

EXPERIENCE OF WORKING OUT AND APPLICATION OF THE ULTRASONIC CONTROL
OF WELDED CONNECTIONS FROM TWO-LAYER STEELS IN THE THICKNESS
FROM 60 TO 250 MM

F.N.Pyshchev, R.G.Okuneva
JSC «VNIPTchimnefteapparatury», Volgograd, Russia
E.V.Bessmertnov
JSC "Volgogradneftemash", Volgograd, Russia

In the report the information on working out and application of technology of the ultrasonic testing of vessels from two-layer steels with thickness of a wall to 250 mm contains.

JSC "Volgogradneftemash" (earlier the factory of oil mechanical engineering of Petrov) over 40 years makes vessels and the devices working under pressure, including from two-layer steels in the thickness to 120 mm with the basic metal from steels 09Г2С, 16ГС, 12ХМ, 15Х5М etc. and a weld cladding layer from steels 08Х13, 08Х18Н10Т, 07Х25Н12Г2Т etc.

NIKHIMMASH and VNIPTchimnefteapparatury in 1968-1973 technological instructions on the ultrasonic testing (UT) butt and angular welded connections from two-layer steels have been developed in the thickness from 10 to 60 mm. In 1981 VNIPTchimnefteapparatury has increased a range of controllable thickness to 120 mm.

In connection with development of manufacturing techniques of reactors of the big capacity for hidrocraking the heavy oil rests application of the ultrasonic testing butt and angular welded connections with thickness of a wall to 220-250 mm from cromium-molibdenium-vanadium steels of type $2\frac{1}{4}$ Cr-1Mo- $\frac{1}{4}$ V of two-layer sheets or with buttering, for example, from materials SA542 TpD Cl 4a + SA240 Tp347 was required.

Feature UT of welded connections of the big thickness (more than 120 mm) from the specified steels often are necessity of monitoring procedure of a full seam of the basic metal after the termination of all process of welding before drawing of a buttering, less - part of a seam after level-by-level (stage-by-stage) welding.

By preparation for the testing the combined standard samples of the enterprise (SSE) with segment reflectors the area 7,10, 20 mm² on vertical sides and on surfaces of a seam for corners of input of an ultrasonic beam 65, 50 and 40° (fig. 1) have been made. On samples have been tested equipment adjustment (were applied flaw detectors УД3-103, УД2-140) and technology of UT. Then technique UT on the basis of the developed technological cards has been tested at manufacturing of reactors R101 and R 201 taking into account requirements of ГОСТ P 52630-2006, OCT 26-291-94 and ASME.

After industrial approbation of technique UT on technological cards it is developed the "Instruction on the ultrasonic testing butt and angular welded connections of vessels and the devices from two-layer steels with thickness of a wall from 60 to 250 mm", which extends on welded connections of vessels with external diameter not less than 1400 mm, with internal diameter of welded unions (hatches, branch pipes) not less than 200 mm.

In the instruction tables with working parametres UT of butt and corner connections for ranges of thickness 60-120, 120-185 and 185-250 mm, schemes of the control of seams, sketches of the combined standard samples of the enterprise (SSE) for sensitivity adjustment of flaw detector with the probe, the DAC- diagrams for seams from the basic metal are resulted.

The sample of the table with parametres of UT is resulted (see the table).

According to the instruction the control of a seam of the basic metal is spent, as a rule, from 2 parties of a wall on 2-3 layers of a seam with application of inclined probes with corners of input 65, 50 and 40°,

and also direct or TR the probes (in accessible places). Examples of schemes of the control on layers are given on fig. 2, 4, 5 (a, b, c), 3a.

After drawing a buttering of a seam the testing of an overlay and a transitive zone by the probe with a corner of input 50 or 40° depending on a thickness (fig. 2d, 3b, 4d, 5d) is carried out .

Parameters layered (3 layers) the ultrasonic testing of butt
Weld connections wall thickness of more than 185 to 250 mm

Thickness of welded sheets, mm	Corner of input of an ultrasonic beam, °	The maximum width of strengthening of a welded seam, mm		limiting sensitivity, mm ²	The testing of a seam of the basic metal							Zone of moving of the probe, at the control of transitive and weld cladding layers on external surface L ₄ , mm (fig. 2d)
					near layer (fig. 2a)			centre (fig. 2b)			zone of moving of the probe at the control of an external layer of a seam on internal surface L ₃ , mm (fig. 2c)	
		on an external surface	on an internal surface		depth of layer H ₁ , mm	width of a zone of moving of the probe, mm		depth of the layer, mm: from H ₁ to H ₂	zone of moving of the probe, mm			
						on external surface L ₁	on internal surface L ₁ '		on external surface: L ₂	on internal surface: from L ₁ to L ₂ '		
over185 to 210	65	90	50	10	60	105	120					
	50							60–105	100	30-120		
	40										90–180	90–140
over 210 to 235	65	90		20	60	110	120					
	50							60–120	115	30-135		
	40										110–200	105–165
over 235 to 250	65	140		60	100	125						
	50						60–125	110	30-155	100–240	100–150	
	40											

Note. Arrow probe – 15 mm, the operating frequency of 2,5 MHz.

After carrying out of heat treatment or hydraulic tests in the absence of access for the testing from within a vessel (for example, in the presence of raw buttering surface) the testing only on an external surface is carried out by two probes: with input corners 65° to depth of 80–90 mm and 50 or 40° - other part of a seam (fig. 6 a,b). In addition the surface of strengthening of a seam and a weld zone is subject to the testing penetrating substances (PT) or magnetic-powder a method (MT).

Sensitivity of the testing and norm according to quality of welded connections are accepted on CTO 00220256-005-2005 (earlier OCT 26-2044-83) for steel vessels and the devices made according to requirements of ΓOCT P 52630-2006 (OCT 26-291-74) or ΓOCT P 50599-93, as durability of the case is provided with the basic metal. Developed technique of the UT is coordinated with the management of Rostehnadzor (Ростехнадзор) and applied at manufacturing of reactors with thickness of a wall of 180 mm from steel SA387 Gr22 Cl 2 with buttering SA240 Tr347 (analogues in Russia 10X2M1 + 08X18H12Б) for Mozyrsky NPZ (Byelarus).

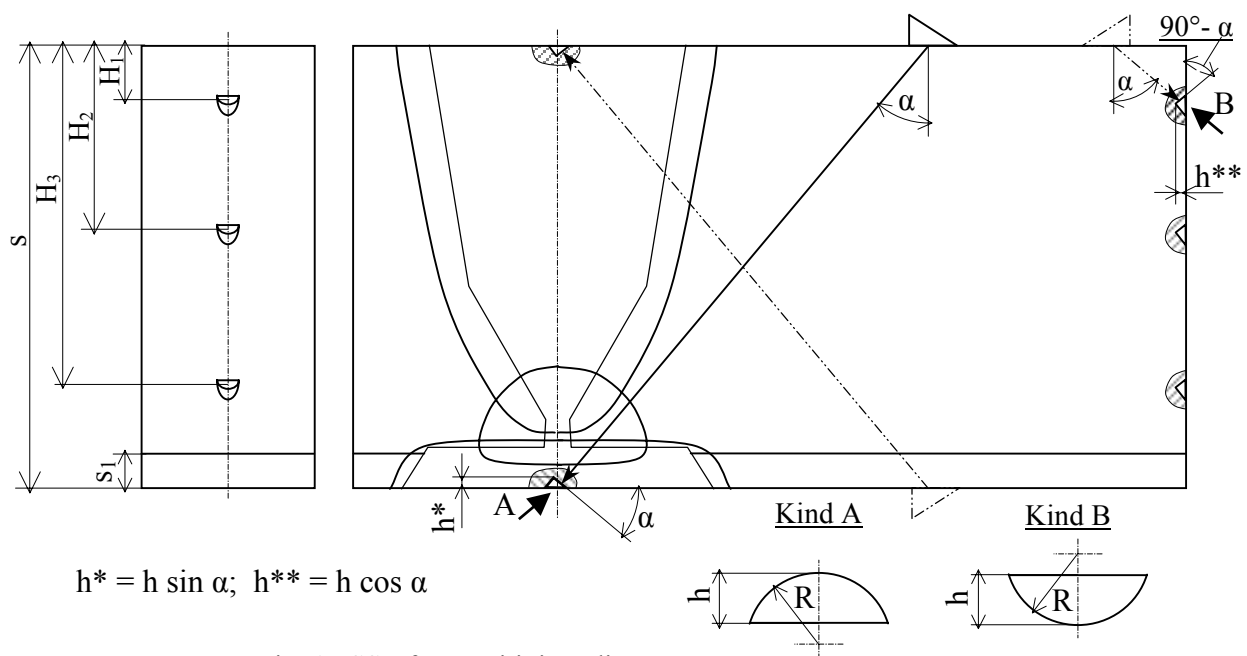


Fig. 1 SSE for sensitivity adjustment

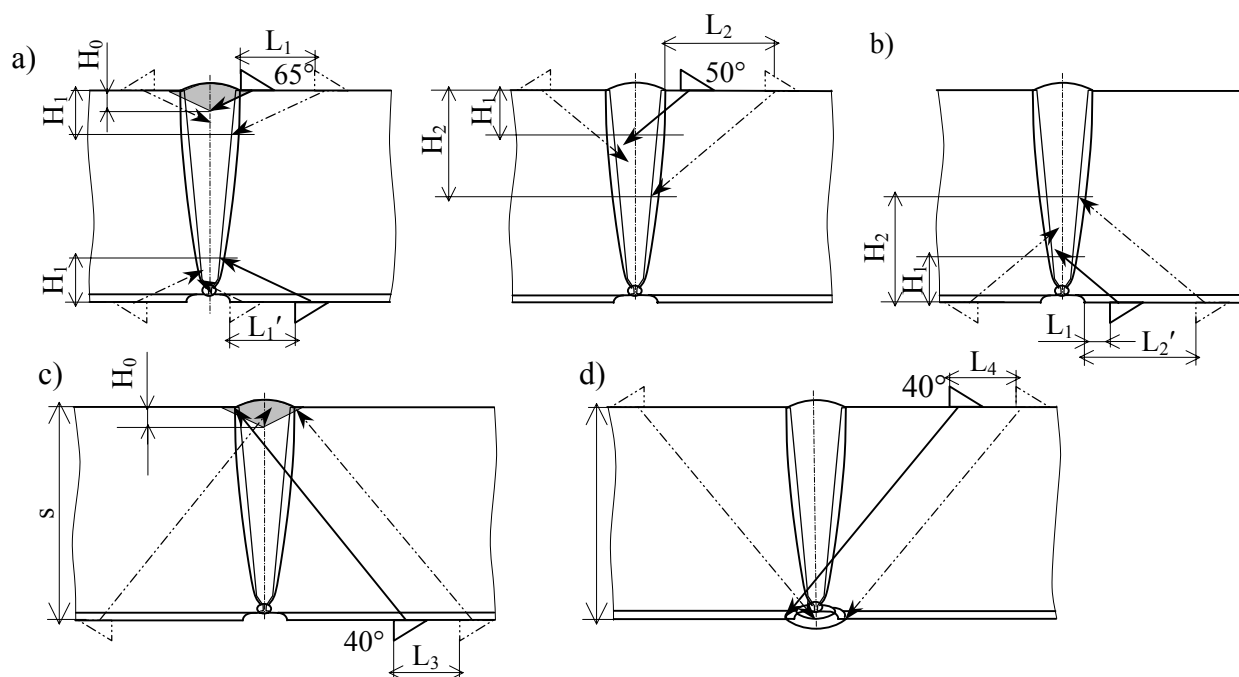


Fig. 2 Schemes of the testing of a butt welded seam on 3 layers and buttering zone

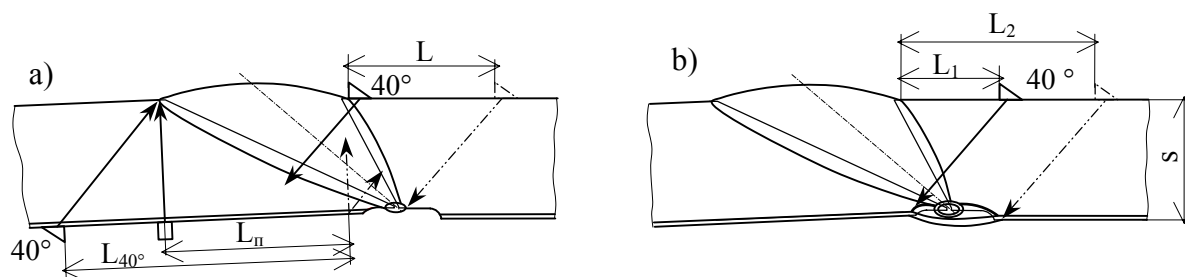


Fig. 3 Schemes of the testing of a ring seam of the bottom

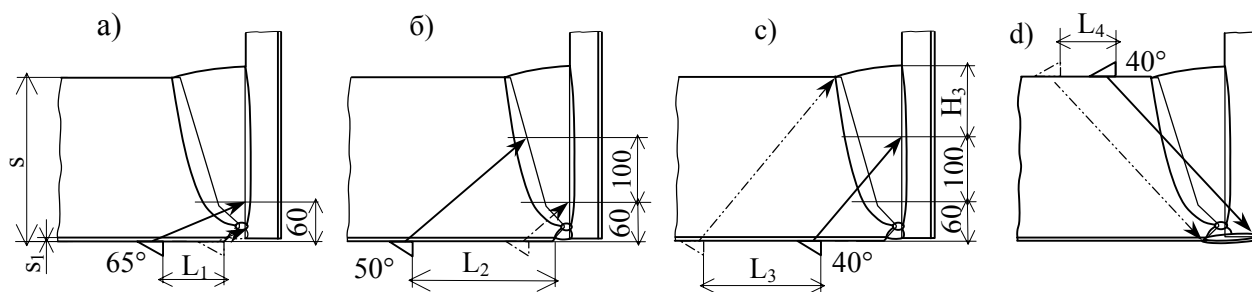


Fig. 4 The scheme of the testing of the angular welded seam on 3 layers and buttering zone

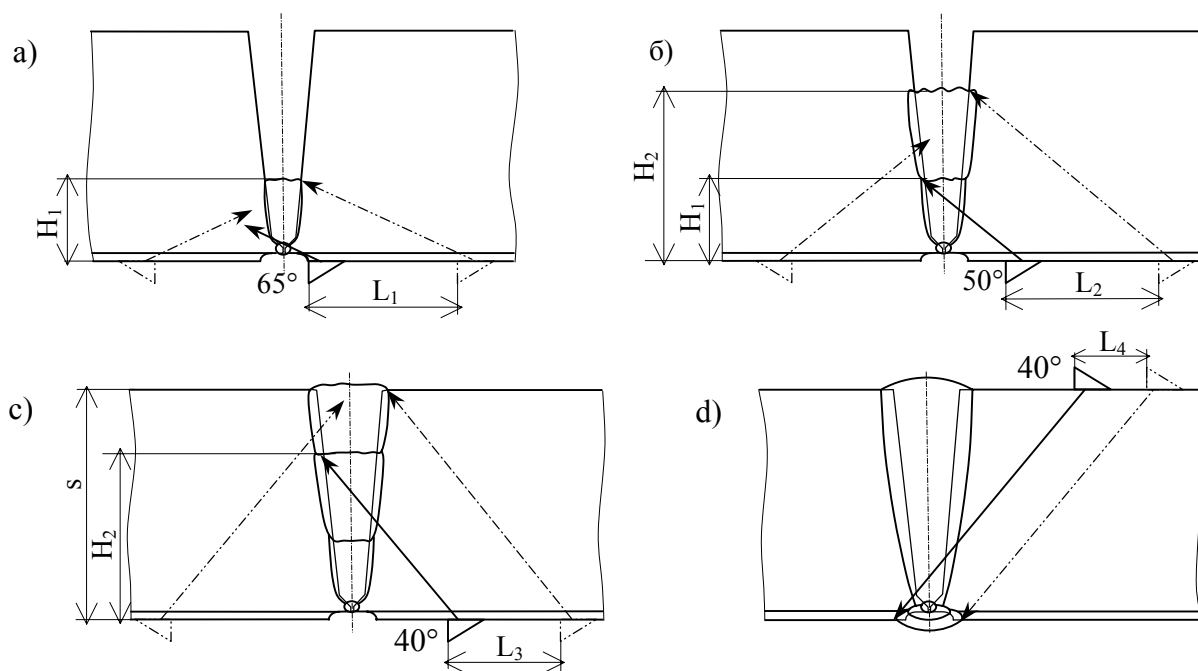


Fig. 5 Schemes of the testing of a welded seam at stage-by-stage welding on layers

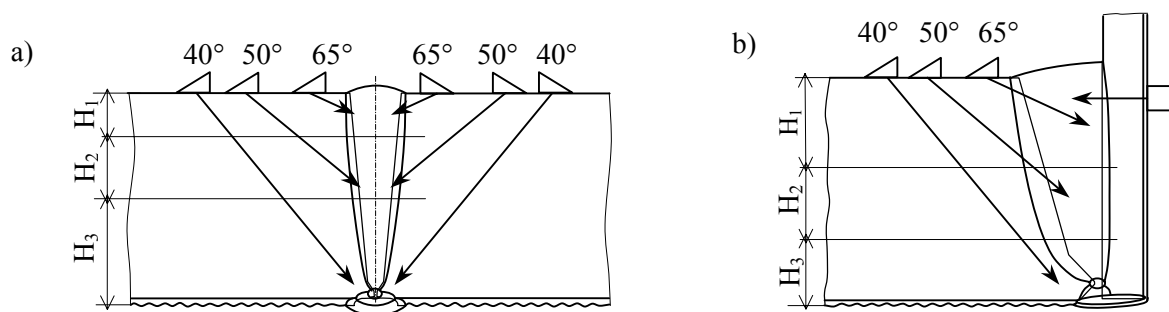


Fig. 6 Schemes of the control of a seam after heat treatment
(in the presence of the buttering of inner surface)

- a) butt welded connection (3 layers);
- b) angular welded connection (3 layers + the direct probe).