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CHARACTERISTICS OF THE PROCESS OF BROAD LAYERED FACING OF THE CYLINDRICAL PARTS WITH THE HELP OF SELF-PROTECTIVE DUST.

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Summary. The aim of the given research was to establish the influence of regime parameters on the melting and facing productivity and the loss of the melted metal. It is established that sufficient uniformity of the facing metal thickness and productivity 5.8 kg/h can be obtained at the current of 400A and under condition of the electrode size 9-11 mm. Under such conditions 12-18% of the melted metal will be flowing from the facing surface in the form of separate drops.

Key words: facing, a broad layer of the metal, shaft, dust

INTRODUCTION

The fastest worn-out parts of agricultural machines have a cylindrical shape and work under conditions of abrasive and other types of wearing. The area of worn-out surfaces (shaft neck, surfaces for bearings etc) does not exceed 10-15% of the part's whole area surface. Removal of such parts involves high costs and also waste of the surfaces not yet worn-out.

One of the ways of dealing with parts' waste is their renewal. The peculiarity of this process is that there is a need to provide the ability of renewable part to work with minimum expenses and with the minimum damage of work surfaces.

The most widely used way of renewing is facing. High properties of facing metal are obtained with the help of alloying. The effective way of introduction of alloying elements under electric bow facing is including the dusts of alloying element into the structure of the dust wire charge or dust tape.

A wide application in farm-machines building and repairing production defines the facing as the self-protective dust wire. It looks like an extensive, made of light steel tape, and core in the form of dust mixture of alloying metals, ferro-alloys, carbides and dusts of gas and slag making substances. Such material for facing has a lot of advantages compared with the solid wire [1, 2]. These advantages consist in simplicity change of chemical structure and in the lack of protective gas or flux and mechanisms for its conducting and the possibility to get a great range of built up materials.

Facing a broad layered metal with a solid electrode wire of a little diameter under flux layer is obtained by transferring the electrode along cylindrical surface along the screw line or separate circular cylinders. To obtain given width of the layer it is necessary to remelt metal of previous cylinder for 50-70%, as the thermal cycle of the first and the last cylinder differs a lot. So, the uniformity of chemical structure of built up layer and its mechanical properties appear.

The application of multi-electrode facing [3, 4] greatly complicates the process and equipment and does not guarantee the necessary quality.

Self-protective dust wire under condition of absence of additional mechanisms for flux or gas supply allows electrode to move in an oscillating way, perpendicular to the vector of facing speed at the width of built-up layer. This technology in comparison with the screw line facing is characterized by the high productivity of facing and uniformity of the built- up metal.

The scheme of broad layered facing is shown in Figure 1. The main parameters of cylindrical parts of the facing with the cross oscillation of the electrode are: speed of the electric wire supply (V_{el}); voltage on the bow (U_d); facing speed (V_f); average speed of the electrode oscillation (V_o); the transferring speed of the electrode end at the extreme positions (V); escape of the electrode (l_e); size *(e)* and radius (*R*) of electrode oscillation.

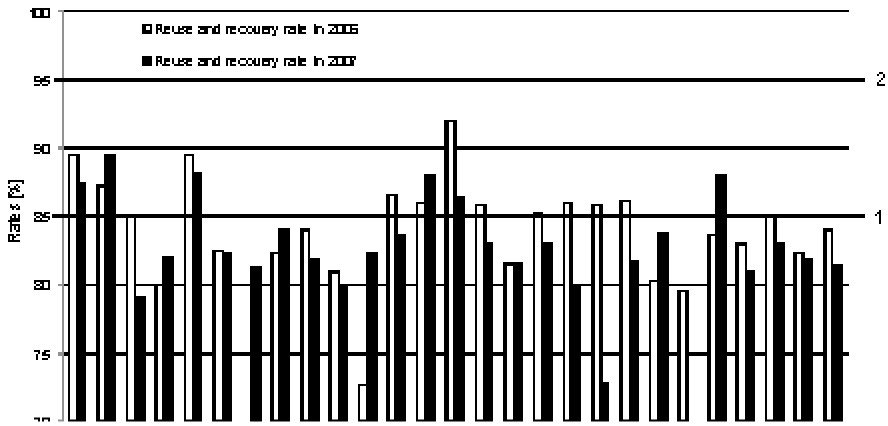

Fig. 1. Scheme of facing of cylinder surface with the diameter *D* with the cross oscillation of electrode on the width *B*.

Practical application of self-protective dust wire under the facing of cylindrical parts of little diameters is restrained by the absence of the most convenient values of these parameters.

THE AIM AND THE TASK OF THE WORK

Taking into consideration the complication of the experiment along with the great quantity of crucial factors, the aim of the work was to determine the influence of the most important parameters of the regime on the productivity of the wire melting and loss of the metal. The meanings of the other parameters in the experiments were chosen as a result of the previous experiments and of the constructive consideration.

MATERIALS AND METHODS

The samples of the 60mm diameter and 50m width made of steel St3 were faced with the self-protective dust wire ПП-Нп 30Х3Г2СМ of the 2,0mm diameter. The wire contained 1-14% of the dusts of gas and slag making substances. The facing was conducted with the special device, with the source of the welding current using rectifier ВДУ-506.

While conducting experiments some parameters of the regime were of permanent value: the speed of the facing – 5.5m/h; voltage on the bow – 27V; average speed of electrode oscillation – 213m/h; speed of the electrode oscillation in the extreme positions – 160m/h. Current strength was changed by regulating the supply speed of the wire within a 200-400 A, escape of the electrode - 16-30mm; electrode size – 8-12 mm, oscillation radius of the electrode - 80-145 mm.

Current strength and voltage were measured with the help of ammeter and voltmeter, time of bow burning - with electric stopwatch of P-30 type up to ± 0,05 sec. Mass of the samples under investigation before and after facing was measured by weighing up to ± 1g. Mass of the built-up metal was determined as the difference of the two numbers. Special device was made to determine the mass of melted wire which was adjusted to the mechanism of wire supply. The device consistsed of ten-toothed cam, tightly joined with the mechanism of wire supply, microswitch, enclosed in the electric circuit of impulses meter and works while the cam turns. One turn of feeding roller corresponded to meter indication of 10 impulses. Mass of the wire supplied per one impulse was measured experimentally.

Coefficients of melting, facing and losses of melted metal as well as facing productivity were calculated using the following formulas:

$$\alpha_{m} = \frac{G_{m} \cdot 3600}{I_{w} \cdot t}; \ \alpha_{f} = \frac{G_{f} \cdot 3600}{I_{w} \cdot t}; \ \mu = \frac{G_{m} - G_{f}}{G_{m}} \cdot 100; \ Q_{f} = \frac{\alpha_{f} \cdot I_{w}}{1000}.$$

In the above-presented formulas:

α_{m}, α_{f} – coefficients of melting and facing, g/A h,
μ - coefficient of losses, %,
G_{m} – mass of melted metal, g,
G_{f} – mass of built-up metal, g,
I_{w} – power of welding current,
t – time of bow burning,
Q_{f} – facing productivity, kg/h.

Calculation of coefficients of melting, facing and losses of melted metal was carried out taking into account the presence of 10-14% of dusts of gas- and slag-making components in wire.

RESEARCH RESULTS

The performed experiments and calculations showed significant changes of the process characteristics at the change of the mentioned parameters.

By radius of electrode oscillation of 80 mm and excepted value of other parameters, facing productivity increases while increasing strength of welding current and escape of electrode (Table 1)

Smaller influence on the productivity of facing is caused by increase of radius of electrode oscillation (Table 2), and by value of R=145 mm productivity even decreases. It is obviously connected with the closing of side surface of wire on beads bulging out at ends of the sample (Figure 2) and excessive sputtering of melted metal, which is proved by the data in Table 3.

Size of electrode considerably influences the productivity of facing. Data from Table 4 prove an increase of losses of melted metal under conditions of research by electrode sizes of more and less than 8-9 mm. It is connected with the flow of melted metal from welding bath in form of drops before and behind the electrode.

Thus, estimation of correctness of choice of electrode size can be done by looking at the built-up layer of metal: if thickness of layer in the middle part is smaller – and size is too large, metal flows backwards, if thickness of layer in the middle part is larger – and size is too small, metal flows forwards at certain temperatures of the heated sample.

It is worth mentioning that electrode size will increase after certain time of working as a result of erasing of metal of opening of current-carrying terminal of nozzle. Optimal size of electrode will occur in case when thickness of layer is the same in any point.

Dependence of productivity of facing on strength of current and size of electrode at excepted values of other parameters is characterized by existence of extreme value at certain values of electrode size (Figure 3).

Table 1. Dependence of productivity of melting on strength of welding current and electrode size at R=80 mm

Current strength, A	Size of electrode, mm	Productivity of melting, kg/h
200	16	$\frac{2,65-2,74}{2,7}$
	23	$\frac{2,88-2,93}{2,9}$
	30	$\frac{3,11-3,28}{3,2}$
300	16	$\frac{4,62-4,79}{4,7}$
	23	$\frac{5,07-5,12}{5,1}$
	30	$\frac{5,40-5,58}{5,5}$
400	16	$\frac{7,11-7,32}{7,2}$
	23	$\frac{7,85-7,96}{7,9}$
	30	$\frac{8,70-8,90}{8,8}$

Table 2. Dependence of productivity of melting on strength of welding current and radius of oscillation at electrode escape *le=23 mm*

Current strength, A	Productivity of melting (kg/h) at radius of oscillation (mm)		
	80	115	145
200	2,87 – 2,93 / 2,9	3,08 – 3,13 / 3,1	2,83 – 2,95 / 2,9
300	5,07 – 5,14 / 5,1	5,18 – 5,21 / 5,2	4,97 – 5,03 / 5,0
400	7,82 – 7,96 / 7,9	7,96 – 8,05 / 8,0	7,41 – 7,57 / 7,5

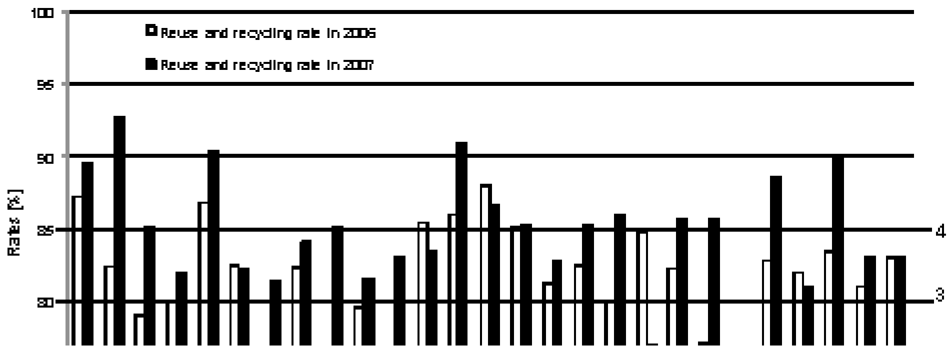

Fig. 2. Appearance of built-up samples

Table 3. Influence of strength of welding current and radius of oscillation of electrode on the losses of melted metal at electrode escape *le=23 mm* and its size *e=8 mm*

Current strength, A	Metal losses (%) at radius of oscillation (mm)		
	80	115	145
200	6,2 – 6,65 / 6,4	9,0 – 9,57 / 9,3	15,1 – 16,7 / 15,8
300	10,1 – 11,0 / 10,5	12,0 – 13,4 / 12,7	16,9 – 18,2 / 17,5

Flow of melted metal is the reason of such dependence. Taking into account the fact that thickness of built-up layer should be even at facing of thick layer of metal with cross oscillation of electrode, its offset from zenith should be chosen to obtain even thickness, allowing certain loss of melted metal at flow from welding bath back to electrode.

Table 4. Influence of strength of welding current and offset of electrode from zenith on losses of melted metal at escape of electrode *le=23 mm* and oscillation radius *R=80 mm*

Current strength, A	Losses of metal (%) at size of electrode (mm)						
	0	4	8	9	10	11	12
200	13,5	8,2	6,4	8,2	10,7	13,4	16,4
300	17,1	11,8	10,5	12,1	14,9	18,1	21,2

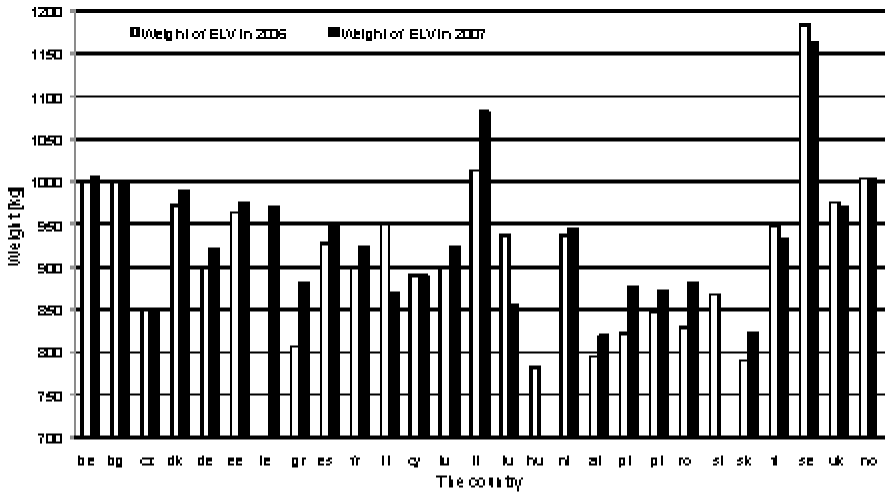

Figure 3. Dependence of productivity of facing on size of electrode at the current 400 A, diameter sample 60 mm and layer thickness 50 mm.

CONCLUSIONS

Researched regime parameters of the facing of cylindrical forms with cross oscillation of self-protective dust wire considerably influenced the productivity of melting and facing.

The maximum productivity of facing 5,8 kg/h at speed of facing 5,5 m/h can be achieved at current 400 A and electrode size 9-11 mm. Increase and decrease of the size causes partial flow of metal of welding bath in form of separate drops.

Sufficient uniformity of thickness of built-up layer is achieved at electrode size 9-11 mm, when 12-18% of the melted metal from the welding bath will flow from the built-up surface.

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CHARAKTERYSTYKA PROCESU UTWARDZANIA POWIERZCHNI WALCA PRZY POMOCY PYŁU OCHRONNEGO.

Streszczenie. Celem niniejszych badań było ustalenie wpływu określonych parametrów na wydajność topnienie i utwardzania oraz straty topionego metalu. Ustalono, że odpowiednią jednolitość grubości pokrywającego metalu oraz wydajność 5.8 kg/h można uzyskać przy prądzie 400A i elektrodach wielkości 9-11 mm. W takich warunkach stopiony metal będzie spływał z powierzchni pokrywy w postaci oddzielnych kropli.

Słowa kluczowe: utwardzanie, gruba warstwa metalu, wał, pyl