INFLUENCE OF TECHNOLOGICAL SCHEMATICS OF INDUCTION SURFACING ON STABILITY OF DEPOSITED LAYER THICKNESS

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Induction surfacing is applied in manufacture and repair of cutting tools of agricultural machinery. Deposited layers improve the tool wear resistance. Here it is important to take into account the deposited layer thickness. The paper presents the results of investigation of geometrical characteristics of a layer of metal deposited by induction process with wear-resistant powder-like consumables by four technological schematics. It is shown that application of shields, horizontal vibration and rotation of the surfaced part improves the stability of geometrical characteristics of the deposited metal layer by 22 %, compared to traditional induction surfacing. A procedure was developed for measurement of geometrical characteristics of the metal layer deposited by induction process, which allows increasing the measurement accuracy, as well as monitoring the stability of layer thickness at development of new technological processes of induction surfacing of thin flat parts. 8 Ref., 3 Figures.

Keywords: *induction surfacing, inductor, surfacing modes, thermal and electromagnetic shields, deposited layer thickness, rotation, horizontal vibration*

In agricultural machinery engineering induction surfacing is used to improve wear resistance of shares of ploughs, cultivators, plant top cutters, etc. [1, 2]. The task of surfacing thin steel disks — top cutters of beet harvesters of a toothed shape of relatively large dimensions and complex configuration, is particularly complicated (Figure 1). Diameter of top-cutter disc is 420 mm, deposited layer width is 30 mm, thickness of base and deposited metal is 3 and $1^{+0.5}_{-0.2}$ mm, respectively [3]. Width of surfaced zone is larger than the height of the tooth proper.

Machining of the layers deposited by induction process on the tools of agricultural machinery is not performed, as a rule. For this reason it is important to select such surfacing modes, which would ensure the specified values of geometrical characteristics of the deposited layers in as-surfaced condition. This, primarily, concerns the deposited metal layer thickness, on which the wear resistance and self-wetting of the surfaced tools depend. In addition, at development of new technological processes with application of induction surfacing [3], very often it is necessary to monitor and compare the influence of a particular technological process of surfacing on geometrical characteristics of the deposited metal layer.

The purpose of this work is investigation of the influence of technological schematics of induction surfacing by wear-resistant powder-like alloys on dimensions of deposited metal layer. As the currently available methods and tools for assessment of geometrical characteristics of the deposited layers are complex in terms of design

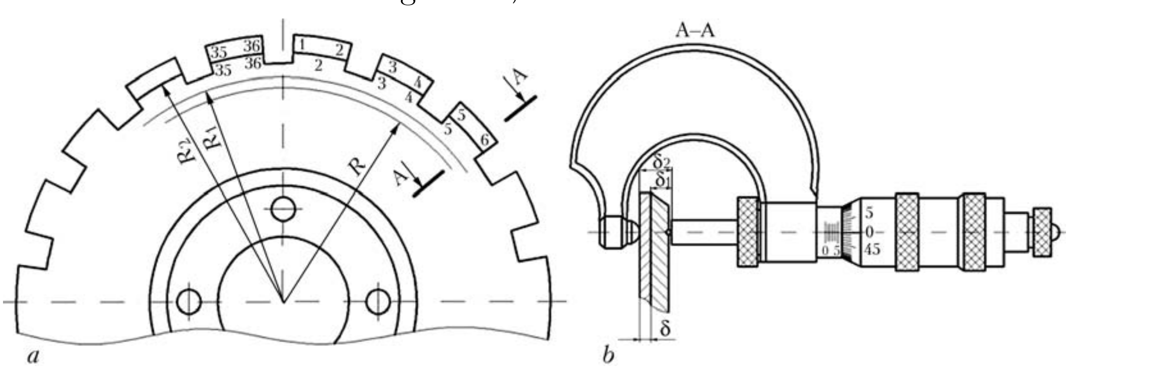

Figure 1. Schematic of configuration of plant top cutter (*a*), and cutter section along *A–A* with the device for deposited layer measurement (*b*)

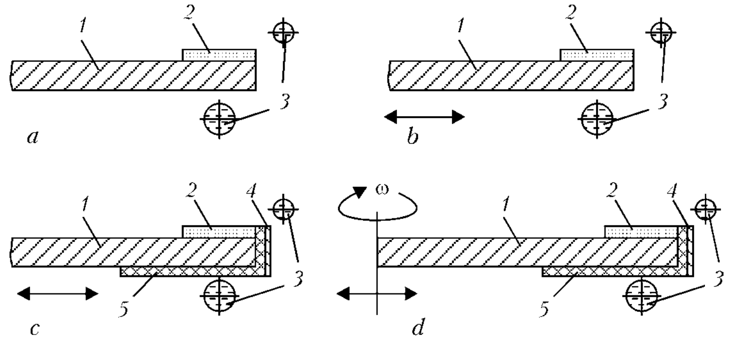

Figure 2. Schematics of induction surfacing used at investigation performance: *a* — without vibrations of surfaced part; *b* — with horizontal vibration of the surfaced part; *c* — with horizontal vibration of the surfaced part using thermal and electromagnetic shields; *d* — same, but with additional rotation of the surfaced part; *1* — part; *2* — deposited metal layer; *3* — two-turn circular inductor; *4*, *5* — electromagnetic and thermal shields, respectively (arrows show the direction of application of vibration and rotation)

[4] and give a large error at measurement, the paper deals with modern measurement tools and methods, which allow measurement of deposited metal thickness with greater accuracy and smaller error.

This work is a study of geometrical characteristics of the deposited layers for four technological schematics of induction surfacing of thin discs (Figure 2, *a*–*d*) [5, 6]. Deposited layer thickness was studied by the following procedure. A special device with a sphere was used to make semispherical recesses at the end face in 36 points around the circumference of radius R_2 = = 202.5 mm, as shown in Figure 1, *a*, from the side opposite to the processed surface of the disc (Figure 1, *b*). Then a micrometer, as well as another sphere of similar diameter, serving as a support for micrometer jaws (one jaw of which is semispherical, and the other has a flat surface), were used to measure the thickness of base metal δ_1 before surfacing (see Figure 1, *b*). Spheres are

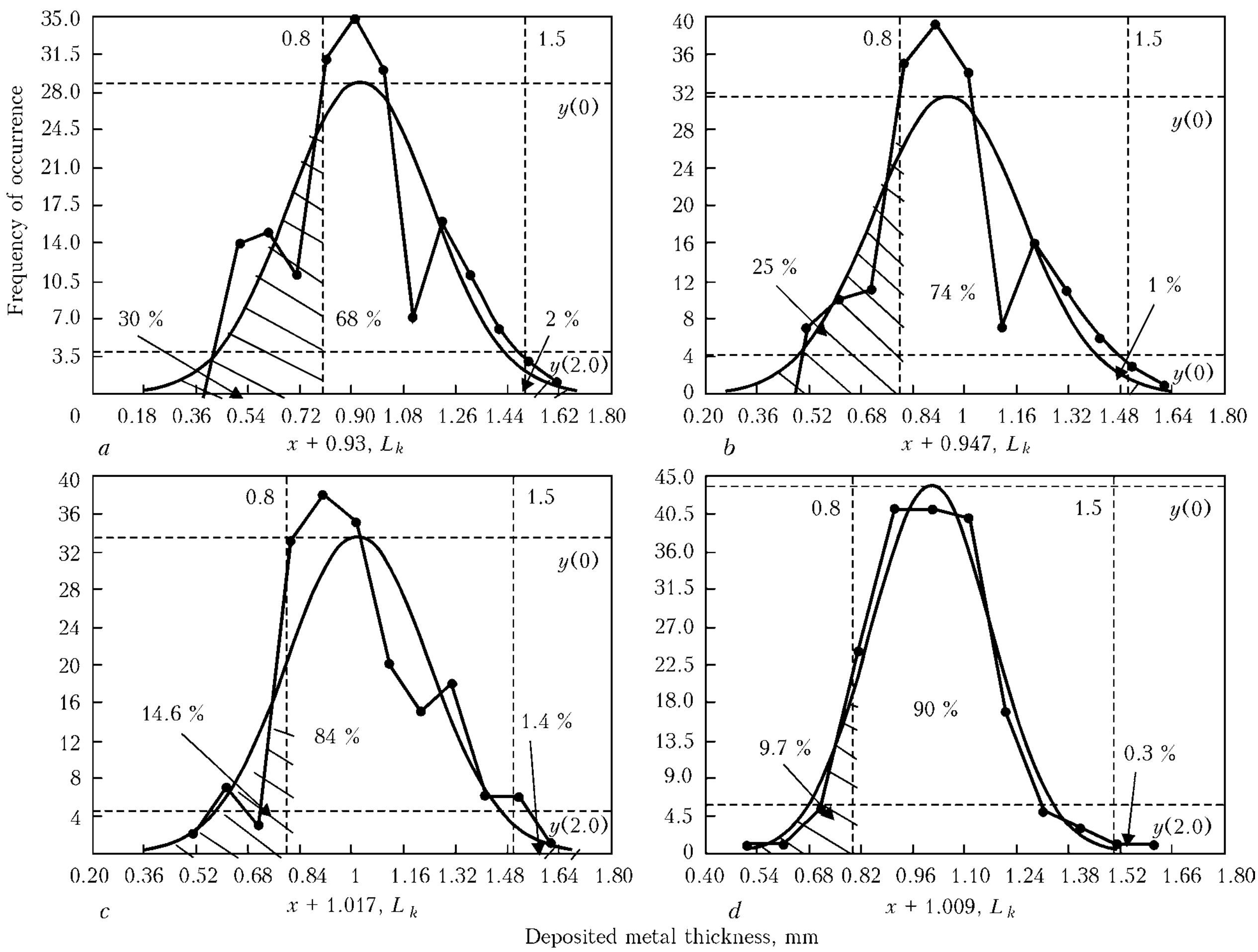

Figure 3. Curves of normal distribution of metal layer thickness (solid curve $y(x)$) and curves of dissipation of actual dimensions (broken curve) by the schematics in Figure 2, *a*–*d*, respectively

required to increase the accuracy of measurement of deposited metal thickness in each of 36 points, as at induction surfacing of thin discs scale forms on the surface, opposite to the processed surface, and large errors can occur at measurement of deposited metal thickness by the micrometer without spheres.

Thickness δ of the deposited layer was determined as difference of thicknesses of surfaced disc δ_2 and base metal δ_1. Investigations were performed using discs made from steel VSt3 and surfaced by induction process with powder-like alloy PG-S1 (sormite-1). Surfacing was conducted using high-frequency generator VChG-60/0.44.

Processing of the results of measurement of deposited layer thickness was performed by mathematical statistics methods [7, 8] by a specially developed algorithm.

Curves of scattering of the actual dimensions and curves of normal distribution of deposited layer thickness for the studied schematics of induction surfacing are given in Figure 3. Unhatched areas located under the curve of normal distribution, theoretically are a percentage of parts, in which the deposited metal thickness is within the tolerance range.

At induction surfacing by the schematic in Figure 2, *d*, 90 % of deposited metal thickness measurements fall into the tolerance range, that is by 22 % greater than at surfacing by the schematic in Figure 2, *a*. In this case, a more uniform thickness of the deposited layer is achieved due to simultaneous application of horizontal vibration, thermal and electromagnetic shields, as well as centrifugal forces, providing uniform distribution of liquid metal in the surfacing zone.

Conclusions

1. Developed procedure for measurement of geometrical characteristics of the metal layer, deposited by induction process, allows increasing the measurement accuracy, as well as controlling the stability of the layer thickness at development of new technological processes and modes of induction surfacing of thin flat parts.

2. Technology of induction surfacing of plant top cutters with horizontal vibration of the surfaced part, using thermal and electromagnetic shields and additional rotation of the surfaced part, improves the stability of geometrical characteristics of the deposited metal layer by 22 %, compared to traditional induction surfacing without application of shields or additional mechanical impact on the solidifying deposited metal.

1. Ryabtsev, I.A. (2004) *Surfacing of parts of machines and mechanisms*. Kiev: Ekotekhnologiya.
2. Senchishin, V.S., Pulka, Ch.V. (2012) Modern methods of surfacing the tools of agricultural tillers and harvesting (Review). *The Paton Welding J.*, **9**, 43–49.
3. Pulka, Ch.V. (2006) *Technological and energy efficiency of induction surfacing of thin steel disks*: Thesis of Dr. of Eng. Sci. Kiev.
4. Bol, A.A. (1984) Development of induction surfacing in agricultural machinery engineering. *Tekhnologiya*, Issue 3, 38.
5. Pulka, Ch.V., Shably, O.N., Senchishin V.S. et al. (2012) Influence of vibration of parts in surfacing on structure and properties of metal. *The Paton Welding J.*, **1**, 23–25.
6. Pulka, Ch.V., Gavrilyuk, V.Ya., Senchishin, V.S. (2013) Improvement of equipment and technology of induction surfacing. *Svarochn. Proizvodstvo* (in the press).
7. Kolker, Ya.D. (1976) *Mathematical analysis of the accuracy of part machining*. Kiev: Tekhnika.
8. Barabashchuk, V.I., Kredentser, B.P., Miroshnichenko, V.I. (1984) *Experiment planning in engineering*. Kiev: Tekhnika.

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