Parameters of forced abrasive slurry in lapping flat surfaces

System wymuszonego dawkowania zawiesiny ściernej w docieraniu powierzchni płaskich

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An innovative dosing system for abrasive slurry is presented. This system allows the dosing and dispensing process to be controlled on the surface of the lapping plate. The system consists of a high-pressure tank equipped with a pneumatic propulsion mixer which ensures continuous mixing of the abrasive suspension. The system also includes a device for applying the component for the lapping plate and electronic control of the forced dosage process.
KEYWORDS: lapping the flat surfaces, forced dosage abrasive slurry

At present, flat lapping is realized, among others, on single-disk lapping plate. This method of surface shaping requires not only special equipment, but also the use of suitable abrasive suspensions. Professional components offered by many manufacturers are available in the form of pastes, suspensions or loose abrasive powders. Abrasive components are intended for treatment of parts made of different materials [2]. This is directly linked with the choice of their dosage.

On the basis of the descriptions contained in the literature [3], it can be noted that the dosage of suspension in the treatment zone is carried out mainly by drip or continuous method (pressure) using a pump, which draws it from a tank and provides a working surface of the lapping area with large excess. This situation has financial implications, since a significant portion of dosed abrasive suspension does not participate in the lapping process at all [1].

Traditional system of dispensing the abrasive suspension

The abrasive suspension dosing process in the traditional system, e.g. in the Abralap 380 (fig. 1), is carried out using a pump (fig. 2), which draws the prepared substance from the tank. This dosage regimen (in the machine) brings the flow rate approximately 400 ml/min. The manufacturer has not offered a solution that would allow control of the amount of administered suspension.

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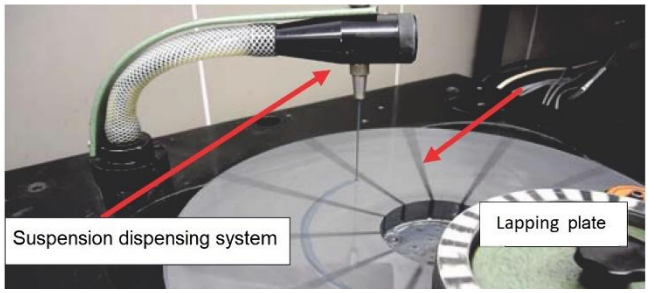

Fig. 1. Dosage of abrasive suspension in Abralap 380 lapping machine

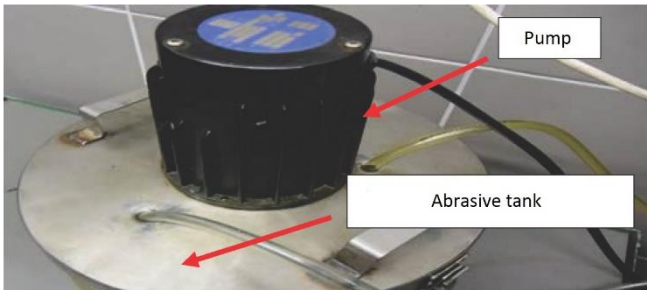

Fig. 2. Suspension pump in Abralap 380 machine

In this solution, only the viscosity of the prepared suspension depends on the proportion of its constituents [5]. Our study involved dosing prepared suspension based on silicon carbide 98C-F400 with cosmetic kerosene and machine oil.

The disadvantage of traditional dosing is that the prepared suspension is not continuously mixed resulting in particle sedimentation and disturbs the assumed percentage of abrasive micro-grains during the machining process. This can be seen when exchanging already lapped items, onto subsequent items that will undergo lapping, as this has an impact on the stability of the process.

Forced dosing system for abrasive suspension

On the basis of analysis of the system used in the machine Abralap 380, a different (forced) method of dosing the abrasive was developed (fig. 3).

This solution preserves the existing system of workpiece placement (fig. 4). Another method of delivering the suspension to a device directly applying the abrasive layer to a lapping plate (fig. 5) was proposed.

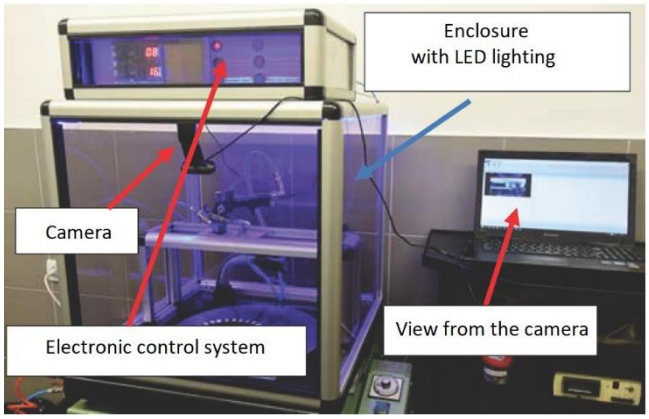

Fig. 3. Forced abrasive suspension dispensing system

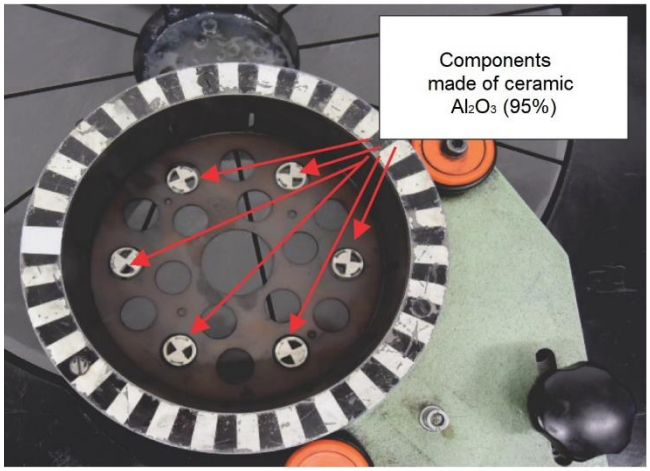

Fig. 4. Workpiece placement in separator for forced dispensing system

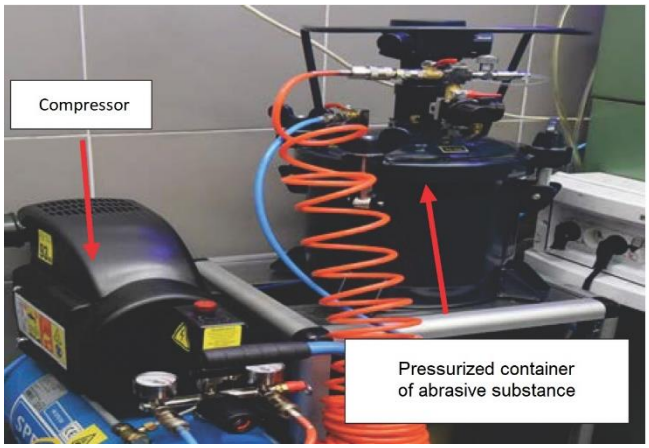

Fig. 5. Abrasive suspension dispensing system

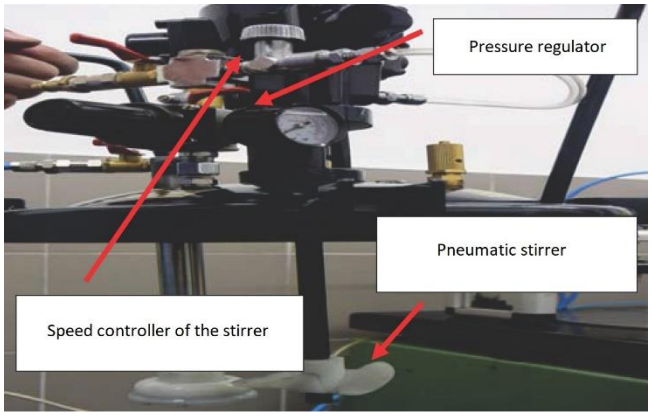

Fig. 6. Continuous mixing system of abrasive suspension

The solution also allows mixing of the suspension in the tank continuously. This is particularly important for the preparation of suspension based on grains or abrasive micro-spheres (fig. 6). The sedimentation problem does not occur in the case of nano-grains.

Modification of the dispensing system for the abrasive slurry also included the method of applying it to the lapping plate. This application is carried out by means of a device enabling the application of an abrasive layer of predetermined thickness for one turning of the lapping plate (fig. 7, table).

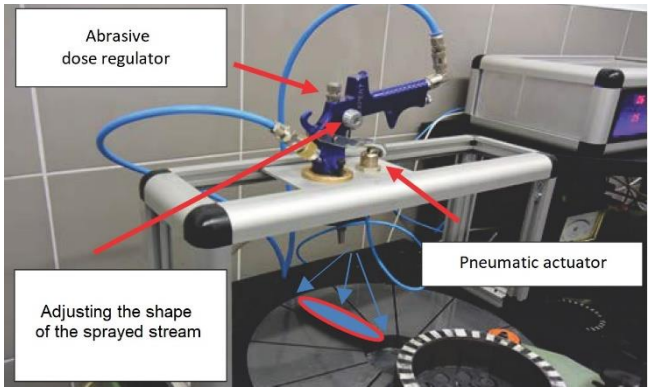

Fig. 7. System of applying abrasive substance to the lapping plate

The dosing process is controlled via an electronic system. This applies to the amount of abrasive suspension applied to the process of lapping. This solution also allows to control the shape of the applied layer and its position on the disc surface (figs. 7–9).

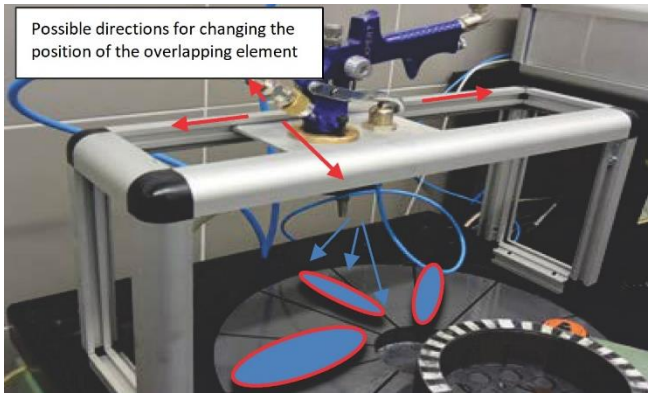

Fig. 8. Elliptic shape, which is assumed by the stream of applied layer, with the possibility of placing it on different areas of the lapping plate

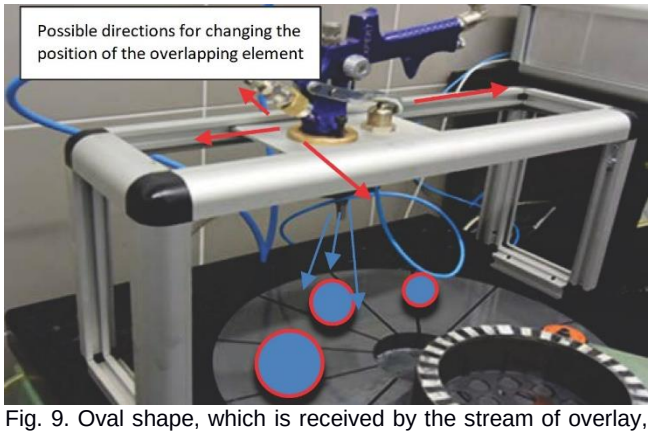

Fig. 9. Oval shape, which is received by the stream of overlay, with the possibility to place it on different areas of the lapping plate

TABLE. Forced dispensing parameters

Content of abrasive grains in suspension, %	10
Volume ratio of machine oil to kerosene	2:1
Kinematic viscosity of liquid, mPa	32
Suspension pressure in the tank, bar	0,8
Rotational speed of the stirrer, rpm	100÷120
Nozzle diameter dozing the suspension, mm	2
Application pressure of the abrasive layer, bar	2,8
Time of application of one abrasive layer, s	3

Fig. 10 shows a graphical representation of the difference in wear of the abrasive suspension (under the same conditions of ceramic elements processing) with different dosing methods.

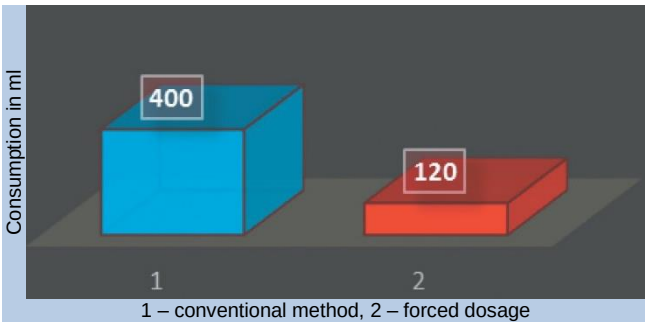

Fig. 10. Abrasive suspension consumption chart in conventional and forced dosing methods

Preliminary investigations also included the observation of a mass loss of Al_2O_3 ceramics (95%) using conventional dispensing the abrasive substance by means of conventional and forced dosage (fig. 11).

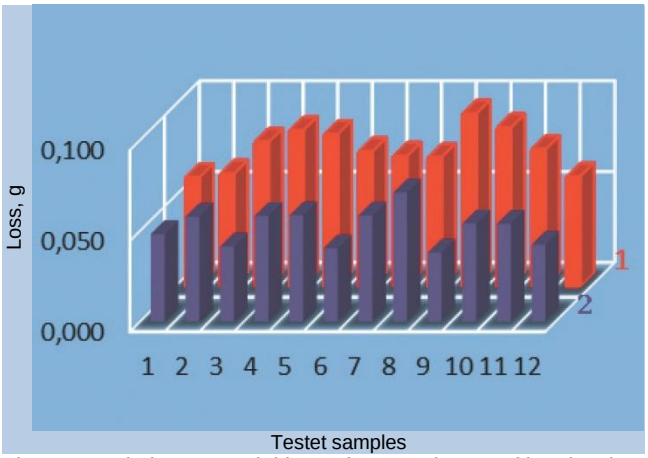

Fig. 11. Workpiece material loss after 10 minutes of lapping (1 – traditional dosage, 2 – forced dosing)

Conclusions

Based on the analysis of the proposed method of forced abrasive suspension application on the Abralap 380 single disc lapping machine, several advantages of this solution can be mentioned:

- abrasive wear was reduced by approximately 70% as compared to conventional dosing (at a specific time of lapping),
- the application of abrasive suspension is planned and repetitive,
- the system allows to control the time interval between the time of applying the next layer,
- the system allows to apply a layer of fixed thickness,
- a continuous mixing system counteracts the sedimentation of the abrasive in the tank.

The proposed solution demonstrates high efficiency in suspension savings, which improves the economic efficiency of the machining process.

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