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# FITTINGS AND PIPELINES MAG TANDEM WELDING

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**Abstract.** This paper presents research on the application process Tandem MIG-MAG welding fittings gas pipelines.

There were studied the implications of what they produce welding two arcs of the two components of different materials, namely steel X pipe 60 and the reinforcing steel tower. Given the welding joint geometry, welding proposed technology consists of a layer of the root, then add layer welding.

Welding of root was performed using electric fusion welding process in gas shielded MAG - CMT (Cold Metal Transfer). In addition to welding layer used electric fusion welding process MAG in active shielding gas (CO2), two-electrode wires (TANDEM).

When welding the root layer machine used was an automatic welding plant FRONIUS TransPuls Synergic 3200 CMT process variant (Cold Metal Transfer) is Corgon 18 protective gas and filler wire ULTRAMAG, Φ = 1.2 mm.

For layer filling the machine with which the experiment was conducted Quinto II welding robot equipped with two power sources, electrode wires used as SG type 3, Φ = 1.2 mm, and CO2 shielding gas.

The study resulted metallographic a weld with good penetration into the melt and the results of the hardness tests are imposed.

**Keywords:** pipelines, gas welding protective environment MAG - CMT, fittings for pipelines

## 1. Introduction

### 1.1. Scope. Motivation

This paper presents research on the construction of natural gas pipelines. Pipelines can be defined as any pipelines, including facilities, equipment and related that ensure the transport of oil between pickup points in sewer lines or and points of delivery to processing plants, depot or terminal.

From the constant need to increase productivity, research is directed toward new procedures and new meanings of existing ones.

In general, the components of the pipes are:
- tubes (pipes) - the main element;
- various equipment, connectors, shaped parts, valves, meters and control expansion compensators.

These steels are micro-alloyed high strength steel and are manufactured by renowned companies in the production of steel. Steel grades such as Domex 600 MC, ALFORM 700M, HZ 80, Durostor 500 are developed by major steel producers of the moment SSAB EMEA - Borlänge, Sweden, voestalpine Stahl GmbH - Linz, Austria and others.

### 1.2. Steel Pipe. Chemical composition, mechanical properties

Ferrite steels needle structure (low-carbon bainite) have high strength characteristics, mainly made by fine grit to obtain and providing precipitation hardening effects of the inter-metallic compounds (nitrides or carbonitrides of the elements of sub microscopic dimensions which are micro-alloyed); strength performance (features Rp 0.2 or Rt 0.5 > 500 N/mm$^2$) and toughness (KV > 130 J and your transition temperature t50% < – 20 °C) provided, led to the inclusion of these steels in low alloy steels category (micro-alloyed) with high strength HSLA (High Strength Low Alloy).

Recovery of complex alloying using thermo mechanical rolling process allows to obtain very high performance characteristics of mechanical strength, while maintaining low levels (which ensures a good weldability) of the carbon concentrations. Table 1 shows the chemical compositions of these steels. Table 2 summarizes the mechanical properties of steels for pipelines.

### 1.3. Steel fittings

All of the components of a technological system that are designed to alter the flow of fluid by opening, closing, partial obstruction of the movement of fluid, dividing or mixing it, or them, visual inspection of fluid circulation and the role of avoiding overpressure (Figure 1).

Valves for gas, oil and oil derivatives are constructed in a variety of industry-specific technology solutions.

Table 1. Chemical composition of steels X 60 to API Spec 5L pipe

| Class or grade steel | %C[a)] max. | % Mn[a)] max. | % P min. | % P max. | % S max. | % Ti max. | Other elements |
|---|---|---|---|---|---|---|---|
| X60 | 0.22 | 1.40 | - | 0.025 | 0.015 | 0.04 | c) d) |

Table 2. The mechanical properties of steels for pipelines

| Class or grade steel | Yield strength $R_{t0.5\ min}$ | | Yield strength $R_{t0.5\ max}$ | | Tensile $(R_m)_{min}$ | | Tensile $(R_m)_{max}$ | |
|---|---|---|---|---|---|---|---|---|
| | psi | MPa | psi | MPa | psi | MPa | psi | MPa |
| X60 | 60000 | 414 | 82000 | 565 | 75000 | 517 | 110000 | 758 |

Figure 1. Valve

They can be installed with flanges or weld through various fusion welding processes efferent duct.

In general, the valve body is made by casting, and the side in contact with the pipe is formed of a machined ring which ensures a high degree of precision in assembly by welding.

## 2. Methods

### 2.1. The experimental

The first part of the experiments was the welding of root samples prepared material pipe and pipe fittings, OT 42 and X 60 [1].

For this we used MAG gas protection method corgon 18. The plant used is FRONIUS TransPuls Synergic with process variant CMT (Cold Metal Transfer), Figure 2.

Figure 2. FRONIUS installation GMAW-CMT

CMT process features include applying a low linear energy transfer and control equipment, the low welding current. There have been a total of 22 samples (see Figure 7), collected material welded the two components, X 60 [2] and OT 42, Figure 3.


Figure 3. Welding tests

Welding load samples was performed by robotic welding (Figure 4).

Figure 4. Welding robot

Welding procedure used is welding shielding gas in MGAW - TANDEM (two wire electrode welding) [3].

In Figure 5 illustrates the welding head welding machines and Figure 6 shows the visual appearance of a weld [5].


Figure 5. Welding torch


Figure 6. Weld

## 2.2. Technological parameters used

For root layer where MGAW - CMT welding parameters were:

⇨ Intensity of welding current, Is = 210 A;
⇨ Voltage electrical arc, U = 24.1 V;
⇨ Welding speed (the speed of the trolley electrode) Vs = 500 mm / min;
⇨ Feed rate of the wire electrode, Ve = 10 cm / min;
⇨ Filler metal type: ULTRAMAG, Φ = 1.2 mm;
⇨ Shielding Gas: CORGON 18.

MGAW-TANDEM technological parameters were summarized in Table 3.

- Filler Metal: SG 3; Φ = 1.2 mm;
- Shielding Gas: $CO2$;
- Material Thickness = 10 mm;
- Parent Material Specification: EN-10208-2;
- Joint type: butt weld [4];
- Gas Flow Rate-Shielding = 15 – 20 l/min [5, 6].

## 3. Results

The metallographic samples taken (Figure 7) welded samples were studied variation in hardness values in all areas of the joint.


Figure 7. Metallographic sample

Table 3. Welding technological parameters of MAG-TANDEM

| Cod | $V_{sud}$ [cm/min] | $I_s$ [A] | | $U_a$ [V] | | $V_e$ [m/min] | |
|---|---|---|---|---|---|---|---|
| | | $I_{s1}$ | $I_{s2}$ | $U_{a1}$ | $U_{a2}$ | $V_{e1}$ | $V_{e2}$ |
| 17. | 18 | 177 | 197 | 23,7 | 22,1 | 7 | 7 |
| 18. | 18 | 198 | 211 | 25,2 | 21,4 | 8 | 8 |
| 1. | 20 | 204 | 210 | 24,6 | 24,5 | 7 | 7 |
| 2. | 20 | 185 | 195 | 27,5 | 23,3 | 8 | 8 |
| 3. | 20 | 290 | 270 | 29,7 | 22,2 | 9 | 9 |
| 4. | 20 | 217 | 216 | 22,8 | 22,4 | 10 | 10 |
| 5. | 22 | 186 | 191 | 23,9 | 22,7 | 7 | 7 |
| 6. | 22 | 222 | 211 | 24,4 | 21,9 | 8 | 8 |
| 7. | 22 | 225 | 232 | 24,5 | 21,7 | 9 | 9 |
| 8. | 22 | 253 | 245 | 21,8 | 22,6 | 10 | 10 |
| 9. | 24 | 189 | 189 | 23,4 | 22,9 | 7 | 7 |
| 10. | 24 | 205 | 208 | 24,3 | 23,0 | 8 | 8 |
| 11. | 24 | 214 | 230 | 24,2 | 22,0 | 9 | 9 |
| 12. | 24 | 263 | 255 | 23,9 | 22,1 | 10 | 10 |
| 13. | 26 | 186 | 188 | 22,5 | 22,5 | 7 | 7 |
| 14. | 26 | 197 | 201 | 24,1 | 22,8 | 8 | 8 |
| 15. | 26 | 208 | 201 | 22,2 | 22,3 | 9 | 9 |
| 16. | 26 | 251 | 255 | 21,7 | 20,7 | 10 | 10 |
| 19. | 28 | 216 | 198 | 24,3 | 24,2 | 7 | 7 |
| 20. | 28 | 227 | 211 | 21,5 | 21,6 | 8 | 8 |
| 21. | 28 | 227 | 228 | 20.0 | 22,0 | 9 | 9 |
| 22. | 28 | 243 | 248 | 23,1 | 22,1 | 10 | 10 |

Table 4 presents the values of hardness of 12 samples metallography.

In Table 4 and Figure 8, there are shown:

BM 1 – Base Metal – X 60;
BM 2 – Base Metal – OT 42;
HAZ 1 – Heat Affected Zone between X 60 and weld;
HAZ 2 – Heat Affected Zone between weld and OT 42.

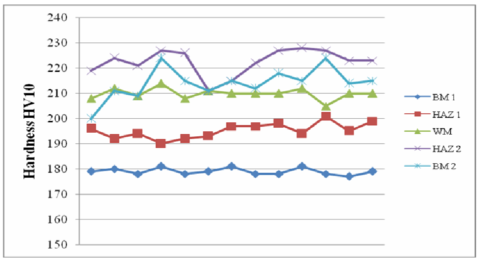


Figure 8. Variation of hardness values in the joint

Table 4. Hardness Test HV 10

| Nr. Det. | Number P / Location | 1 | 2 | 3 | 4 | 5 | 5 | 6 | 6 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BM 1 | 179 | 184 | 176 | 185 | 179 | 180 | 181 | 180 | 179 | 184 | 176 | 180 | 185 |
| 2 | BM 1 | 175 | 179 | 177 | 176 | 179 | 176 | 183 | 179 | 180 | 175 | 173 | 179 | 176 |
| 3 | BM 1 | 183 | 177 | 181 | 181 | 177 | 182 | 178 | 175 | 176 | 183 | 186 | 173 | 178 |
| | Med.BM 1 | 179 | 180 | 178 | 181 | 178 | 179 | 181 | 178 | 178 | 181 | 178 | 177 | 179 |
| 4 | HAZ 1 | 189 | 192 | 190 | 188 | 190 | 188 | 203 | 187 | 197 | 190 | 193 | 189 | 201 |
| 5 | HAZ 1 | 196 | 197 | 194 | 193 | 192 | 198 | 190 | 204 | 198 | 190 | 203 | 200 | 197 |
| 6 | HAZ 1 | 203 | 187 | 199 | 190 | 195 | 193 | 198 | 201 | 199 | 203 | 206 | 197 | 199 |
| | Media HAZ 1 | 196 | 192 | 194 | 190 | 192 | 193 | 197 | 197 | 198 | 194 | 201 | 195 | 199 |
| 7 | WM | 209 | 211 | 215 | 209 | 211 | 208 | 209 | 218 | 204 | 210 | 214 | 205 | 215 |
| 8 | WM | 205 | 216 | 210 | 221 | 209 | 209 | 217 | 202 | 217 | 215 | 201 | 208 | 210 |
| 9 | WM | 209 | 210 | 203 | 214 | 205 | 218 | 204 | 210 | 211 | 213 | 201 | 217 | 205 |
| | Media WM | 208 | 212 | 209 | 214 | 208 | 211 | 210 | 210 | 210 | 212 | 205 | 210 | 210 |
| 10 | HAZ 2 | 217 | 223 | 208 | 220 | 230 | 207 | 220 | 215 | 232 | 230 | 227 | 228 | 231 |
| 11 | HAZ 2 | 221 | 229 | 231 | 228 | 228 | 216 | 212 | 228 | 225 | 223 | 225 | 218 | 218 |
| 12 | HAZ 2 | 219 | 221 | 225 | 233 | 222 | 211 | 215 | 223 | 226 | 233 | 231 | 225 | 222 |
| | Media HAZ 2 | 219 | 224 | 221 | 227 | 226 | 211 | 215 | 222 | 227 | 228 | 227 | 223 | 223 |
| 13 | BM 2 | 198 | 217 | 201 | 227 | 216 | 217 | 215 | 213 | 218 | 223 | 221 | 216 | 222 |
| 14 | BM 2 | 204 | 206 | 216 | 222 | 221 | 204 | 211 | 210 | 222 | 213 | 217 | 210 | 208 |
| 15 | BM 2 | 200 | 210 | 212 | 223 | 210 | 212 | 220 | 214 | 216 | 211 | 234 | 217 | 215 |
| | Media BM 2 | 200 | 211 | 209 | 224 | 215 | 211 | 215 | 212 | 218 | 215 | 224 | 214 | 215 |

## 4. Research perspectives

Given the results of this research, we can say that it is the prerequisite for future studies of technological parameters applied TANDEM welding MAG welding pipelines.

The method applied can be characterized as a high yield with high deposition rate, as applied by robots offer a guarantee of quality weld, first of penetration and the corresponding melting.

## 5. Conclusion

In the following experiments were analyzed pooled samples of hardness results in a range of values that result in good running behavior of the pipe.

Knowing the importance of entering the execution layer root welds attention was directed towards its achievement through the most appropriate welding process.

The study opens perspectives for research in the assembly fittings (valves) on pipelines by researching application of tandem MIG-MAG welding pipes.

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