ARCHIVES
of
FOUNDRY ENGINEERING
Published quarterly as the organ of the Foundry Commission of the Polish Academy of Sciences

ISSN (1897-3310)
Volume 9
Issue 1/2009
103-106

23/1

The influence of grinding parameters of the surface layer of low-alloyed high-speed steel

J. Jaworski
Department of Manufacturing Processes and Production Organization,
Rzeszow University of Technology, ul. W. Pola 2, 350 – 9509 Rzeszow
Contact: e – mail: jjktmiop@prz.rzeszow.pl:

Received 26.02.2009; accepted in revised form: 30.03.2009

Summary

The measurements of machining forces, temperature and quality parameters of surface layer and ratio of grinding property of selected grades of low-alloyed high speed steels were carried out. It was shown that improvement of grinding properties of low-alloyed high-speed steels is possible on the way of efficient selection of their chemical constitution, which is confirmed by results of researches of grinding properties of SW2M5 steel

Key words: temperature, grinding forces, grinding properties, secondary austenite

1. Introduction

It is a well-known fact, that during tools sharpening, their tool life is often subject to changes [1,2]. Loss of tool life under cut is caused by wheel burns on a surface of tool point, which are formed during tools sharpening. High temperatures of grinding facilitate the formation of increased amount of secondary austenite on a surface layer of high-speed steel. It reduces tool life under cut. Therefore, possibility of these defects appearance should be excluded by choice of adequate sharpening parameters.
The aim of this work was investigation for establish "The influence of grinding parameters on: forces, temperature, grinding ratio and surface layer parameters of selected grades of low-alloyed high-speed steels" /LAHSS/.

2. Research method

The samples for research with dimensions 6x6x65 mm were made of experimental melts. Table 1 shows their chemical constitution. The heat treatment was carried out according to recommendation of suitable standards.
A researches were carried out on the flat-surface grinder with a disk-type grinding wheel 25A-60-KUBE33 without cooling. Influence of grinding parameters were defined especially for: forces, temperature, roughness of surface and coefficient of grinding with a large range of grinding parameters: Vc=20 m/s, ap=0,005-0,035, Vf=2-6 m/min, without cross-feed on the whole width of sample. After each researches the disk-type grinding wheel was honing by diamond honing. Temperature was measured by half-artificial thermocouple according to methodology, which is known[3,4]. Force was measured by using dynamometer, whereas roughness of surface was measured using profilograph Sutronic 3+ and micro-hardness by using micro-hardness tester Brivisor KL2 on oblique cuts. Amount of secondary austenite both on the surface and on the depth of its falling into areas was determined by Philips device. Coefficient of grinding is evaluated using the following formula: k=Qm/Py, where Qm – amount of material, which is taken off in time unit, Py – inverted grinding force.

Table 1. New low-alloyed high speed steel grades – chemical constitution and physical-mechanical properties

Steel grade	Chemical constitution in %						Physical-mechanical properties			
	C	W	Mo	Cr	V	Si	Hardness HRC	Strength Rg MPa	Impact resistance J/m^2	Hardening temperature K
ABCIII	1,00	2,98	2,83	4,2	2,30		64	3500	3,2 x10^5	1453-1483
SW2M5	0,99	1,67	4,79	3,7	1,15		64	3300	4,2 x10^5	1353-1443
SW3S2	1,11	3,35	1,15	4,6	1,75	2,05	63	3500	4,6 x 10^5	1353- 1443
SW7M	0,82	5,55	5,13	4,2	2,06		64	3400	4,8 x 10^5	1473- 1503

3. Results and discussion

Results of investigation of machining forces in dependence on grinding depth and lengthwise feed are presented in figure 1.

As it can be seen in figure 1, the both parameters influence of forces identically during grinding of selected four grades of high-speed steels but value of forces is different. The least force is for steels SW2M5 and SW7M and it rises during steels ABCIII and SW3S2 grinding.

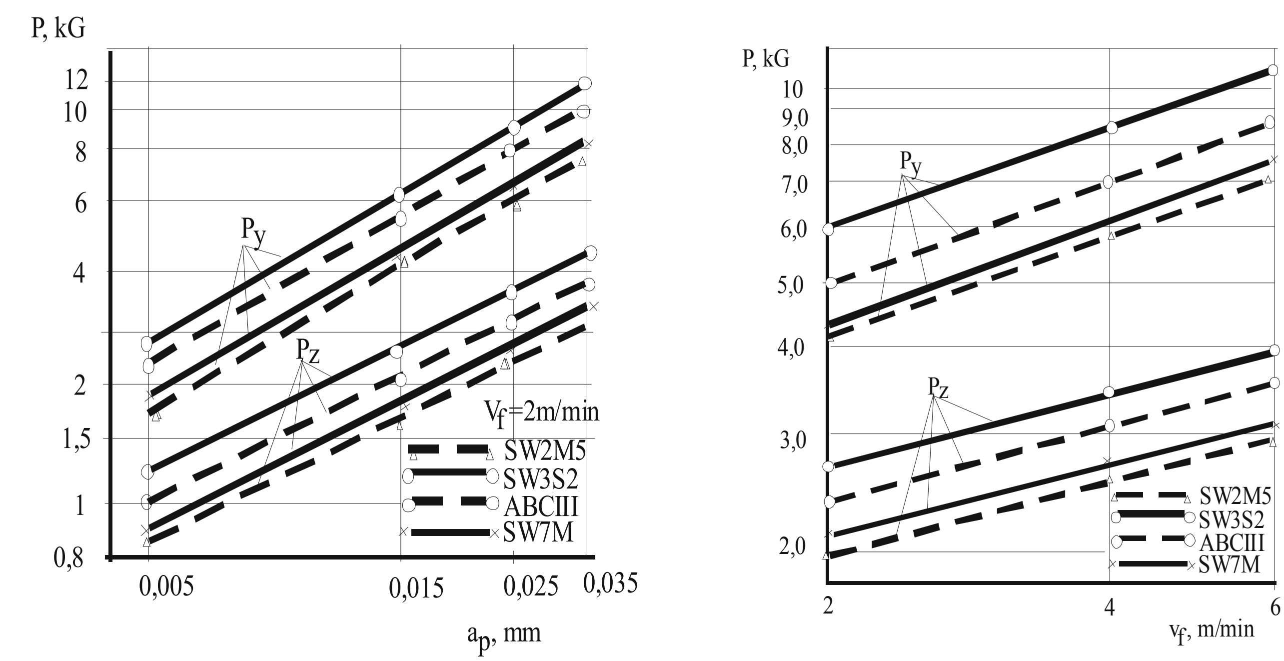

Fig. 1. The influence of grinding depth and lengthwise feed on grinding forces

It can be explained the same results as because the largest impact on value of grinding forces have vanadium carbide and the both grades of these steels contain in greater amount of vanadium in their chemical constitution. Although SW3S2 steel contains less amount of vanadium, its machining forces are greater than ABCIII steel grinding. It can be explained by the greater amount of carbon in SW3S2 steel [5]. The grinding temperature increases together with the rise of grinding forces which can be seen in figure nr. Therefore more significant modification on the surface layer are followed.

The quality of surface layer is usually evaluated according to the following factors[3,6]:

- depth of occurrence of structural modifications in surface layer,
- depth of micro-hardness modification,
- micro-cracks forming as a result of momentary and ultimate stress,
- surface roughness.

In many researches it is taken on amount of secondary austenite as a main criterion of evaluation of surface layer quality during tools sharpening. The impact of grinding parameters on amount of secondary austenite both on the surface and at the depth of 10µm and 20 µm was presented in this paper, which is showed in figure 3.

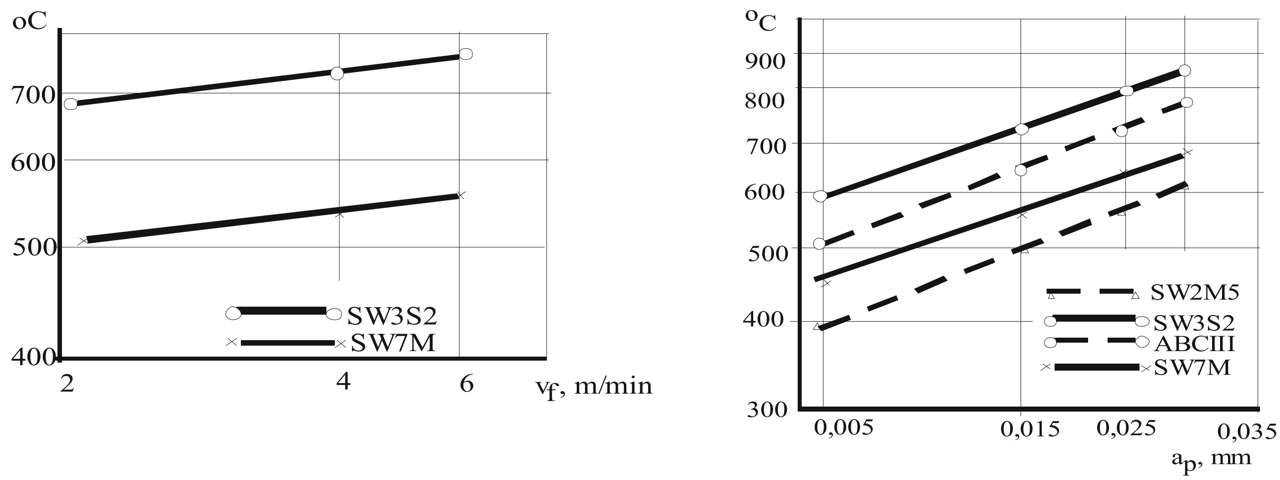

Fig. 2. The influence of grinding depth and lengthwise feed on temperature

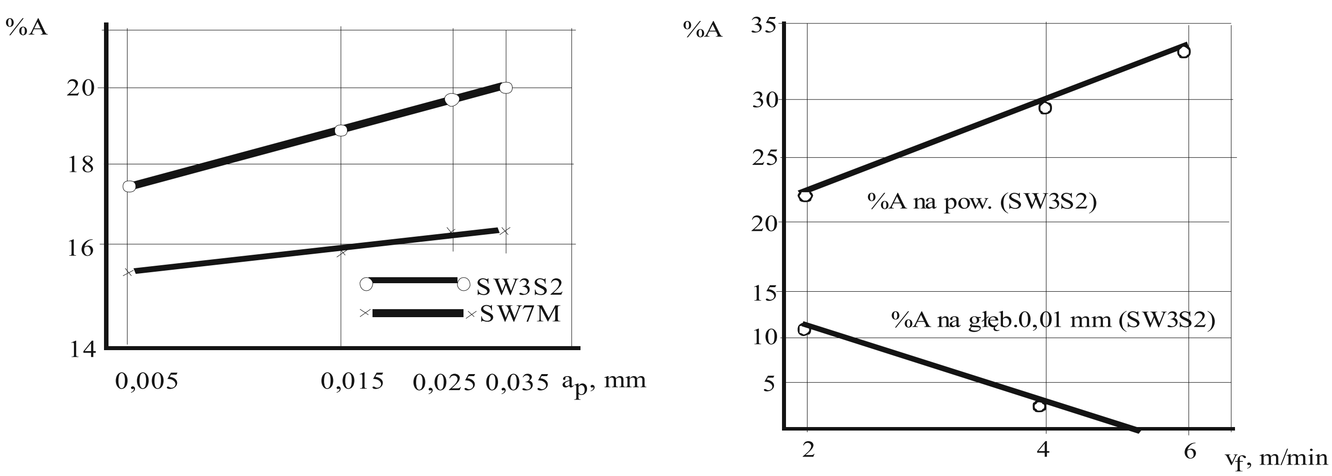

Fig. 3. The influence of grinding depth and lengthwise feed on an amount of secondary austenite

As it can be seen in figure nr , amount of secondary austenite for SW3S2 steel is larger than for SW7M steel. Secondary austenite is occurred at the depth of 10 µm as well, however in relatively less amount. It was not located at the depth of 20 µm. With lengthwise feed rising, austenite is located in more thin layers, which is proved by decreasing of its content at the depth of 10 µm, although its amount increases considerably on the surface. The impact of grinding depth on amount of austenite at subsurface layer is presented definitely more distinctly. From the quality of surface layer point of view, to increase efficiency of sharpening in the way of increase its parameters, it is better to increase lengthwise feed than grinding depth. Ultimate stresses at surface layer were not investigated. It is known, that their source is temperature gradient before all in normal intersection to machining surface. It can be assumed, that for SW32S steel the level of stresses will be a little bit higher than for SW7M steel. After research had terminated and samples had checked, it was determined that level of ultimate stresses did not lead to form a net grinding crack in the scope of grinding parameters research. Micro-hardness of surface layer in dependence on grinding depth was measured on the skew polished sections. The results are presented in table 2.

As it can be seen in table 2, micro-hardness of SW3S2 steel is underwent considerable modification together with increase of grinding depth. Decrease of hardness can be observed at ap=0,015 mm and rise of hardness at ap=0,025÷0,035 mm. Decrease of hardness for SW7M steel is not be observed at all and rise of hardness is less substantial at ap=0,035 mm. Research results confirm higher propensity to structural modifications for SW3S2 steel during grinding. Surface roughness is very important parameter of machined surface quality. Results of measure of Ra parameter are presented in table 3.

As it can be seen in table 3, it is not observed the substantial differences of surface finish for selected steel grades. It decreases together with rise of grinding depth and lengthwise feed in each case. Differences in surface finish in the research scope have not impact on machinability of tools. Values of grinding ratio, which are expressed as a relation of value of grinded material amount to value of inverted grinding force Py are showed in table 4.
As it can be seen in table 4, low-alloyed high-speed steels have worse grinding properties than SW7M steel with the exception of SW2M5, where that ratio is even a little bit higher. Value of that ratio can be, in a certain degree, the characteristic of efficiency and quality of LAHSS grinding process[7].

Table 2. Micro-hardness of surface layer in dependence on grinding depth

Steel grade	Distance from surface	Micro-hardness (kPa) in relation of grinding depth (mm)			
		0, 005	0,015	0,025	0,035
SW3S2	0	910	820	1040	1060
	10	910	870	890	990
	20	910	910	910	910
SW7M	0	930	930	930	1030
	10	930	910	930	960
	20	930	930	930	930

Table 3. Results of measure of surface roughness Ra

Steel grades	Ra					
	a_p mm, v_f=2m/min				v_f m/min a_p=0,015mm	
	0,005	0,015	0,025	0,035	4	6
SW3S2	0,26	0,53	0,75	0,90	0,67	0,80
SW2M5	0,24	0,49	0,68	0,77	0,63	0,77
ABCIII	0,27	0,54	0,79	0,93	0,71	0,86
SW7M	0,22	0,43	0,60	0,74	0,63	0,74

Tab.4. Value of grinding ratio of selected grades of LAHSS

Steel grades	SW3S2	SW2M5	ABCIII	SW7M
K=Qm/Py	3,58	7,32	5,76	6,89

4. Conclusions

1. Improvement of grinding properties of low-alloyed high-speed steels is possible on the way of efficient selection of their chemical constitution, which is confirmed by results of researches of grinding properties of SW2M5 steel.
2. Value of grinding ratio is conditioned by grinding forces, which value has impact on grinding temperature. ABCIII and SW3S2 steels are grinded worse than SW2M5 and SW7M.
3. To ensure high quality of tool surface layer (less amount of secondary austenite, lack of wheel burn and micro-cracks) during tools made of LAHSS sharpening, grinding temperature should be aspired to decrease. To achieve this aim, following states should be done: using of borazon abrasive disk, decreasing of sharpening parameters or selection of optimal grinding fluids for specific conditions.

Bibliography

1. W.A. Sinopalnikow, S.N. Grigoriew. Reliability and diagnosis of technological systems, MGU STANKIN, Moskwa, 2003.
2. J. Jaworski, Influence of temperature of austenitization on mechanics properties mechinability and polishing of SW3S2 steel, Acta Metallurgica Slovaca vol. 2 2002 No. 8 (139-144) in Polisch
3. E.N. Masłow, Theory of material polishing. Maschinostrojenie, Moskwa 1974
4. J. A. Geller, Tool steels. Metałłurgija 1983
5. F. Miś, Influence of polishing on the mechanics properties and tensions in high alloy tool steel. ZN Prz, 1983.
6. Z. Weiss, Distribution of temperature in upper layer of object during polishing. Technology of polishing. Scientific and Technical Conference, Rzeszów 1974.
7. Jaworski J., Influence of heat treatment an grinding susceptibility of low-alloy high speed steel SW3S2, Archives of foundry vel. 3 , No 7 2003 (165-170) in Polish