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NEW EQUIPMENT FOR PREPARATION OF POSITION BUTTS OF NPP PIPELINES FOR WELDING*

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Investigations and practical experience showed that the quality of welded joints of pipelines, meeting the modern requirements largely depends on the quality of treatment of the end faces of groove edges of their butts prior to welding and on the quality of assembly of pipeline parts directly before welding. The paper presents the results of experimental, technological and design works carried out at the Engineering Center for Welding and Control in the Field of Nuclear Energy, on development of a facing tool for metal pipes of 76 to 108 mm diameter. It is shown that, in comparison with the best foreign analogs, the designed facing tool has a number of significant technological and operational advantages. 7 Ref., 2 Tables, 1 Figure.

Keywords: *nuclear power engineering, position butt joints of pipelines, machining, pneumatic drive, facing tools, carriages, cutters*

During performance of investigations and experimental and technological works the effect of the accuracy of edge preparation of parts of metal pipelines with nominal outer diameter of 76, 89 and 108 mm, the geometrical elements of which meet the requirements of PN AE G-7-009–89 and OST 24.125.02–89 was studied, and the range of optimum modes for treatment of these edges by cutting were established.

Investigations were performed on samples of parts of pipelines from steel 08Kh18N10T and steel 20 of nominal diameters of 76; 89 and 108 mm, and nominal wall thickness of 7.0; 8.0 and 12.0 mm, respectively. The edges of pipeline part samples used for investigations and experimental-technological works were treated using screw-cutting lathe 1M61 and milling machine 6R82Sh.

Treatment of groove edges of butts of the tested samples of pipeline parts for simulation of deviations of the linear and angular dimensions, specified by PN AE G-7-009–89 and OST 24.125.02–89 for welded joints of C-42 type, was performed in keeping with Table 1. Here, the asymmetry of beveling angles of groove edges of pipeline part samples for simulation of deviations from the normative values was equal to 4 and 8° for pipes with nominal dimensions of 76×7.0; 89×8.0 and 108×12.0 mm.

During treatment of the tested samples of parts of pipelines from steel 08Kh18N10T and steel 20, their

Table 1. Linear dimensions of edge preparation of samples of pipeline parts for simulation of deviations from specified values

Nominal dimensions of pipe (D×S), mm	Edge preparation						
	Bore diameter d_b, mm		Wall thickness in boring location, not less than	Blunting (S–M) at $S_1 = S_2$, mm			
	Nominal value	Largest allowable deviation		S_1–M_1	S_2–M_2		
					$M_2 = M_1$	$M_2 = M_1 + 1$	$M_2 = M_1 + 1.5$
76×7.0	63	+0.23	5.6	$2.3^{+0.4}$	$3.3^{+0.4}$	$3.8^{+0.4}$	$4.2^{+0.4}$
89×8.0	74		6.5	$2.7^{+0.3}$	$2.7^{+0.3}$	$3.7^{+0.3}$	$4.2^{+0.3}$
108×12.0	88		8.8	$3.0^{-0.3}$	$3.0^{-0.3}$	$4.0^{-0.3}$	$4.5^{-0.3}$
Note. Explanation of designations of dimensions S_1, S_2, M_1 and M_2 is given in [1].							

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linear and angular dimensions were controlled with application of standard measuring devices, in particular, calipers ShTs-P-160 and ShTs-P-250 to GOST 166 (greatest measurement error of ±0.07 and ±0.08 mm, respectively), indicator wall meters S-10A and S-25 to GOST 11358 (greatest measurement error of ±0.02 and ±0.10 mm, respectively), goniometer with nonius UT mod. 127, with measurement range from 0 to 18° and greatest measurement error of ±2′ [2].

The main part of the treated in keeping with Table 1 test samples of parts of pipelines from steel 08Kh18N10T and steel 20 were joined by multipass automatic orbital nonconsumable electrode argon-arc welding (GTAW) with filler wire feed and nonconsumable electrode oscillations. Here, a prototype of orbital automatic welding machine ADTs 628 UKhL4 developed at SEC WCNE was used [3], and a certain part of these test samples were joined by multipass manual arc welding (GTAW) with filler wire feeding and nonconsumable electrode argon-arc welding (TIG) with filler wire feeding. TIG welding was performed with application of earlier developed by SEC WCNE prototypes of power source ITs 617 U3.1 for TIG and GTAW welding, power supply module MPS-101 and electronic regulator of welding current RDG-201 U3.1 [4], as well as ABITIG GRIPP 26 torch (ABICOR BINZEL Company) with tungsten electrode of WT20 grade of 3.15 mm diameter. At test welding of butt joints of parts of pipelines from steel 08Kh18N10T, wire Sv-04Kh19N11M3 was used as filler, and for those from steel 20 wire Sv-08G2S was applied, the diameter of these wires being 1.6 mm.

The quality of welded joints of the tested samples of parts of pipelines of nominal diameter from 76 to 108 mm, was controlled by visual, radiographic and penetrant techniques [5].

As a result of performance of several series of test welds it was established that:

• asymmetry of bevel angles of edges on parts of metal pipelines of 76 to 108 mm diameter during performance of welded joints of C-42 type should not be higher than 4°, as at larger values of bevel asymmetry characteristic are such continuity defects as inadmissible violation of weld formation, lacks-of-penetration of the edges and individual beads, lacks-of-penetration of filling passes, «sagging» of part of the weld near the edge with a greater bevel, undercuts in the facing weld;

• deviations of internal diameter boring from the normative values during performance of welded joints of C-42 type should not exceed +0.23 mm for pipes with nominal outer diameter from 76 to 108 mm inclusive, and the difference between blunting of both the edges should not exceed 0.5 mm, as the welded joints of pipeline parts, where blunting of one of the edges differs from blunting of the other one by more than 0.5 mm, are prone to such weld root defects as violation of its specified shape, lacks-of-penetration, weld «sagging» from one of its sides, and «shrinkage cavities» or lacks-of-fusion from the other. Here, it should be noted that in the case of application of the modes of modulated current welding when joining parts of metal pipelines of 76 to 108 mm diameter, even at up to 0.75 mm difference between edges blunting, weld root defects are very rare, and in most of the cases they were not detected at all, and at up to 0.60 mm difference between edges blunting these defects are practically completely absent;

• based on the recommendations, arising from many years of research on machining parts from steels of austenitic class and available production experience of such treatment [6], in the case of thin external longitudinal turning and cross-cutting of parts from steels of austenitic class (for instance, 08Kh18N10T) the region of optimum values of cutting speed is limited by the range from 10 to 40 m/min, values of correction factors K_{m} and K_{nv} (first of which takes into account the influence of physico-mechanical properties of the billet from corrosion-resistant steel on cutting speed, and the second — the influence of the state of this billet surface on cutting speed) are equal to 0.8 and 0.9, respectively, and the feed values for finish turning of parts from heat-resistant and stainless steels — from 0.04 to 0.12 mm/rev., respectively.

When facing tool TRTs 108 U3.1 was developed, results of analyzing the information on the parameters, characteristics and design of the available in the market best foreign samples of equipment for treating the end faces and edges of pipeline parts to be welded and main disadvantages inherent in these analogs were taken into consideration [1]. The desire to standardize the main components of domestic equipment for machining the end faces and edges of pipeline parts before welding was also taken into account.

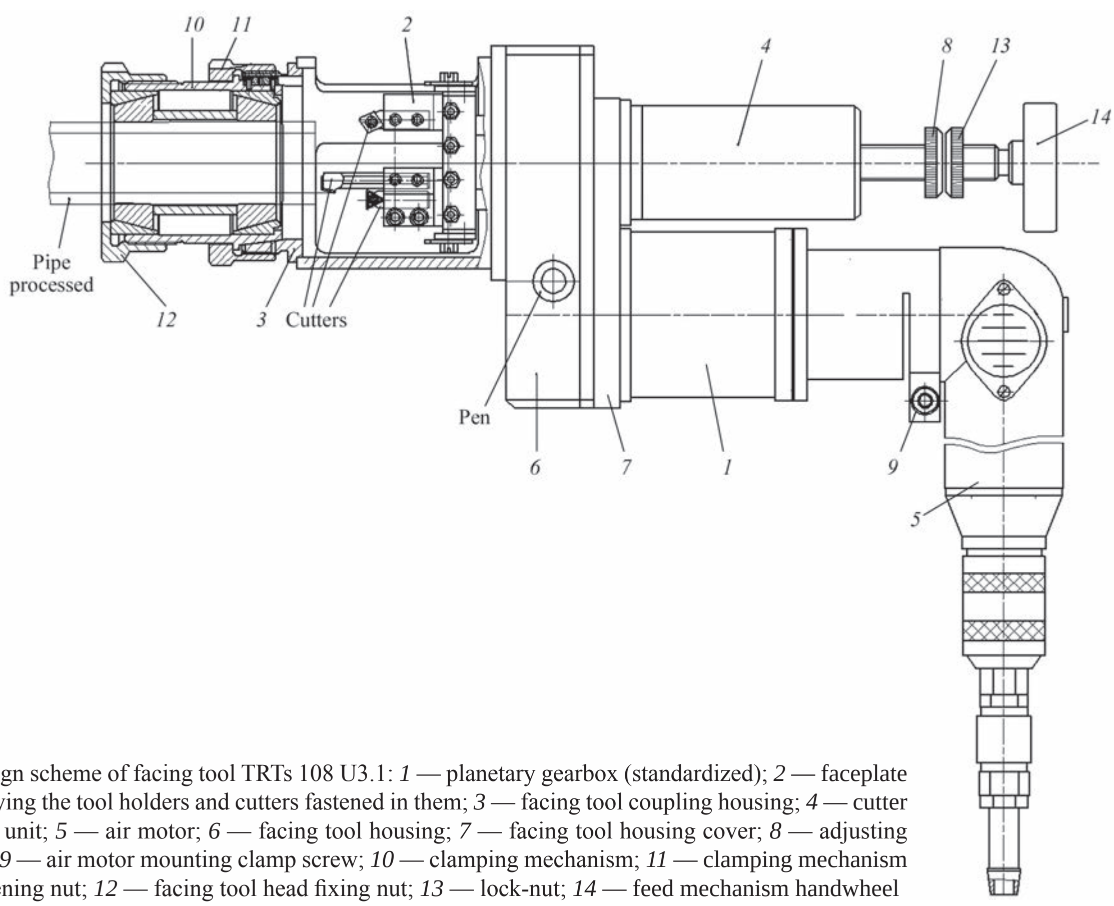
We used the kinematic scheme, similar to that of facing tool TRTs 76 U3.1 [1], and also performed calculations of transmissions and faceplate mechanisms of this facing tool, calculation of strength and fatigue life of elements of such transmissions and mechanisms and calculations of cutting forces. This enabled selection of the required materials of the main pars of facing tool TRTs 108 U3.1 and allowed taking

Table 2. Main parameters and characteristics of test samples of facing tools TRTs 76 U3.1 and TRTs 108 U3.1 and some of their foreign analogs

Name of parameter or characteristic	Model			
	TRTs 76 U3.1	TRTs 108 U3.1	Mangust-2T (Russia)	PROTEM PUS40 (France)
Smallest outer diameter of treated pipe, mm	38	76	45	43
Largest outer diameter of treated pipe, mm	76	108	120	219
Maximum wall thickness of treated pipe, mm	7.0	12.0	5.0	16.0
Depth of bore of internal diameter of treated pipe, mm, not more than	15	20	Boring option is not available	
Basing	On outer surface of treated pipe		Internal basing	
Maximum possible number of cutters in tool holders, pcs	4		1	1
Method of feeding the cutters	Manually			
Cutter feeding, mm/rev., not more than	0.15		0.20	
Frequency of faceplate revolution nominal, rpms	100	70	70	25
Compressed air consumption during idle running, m^3/min, not more than	1.5		1.7	1.6
Weight with drive, kg; not more than	12.6	13.4	9.5	16.0

design solutions for its main components, similar to those which were taken during design of facing tool TRTs 76 U3.1 [1, 7], in particular as regards one-time external basing, faceplate design, self-centering coaxially with longitudinal axes of the treated pipe and basing mechanism. To provide feeding of air-oil mixture to facing tool TRTs 108 U3.1, a unified block of air preparation, applied in facing tools TRTs 38 U3.1, TRTs 76 U3.1 and split pipe cutter TRTs 660 U3.1, was used.

Table 2 gives the main parameters and characteristics of test samples of facing tools TRTs 76 U3.1



Design scheme of facing tool TRTs 108 U3.1: *1* — planetary gearbox (standardized); *2* — faceplate carrying the tool holders and cutters fastened in them; *3* — facing tool coupling housing; *4* — cutter feed unit; *5* — air motor; *6* — facing tool housing; *7* — facing tool housing cover; *8* — adjusting nut; *9* — air motor mounting clamp screw; *10* — clamping mechanism; *11* — clamping mechanism fastening nut; *12* — facing tool head fixing nut; *13* — lock-nut; *14* — feed mechanism handwheel and TRTs 108 U3.1, as well as some of their foreign analogs from among the best foreign samples.

Design scheme of facing tool TRTs 108 U3.1 constructed using the endineering solution given in [7], is shown in the Figure.

Conclusions

1. New import-substituting facing tool TRTs 108 U3.1 for preparation in welding of position butts of pipelines of 76 to 108 mm diameter of NPP power units and facilities of other sectors of Ukrainian economy was developed.

2. The following was achieved as a result of development of facing tool TRTs 108 U3.1:

- expansion of technological capabilities of domestic equipment for preparation for welding of parts of position butts of metal pipelines and increase of the efficiency of the processes of machining the end faces and edges;
- improvement of the quality and accuracy of preparation of these end faces and edges for manual or automatic welding;
- simplifying and lowering the cost of maintenance of facing tools, lowering the cost to manufacture such items by not less than 1.5 to 2.0 times.

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