

## **ASPECTS OF ROOT PROTECTION IN WELDING**

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**ABSTRACT:** This paper presents the results of research in case of root protection welding, the materials which was welded is normal steel, but this kind of protection is usually when we weld stainless steel. The paper presents the technological problems of root protection with gas in time of welding, aspects about quality and productivity of welding.

**KEYWORDS :** gas protect, normal steel, welding, protection device

### **1. INTRODUCTION**

Root protection in welding carbon and low alloy steels. Technological features on the opportunity to protect root welding unalloyed and low alloyed carbon steel protecting

The root problem of unalloyed and low alloyed carbon steels against oxidation is not acute, wit being able to say that it is at first sight, even a false problem. This is because these steels are not resistant to oxidation. Therefore the root protection gas used in welding these steels, to prevent oxidation of molten metal and its adjacent areas is irrelevant and meaningless as long as the rest of the material surfaces are oxidized.

It is generally considered that the protection achieved by proper shielding gas used in welding to protect the metal bath, the arc and tungsten electrode fusible by gas entering the root on the opposite side made it through the opening of the joint space is sufficient for this case for protection and formation of a molten metal roots acceptable. Of course, due to high temperature molten metal and the surrounding area a stronger oxidation than the surrounding areas still occurs, but not out of the normal oxidation of these steels. However, this trend is unfavorable root oxidation in terms of quality welding point, the poor geometry of the root layer, the layer of root surface aesthetics and not least the danger of root defects such as lack of fusion, lack of penetration, pores, inclusions of oxides, leakage of material, in some cases when the material is strong temperature oxidation during welding is so strong that the surface roughness has a very

strong form of cracks (surface cracks) or rough surface, like a lunar terrain.

They can be focused on the weld root area with adverse effects in operation of the product (usually pipes) and a shorter life for variable demands, changing how the flow of impurities that setting the working fluid in these rough and filling in while opening the pipe.

Therefore in practice there are situations when the recommended root protection layer welding using so-called "gas training" in the case of carbon steel low alloy steels in particular, mainly heat-resistant steel category, but not only.

Such situations are encountered where high strength welded joints in the composition of metallic structures with important implications highly important in case of damage, nuclear or thermal energy to weld tubular-shaped construction (mainly pipes), heat exchangers subjected to high pressure and temperature demands hundreds of bars that hundreds of degrees and, not least low-alloy steel welding with strong tendency to oxidation, such as the last generation high-temperature welding low alloy with 5 - 9% Cr, Mo, V, B, etc.. allowing operation up to temperatures of 700°C in thermal power plants in the last generation where the root layer welding pipe wall membrane composition is required to use the root protection gas for TIG welding them. Therefore use of protective gas welding root layer of alloyed carbon steel pipes or low alloy has no right to protect these areas against oxidation but refers to obtaining welds with superior characteristics. Among the most important effects of the breath of a

gas or gas protection welding training at the root layer remember:

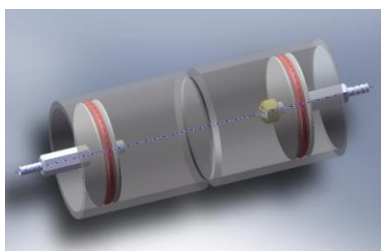
- ✓ superior quality and strength of the weld
- ✓ improving root layer geometry;
- ✓ special aesthetic surface root layer, uniform and less oxidized;
- ✓ reducing the danger of formation of defects at the root: no melting, marginal notches, pores, inclusions of oxides, leakage of material on the material, etc..;
- ✓ reduced root oxidation phenomenon of molten metal and weld adjacent areas;
- ✓ support metal bath by overpressure produced within the cushion gas pipe, with beneficial effects on root geometry layer that trend to reduce leakage of molten metal and filling the pipe, hence the name "gas training" for protection root;
- ✓ not least easier and safer execution of the root layer, reducing operator stress welder.

## 2. DESIGN OF GAS PROTECTION DEVICE TO ROOT

On the basis of gas above the protection layer of the root, namely the topic of this diploma project, namely research on WIG welding carbon steel pipes using "gas training" root protection was designed and built a device that to allow study of the influence on the formation of protective gas layer on the root and quality. The device was designed for welding pipes with diameter of 105 +/-2mm.

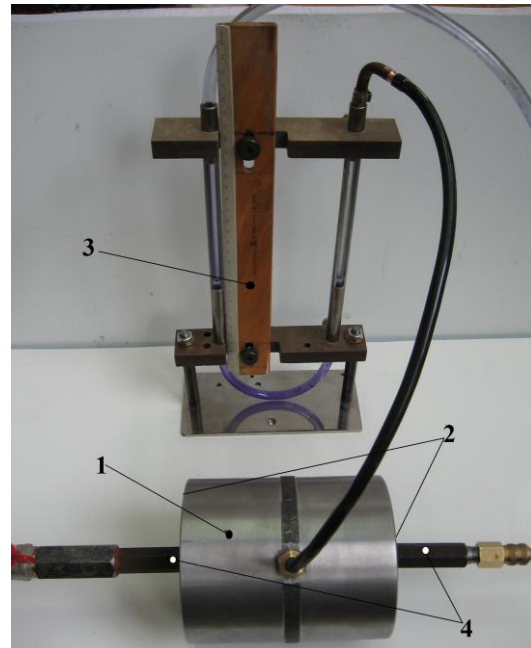
The device design have considered the following objectives:

- possibility of using the device to weld pipe diameter of 105 +/-2mm;
- study the influence of overpressure on the gas flow inside the pipe;
- study the influence of gas flow rate on the excess pressure inside the pipe;
- measurement of overpressure inside the pipe at different flow rates and gas flow rates;



**Figure .1.** - Exploded gas protection device to root

In Fig. 1. presents the overall design of the device in 3D perspective made in Solid Works, and in Fig. 2. is the image of the protective device made.



**Figure .2.** - Device for measuring gas pressure of training and protection of root

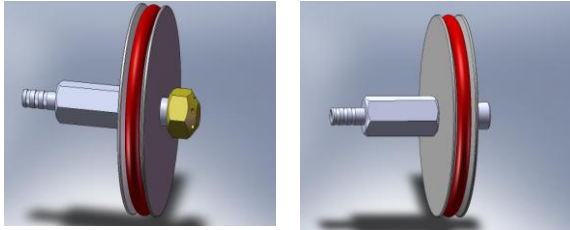
The main components of the device are made:

1. device body;
2. caps with seals;
3. pressure measuring system;
4. fittings and hoses for gas entry and exit;
5. gas cylinder pressure reducer.

Device body is made of a pipe Ø121x8x250 mm dimensions. He provided the means for connecting a connecting system for measuring the pressure inside the pipe. Ensure tightness is achieved with two lids Fig. 4. through two sets of toroidal form (O-ring) of high temperature resistant silicone 300-400 ° C to as the pipe temperature is expected to reach the seal area during welding. Given the difficulty of procurement of commercial liners with dimensions and operating conditions imposed, seals were made for its own in the workshop of welding, it is projecting and executing the vulcanization of the silicone matrix, shown in Fig. 3.



**Figure 3.** -Matrix for the execution of silicone gasket



**Figure 4.** - Covers Silicone sealing gasket

Caps are provided with two connectors for connecting input and output hoses protective gas. Input connection has a fixed diameter ... mm and outlet diameter allows you to change out of gas (and consequently the pressure inside) by means of interchangeable discs with a diameter of 1.5, 2.0, 3, 0, 4.0, 5.0, 6.0 mm fixed connection.

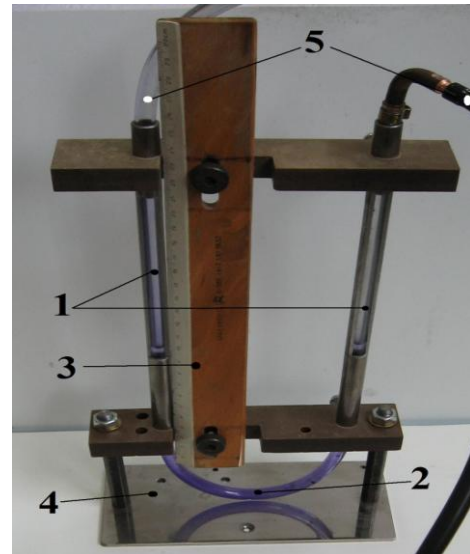
To ensure more effective protection to the root as that for laminar flow as protective gas inlet connector is provided with a gas diffuser radial - axial evenly distributing protective gas inside the pipe.

To achieve the protective gas overpressure inside the outlet pipe should always be lower than the inlet, which is provided in the design of the two connections.

Since the excess pressure inside the pipe is or should be relatively small to avoid the danger of blowing molten metal during welding by gas protection, it takes a sensitive and accurate gauge and using a classical gauge is possible in this case.

For this reason a pressure gauge was designed and built their own design to meet the demands of measuring very low pressures. In the literature it is recommended that root protection gas pressure to be the order of 50-70 mm of H<sub>2</sub>O, ie very small for the reason given above.

In Fig.5. presents experimental gauge used.



**Figure 5.** - Experimental determination of pressure gauge for gas

Gauge consists of following parts:

1. two vertical tubes (columns) parallel to measure the pressure difference;
2. working fluid;
3. equipment for measuring the level difference;
4. the metal;
5. fittings and hoses;

Gauge columns are made of a transparent plastic hose position for viewing depending on the differential fluid pressure measured. For hardening plastic tube is inserted into the two pipes on the outside diameter of the tube calibrated and provided with slits milled. In the right column on the left is placed a ruler graduated in millimeters to measure the liquid level difference. The entire assembly is mounted on a metal frame comprising a base plate, two thrusts of the respective mounting uprights for positioning and securing two columns and graduated ruler. To achieve a high measuring accuracy as working fluid used is water, and for a better view as the water was colored with ink. Determination of pressure in the pipe is made by calculation after the first level was measured difference in the two columns, with the known relationship:

$$p = \rho \times g \times h \quad [\text{Pa}]$$

where:  $\rho$  - water density (kg/m<sup>3</sup>);  
 $g$  - gravitational acceleration (m/s<sup>2</sup>);  
 $h$  - level difference of the two columns (m).

### 3. EXPERIMENTAL DETERMINATIONS

Experimental measurements have focused on the following research directions:

- Influence on overpressure protection gas flow inside the pipe;
- Bore out the influence of excess pressure inside the gas pipe;

Investigations were performed for different gas flow rates that different bore diameters of the exhaust gas pipe. Table 1. presents the influence of the overpressure protection gas flow inside the pipe for gas flow rates currently used in practice ie 5l/min, 10l/min, 12l/min, 15l/min and 20l/min at different bore diameters output gas, 2.0 mm, 2.5 mm, 3.0 mm, 3.5 mm, 4.0 mm, 4.5 mm, 5.0 mm, 5.5 mm, 6.0 mm, 6.5 mm and diameter ratio between input and diameter of gas outlet pipe.

The analysis results are found as follows:

- the flow of 5l/min Table .1. and Figure 6. liquid bump in the two columns is almost imperceptible to bore out, which confirms that there is pressure inside the pipe or is negligible;
- the flow of 10l/min Table .2. and Figure 7. pressure inside the pipe exceeds the recommended value for holes less than 2.5 mm respectively below the limit values prescribed in holes larger than 3.0 mm, becoming negligible for holes larger than 5 mm;
- 12l/min throughput Table 3. and Figure 8 .. inside pipe pressure values fall within the limits allowed only outlet diameter of 3.0 mm (60mm col. H<sub>2</sub>O), exceeding the limits for small diameters that are below these limits situations in diameters larger than 4 mm, this corresponds to a diameter ratio between the input and output  $d_i / d_e = 6.5 / 3 = \text{approx. } 2$ ;
- at rates of 15 l / min Table 4. and Figure 9. best values of the overpressure is obtained for output diameters of 3.5 4.0 mm respectively, corresponding to reports aprox.1 ie, 8 ... 1.6;
- the flow of 20l/min Table .5. and Figure .10. corresponding values of the overpressure limits allowed values inside pipe diameters correspond to output of 4.0 4.5 mm respectively, corresponding to reports about that. 1.6 ... 1.3;

### 4. CONCLUSIONS

It is found that as gas flow increased protection, outlet diameter must increase accordingly, the ratio of two diameters that progressively decreases, the small diameter and high flow of gas over 15l/min choice of exit diameters small overpressure leading to the danger so great that splashing of molten metal bath is imminent effects on weld quality;

- can establish a design factor "cp" to define the correlation that must exist between the protective gas flow ratio used input and output diameters so that the amount of excess pressure inside the pipe to the recommended limits of 50-70 mmcol. H<sub>2</sub>O:

$$c_p = Q \text{ (l/min)} \times (d_i/d_e) = 25 - 30 = \text{const.}$$

Obs.: The above relationship allows an acceptable size of the device root protection gas;

- the same diameter of the outlet overpressure increases with increasing gas flow;
- at the same gas flow decreases with increasing overpressure orifice exit diameter;
- measurements above are valid and true only if the use of joints with joint opening  $b = \text{approx. } 0\text{mm}$  or in case of overlap joints, using the joints of "Lockers" for joints with openings  $0\text{mm}$   $b$  different, considerably lower excess pressure inside the pipe and tends to zero because the section corresponding joint opening is much higher than the outlet section of the device which makes the gas out mainly by heart and almost negligible through the hole, to avoid further loss of hole gas output is obscure in this case almost disappears root support effect exerted by gas cushion effect on the quality of the root layer, in this case to ensure a certain gas overpressure at the root is practiced especially in large diameter pipes cover almost the entire joint in the circumference, less the adhesive sheets of aluminum welding, followed as it progresses with root welding foil layer to depart gradually, in which case the action and influence outlet is manifested in phase Closing the root of the weld when gas goes through orifice protection necessary to avoid creating excess defects, if the hole was obstructed before beginning welding must be open before closing it welds the root, otherwise the danger of overpressure inside the pipe due to

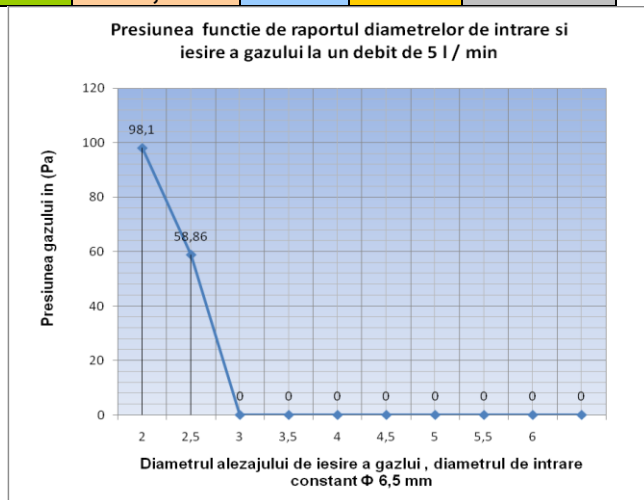
increased protective gas expansion inevitably lead to the appearance of pores in the weld crater closing, vermicular-shaped pores with radial orientation;

determinations are also available to weld the second layer, the so-called "warm layer" also when it is recommended to protect gas in view of the danger of oxidation of the surface layer of the root inside the pipe as strong warming effect on red of material previously submitted, if the gas pressure inside the protective pipe is too big breakthrough comes danger and spatter layer of material, namely the appearance of pores in the weld;

- cost reasons is not recommended as protective gas flow to be greater than 10l/min;
- protective gas was used would 100%;
- results and conclusions measured by the research were used in experimental research on the protection of gas pipe welding the root of the following chapter.

**Table .1** .- pressure to diameter ratio of input and output at a rate of 5 l / min

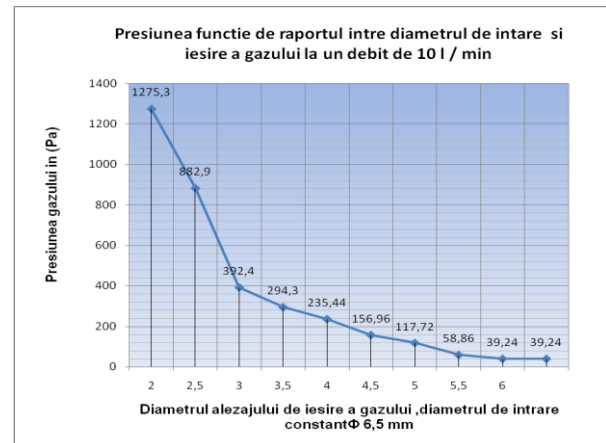
No. Crt.	Bore diameter	Gas flow 5 l	mm H2O	Pressure (Pa)
1	2	5	0,01	98,1
2	2,5	5	0,006	58,86
3	3	5	0	0
4	3,5	5	0	0
5	4	5	0	0
6	4,5	5	0	0
7	5	5	0	0
8	5,5	5	0	0
9	6	5	0	0
10	6,5	5	0	0



**Figure 6.** - Graph the ratio diameter pressure input, output

**Table .2.-** Pressure to diameter ratio of input and output at a rate of 10 l / min

No. Crt.	Bore diameter	Gas flow 10 l	mm H2O	Pressure (Pa)
1	2	10	0,13	1275,3
2	2,5	10	0,09	882,9
3	3	10	0,04	392,4
4	3,5	10	0,03	294,3
5	4	10	0,024	235,44
6	4,5	10	0,016	156,96
7	5	10	0,012	117,72
8	5,5	10	0,006	58,86
9	6	10	0,004	39,24
10	6,5	10	0,004	39,24



**Figure .7.** Graph the ratio diameter pressure input, output

**Table .3.-** Pressure to diameter ratio of input and output at a rate of 12 l / min

No. Crt.	Bore diameter	Gas flow 12 l	mm H2O	Pressure (Pa)
1	2	12	0,134	1314,54
2	2,5	12	0,13	1275,3
3	3	12	0,06	588,6
4	3,5	12	0,042	412,02
5	4	12	0,028	274,68
6	4,5	12	0,022	215,82
7	5	12	0,02	196,2
8	5,5	12	0,012	117,72
9	6	12	0,008	78,48
10	6,5	12	0,006	58,86

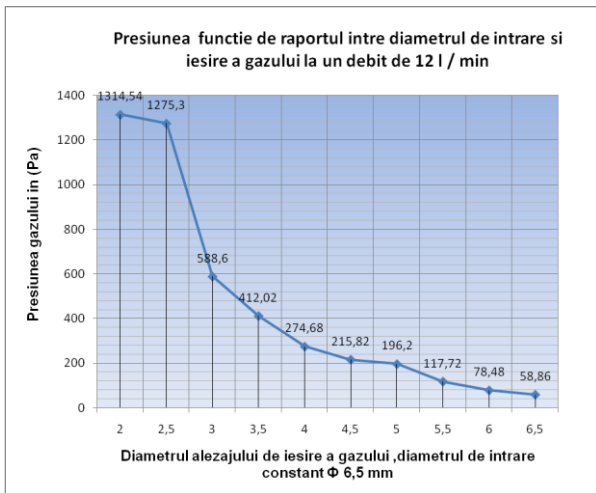


Figura .8. – Graph the ratio diameter pressure input, output

Table .4.- Pressure to diameter ratio of input and output at a rate of 15l / min

No. Crt.	Bore diameter	Gas flow 15 l	mm H2O	Pressure (Pa)
1	2	15	0,28	2746,8
2	2,5	15	0,164	1608,84
3	3	15	0,114	1118,34
4	3,5	15	0,068	667,08
5	4	15	0,054	529,74
6	4,5	15	0,034	333,54
7	5	15	0,03	294,3
8	5,5	15	0,022	215,82
9	6	15	0,02	196,2
10	6,5	15	0,01	98,1

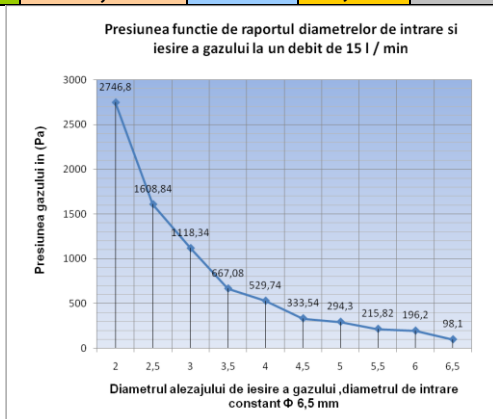


Figure .9. – Graph the ratio diameter pressure input, output

Table .5.- Pressure to diameter ratio of input and output at a rate de20l / min

No. Crt.	Bore diameter	Gas flow 20 l	mm H2O	Pressure (Pa)
1	2	20		0
2	2,5	20	0,208	2040,48
3	3	20	0,196	1922,76
4	3,5	20	0,1	981
5	4	20	0,082	804,42
6	4,5	20	0,056	549,36
7	5	20	0,036	353,16
8	5,5	20	0,032	313,92
9	6	20	0,028	274,68
10	6,5	20	0,012	117,72

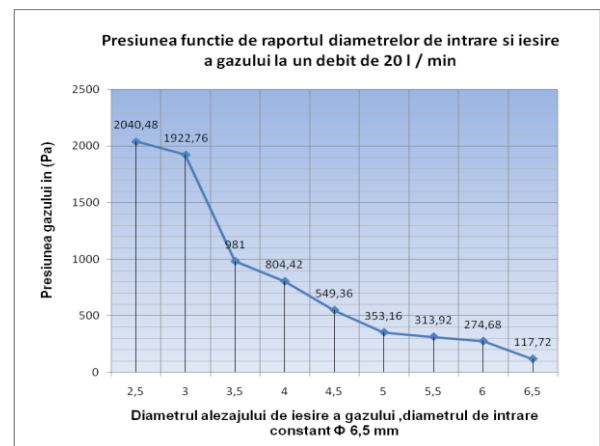


Figure .10. – Graph the ratio diameter pressure input, output

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