PLASMA-POWDER SURFACING OF POWER FITTING RODS

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Iron-based filler powder 15Kh19N9M4S5G3D was selected, and technology of mechanized plasma surfacing of sealing and cylindrical surfaces of rods (spindles) of fittings, operating in thermal and nuclear power stations, was developed. Metal deposited with this powder has the required service properties, and its price is lower compared to earlier applied for this purpose nickel alloys. Application of plasma-powder surfacing of rods of power fittings instead of coated-electrode manual arc and automatic flux-cored arc surfacing allowed improving the deposited metal quality, reducing machining tolerances, as well as lowering the surfacing costs and extending the service life of stop valves. 5 Ref., 1 Table, 6 Figures.

Keywords: *plasma-powder surfacing, surfacing powders, surfacing equipment, stop valves, rods, spindles*

Experience of application of mechanized plasma surfacing in power fitting manufacture is indicative of significant technical and economic advantages of this process compared to manual arc surfacing. In addition to higher efficiency, lower consumption of expensive and deficit surfacing consumables and better labour conditions, a higher quality of surfaced parts is also provided.

Nickel- and cobalt-based alloys are widely applied for plasma surfacing of power fitting parts. Alloys of these types have high technological and service properties. They, however, have the great disadvantage of a high cost. Less expensive iron-base alloys have been now developed for surfacing fitting parts for various purposes. However, as was mentioned above, many enterprises of CIS countries still apply manual electric arc surfacing with stick electrodes or mechanized flux-cored arc surfacing for this purpose. Arc surfacing of fitting parts is performed, as a rule, in three layers, leading to excessive consumption of surfacing consumables and prolongation of surfacing process duration [1, 2].

In batch production the fitting rods (spindles) are manufactured from 25Kh1MF steel, and their sealing surfaces are surfaced manually in 3–4 layers with TsN-12M electrodes in a copper water-cooled crucible (Figure 1). Technological process envisages billet preheating and subsequent tempering of surfaced parts. Non-uniform hardness by the height of the deposited layer, presence of slag inclusions, pores and other defects, as well as a low efficiency of manual labour — these are the factors, inherent to this surfacing technology.

PWI developed the technology of mechanized plasma surfacing of fitting parts, in particular, sealing and cylindrical surfaces of rods (spindles), with powder of iron-based alloy 15Kh19N9M4S5G3D [3]. This surfacing process allows application of thin metal layers at small penetration (5–10 %) of base metal. Dimensions of deposited beads can be adjusted in broad ranges: deposited layer thickness δ = 1–6 mm, width b = 4–50 mm. When this technology is used, the cost of filler materials is reduced, high efficiency and good quality of deposited metal are ensured, labour conditions are greatly improved and longer service life of the fittings is achieved [4].

Plasma-powder surfacing of sealing surface of the rods is performed using the diagram shown in Figure 2. To prevent pouring down of the deposited layer and to ensure sound formation of

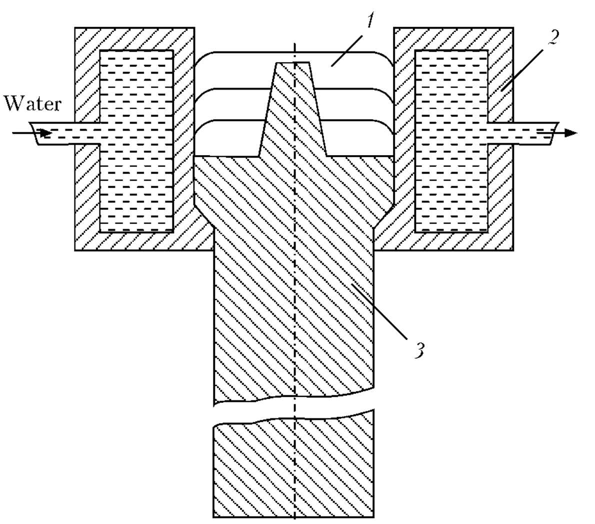

Figure 1. Schematic of manual arc surfacing of rods of DN 50 valves: *1* — deposited metal; *2* — water-cooled copper crucible; *3* — rod billet

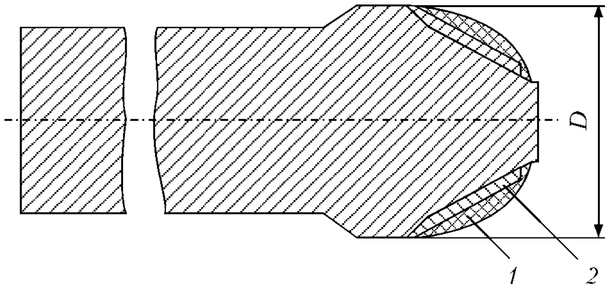

Figure 2. Schematic of edge preparation and surfacing of DN 50 rods: *1* — deposited metal before machining; *2* — same after machining

the deposited bead, the rod billet for surfacing had a protrusion of diameter *D* and length of 5–7 mm. Bead cross-sectional shape at optimum surfacing conditions looks like a sessile drop.

Compared to manual multilayer surfacing, plasma-powder surfacing reduces filler material consumption approximately 2 times.

In addition to conical sealing surface, also the cylindrical contact surface is wearing on the rods. As shown by verification of service durability of fittings under production conditions, the share of rod damage over this surface can be up to 15 % [5]. Currently applied strengthening methods, namely nitriding, boriding, chromium plating, thermal or electric arc surfacing do not completely meet the requirements of modern fitting engineering.

Plasma-powder surfacing gives positive results also in this case. Surfacing of cylindrical surfaces of the rods is performed along a helical line in one layer by powders based on nickel, cobalt and iron.

An important technological parameter at surfacing of cylindrical parts along a helical line is the value of plasmatron displacement from zenith [4]. Conducted investigations showed that this value rises with increase of billet diameter and surfacing speed (Figure 3). Increasing the diameter widens the range of optimum values of displacement. With increase of surfacing speed bead formation becomes more sensitive to the change of the value of displacement, as here the current and powder feed increase, accordingly, and, therefore, also the weld pool width. Reduction of displacement impairs formation and leads to increase of penetration.

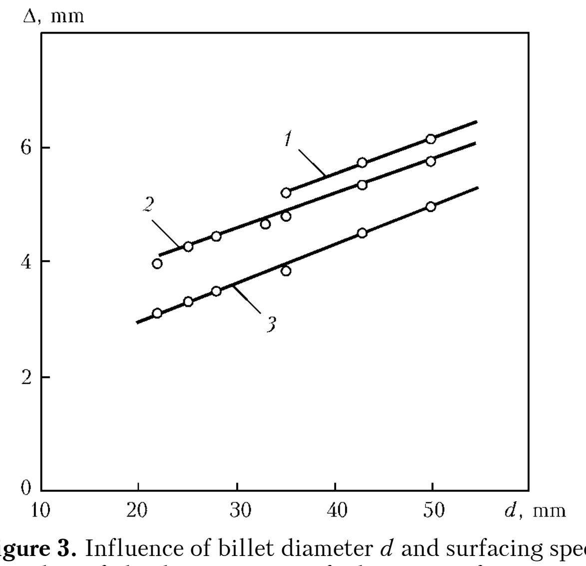

Figure 3. Influence of billet diameter *d* and surfacing speed on value of displacement ΔZ of plasmatron from zenith: *1* — 7.0; *2* — 5.0; *3* — 3.6 mm

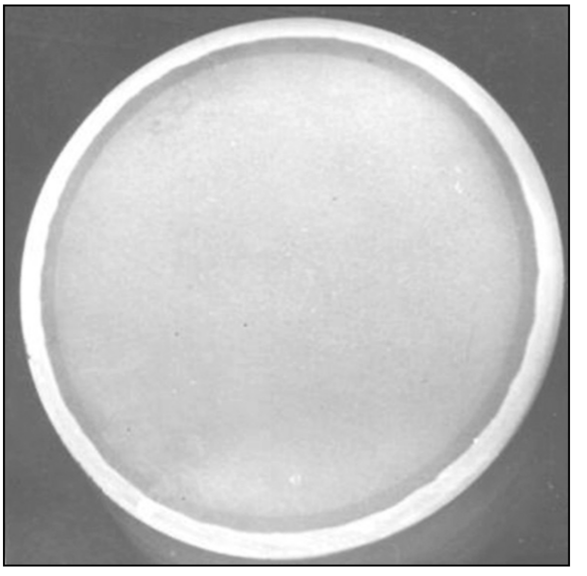

Figure 4. Transverse macrosection of cylindrical part of the rod of DN 50 gate valve surfaced by plasma-powder process

Rods of 25–30 mm diameter are surfaced in one layer, without preheating, at the efficiency of 3 kg/h. Larger parts can be surfaced with the efficiency of up to 5 kg/h. Rod billet surface to be processed is located parallel to the edge of plasmatron nozzle at the distance of 7–9 mm. Gas flow rate is maintained within the following ranges, l/min: plasma and carrier gas — 1.5–2 each, shielding gas — 8–10. Arc current, powder feed, deposition rate and displacement from zenith are selected so as to provide the required bead dimensions and good formation of the deposited layer (Figure 4).

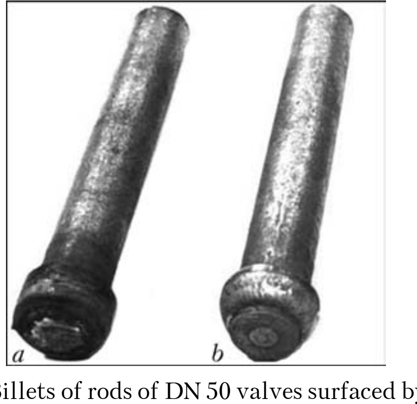

Figure 5. Billets of rods of DN 50 valves surfaced by manual arc (*a*) and plasma (*b*) processes

Main parameters of the mode of plasma-powder surfacing of sealing surfaces of rods of DN 40 and DN 50 valves

Rod diameter, mm	Surfacing current, A	Powder flow rate, g/min	Plasmatron displacement, mm	Time of one revolution, min
40	160	35	5.0	0.68
50	180	40	6.5	1

The Table gives the main parameters of the mode of plasma-powder surfacing of sealing surfaces of rods of DN 40 and DN 50 valves, and Figure 5 shows rod billets surfaced by arc and plasma-powder processes.

Under production conditions semi-automatic surfacing of the rods is performed in the machine based on A1756 unit (design of PWI Design-Experimental Technological Bureau).

The machine (Figure 6) includes A1756 unit, manipulator, bed plate, control cabinet and power source VDU-504. Manipulator consists of the bed plate, reduction gear with electric motor, pneumatic chuck and current conduit. In the initial position the pneumatic chuck is unclamped, and the manipulator is inclined towards the unit.

Main elements of plasma surfacing technology are as follows: automatic clamping of the billet, manipulator displacement using a pneumomechanical system under the plasmatron into the working position and automatic connection of billet rotation and plasma arc excitation. After completion of surfacing and issuing «Stop» command, automatic welding-up of the crater and manipulator returning to the initial condition are performed. After surfacing the batch of parts are placed into the furnace, and heat treatment is performed.

At plasma surfacing with small penetration of the base metal, the specified hardness of deposited metal is achieved already at the distance of 0.5–1.0 mm from the fusion line [3]. To ensure a high performance of parts after machining, it is sufficient to deposit a metal layer of 1.8–2.5 mm thickness. In practice this thickness is maintained in the range of 2.0–2.5 mm. Scatter of metal hardness values on one billet is not greater than *HRC* 5.

Mechanization of surfacing process with application of highly-efficient shielding of the deposited metal by argon allowed a considerable reduction of the probability of defect formation (pores, slag inclusions, lacks-of-penetration), inherent to manual electric arc surfacing with stick electrodes and mechanized arc surfacing with flux-cored wires.

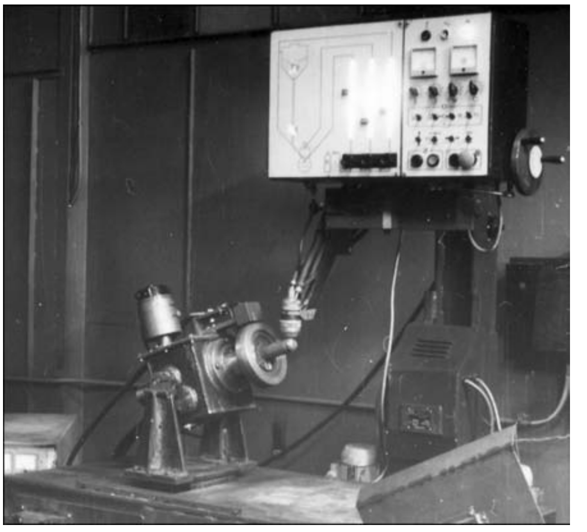

Figure 6. Unit for treatment of sealing surfaces of valve rods

Technology of automated plasma surfacing with powder of iron-base alloy 15Kh19N9M4S5G3D of sealing and cylindrical surfaces of rods was developed. Metal deposited with this powder, has the required service properties and compared to nickel alloys earlier applied for this purpose, it has a lower price. It is shown that plasma-powder surfacing provides the required composition of the deposited metal already in the first layer. It also ensures excellent formation and high quality of the deposited metal.

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