CHARGING OF CAST IRON WITH ABRASIVE DURING LAPPING

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1. Introduction

The method of dosaging abrasive slurry or abrasive compound has an essential effect on the efficiency and quality of lapping [3-5]. Besides the unbound method of abrasive charging the lapping tool, where abrasive slurry is delivered as drops or the abrasive compound is laid on the lapping active face during the process, a new surface treatment with lapping tools force charged with abradents is developed. This technology has found, above all, a use for in very precise lapping. This surface treatment is characterized by a comparatively low efficiency and a small roughness of the lapped surface.

The charging process is usually done manually, with the use of a hardened disk or roller. First of all, after the cleaning of the active lapping face, the abrasive compound (e.g. diamond paste) is spread on it. Next the grains are pressed in manually with the use of a roller. This operation should be done a few times, in different directions, after which the active face should be additionally rolled with a steel disk or a sintered carbide disk. This action takes only over a dozen of seconds. The above allows to even-out the protrusions of the micrograins pressed into the lapping tool face. Directly before using the charged lapping tool it should be shower - washed and dried.

The manual charging can be applied to a single - disk lapper, for which the tool is rotated. The charging time is relatively long. The efficiency and the quality of the charging is not very high, due to the difficulties of the uniformly distribution of the abradent micrograins. An additional problem is that the compression of the charging elements is not constant, which causes differences in the micrograin penetration of the lapping tool face. From some time, research has been done about machine surface charging. Introducing a mechanical drive should eliminate the fundamental faults of the manual charging.

Ulegin and Ogorodnikov [5] made an attempt to explain the physical aspect of the phenomenon of compressing diamond micrograins into the surface of cast iron lapping tools, for different chemical compositions and microstructures. Observations of the surface during the respective phases of the lapping process, showed that the diamond micrograins are compressed, first of all, into the graphite and to a lesser degree (most often unstably) into the cast iron metallic matrix. The smaller micrograins are embedded in the plate graphite, larger ones are embedded in the nodular graphite inclusions. In the case of larger differences between the size of the abradent and graphite section, then we have a filling of singular graphite inclusions with a few micrograins. There are also formed on the surface, micro-recesses due to the displacement of the micrograins, generally caused by rotation. It takes place especially when on the micrograin moveme trajectory their are sections of graphite intrusions smaller than abradent micrograins. It was found that the heating-up of the lapping tool is the cause of the forming of a thin film, a product of the reaction with the oil, a component of the abrasive slurry. Its thickness is not constant as was determined by the electric resistance measurements. The molecular bond between the existing film and the cast iron metallic matrix favours the consolidation of the smaller micrograins compressed into the surface. The graphite oxidation is followed by its volumic increasement, which increases its capability to maintaining the micrograins.

The sinking of micrograins into the graphite intrusions is also indicated by other research workers [4]. An intensivity of this process can be made by a correct selection of the graphite intrusion size and shape.

2. Technique and the kinematic of the forced charging

The device presented on Figure 1 is composed of three arms (1-3) spaced every 120^{o} and fixed to the lapping machines auxiliary table. The diameter of the lapping disk (5) which rotates is 900 mm. The arms (1-3) are spaced between the conditioning rings (4). A conical rubber roller (7) (Fig.2), provided for distributing the abrasive micrograins on the disk surface, is mounted on arm (1). Roller (7) is pressed to the lapping tool by a press bolt (9), and is lifted by springs (9). Strips (11) with conical charging rollers (6) in angle bearings are fixed to the other arms. Arm (11) with charging rollers (6) is lifted by springs (10), whereas the working load is exerted by a pneumatic servo-motor (16). To the arm (2) is fixed a movable strip (12) with a abradent storage bin (13). The abradent dosage, through the feeding pipe (14), is regulated by a regulating screw (15). After finishing the abrasive charging, the conical rollers (6) as well as the roller distributing the abradent (7), cannot be in contact with disk surface (5). Economical dosaging of the abradents has an essential meaning, especially in the case of super-hard abradents, which are expensive materials. The use of conical charging rollers eliminates the phenomenon of slipping between the roller and the disk, whereas the pneumatical pressing reduces the uniformity of the micrograin load. The proposed constructional solution gives a base for automation of such a type of lapping technology.

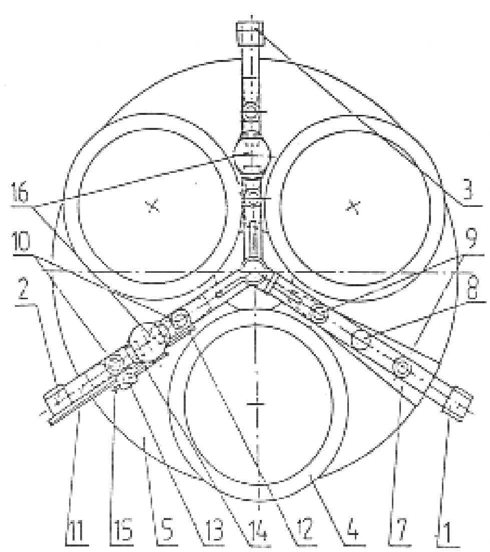


Fig.1. General top view of the productive version of the device for abrasive charging of the lapping tool surface

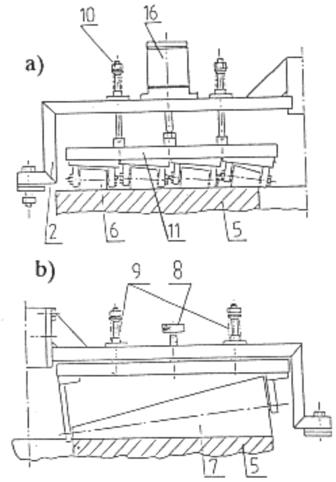


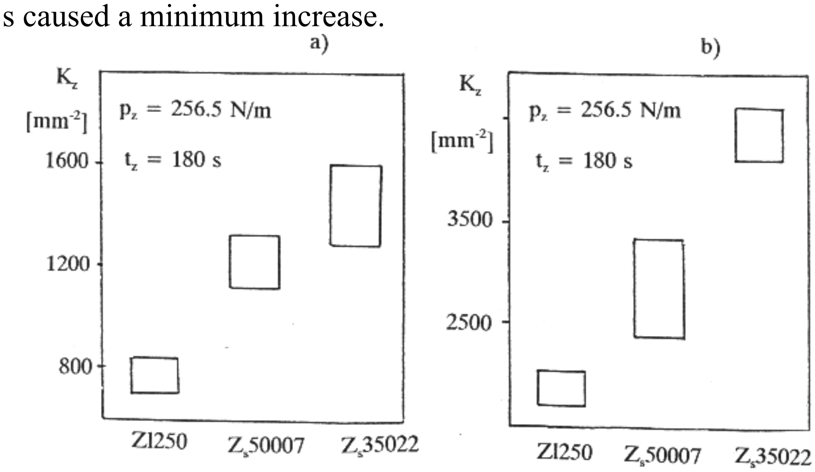
Fig.2. Conical roller assembly for lapping tool charging (a) and the position of the abrasive micrograin distributiong rubber roller (b)

3. Research of the forced charging

An evaluation of the charging quality was carried out on a lapping disk, which active area was equal to 84.82 cm^2. The research variable factors were the unit pressure p_z = 156.5 - 310.5 N/m, mean velocity v = 0.036 - 0.068 m/s and the charging time t_z = 60 - 240 s. The necessary amount of tests and the range of the tested factors change of value were determined during the preliminary tests. The disk surface was observed on a scanning electron microscope.

The size of the micrograins embedded in the surface of the lapping tool decreased when the roller unit pressure and the charging time increase and so, for the charging of a Z_S50007 cast iron lapping tool with silicon carbide micrograins (99C) 320 was received z = 20 - 26 μm (p_z = 256.5 N/m, t_z = 180 s, v = 0.059 m/s), and by using 99C of a number 800 the following was observed z = 2 - 6 μm (p_z = 256.5 N/m, t_z = 300 s, v = 0.059 m/s).

Figure 3 presents the influence of the micrograin number on the intensivity of the abrasive charging of grey cast iron. The highest intensity was received for the Z_s35022 cast iron. The concentration of micrograins increased together with the increase of the charging time from t_z=180 to 300 s caused a minimum increase.



4. Final remarks

The carried out research shows [1,2] that in the case of large differences between the abradent grain size and the size of the cast iron graphite intrusions, there can be a simultaneous penetration of a few micrograins into the graphite. Other than charging the graphite there is also an intensive penetration into the cast iron metallic matrix, into the ferrite as well as the pearlite. A relatively high intensity of penetration of larger sized micrograins on the borders of graphite intrusions and in the ferrite halo were observed. An experiment was carried out to determine the empirical probability of the 800 micrograin (silicon carbide: expected value $E(Z) = 6.81$ μm, standard deviation $D(Z) = 4.08$ μm) penetration into the Z_s55003 cast iron graphite intrusions. The n_g X-ray patterns were analyzed, concerning the silicon lay-out, FeK_α and SiK_α ,on the cast iron surface after $t = 135$ s (conditions for unbounded abradent charging: $p = 0.19$ MPa, $v = 0.40$ m/s). The experimental sample size n_g was specified on the basis of the preliminary test. According to research results, the empirical probability of the abradent penetration into the graphite amounts to $P = 0.0814$. Because the amount of graphite sections on one unit area amounts to $N_A = 98\ mm^{-2}$, therefore we can assume that on the area of 1 mm^2 there shall be 8 graphite intrusions penetrated by abrasive grains.

References

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