ON POSSIBILITY OF APPLYING PARTS PRODUCED BY ADDITIVE TECHNOLOGY IN HIGH PRESSURE GATE VALVES

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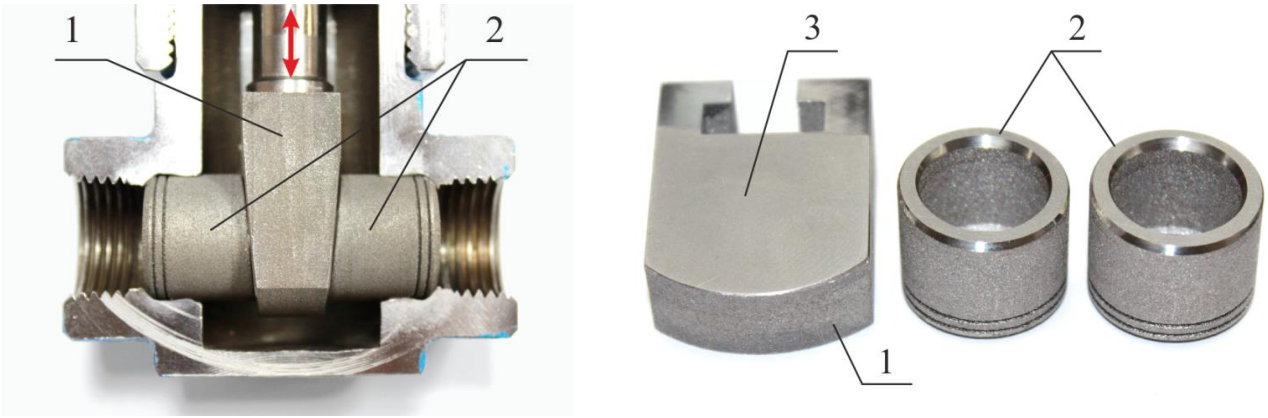
Selective laser melting (SLM) is a promising additive technology capable of reducing costs and resources. It makes it possible to produce metal powder parts with high mechanical and operational qualities which are not typical for prototypes after machining. For instance, this can be said about stainless austenitic steels that are used for production of gate shutters and valves designed for conducting water-gas-oil mixtures and aggressive media which are likely to cause corrosion.

The purpose of this research is to look into the properties and to complete a comparative analysis of service life of parts in the gate unit of a wedge gate valve (Fig. 1); the valve has a port area of Dn 15mm, the pressure of the medium is 2.5 MPa, the parts were made by machining AISI 321 rolled steel and welding CN-12M (%: C 0.08; Si 4.00; Mn 3.67; Ni 6.97; Cr 15.46; Mo 5.74; Nb 1.08; S 0.010; P 0.029) material onto the sealing surface and by applying the selective laser melting technology making use of EOS PH-1 steel powder (%: Cr 14.0-15.5; Ni 3.5-5.5; Cu 2.5-4.5; Mn≤1; Si≤1; Mo≤0.5; Nb 0.15-0.45; C≤0.07).



a b

Figure 1. Gate unit a) and parts of the gate unit b): 1 – wedge; 2 – seats; 3 – sealing surface located at 5° to the axis

The parts 'wedge' and 'seat' of the gate unites fabricated from rolled steel were machined on MIKRON VCE600 Pro и Takisawa E810 CNC machines. The welded surface was ground on a 3B722 machine to obtain Ra=0.4 μm roughness. Selective laser melting was done on an EOSINT M280 unit, the parts were made by layer-by-layer horizontal adding, the thickness of the layer being 30 μm. The structure of the melted material is presented in Fig. 2.

After the addition had been completed and the pad had been separated from the part, fine milling of the sealing surfaces was done on a MIKRON VCE600 machine with a KORLOY RM4PCM4050HR-M end mill with LNMX 15 1008 and PNR 5300 plates made from PC 5300 alloy. The feed modes were as follows: the spindle ran at n=800 rev/min; the cutting rate was 125 m/min; the feed was f_z=0.03125 mm/tooth; the depth the removed layer was a_p=0.1mm.

Milling modes were selected so that no overheating could occur; the cutting was dry. A special stand was used for lapping of sealing surfaces on the wedges and seats with ASMG NOMG

10/7 TU2-037-506-85diamond paste to provide for required nonflatness not over 0.02 and roughness Ra=0.6 μm.

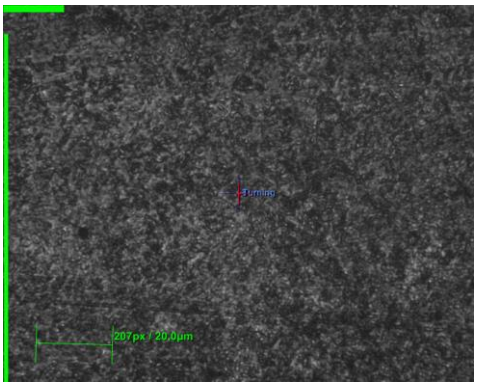


Figure 2. Structure of the material of the wedge produced by laser melting from PH-1 powder.

Research methods. Roughness of the sealing surfaces on the wedge was measured with a Wyko NT1100 optical 3D-profilometer, microhardness – with an EcoHard XM1270C microhardness tester; a PIM-DV-1 instrument was used to measure hardness and mechanical properties. To find out the service life in cycles the valves were tested on a special test stand until they began to leak. Roughness, mechanical properties of the sealing surfaces and service lives of the valves are illustrated in table 1. The values that describe mechanical properties of the wedge fabricated by selective laser melting are practically the same as those cited in the paper [1].

Table 1. Roughness and mechanical properties of wedge sealing surfaces, service life of the valve

Technology of producing wedges	Roughness Ra, μm	Micro-hardness $HV_{0.05}$	Hardness HB	Yield strength YS, MPa	Tensile strength TS, MPa	Cycles number
Machining and welding	0.4±0.05	488±23	364±22	1034±36	1252±40	3609
Selective laser melting	0,53±0.05	394±13	327±25	923±83	1131±88	3450

Tests showed that application of components produced by the SLM technology in gate units of valves meets customers' requirements on service life – 2000 cycles of closing and opening. Yet, the cost effectiveness of these components remains high, reaching 20% of the total cost of the valve, while the cost effectiveness of the components produced by conventional technologys does not exceed 11%.

Further fine-tuning of the modes employed for thermal production of the wedge is a promising trend for future research into the properties of valve components produced with applying the SLM technology.

References

1. Galimova L.A., Atroschenko V.V., Smirnov V.V., Churakova A.A., Gunderov, Zamanova G.I. Structure and mechanical properties of stainless samples produced by selective melting // Bashkir University Review (Vestnik Bashkirskogo Universiteta). 2016. Vol. 21. №2. P.p. 258-262.