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APPLICATION OF EDI IN INCREASING DURABILITY OF GLASS MOULDING FORMS POANSONS

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Abstract: The results of experimental investigations into increasing the durability of glass moulding forms poansons are presented in this work. The increase of durability in these pieces is realized through the formation of graphite pellicles on their active surface by applying electrical discharges in impulse (EDI). The graphite pellicle formation provokes partial surface hardening simultaneously serving as ointment in solid state, the result being the increase of machined piece functional performances. Experimental investigations have shown that the formation of graphite deposits on the active surface of pieces constituents of glass BT-1 moulding forms increases their durability, at least, by two times.
Key words: durability, graphite pellicle, electrical discharges in impulse, wearing, surface

1. INTRODUCTION

It is well known that after a few hours of functioning the equipment and pieces do not possess the same indices of exploitation, their technical state gets worse and reparation is needed to turn the machines or pieces to a normal functioning for a determined period of time.
The pieces and machine aggregates wear out in the working process which leads to a modification of geometrical dimensions, form, weight, and properties of superficial layers; sometimes this ends in the appearance of cracks, bendings, torsions, distortions and breaking.
Thus for a normal functioning it is necessary for the pieces to possess functioning security which means the ability of a piece or product to work according to its destination, with a minimum of expenses within the given period and conditions of exploitation. Functioning under difficult conditions of exploitation the machines and pieces possess functioning security closely related to the crack uniformity and the modification of structure and physico-chemical properties of materials, especially in the surface superficial layer (Bardac et al., 2005).
The wear speed is caused by a number of factors which should be taken into account at designing, building, repairing and exploiting the equipment. The prevention of piece rapid wearing and the increase of the machine functioning duration are realized if the following measures are taken (Paraschiv, 2005): the surface processing should be done at an optimum smoothness; deposition of layers resistance to wearing; application of thermal, thermo chemical or electric treatment.
At present, in order to apply thermal, thermo chemical treatment and deposits of layers resistent to wearing one can use both conventional and non conventional methods of surface processing including the traditional thermal and thermo chemical treatment, processing through metallization, processing through plastic deformation, processing with the gas flame, processing through galvanization, hardening through ionic nitriding, through magnetic impulses, through radiation laser, through electric discharges in impulse, in a regime of electric contact and in a regime of subexcitation, etc.
Graphite deposit and superficial layer hardening with the help of electric discharges in impulse are based on the electric erosion effect and polar transfer of the tool-electrode material on the surface of the electrode- a piece under the action of thermal and electric fields in the interstice.
Due to the fact that the glass plant of Chisinau faces several problems concerning the durability of pieces that are components of glass moulding forms namely the appearance of such defects as zones of tearing the material out of the transverse plate body (because of the adherence of the moulded material on the transverse plate surface followed by the mechanical action of the tool-machine), deformation of the transverse plate peak (due to the sliding of the glass mass on it and is shown through the appearance of scratches and cracks); marks of surface burns (because of insufficient cooling and the process of heat accumulation in the body of the transverse plate). The above said considerably influences the decrease of durability of pieces that are constituents of glass moulding forms, particularly of transverse plates functioning underthe most difficult conditions.

Following from the above said we aimed at increasing the durability of transverse plates made of cast iron by forming on their active surface of graphite pellicles accompanied by hardening the metal substratum. The method of processing is realised through the application of electric discharges in impulse in a regime of subexcitation. The tool-electrode is made of graphite and connected to the circuit of generator discharge of current impulse as cathode.

2. MATERIALS AND METHODS OF EXPERIMENTAL INVESTIGATIONS

The scheme of technological process of graphite deposit simultaneously accompanied by hardening the active surface of the transverse plate by applying electric discharges in impulse is presented in fig.1

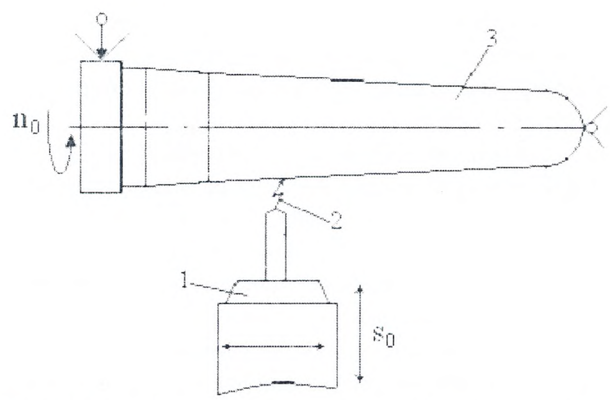


Fig.1. Scheme of electrode distribution in the processsing with electric discharges in impulse: 1 - cathode, 2 - plasma canal, 3 - anode; n_0 – the frequence of workpiece rotation; s_0 – the feed of tool-electrode

The interstice between the tool-electrode and the processed piece was invariable throughout the processing (S = 1 mm). The tool-electrode may be removed as necessary in the directions presented in the scheme. Anode 3 presents the piece (the transverse plate fig. 2, a) that was fixes and centered with a rotating peakretated under the influence of the tool-machine device. When the electric circuit between the piece-electrode and the tool-electrode due to the high power impulse generated by the supplying source inducing unit the interstice is perforated and this is accompanied by the formation of the conductivity canal through which the energy of the power impulse accompanied by the formation of the plasma canal is emitted. As a result of the interaction between the plasma canal and the surface of the tool-electrode the graphite erodes and is transferred to the piece surface where the graphite pellicle is formed. Modifications of the physico chemical properties in the processed siperficial layer take place simultaneously under the pellicle of deposition.

The material of the glass moulding form transverse plate is made of cast iron, the tool-electrode represents a bar with thediameter equal to 3 mm made of electro technical graphiteof the type MPG-6. The graphite was used as cathode because based on the studied literature and our personal experiments (Paraschiv, 2005; Besliu, 2008; Topala & Besliu, 2008; Topala & Stoicev, 2008) it erodes more as cathode than as anode, this results in the deposition on the piece surface of a greater quantity of carbon which due to the impulse of applied energy difuses in the surface layer causing structural changes. The previously experiments made on steel (Besliu, 2008; Topala & Besliu, 2008) have demonstrated that the microdurability of the affected layer increases considerably.

In order to obtain the minimal roughness of a uniform graphite pellicle and a high durability of the transverse plate surface the following processing regime was selected: the charging power of the condenser battery of the current impulse generator U_c = 200 V, the size of the interstice S = 1 mm, the condenser battery capacity C = 600 μF, the frequency of current impulses f = 10 Hz, the number of passes n = 2, the energy accumulated on the condenser battery W_c = 12 J, the energy emitted in the interstice W_S = 4,8 J.

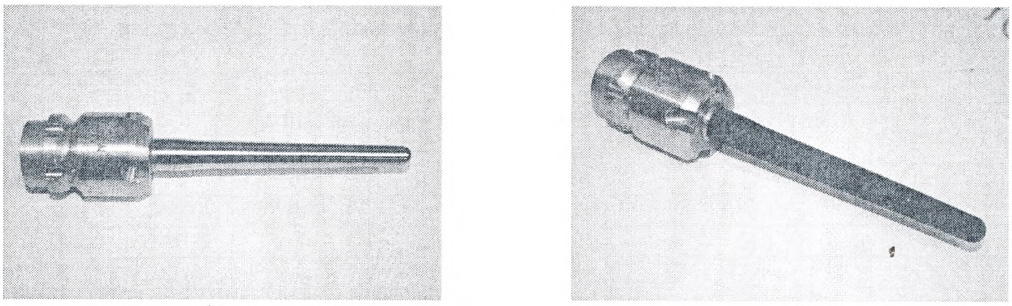
The universal microscope UIM-21 was used to measure the level of wearing because it allows measurement with an error of 1μm. To begin with we measured the diameter in ten points of two newly produced transverse plates establishing the sign point zero. A transverse plate was covered with a graphite pellicle and subjected to dimensional measurements in the same ten points as in the newly produced one; the procedure was repeated after the transverse plates were included in the glass product fabrication flux. For the newly made transverse plate (sample 23) 39900 cycles (75 hours). The cycle frequency constitutes v=8.75 cycles per minute. The temperature of the glass drop 1129°C; the glass used was of the BT-1 type whose chemical composition according to the standard SM GOST R 52022-2004 is presented in table 1.

Table 1. Chemical composition of BT-1 glass

Mark	Chemical composition, %					
	SiO_2	Al_2O_3+Fe_2O_3	CaO+MgO	Na_2O	SO_3	Fe_2O_3
BT-1	72	2,5	11	14	〈 0.5	〈 0,1

3. RESULTS AND THEIR ANALYSIS

The analysis of processed surface morphology has shown that physico chemical changes on the surface do not excel micrometric sizes. Except for the initial components of the processed material, a considerable quantity of carbon (about 90 %) has been found.The analysis of transversal microfiling microstructure shows that part of the carbon transferred onto the piece surface difuses in its depth at depths of micrometer order. We can suppose that new phases are being formed including those of carbides of alloy components used to manufacture the piece and of those of graphite on its surface. These lead to physico-chemical modifications of the piece material and of those of exploitation.



a) b)

Fig. 2. General sight of the transverse plates of glass moulding forms: a) unprocessed; b) processed through electric discharges in impulse

In paper (Topala et al., 2010), transverse plates were tried under real conditions of exploitation and it was stated as a result that the transverse plates of moulding forms on whose active surface graphite pellicles were formed functioned in 57600 cycles during the absence of form and dimension modifications.

Thus experimental investigations in the technological cycle were executed to compare the wear of transverse plates of glass moulding forms. Two transverse plates were subjected to trial, one of them covered with graphite through electric discharges in impulse, the second being unprocessed, the presentation is given in Fig. 3.

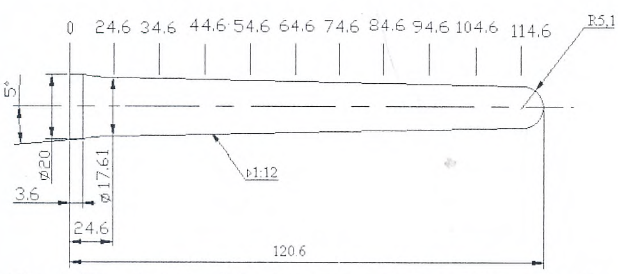


Fig. 3. The sketch of the transverse plate and the points in which the measuring started beginning with zero

After the piece was covered with graphite the transverse plate diameter increased aproximately by 35 μm compared to the initial diameter, that is, as a result we have graphite deposits whose average thickness is about 35 μm on the surface under the form of pellicle.

If we investigate sample 19 that was not processed through EDI before and after functioning in the technological cycle we notice that its diametetr in some points decreases up to approximately 11 μm. Sample 23 is studied from three points of view, at the initial stage, then after the application of electric discharges in impulse, and, finally, after it was subjected to wearing. After the transverse plate was subjected to processing through EDI its diameter increases within admissible limits, (fig.4, curve 3) due to graphite deposits on its surface. Investigating the piece after it has functioned in the above described regimes a decrease of its initial diameter is visible in all the cases (Fig. 4).

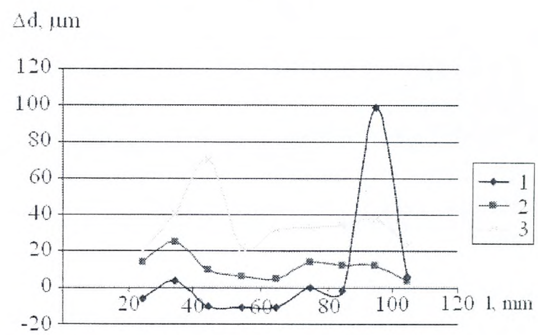


Fig. 4. The dependence of the transverse diameter on the length of its active part for: 1 – sample 19 after functioning in the technological function; 2 – sample 23 after functioning in the technological function; 3 – sample 23 after graphite pellicle formation using the EDI method

Fig. 4 shows us that besides the decrease of the transverse plate diameter (19) its increase is sometimes noticed and this may be explained by the adherence of the glass mass to the active surface of the transverse plate. This phenomenon was not practically observed in the case of piece 23 covered with the graphite pellicle. This proves that the graphite layer deposited on the surface of the transverse plate simultaneously performs more functions: antiwearing protection, it excludes adherence of the glass mass to its surface, it is an ointment in solid state, and increases the piece refractability. After measuring the wear of the transverse plate covered with graphite after functioning in the technological cycle (for 75 hours) we can notice that dimensions along the active length have not reached the initial quota, while the transverse plate (19) has suffered dimensional wearing of about 10 μm on certain portions,; on the other portions the initial dimensions have increased on account of the glass mass adherence. Comparing the obtained results concerning the dimensional wearing of the transverse plate with and without graphite deposits we may state that those with graphite deposits possess some reserve of functioning before they reach the initial dimensions and, of course, a considerable reserve before reaching the value of admissible technological wear.

Table 2. The wearing size of the transverse plates subjected to exploitation

Transverse plate diameter,mm					The measuring interval, mm	Δd_1, mm	Δd_2, mm	Δd_3, mm
Before processing		After processing with EDI	After functioning in the technological cycle					
Nr.19	Nr.23	Nr.23	Nr.19	Nr.23				
17,61	17,586	17,606	17,604	17,6	24,6	-0,006	0,02	0,006
17,206	17,171	17,212	17,21	17,196	34,6	0,004	0,041	0,016
16,82	16,78	16,85	16,81	16,79	44,6	-0,01	0,07	0,060
16,42	16,387	16,409	16,409	16,393	54,6	-0,011	0,022	0,016
16,023	15,99	16,022	16,012	15,995	64,6	-0,011	0,032	0,027
15,61	15,586	15,619	15,61	15,6	74,6	0	0,033	0,019
15,22	15,19	15,224	15,218	15,202	84,6	-0,002	0,034	0,022
14,83	14,792	14,83	14,929	14,804	94,6	0,099	0,038	0,026
14,42	14,397	14,421	14,426	14,401	104,6	0,006	0,024	0,020

The information presented in table 2 shows that the difference between the transverse plate diameter after functioning in the cycle (withou graphite deposits) and the dimensions of the transverse plate with graphite pellicle formed by applying EDI the wear of the latter is a little higher. This may be also explained by the fact thatf the action of the plasma canal of electric discharges in impulse with the piece surface results in the formation of some microirregularities which probably induce the increase of wearing and disappear after a period of its interaction with the glass mass; what remains is the superficial layer physico chemically modified with high properties of exploitation which possess a high resistance to wearing.

4. CONCLUSIONS

The results of our experimental investigations allow us to conclude that:

- the graphite layer deposited on the surface of the transverse plate simultaneously performs more functions: antiwearing protection, it excludes adherence of the glass mass to its surface, it is an ointment in solid state, and increases the piece refractability;
- the formation of metal carbides with increased resistance to wearing is possible under the graphite pellicle on the active surface of the transverse plate;
- the formation of graphite deposits on the active surface of pieces constituents of glass moulding forms increases their durability, at least, by two times.

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