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DEVELOPMENT OF INDUCTION SURFACING TECHNOLOGY FOR DISC KNIVES

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Annotation
The article presents the proposed technology of induction surfacing of a wear-resistant coating on the cutting edge of a disc knife with sormite No. 1 material with increased wear resistance.

Keywords: disc knife, sormite №1, flux, surfacing, slag, induction surfacing blade, wear resistance, surfacing material, charge.

Introduction

In the process of trenchless repair of pipelines, disc knives can work in conditions of intense abrasive wear. When working under these conditions, the technology of induction surfacing on the cutting edge of a disc knife of sormite №1 material with increased wear resistance is proposed.
Disc knives of working mechanisms are usually made of alloyed tool steels, for example HVG [1,3]. In this paper, it is proposed to use cheaper steel as the basis of knives, and to apply a wear-resistant material to its surface (on the cutting edge of the knife) by induction surfacing [4,5]. It was decided to use 45 steel as the basis of the disc knife, and sormite №1 powder and AN–20 flux as the surfaced material.

Main part

Steel 45 is a high-quality structural carbon steel. It is used in industry for the manufacture of such parts as: shaft gears, crankshafts and camshafts, gears, spindles, cylinders, cams and other normalized, improved and subjected to surface heat treatment parts that require increased strength. A surfacing material in the form of a charge was applied to the surface of the disc knife samples from this material, the quantitative composition of which is given in Table 1.

Composition of the deposited charge Table 1

Surfaced material	Content, %
Sormayt	80
AH-20	20

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Sormite №1 is an iron-based alloy with chromium, nickel, silicon and manganese as the main alloying elements. The chemical composition of sormite №1 is presented in Table 2.

Chemical composition of sormite alloy No. 1 Table 2

Chemical element	Cr	Ni	Si	Mn	C
The content of the element, %	25-31	3,8-5,0	2,8-4,2	0,5-1,55	2,5-3

In terms of chemical composition and structure, sormite alloy №1 is close to high-alloyed white cast irons. The hardness of sormite №1 is 49-54 HRC. This alloy is processed by grinding. It is made in the form of rods and powder.

Sormite №1 is widely used for fast-wearing parts of machines and tools operating under conditions of abrasive wear, for surfacing parts that work without sudden shocks and impacts, for example: bending and drawing matrices, punches, measuring tools (staples, templates), lathes centers, metal cutting knives, as well as for surfacing parts experiencing mechanical and chemical wear, for example, valve seats of internal combustion engines, etc. Based on the above, sormite №1 can be used as a surfacing material on the cutting edge of disc knives of working mechanisms for trenchless repair of pipelines.

Also, the advantage of sormite №1 is that it has paramagnetic properties and does not need to be sintered or briquetted during induction surfacing.

Sormite №1 AN-20 was selected in accordance with the requirements for fluxes for surfacing using high-chromium materials, which is sormite №1. The chemical composition of the AN-20 flux is shown in Table 3.

Chemical composition of AN-20 flux Table 3

Chemical element	CaF_2	Al_2O_3	SiO_2	MgO	CaO	K_2O $+Na_2$	MnO	Fe_2O_3	S	P
The content of the element, %	25-33	27-32	19-24	9-13	3-9	2-3	<0,5	<0,8	<0,06	<0,03

Flux density AN-20 – 1,3–1,8 g/cm3.

The proposed technology of induction surfacing of a wear-resistant coating on the cutting edge of a disc knife consists of three main stages: preparatory, main and final.

1) Preparatory stage

Production of knife blanks

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The blanks of the disc knives were made (Figure 2) with a groove to prevent spillage and to fix the surfacing mixture on the surfaced part. The blanks of the knives were made of 45 steel. The thickness of the workpiece is 10 mm, the outer diameter is 100 mm, the depth of the groove is 5 mm, the width of the groove is 10 mm (Fig. 1).

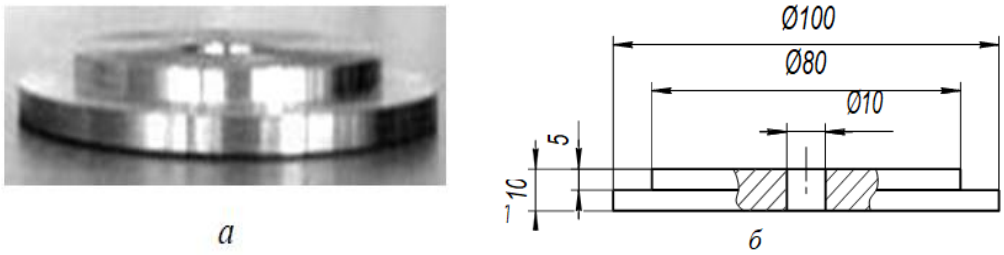

Fig1. The resulting blank disc knife: a – photo; b – drawing

Production of graphite mold

The mold is made in order to retain the molten charge. The thickness of the graphite mold is 10 mm, the diameter of the hole is 100 mm, the length and width are 250 mm each.

Graphite formation segment

The graphite layer is cut off mechanically, for example, by an angle grinder (grinder).

Grinding and thickness leveling

This operation is necessary to ensure the thickness of the graphite mold equal to the thickness of the blank disc knife.

Drilling a hole

Drilling a hole in a graphite mold is required to place a disk knife blank in it (Fig. 2). In this case, the diameter of the hole is equal to the outer diameter of the knife.

a b

Fig2. Drilling a hole in the form of: a – beginning; b – ending

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Placement of the knife blank in graphite form

Placement of the disk knife blank (fig.3) it is performed to fix it in a stationary state and apply a better coating.

Fig.3 Placement of the knife blank in graphite form

Preparation of powder mixture for surfacing

For induction surfacing of a wear-resistant coating on the cutting edge of a disc knife, it is necessary to prepare a powder mixture consisting of sormite №1 and AN-20 flux in a ratio of 4:1, table1.

Checking the quality of the knife surface

Before surfacing, it is necessary to check the quality of the knife surface. It must be cleaned of rust, oxide films and dirt.

Application of surfacing charge

The prepared surfacing charge is evenly applied to the surfaced surface of the blank of the disc knife

2) The main stage (surfacing of a wear-resistant coating on the knife)

For induction surfacing of sormite №1 on the cutting edge of the disc knife, a high-frequency transistor generator UVG 2-25 was used. The power of the installation is 25 kW, the current frequency is up to 100 kHz.

The blank of a disk knife in graphite form with a surfacing mixture is placed under an end-type inductor with a ferrite amplifier. After that, the induction surfacing process is carried out at a speed of 5-6 m / h at the operating frequency of the generator current of 44-46 kHz, evenly rotating the platform until the entire cutting edge of the knife along the circumference of its outer diameter is deposited (Fig.4)

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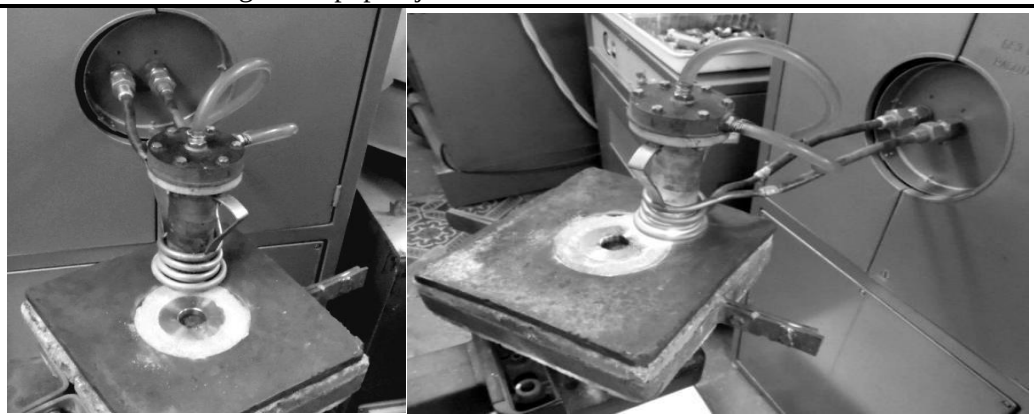

Fig.4 Induction surfacing of the disk knife blank:

a – heating; b – melting of the surfacing charge

The coating is applied on one side of the knife in 2 passes.

3) The final stage of the technology

Heat treatment of the knife workpiece.

After completion of the induction surfacing process, the blank of the disc knife should be removed from the graphite mold and subjected to heat treatment in a normalization furnace. This is necessary to eliminate the consequences of overheating of the base metal during induction surfacing.

Although the material of the base metal of the knife is medium–carbon steel, in this technology, the normalization operation after surfacing is not mandatory, because the resulting disc knife does not work under dynamic loads.

Removal of slag crust and scale from the outer surface of the knife

The surface of the resulting deposited disc knife (Fig.5) mechanically processed to remove scale (grinding) and slag crust.

Fig.5 Disc knife, deposited with sormite №1

Surfacing quality control

After cleaning the disc knife from slag and scale, visual and measuring quality control of the deposited layer is performed. The surfaced coating has a smooth defect-free surface. The presence of pores and external cracks is not observed.

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The thickness of the deposited layer corresponds to the specified dimensions and is 2-4 mm. The penetration depth is 2-4 microns. The hardness of the deposited layer is 49-54 HRC.

Sharpening the blade of a disc knife.

After carrying out visual and measuring quality control, the blade of the disc knife is sharpened on both sides on the grinding machine to the value of the sharpening angle equal to 60.

Quality control of geometric parameters of the knife

After machining and sharpening, the disc knife must be checked for compliance with the required geometric dimensions – outer diameter, diameter for the seat (shaft), thickness and angle of sharpening. Deviations should not exceed 1%.

Conclusion

After that, the disc knife is ready for testing. Since standards for testing disc knives of working mechanisms for trenchless repair of pipelines have not yet been developed, but there is a similarity with wear resistance tests, in this regard, when developing a methodology for such tests at this stage, the basic principles and provisions laid down in the methods for conducting tribotechnical tests were used.

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