INSTALLATION FOR THE MECHANIZED WELDING OF TUBULAR PLATES IN BLAST-PRESSURE TANKS

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Abstract: The paper presents a proposal for mechanizing the welding of breaker strips on the two metal plates belonging to the subassembly that returns the flame on heat exchangers. This implies direct welding with fixture. The device ensures the MIG/MAG circular mechanized welding of bolts with a diameter comprised between 20-32 mm, inside the tubular plates made of P295GH, P355GH, 16Mo3 steel with a thickness of 10, 16 and 20 mm. The proposed mechanization leads to an increase in productivity and in the quality of the joint, a decrease of fabrication costs, it facilitates the execution conditions and requires a minimal investment on the part of the beneficiary. Also, it can be applied to a large variety of types and dimensions of bolt-tubular plate joints.

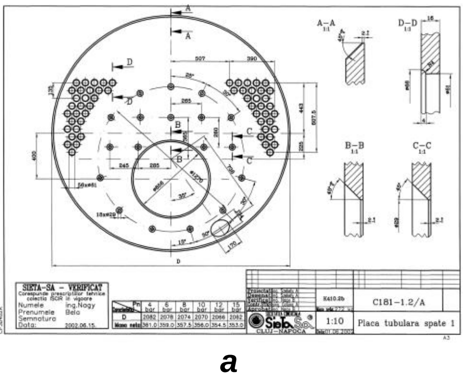
Keywords: breaker strip, tubular plate, MIG/MAG welding, heat exchanger, mechanized welding device, circular connection (joint).

1. INTRODUCTION

Blast-pressure tanks are installations used either for heating or vaporizing water, using the heat produced by burning fuels or by an industrial process through which there is a heat exchange between two fluids of different temperatures.

The separation surfaces that ensure an exchange of heat between the burning gases and the thermal agent are the walls of the exchanger and the "flame-returning" subassembly, which may have different geometries. Fig.1 shows, for example, a cylinder-shaped one, a square-form one and a combination between the two.

The breaker strips in fig.2 are elements of resistance, protection and they also facilitate the co-work between the two metal tubular plates, thus forming an assembly called "the flame-return area" and mounted in the boilers' furnace.



a

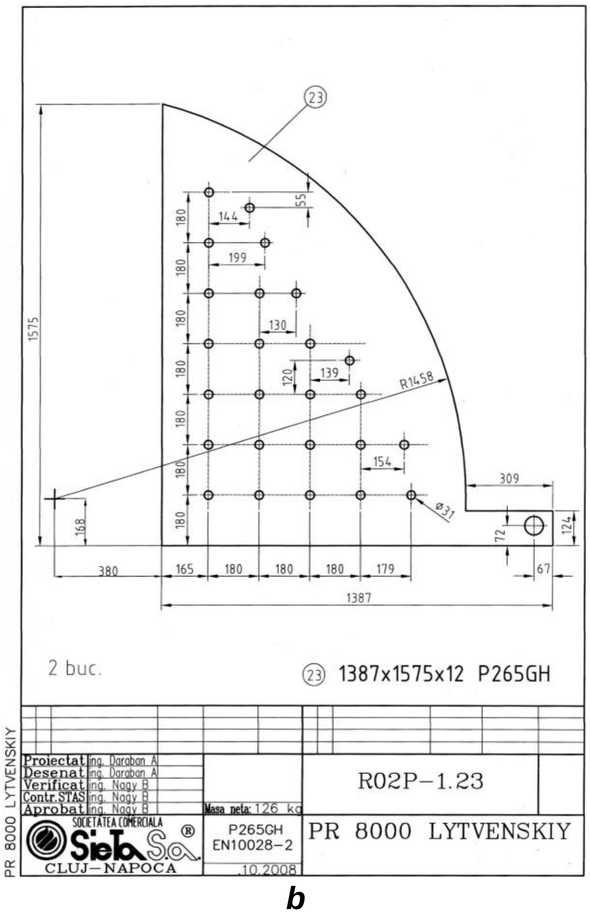


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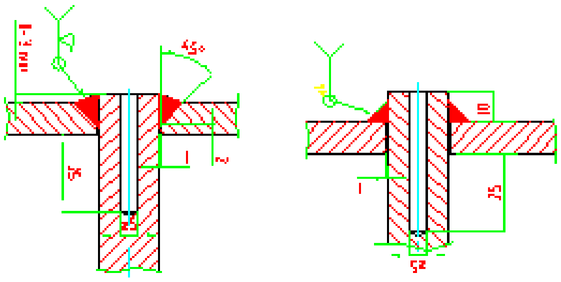
Fig.1. Tubular plate – breaker strip: a - circular; b - straight-curved.



a b

Fig.2. Breaker strip – tubular plate: a – elbow joint with penetration; b – elbow joint without penetration.

2. THE WELDING PROCESS

When choosing the welding process for making a welded joint, we need to take into consideration aspects such as: the base metal, the geometrical elements of the welding (length, thickness), the importance of the welded joint correlated with the quality class, the possibility of mechanized welding, with profound implications on the productivity, quality and price, the form and type of the welded joint, the welding position, access and place, the technical design, execution and control requirements and so on.

The recommended process for the application described in this paper is MIG/MAG welding in a protective gas environment. By analyzing the features of the joint and the beneficiary's appliances we can see that the application described herein is best suited by mechanized welding in a protective gas environment, with fusible electrode. The type of welding can be chosen: either MIG/MA with transfer by short-circuit, by spraying or, if the required conditions are met, pulse current welding.

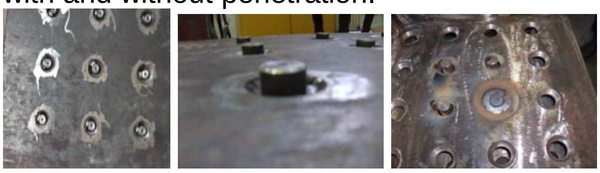
The base materials used to make the connection between the tubular plate and the breaker strip are steels of the following types: P295GH; P355GH; 16Mo3, according to SR EN 10025 - 2:2004, as plate and laminated bar steel respectively. The chemical composition of the steels is presented in table 1.

Mechanizing the fabrication of the subassembly of the type tubular plate – breaker strip, part of the blast-pressure tanks, implies a series of mechanical and electrical processes to prepare and perform it. Some of these processes are: cutting, drilling and finally, welding the bolts in the two metal plates.

Table 1: The chemical composition of the base metal

Steel brand		Classi-fication 1)	Content, in %													
Alpha-numeric symbol	Numeric symbol		C	Si max.	Mn	P max.	S max.	Al. tot	Cr	Cu 3) max.	Mo	Nb max.	N max.	Ti max.	V max.	Cr+Cu+Mo+Ni max.
P295GH	1.0481	UQ	0,08 0,20	0,40	0,90 1,50	0,030	0,025	min. 0,020	max. 0,30	0,30	max. 0,08	0,01	0,30	0,03	0,02	0,70
P355GH	1.5415	UQ	0,10 0,22	0,60	1,00 1,70	0,030	0,025	min. 0,020	max . 0,30	0,30	max 0,08	0,01	0,30	0,03	0,02	0.70
16 Mo 3	1.5415	LE	0,12 0,20	0,35	0,40 0,90	0,030	0,025	4)	max . 0,30	0,30	0,25 0,35		0,30	-	-	-

Fig.3 shows the geometry of the welded connection between the breaker strip and the tubular plate, namely a circular elbow joint, with and without penetration.



a b c

Fig.3. Geometry of the bolt-tubular plate joint: a – on the same level with the plate; b – on a higher level; c – after welding.

3. EXPERIMENTAL RESEARCH

3.1. The Installation and the Welding Device

The mechanized welding installation is made of: the welding source with a LUC 500 Aristo (ESAB) inverter, the positioning and rotating device, the mechanized welding pistol and other accessories.

The welding source is a synergic – universal one. The power of the arc is automatically regulated and controlled by modifying the feed rate of the electrode wire. MIG/MAG welding allows for the parameters to be modified within the following limits: the welding current I_s = 30 – 500A, the voltage of the arc U_a = 10 – 46V, the feed rate of the electrode wire v_{as} = 0 – 22m/min.

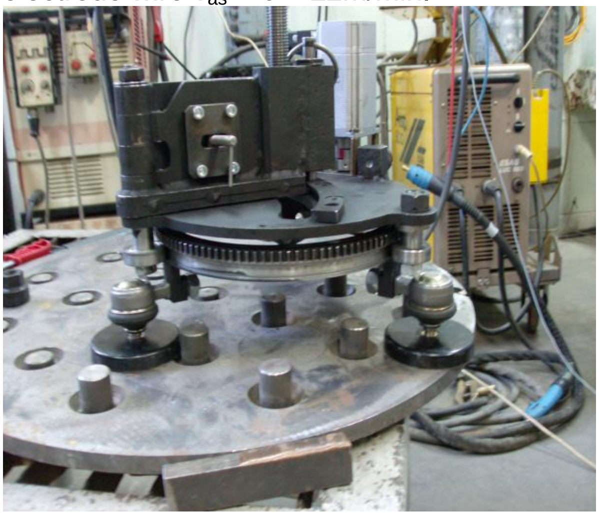


Fig.4. The welding device

The device presented in fig.4 was suggested for use in order to mechanize the welding speed; it is produced by the company called S.C. TES WELDING from Timisoara. The equipment is simple, cheap and modular. It can automatically cut or weld in circular shape, ensuring a rigorously constant speed both horizontally and vertically. The portable constructive solution affords its rapid positioning, centering and mounting on the place of the welding, in any position, by using permanent magnets.

The continuous regulation of the welding speed is done by using a gear-motor with a circular crown gear.

The mechanized welding pistol is placed on the welding device by using a special positioning and control system.

3.2. The Welding Technology

The experimental research for establishing the welding technology was done in the following conditions:

- welding position: horizontal - PA/EN ISO 6943/2000;
- welding technique: with transfer by short arc and pulse;
- base metal: P295 GH;
- thickness of the tubular plate: 16 mm;
- dimensions of the bolt: Ø28 mm;
- additional material: G3Si1/EN 440/96;
- diameter of the electrode wire: d_s = 1,2mm;
- protective gas: M21/EN 439/96;
- angle of the electrode wire: $\alpha = 90^\circ$;

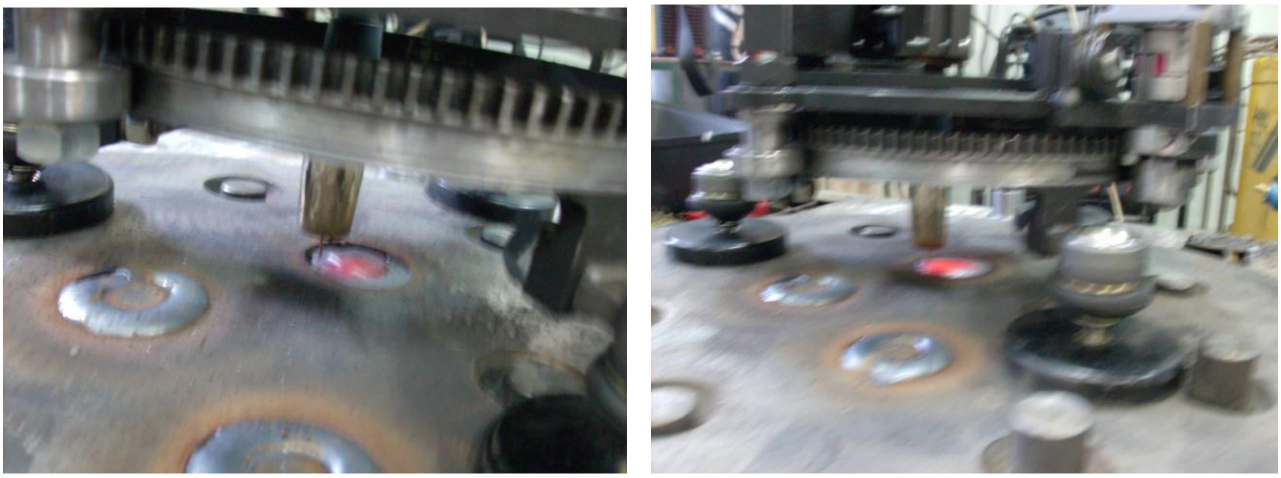
The preparation of the joint, as well as the positioning of the components and of the device is presented in fig.5. A frontal joint with imposed penetration of 16 mm was executed. Before welding, the surfaces near the joint were polished until they became shiny metal and the welding was done under the parameters presented in table 2.

Fig.5. Preparation for welding.

Table 2: The main welding parameters

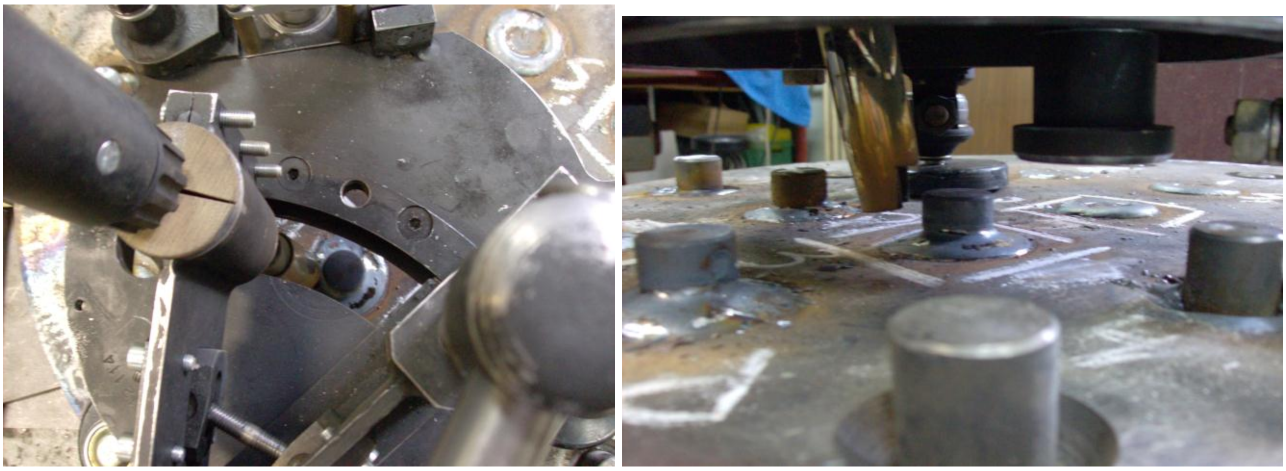
Nr. crt.	Drop transfer	I_s [A]	U_a [v]	V_s [cm/min]	V_{as} [m/min]	Q [l/min]	E_l [kj/cm]	Notes
1	**Short-arc**	140	19	18	4.3	12	1,47	On the same level
2		150	21	18	5.7	12	1,75	
3		160	22	18	5.75	12	1,95	
4		155	21	18	5.7	12	1,8	Increased height
5		170	22.5	18	5.8	12	2,12	
1	**Pulse**	150	$37U_p$	18	5.5	12	3,08	On the same level
2		150	$35U_p$	18	5.5	12	2,91	
3		150	$33.8U_p$	18	5.7	12	2,81	
4		160	$38U_p$	18	5.8	12	3,37	Increased height
5		160	$36U_p$	18	5.6	12	3,2	

The visual control underlines that an aesthetic structure appears, having fine and regular scales, typical for MIG/MAG welding. The structure has a small increased height, fine passage to the base metal, without defects such as marginal cuts – see figures 6-7-8.



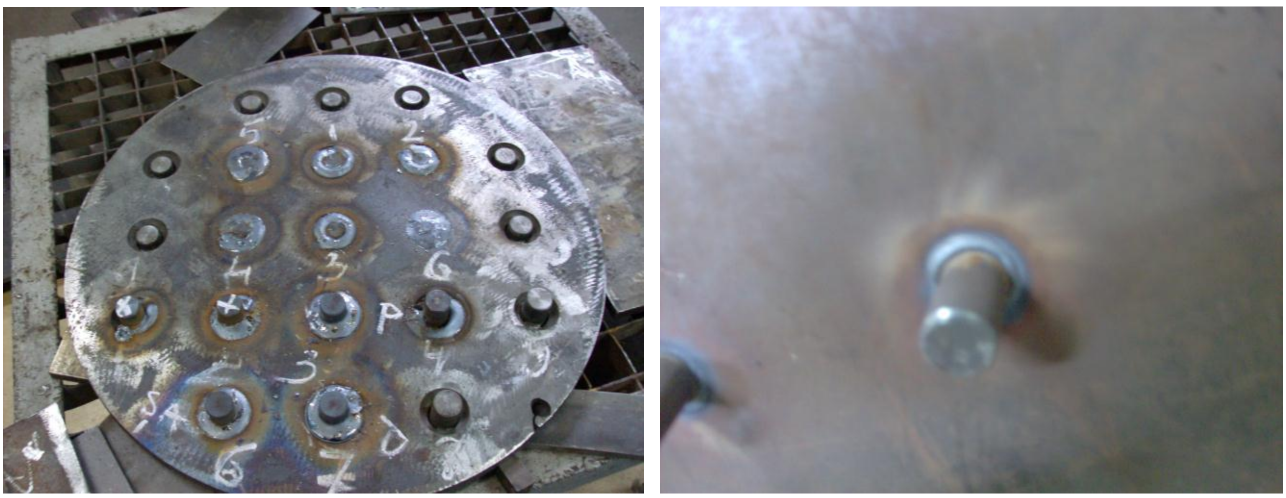
a ***b***

Fig.6. Welding a 28mm breaker strip, on the same level with the tubular plate: a – first layer; b – second layer.



a ***b***

Fig.7. Welding a 28mm breaker strip with increased height: a – first layer; b – second layer.



a ***b***

Fig.8. Visual aspect of the weldings: a – welded breaker strips; b – welding penetration.

4. CONCLUSION

The welded joints between a breaker strip and a tubular plate found in blast-pressure tanks are suited for being mechanized, both from the point of view of the shape and geometry of the welding but also from that of the high number of identical weldings that need to be executed for one product. The form and dimension of the weldings, the conditions for exploitation and the quality requirements recommend, in this case, the use of mechanized WIG or MIG/MAG welding in a protective gas environment.

This paper presents a proposal for mechanization that is easily implemented, flexible and uses equipments and devices that are, in their turn, easy to mount, center and adjust. The paper also comprises a presentation of the experiments that were made to improve the mechanized MIG/MAG welding technology, by using short arc and pulse current.

To conclude, our solution allows an easy passage from one type and dimension of product to another, which is extremely important in the case of singular products or small series of products. From this point of view, this application can be used unlimitedly. Mechanization also helps increase productivity and the quality of the weldings, it eliminates or at least cuts down necessary reparations and production costs, all of these being achieved with minimal and accessble investments.

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[4] *** SR EN 440/96: *Sârme electrod pentru sudarea cu arc electric în mediu de gaz protector cu electrod fuzibil a oţelurilor nealiate şi cu granulatie fină. Clasificare – Electrode wires for electric arc welding in a protective gas environment, with fusible electrode, of non-alloy steels with fine druse. Classification*

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[6] *** STAS 880/80 : *Oţeluri carbon de calitate pentru tratament termic destinate construcţiei de maşini – Quality carbon steels for thermal treatment in machine constructions*

[7] *** STAS 8183/80 : *Oţeluri pentru ţevi fără sudură, de uz general – General use steels for pipes without welding.*