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# RESEARCHES CONCERNING THE ULTASONIC ENERGY INFLUENCE ON THE RESISTENCE TO THE ABRASIVE WEAR OF LOADED WELDED PARTS

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The researches presented in the paper refer to the effect of ultrasounds propagation in the liquid metal bath on the process of transferring the additive material through the electric arch and on the crystallization process, and all these effects are analyzed for loaded welded parts solicited at the abrasive wear. All these influences are conferred to these two basic phenomena due to the ultrasounds propagation in liquid environments, namely, ultra-acoustic cavitation and acceleration of the diffusion process. The results concerns the resistance to the wear obtained for the loaded parts through manual welding with electric arch and classically covered electrode and ultrasonically activated.

*Key words:* overlay welding, manual welding, ultrasound activation, abrasive wear

## INTRODUCTION

Overlay welding supposes the deposition of an additive material over a base material in order to obtain some desired characteristics and sizes (high resistance to tiredness and to erosion and/or corrosion wear). The efficiency of the reconditioning technological process depends firstly on the couple basic layer – additive slayer and on the manner in which the homogeneous link between the marginal atoms of the two materials in the zone of contact and near the zone of contact is made [1].

The homogenous link is the results of the technological stages of depositing the additive material on the base material. The most important technological stages of the reconditioning process through overlay welding are: the suitable processing of the surface over which the additive material is deposited; cleaning, scaling, degreasing it aiming to create some optimal conditions of adhesion of the additive material to the basic material; preheating the basic material aiming to reduce the temperature gradient; the proper deposition; insuring some solidification conditions by avoiding the apparition of fissures; applying some suitable thermal treatments with the desired exploitation characteristics and the processing at the functioning sizes [2].

Each of these stages can be more or less influenced if the ultrasonic energy due to the deposition process in ultrasonic field is superposed on the classical energy [3].

The efficiency of the reconditioning process in ultrasonic field depends firstly on the manner of introducing the ultrasonic energy in the welding bath. The researches we have carried out shoed that the ultrasounds propagation in the liquid metal bath has significant influences on process of transferring the additive metal through the electrical arch and on the crystallization process. All these influences are conferred to the two basic phenomena due to the ultrasounds propagation in liquid environments, namely the ultra-acoustic cavitation and the acceleration of the diffusion process [4,5].

The most difficult problem is connected with the modality of introducing the ultrasonic energy into the liquid metal bath [6,7]. In the paper we used the introduction of ultrasounds directly into the welding bath.

## MATERIALS

In order to characterize the wear behavior of the classically deposed layer in the ultrasonic field we had in view to establish its coefficient of friction and its wear rate in different obtaining and working conditions. The coefficient of friction, defined as the ratio of tangential friction force and normal load depends on various factors, the most important being: the type and characteristics of materials in contact; the gliding speed; the possibility of forming the transferred layer; the regime of friction-greasing; he characteristics of the working environment etc.

In order to establish the resistance to wear we have carried out various tests, in certain technological conditions, which were subject to the test to wear on an experimental stand. The modality to try the wear supposes the test of abrasive wear using an abrasive strip, because it was noticed that the analyzed parts beard a strong abrasive wear.

In order to optimize the parameters of the reconditioning process through overlay welding in ultrasonic

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fields we have carried out various tests of overlay welding in different technological conditions, namely: **TEST 1** – carried out in the following technological conditions:

– basic material: OL 42;
– sheet thickness: 10,0 mm;
– additive material: steal of tools as un electrode with diameter of ø 4 mm;
– hardness of the additive material: 64÷65 HRC;
– welding process: manual welding with electrical arch and covered electrode ultrasonically activated;
– welding intensity: Is = 160 A;
– ultrasounds frequency: 24 KHz;
– vibration amplitude: 85÷43 µm;
– concentrator of ultrasonic energy sole type;
– duration of activating the welding bath: 5 min
– welding tension: Us = 25 V;
– theoretical coefficient of deposition (kg deposed metal/kg electrodes): 0,58;
– measured coefficient of deposition (kg deposed metal through welding/kg consumed electrodes): 0,45.

In the researches have been realized three variants for test 1, namely: test 1-1 obtained by depositing a layer of material by welding classic, test 1-2 obtained by depositing to three layers by welding classic, test 1-3 obtained by depositing of two layers by welding in ultrasonic field.

**TEST 2** – carried out in the following technological conditions:

– basic material: OL 42;
– sheet thickness: 10,0 mm;
– additive material: welding wire with auto protection type LINCORE 60-G as electrode with diameter of ø 2 mm;
– welding process: manual welding with electrical arch and covered electrode ultrasonically activated;
– welding intensity: Is = 180 A;
– welding tension: Us = 27 V;
– hardness of the additive material: 58÷60 HRC;
– ultrasounds frequency: 20 KHz;
– vibration amplitude: 55÷32 µm;
– concentrator of ultrasonic energy sole type;
– duration of ultrasonic activation: 5 min.;
– theoretical coefficient of deposition: 0,6;
– measured coefficient of deposition: 0,4.

In these technological conditions have obtained three variants for test 2, namely: test2-1 obtained by depositing a layer of material by welding classic, test 2-2 obtained by depositing a layer of material by welding in ultrasonic field, test 2 – 3 obtained by depositing a two layers by welding classic.

**TEST 3** – carried out in the following technological conditions:

– basic material: OL 42;
– sheet thickness: 10,0 mm;
– additive material: medium-hard welding wire, as electrode with diameter of ø 4 mm;
– the welding process used at overlay: manual welding with electrical arch and classically covered electrode and ultrasonically activated;
– welding intensity: Is = 140 A;
– welding tension: Us = 24 V;
– ultrasounds frequency: 22 KHz;
– oscillation amplitude: 45÷22 µm;
– concentrator of ultrasonic energy sole type;
– hardness of the additive material: 200÷230 HB;
– theoretical coefficient of deposition: 0,87;
– measured coefficient of deposition: 0,81.

In these technological conditions have obtained three variants for test 3, namely: test 3-1 – obtained by depositing a layer by welding classic, test 3-3 – obtained by depositing the two layers by welding classic, test 3 – 3 obtained by depositing three layers of weld filler material in ultrasonic field.

## RESULTS AND DISCUSSION

The tests we have carried out were subject to the abrasive wear testing, with the help of the projected stand, during 5 testing cycles of, each of them with duration of 5 minutes.

The test were not pressed on the abrasive strip, they sit on the strip with their own load, while the abrasive strip had a translation movement. We measured the initial test thickness, and after the polishing with abrasive strip, a time of 25 minutes in cycles of 5 minutes per cycle we measures once again the part's thickness for test 1 and test 2. Since the material deposited for test 3 has a lower hardness, the testing time to wear abrasion was reduced to 20%, ie 5 minutes in 1 minute cycles Because the hardness of the deposed layers is very high (between 55 HRC and 65 HRC) and to avoid influencing the measurements, we replaced the abrasive paper in the beginning of each set of 3 tests. The results obtained after five cycles of testing at the abrasive wear test, for test 1, are presented in Table 1, and the image with the wore tests after the five cycles of testing is presented in Figure 1. In what the results obtained after five cycles of abrasive wear testing are concerned, for test 2, are presented in Table 2, and the image with the wore tests after the five cycles of testing is presented in Figure 2.

After five cycles of abrasive wear testing there have been obtained for test 3 series of results that are presented in Table 3, and the image with the wore tests after the five cycles of testing is presented in Figure 3.

Table 1 **Experimental results obtained after abrasive wear testing for test 1/ wt / mm**

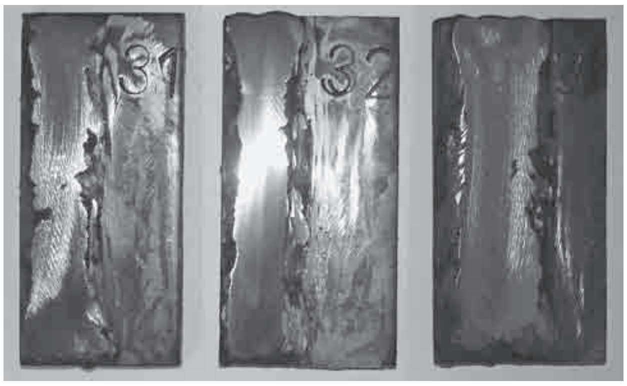
| No. | The when trying | Thickness of the deposited | | |
|---|---|---|---|---|
| | | Test 1-1 | Test 1-2 | Test 1-3 |
| 1 | 0 min | 13,9 | 14,3 | 16,5 |
| 2 | after 5 min. | 13,7 | 14,2 | 16,3 |
| 3 | after 10 min. | 13,4 | 14,0 | 16,1 |
| 4 | after 15 min. | 13,1 | 13,9 | 16,0 |
| 5 | after 20 min. | 12,6 | 13,8 | 15,7 |
| 6 | after 25 min. | 12,2 | 13,7 | 15,4 |

a b c

**Figure 1** General view of tests carried out through wear testing after five cycles of wear testing (5 minutes), test 2: a – test 1-1; b – test 1-2; c – test 1-3.

a b c

**Figure 2** General view of tests carried out through wear testing after five cycles of wear testing (25 minutes), test 2: a – test 2-1; b – test 2-2; c – test 2-3.



a b c

**Figure 3** General view of the tests carried out by loading with welding after five cycles of wear testing (25 minutes), test 3: a – test 3-1; b – test 3-2; c – test 3-3

## CONCLUSIONS

Analyzing the size of the wear for the first sample, when using as filler material the tool steel as electrode there is an increased wear of the layers deposited by the conventional procedure and less wear for deposition by ultrasonic field welding, although the hardness value was quite high (58÷62 HRC). In conclusion, this type of material is not recommended for restoring by loading with welding because friction resistance is quite low. We recommend using this filler material for reconditioning by welding in ultrasonic field.

The analysis of the results for sample 2 shows that resistance to wear by abrasion is better in the 2-2 test, when we put a layer of filler material in ultrasonic field, as hardness is increased by several units compared to the 2-1 and 2-3 samples and this is due to the fact that dilution in this layer is much smaller than in the other samples. Therefore, in this case it is recommended to charge by ultrasonic field welding.

The observation of the results obtained for sample 3 shows that resistance to wear by abrasion is better in the 3-3 test, when one layer was deposited in ultrasonic field, not two layers and this is due to the fact that dilution in the third case is much smaller than in the sample 3-1, which was filled by the classic single layer procedure.

It was also found that the adherence of the layer deposited onto the base coat is much better for the ultrasonic field filling, increasing as the frequency and the duration of activation increases.

Table 2 **Experimental results obtained after abrasive wear testing for test 2 / wt / mm**

| No. | The when trying | Thickness of the deposited | | |
|---|---|---|---|---|
| | | Test 2-1 | Test 2-2 | Test 2-3 |
| 1 | 0 min | 14,0 | 13,5 | 16,7 |
| 2 | after 5 min. | 13,9 | 13,4 | 16,6 |
| 3 | after 10 min. | 13,7 | 13,3 | 16,5 |
| 4 | after 15 min. | 13,6 | 13,2 | 16,4 |
| 5 | after 20 min. | 13,4 | 13,1 | 16,3 |
| 6 | after 25 min. | 13,1 | 13,0 | 16,2 |

Table 3 **Experimental results obtained after abrasive wear testing for test 3 / wt / mm**

| No. | The when trying | Thickness of the deposited | | |
|---|---|---|---|---|
| | | Test 3-1 | Test 3-2 | Test 3-3 |
| 1 | 0 min | 13,5 | 14,5 | 13,7 |
| 2 | after 1 min. | 13,4 | 14,4 | 13,6 |
| 3 | after 2 min. | 13,2 | 14,1 | 13,5 |
| 4 | after 3 min. | 12,9 | 12,7 | 13,4 |
| 5 | after 4 min. | 11,7 | 11,3 | 13,3 |
| 6 | after 5 min. | 10,4 | 10,6 | 13,2 |

## REFERENCES


[1] Gh. Amza, D. Dobrota, Ultrasound applications active, AGIR Publishing, 2008, 336-360.

[2] P. D. Edmonds, F. Dunn, Ultrasonics/Methods of Exxperimental Physics, Caliofornia, Academic Press, (19) 1981.

[3] C. Chen, L. Yan, E. Siu-Wai Kong Y. Zhang, Ultrasonics, Ferroelectrics and Frequency Control, 48 (2001), 6, 1632 – 1639.

[4] M. Dunder, S. Aracic, I. Samardzic, Metalurgija Journal, METABAK, 47(2008) 2, 87-91.

[5] S. Matsuokaa, H. Imaib, Journal of Materials Processing Technology, 209 (2009) 2, 954–960.

[6] P. Burgardt, C.R. Heiple, Welding Research Supllement,(1992), 341.

[7] J. Norrish, Advanced welding processes, Institute of Physics Publishing, Bristol, Philadelphia and New York, 1992.


**Note:** The responsible translator for English language is S.C. PURTRAD S.R.L., Targu Jiu, Romania