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The analysis of impact energy distribution of grinding chips in machining chamber of disc finishing machine

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Introduction

Disc Finishing Machines are designed for quick and effective surface treatment of metal workpieces with complex shapes and components made from plastic or metal. Processing time is determined by the energy of ceramic-bonded or plastic abrasives (chips), which is created by rotating movement of the bottom disc of machine. The machining process occurs mainly as a result of the impact of abrasives on the machined surface, as a result of which there are processes of micro-scraping with abrasive grains located in the binder [1-6]. The presented test results show that the energy distribution of the impact in the rotary machines, in a steady state, is variable in its axial cross-section. Knowledge of the location and size of the areas with the highest energy impact can be the basis for working region indication in order to conduct the treatment providing the highest efficiency.

Methodology

The tests were carried out on a table-top disc finishing machine type EC6 (produced by ZMM Avalon Wojciech Gibuła, Poland) for wet processing — Fig. 1. A high frequency acoustic emission signal (AE) was used to register impact energy, collected from a sample placed in specific places of the cross section of grinding media stream during its working movement.

a) b)

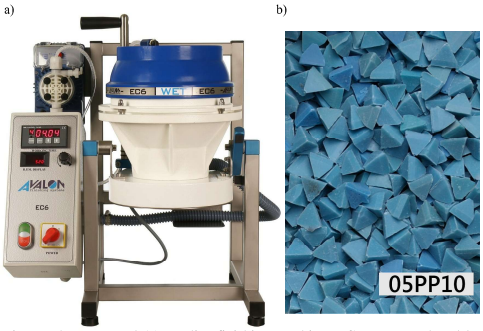

Fig. 1. The test stand (a) — disc finishing machine, EC6 type, produced by ZMM Avalon Wojciech Gibuła (Poland) and plastic bonded grinding chips with a low density used mainly for fine wet grinding of metals with addition of compound (b) — pyramid shape 05PP10 (supplier: AREX-POL)

The tests used flat samples with a diameter of 20 mm and a thickness of 1 mm, made of brass MO59 type. A measuring system, consisting of a Kistler 8152B sensor, copuler 5125B and National Instruments PXIe-1073/6124 acquire subsystem was used to acquire the AE signals.
The research process was carried out using piramide shape chips with a plastic (resin) bind with a density of about 1.6 g/cm^3 (Fig. 1b).
Before testing the impact energy of the chips stream on the workpiece, the distributions of areas occupied by abrasive particles for the different rotational speeds (150, 300 and 450 rpm) were determined.

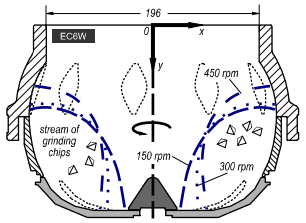

Fig. 2. The overview of working chamber of EC6W machine with marked distribution of areas occupied by grinding chips (the stream) for various rotational speeds

With the increase of rotational speed of the working chamber, the distribution of the working stream (looking in the cross section) changes (Fig. 2). It is followed by its narrowing in the transverse direction of the machine chamber and elongation in the axial direction. This has also a significant impact on the energy distribution of the stream of working chips impact on the surface of the measurement sample.

Results

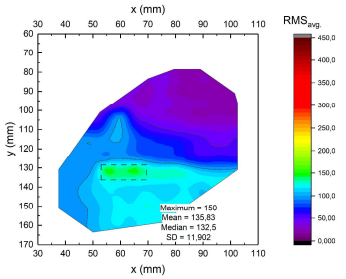

Fig. 3. Distribution of average energy values of the acoustic emission signal (AE_{rms}) in the cross-section of stream for the rotational speed of 150 rpm

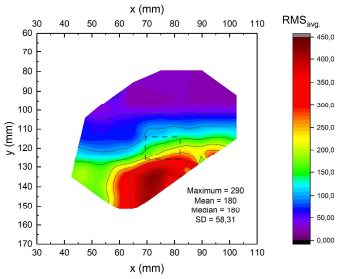

Fig. 4. Distribution of average energy values of the acoustic emission signal (AE_{rms}) in the cross-section of stream for the rotational speed of 300 rpm

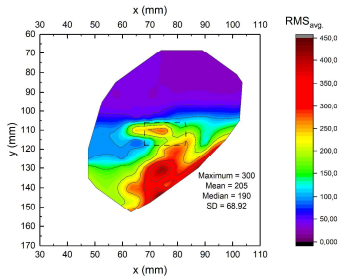

Fig. 5. Distribution of average energy values of the acoustic emission signal (AE_{rms}) in the cross-section of stream for the rotational speed of 450 rpm

Tab. 1. Area of ROI and acoustic emission signal values recorded for different rotational speeds of EC6W disc finishing machine

	AE_{rms}, V				Region of Interes (ROI)	AE_{rms} in ROI, V			
Rotational speed, rpm	Max. value	Avg. value	Median	Standard deviation	Area, mm^2	Max. value	Avg. value	Median	Standard deviation
150	150	79.2	85.0	36.9	128.5	150	135.8	132.5	11.9
300	410	147.2	110.0	118.0	150.8	290	180.0	180.0	58.3
450	425	130.7	95.0	108.5	180.0	300	205.0	190.0	68.9

The areas of interest (ROI) with the highest energy and machining potential in which the highest surface treatment efficiency is expected are indicated on the maps (Figure 3-5). These areas are characterized by a varied shape and spatial location, with the area of their surface expanding and becoming more diverse along with the increase of the rotational speed. The characteristics of qualitative and quantitative of those maps are presented in the table 1.
The maximum registered values of the acoustic emission signal and observed area of the ROI increase as the speed increases. On the other hand, the average AE values in the stream are unevenly distributed and are not directly proportional to the rotational speed.

Analysis

Fig. 6-7 shows the quantitative characteristics of region of interest (ROI) in relation to the average value of the acoustic emission signal and area size of ROI, depending on the rotational speed of the machine chamber. The regression models are provided in the tables.
In synthetic terms, the ternary plot of the maximum values of the acoustic emission signal and the area of ROI depending on the rotational speed is shown in Fig. 8.

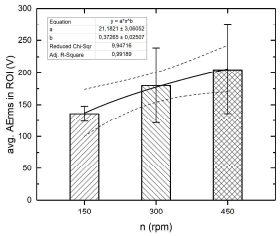

Fig. 6. The average value of the acoustic emission signal in the area of interest (ROI) depending on the rotational speed.

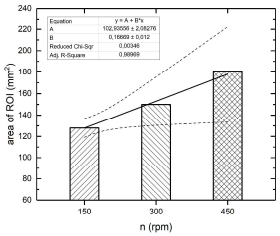

Fig. 7. Area of the analyzed region of interest (ROI) depending on the rotational speed

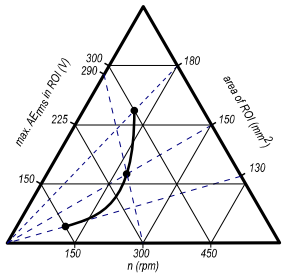

Fig. 8. The ternary plot of the maximum values of the acoustic emission signal (AErms) and the area of ROI depending on the rotational speed

Conclusion

The tests have shown that the impact energy of the working medium in the form of grinding chips in the chamber of disk finishing machine in a steady state is variable in its axial cross-section. For this reason, the spatial orientation of the workpieces should be suitably forced with the help of fixture that perform a positioning movement in the radial and axial coordinate system of the working zone.
Using the proposed methodology for measuring the maximum values of the AE signal in the stream of working medium, it is possible to influence the intensity of the surface treatment.

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Key words:
surface finishing, rotary machines, stream energy, process efficiency, acoustic emission

References:

1. Gillespie L.K. (2007): Mass finishing handbook. Industrial Press Inc., New York.
2. Marciniak M., Stefko A., Szyrle W. (1983): Podstawy obróbki w wygładzarkach pojemnikowych. WNT, Warszawa.
3. Marcus S. (2011). Mass Finishing - What i sit All About. The choices in equipment, media and compounds for your applications. [online] Fundamentals Post. 2/21/2011. Available on-line: http://www.pfonline.com/articles/mass-finishing-what-is-it-all-about-
4. Szyrle W. (1988): Charakterystyka pracy wygładzarek i urządzeń pomocniczych oraz zasady doboru kształtek i roztworów wspomagających. Przegląd Mechaniczny, volume 23, pp. 15-19.
5. Woźniak K. (2014): Kształtki metalowe jako narzędzia robocze w wygładzarkach pojemnikowych. Obróbka Metalu, volume 3, pp. 54-60.
6. Woźniak, K. Wincenciak. M. (2015): Współczesne wygładzarki pojemnikowe. Obróbka Metalu, volume 4, 23-34.