

# A COST EFFECTIVE RAPID WELD TECHNOLOGY CONFIGURATION

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## Abstract

The research focuses on determining the application parameters of a new process developed by Cloos. With the use of Cloos Rapid Weld technology (metal active gas welding), the authors carried out welding experiments on S235JR steel sheets (6 mm and 8 mm thick). The results of the welding experiments were verified by hardness measurement [1–3]. The goal is to establish one side one row suitable welded joint by the used technology.

**Keywords:** *Rapid weld, Cloos, hardness.*

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## 1. Introduction

The welding technology, including processes and power sources began to develop rapidly in the recent decade. In the case of the welded construction manufacturing, the industry requires high productivity performance, reproducibility and good quality. Several companies use for the appellation of their welding processes a special name, which rather refers only to the specifics of the technology. Cause these results we may meet several new welding process names. The applicable parameters for the welding process not published by the manufacturer every time. The limits of the individual power sources, the processes, and parameter sets can be determined by measuring.

## 2. Rapid Weld and T.I.M.E. technology

A Cloos Rapid Weld technology is recognized as the T.I.M.E. (Transferred Ionized Molten Energy) method [4]. Typically, by increasing the power of arc welding, the production volume is increased, and by increasing the wire speed, the number of errors caused by material transfer disturbances can be reduced.

Rapid Weld technology regulates the current as a function of the free wire length. The resulting

weld seam shows consistent fusion over its entire length, even with increased free wire length. This method variant is characterized by high power, the wire feed speed can be between 14 m/min and 34 m/min, while the current typically ranges from 400 to 550 A. It is mainly used in thick plate welding in industry today, mostly in the manufacture of crane components and pressure vessels [5].

Figure 1. shows the evolution of the amperage and of the arc voltage during Rapid Weld technology.

## 3. Exploring applications

In my research, I was looking for the answer to whether it is possible to apply the technology to welding a medium-thick plate to reduce the time required for production. [6–8]

The test was performed on 6 mm and 8 mm thick S235 JR steel plates. We conducted the experiments with the aim of creating a weld seam of acceptable quality from one side, and one row. An M21 shielding gas mixture was used for the test. The composition of the corgon produced by Linde contains 18% CO<sub>2</sub> and 82% Ar, the standard is called „ISO 14175-M21-Arc-18”.

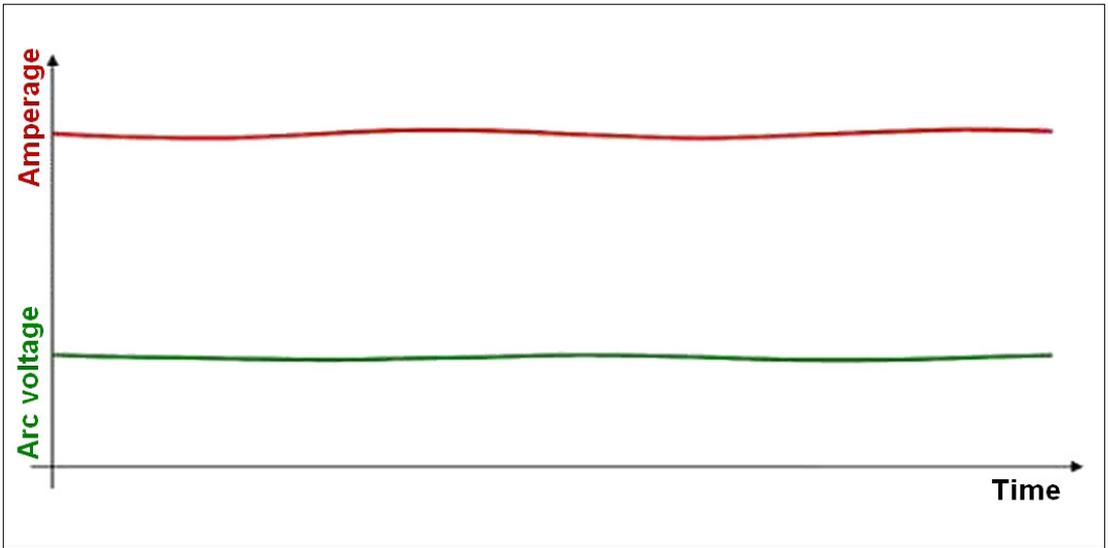


Figure 1. Image Rapid Weld amperage/arc voltage changes.

3.1. Experiments

S235 JR general-purpose steel with a plate thickness [8 mm] was used in the tests. The goal was to create a seam of acceptable quality from one side using a single row [9–11]. Based on our experience in 2018, we used a shorter than usual 100×150 mm plate because due to the thermal load it proved very difficult to produce longer high-quality seams, and due to the limited number of specimens we tried to make as many tests as possible from the existing material. During the trials, the primary variable was the chamfering of the plates from 0 to 45 ° chamfering. 5-5 pieces made of 0 °, 15 °, 30 °, and 45 ° parts were prepared for testing. The chamfers were created with a planer, and the top oxide layer was removed from the metal surface immediately before welding, and the specimens were cleaned so that dirt would not affect the final result. Three test welds were performed to calibrate the welding equipment before starting work on the test pieces. Based on the performed test, we worked in the zone between 345–365 A in terms of current, and 40–43 V in terms of voltage. In each case, 2 of the pieces with the same beveled angle were welded without gaps, 2 with a 1mm gap, and 1 with a 2 mm gap. With this, our goal was to gain experience of how sensitive the procedure was to accuracy of setup. Figure 2. shows an unsuitable test piece.

Table 1. summarizes the different settings at which the welding tests were performed and

Table 1. Summary of experimental parameters.

Chamfering (°)	Gap (mm)	Edge band (i/n)	Appropriateness (i/n)
0	0		fail
15	0		acceptable
15	0	x	acceptable
30	0		acceptable
30	0	x	acceptable
45	0		fail
45	0	x	fail
0	1		fail
15	1		excellent
15	1	x	excellent
30	1		fail
30	1	x	fail
45	1		fail
45	1	x	fail
0	2		fail
15	2		fail
30	2		fail
45	2		fail



**Figure 2.** *Unsuitable test piece.*



**Figure 3.** *Acceptable 15-degree seam.*

which were considered appropriate based on visual inspection.

In our case, the edge band means a thin 1 mm 45-degree chamfer made by hand with an angle grinder on the chamfered pieces. As a result of visual inspection, we found that the best seam can be formed by adjusting the 15-degree chamfer and 1 mm gap. The 2 mm gap was so large that the shielding gas, and the filler material was simply blown through it by the high current. In addition to using a 0 mm gap, we were able to create a suitable seam with both 15-degree and 30-degree chamfering. The experiments showed that what we initially set out to achieve, without sharpening, did not materialize (Figure 3.).

#### 4. Cutting, grinding, polishing

The fusion of the pieces and the conformity of the seam were checked by hardness measurement and metallographic examinations. For these studies, the parts were prepared as follows.

We used a Bomar STG 230 G saw for cutting, which allowed us to perform the cutting with continuous cooling, so we did not affect the formed fabric structure.

Grinding and polishing were performed on a Struers LaboForce-50. Gradually increasing the fineness of sanding using Struers Waterproft SiC sandpaper 60; 120; 250; 500; 800; the pieces were finished using 1200 paper. After grinding, the polishing was performed first at a roughness of 3  $\mu\text{m}$  and then at a roughness of 1  $\mu\text{m}$ . The surface of the samples was etched with Nital 3 acid. The pieces thus prepared were examined using a light microscope [12–14].

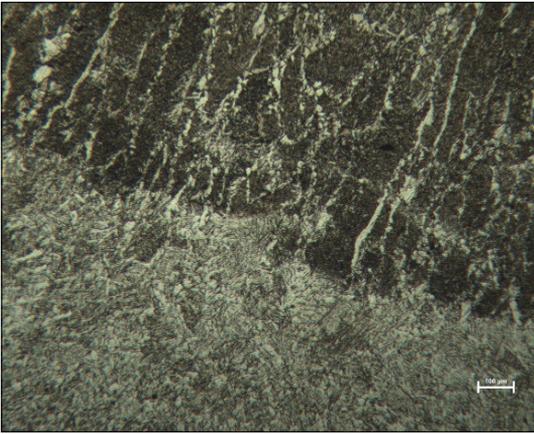
The finished joints did not show the appearance of martensite. The expected ferrite-perlite fabric can be seen in the completed images. The extent of the heat-affected zone indicates that the medium-thick plate is not subjected to too high a thermal load during welding at a suitable speed.

The picture of the grindings clearly shows that the seams were created with the right depth of fusion. Weld joints were suitable for both 15-degree and 30-degree chamfering.

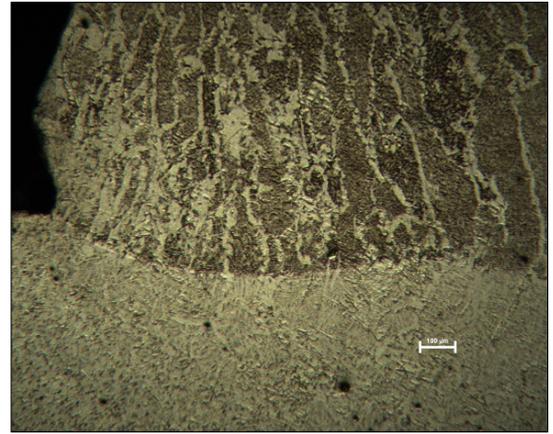
After examining the tissue structure of our samples, we performed a micro Vickers hardness measurement with a microscope. In the case of the Vickers method, a diamond pyramid with an apex angle of 136° is our piercing tool, in the case of the micro Vickers method, a small impression visible only under a microscope is made on the surface of the piece. The surface area of the imprint is proportional to the hardness, so the hardness of the material can be deduced from the average of the two diagonals.

The hardness was measured in the melt zone of the two samples, in the heat effect zone and in the raw material with a load of 200 g, in order to verify the tissue structure seen under the microscope [15–18]. We performed 3-3 measurements in each zone and then evaluated their results.

Hardness HV 130 was recorded in the melt zone of each sample, HV 103 in the zone of heat effect, and HV 116 in the raw material. HV 105 was obtained in the melt zone of the second sample, HV 125 in the zone of heat exposure, and HV 121 in the raw material. The results obtained confirm our expectations.



**Figure 4.** 15° chamfering, 1 mm gap 4x20 magnification the seam and the heat affected zone



**Figure 5.** 30° chamfering, 0 gap 4x20 magnification

## 5. Conclusions

As a summary of the studies, the set goal was achieved. A medium-thick plate (8 mm) was welded from one side, in one row, using Rapid Weld technology to create a seam of acceptable quality. Based on the evaluation of the results, a 15 ° chamfer and a 1 mm gap clearly gave the best results, shown in **Figure 4**. On pieces made with a 15 ° and 30 ° chamfer (**Figure 5**) without the use of a gap, it can be seen that the degree of fusion into the horizontal plate of the corner seam is lower, but even then, seams of acceptable quality can be created. However, it can also be stated that the pieces without chamfering were not suitable in this material thickness.

Due to the high beam and heat load of the process, automation is recommended to further improve the quality of the seam, so gap-free welding may prove to be the best solution due to its better cost-effectiveness.

Finally, three- or four-component gas mixtures can be used to improve seam quality, which can provide better edge melting by improving arc stability.

The experiment can also be continued in the direction that the welding is automated or if the preparations are performed by flame cutting or plasma cutting.

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