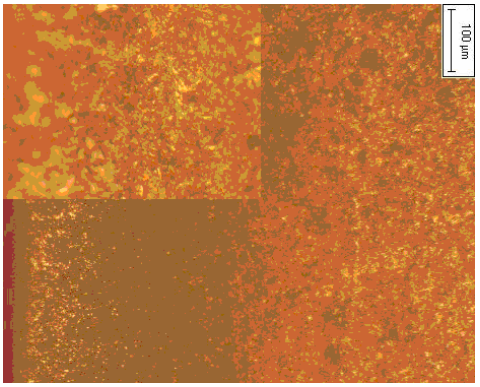

Figure 8: Microstructure with C3 composition

With a magnification of 100 times the overall structure of the permeability, layer can be seen. The outer region has light dots of carbide and nitrogen (more visible while magnifying 500 times (exaggerated marking area), followed by fine small (black) metallurgical areas with high values on the glycolysis hardness after that is the transition area.

The hardness distribution line also reflects the change of microstructure: The surface hardness value is 65HRC, the overall depth of the permeability layer is not large. Perhaps due to the relatively large amount of gas, the generated carbide phases prevent the diffusion of carbon and nitrogen. However, the effective thickness of the permeability layer (distance from the point of hardness 50HRC to the surface) is quite large, ensuring the abrasion resistance of the anchor core (Figure 9).

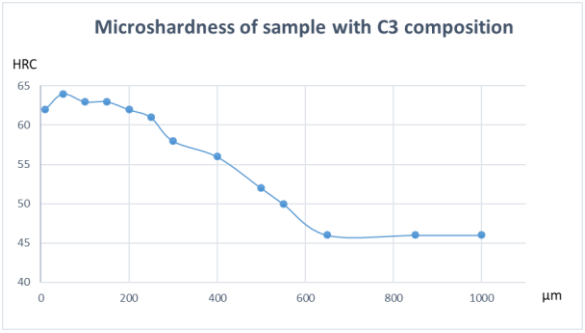

Figure 9: Microhardness of sample with C3 composition

3.4 The composition C4

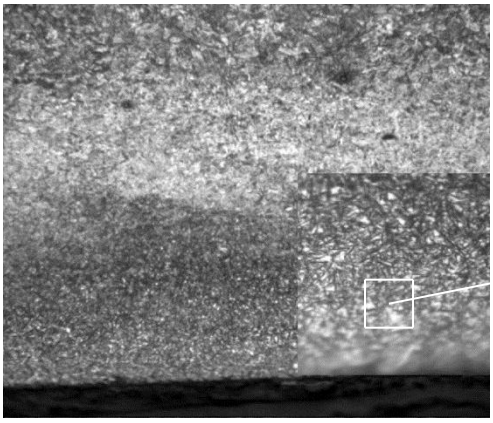

Figure 10: Microhardness of sample with C4 composition

Clearly visible in a finer microstructure, the 500-fold magnification clearly shows very high amounts of carbide and nitrogen (light-colored particles). The microhardness of the distribution line (Figure 11) shows that the surface hardness is quite low, possibly due to a large amount of gas, large surface carbon content increases the non-martensite after quenching.

All anchor core absorbent according to C1 mode; C2; C3 when trying to pull in the Ministry of Transport's Science and Technology Department has achieved TC (Transportation industry standard) on traction (over 18 tons) and cable holding capacity..

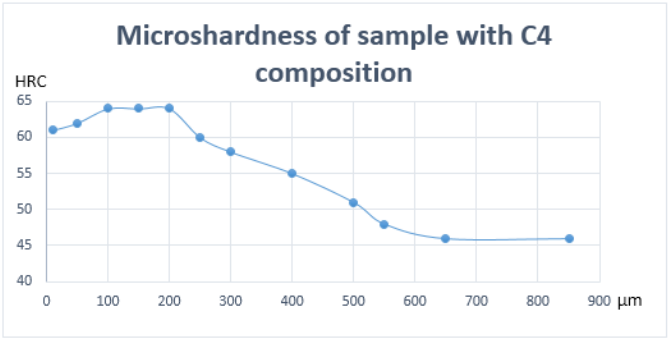

Figure 11: Microhardness of sample with C3 composition

4. CONCLUSIONS

1. With the appropriate ratio of carbon-nitrogen-permeable gases and environments, it is possible to establish the gases available in Vietnam. Samples permeable in C1 mode; C2; C3 all have nest, smooth, high surface hardness, suitable hardness. The anchor core absorbent according to the above regimes all meet and exceed TCN.
2. When changing the permeability rate, the permeability properties change. The ratio of CO2 / gas in the range of 0.8 to 1.8 permeability is not much changed. When drastically reducing the CO2 / gas ratio is 0.5, surface hardness significantly decreases.

REFERENCES

[1] Le Thi Chieu, Carburizing, Carbonitriding and Nitriding Process, NXB BKHN, 2015.

[2] ASM, Heat treating, Vol 4, 2011.

[3] Jerzy Ratajski, Roman Olik, Tomasz Suszko, Jerzy Dobrodziej and Jerzy Michalski: Design, Control and in Situ Visualization of gas nitriding Process. Sensors . 2010, 10, 219-240. DOI: 10.3390/s100100218

[4] Dobrodziej, J.; Mazurkiewicz, A.; Ratajski, J.; Suszko, T.; Michalski, J. The methodology of fuzzy logic application in the modelling of thermodiffusive and PVD processes—Intelligent tools for support of designing in surface treatments. In Proceedings of the International Federation of Heat Treatment and Surface Engineering (IFHTSE) Congress, Brisbane, Australia, 2007.

[5] Reti, T.; Czinege, I.; Frelde, I.; Grum, J.; Ju, D.Y. Selection of tools materials for cold forming operations using a computerized decision support system. In Proceedings of the 17th International Federation of Heat Treatment and Surface Engineering (IFHTSE) Congress, Kobe, Japan, 2008.

[6] Burakowski, T.; Wierzchoń, T. Surface engineering of metals: principles, equipment, technologies. Taylor and Francis Group, LLC: Boca Raton, FL, USA, 2008.

[7] Dobrzański, L.A.; Madejski, J. Prototype of an expert system for selection of coatings for metals. J. Mater. Proc. Technol. 2006, 175, 163-172.

[8] Mazurkiewicz, A. Mechanisms of knowledge transformation in the area of advanced technologies of surface engineering. In Incorporating Heat Treatment of Metals International Heat Treatment and Surface Engineering; IOM3: London, UK, 2007; Volume 1, pp. 108-113.

[9] Harada, A. The framework of Kansei engineering. Report of Modelling the Evaluation Structure of Kansei. University of Tsukuba, Tsukuba, Japan, 1997; pp. 49-55.

[10] Pitsch, W.; Houdremont, E. Ein Beitrug zum System Eisen-Stickstoff. Archiv für das Eisenhüttenwesen 1956, 27, 281-284.

[11] Gurov, K.P.; Kartaszkin, B.A.; Ugastie, J.E. Wzimnaja Diffuzija w Mnogofaznych Sistemach; Nauka: Moscow, Russia, 1981.

[12] Ratajski, J. Model of growth kinetics of nitrided layer in the binary Fe-N system. Zeitschrift fur Metallkunde 2004, 95, 23-29.

[13] Luger, G.F. Artificial intelligence and strategie for complex problem solving. 5th ed.; Addison- Wesley: London, UK, 2005.

[14] Frazer, B.C. Magnetic structure of Fe4N. Phys. Rev. 1958, 112, 751-754.

[15] Eickel, K.H.; Pitsch, W. Magnetic Property of Heksagonal Nitride Fe2,3 N. Phys. Stat. Sol. 1970, 39, 121-131.

[16] Heptner, H.; Stroppe, H. Magnetische und magneinductive Werkstoffprüfung; VEB Deutscher Verlag für Grundstoffindustrie: Leipzig, Germany, 1965.

[17] Mittemeijer, E.J. The relation between macro-and microstresses and mechanical. In Proceedings of the TMS-AIME Session on "Microstructural and Residual Stress Effects on the Properties of Case-Hardened steels", Warrendale, PA, USA, 1984; pp. 161-187.

[18] B. Edenhofer, W. Grafen, J. Muller-Ziller: Plasma-carburising and surface heat treatment process for the new century, Surface and Coatings Technology 143-144 (3001), p. 335-334

[19] Winfried Gräfen, Bernd Edenhofer: New developments in thermo-chemical diffusion processes, Surface & Coatings Technology 300 (3005), p.1330–1336

[20] M.F. Yan, Z.R. Liu: Study on microstructure and microhardness in surface layer of 30CrMnTi steel carburised at 330oC with and without RE, Materials Chemistry and Physics 73 (3001), p.97–100.

[21] N. A. Titov: Carbon potential and composition of a neutral controlled atmosphere produced from methane and a nitrogen-oxygen mixture, Metallovedenie i Termicheskaya Obrabotka Metallov, No.6(1993), p. 10-14

[22] V. G. Khoroshailov and E. L. Gyulikhandanov: Saturation of steel in carburising and nitrocementation, Metallovedenie i Termicheskaya Obrabotka Metallov,No. 69(1970), p. 73

[23] L. A. Mikhailov: Calculation of the parameters of the process and the gas condition during carburising, Metallovedenie i Termicheskaya Obrabotka Metallov, No. 79(1973), pp. 71-75