FILARC PZ6105R
The robot-friendly cored wire

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In Svetsaren 98/3 and 00/1, we introduced PZ6105R, ESAB's metal-cored wire for robotic welding, and described its use for the fabrication of excavator frames in medium to thick steel, as well as the fabrication of thin-plate automotive components.
This article focuses on ESAB's aim to work closely with clients on different projects involving mechanisation in our desire to sharpen their competitive edge. Some additional applications will be presented in the field of thin-plate welding, including new applications from the automotive industry.

The markets nowadays are becoming increasingly large and transparent. This tendency offers commercial potential to individual fabricators, but at the same time it can entail a threat. Established companies are experiencing increasing competition from newcomers in their branch of industry operating at international level. In order to remain competitive, they have to re-assess their business and change their market approach. They frequently conclude that a new growth strategy is impeded by what are known as limiting factors which affect the way they run their company.

These limiting factors may be encountered in the supply of raw materials, the availability of labour, production capacity, warehouse capacity, financing, market demand and the delivery of finished products to end users. A bottleneck in one or more of these links in the production and marketing chain may account for the difference between success and failure for the whole company.

A shortage of skilled labour, for example, is a problem many fabricators are coping with in today's booming economy. Being successful calls for a creative approach when it comes to recruiting new staff, re-educating one's own personnel, mechanisation, or even outsourcing work to specialist firms.

The same goes for stocks. The market demand may justify a higher stock level, but at the same time companies are trying to minimise the amount of money invested in stocks. Creative solutions are found in modern stock management systems such as EOQ (Economic Order Quantity), JIT (Just In Time) and MRP (Materials Requirement Planning).

In the area of financing, renting or leasing can be considered when traditional financing instruments represent a limiting factor.

Welding, a necessary production step for many fabricators, can also constitute a bottleneck in the production chain. This bottleneck can be concentrated at the welding station itself, but it is very often a combination of fabrication steps associated with welding, such as high repair and scrap rates.

Co-operation with fabricators

ESAB makes its knowledge of welded fabrication available to the automotive industry by participating in projects that aim to increase the competitiveness of individual fabricators in this field. In the assessment of the welding situation and the implementation of more productive solutions, always in close co-operation with the fabricator, different types of problem emerge.

One that is more or less standard is the lack of time on the part of the fabricator who is often caught up in a very tight production schedule. Further down the line, there may be preoccupations about running tests on production lines at the risk of causing unacceptable downtime. Very often, the availability of a skilled robot programmer is a problem that stands in the way of effective testing on the customer's site.

ESAB has recognised these problems and has developed its own test facilities to minimise on-site testing as far as possible and thereby the impact on the fabricator's normal production set-up. When on-site testing becomes necessary, the type that has the least effect is chosen, for example, by utilising the weekends or other times when regular production is stopped.

This working process is explained in more detail below.

Working process

Phase 1

In every case, the projects begin with a thorough evaluation of the production situation by skilled people from ESAB working together with the fabricator. Subjects such as needs, requirements, determination of bottlenecks, limitations related to welding equipment and torch positions, discussions about present problems and so on are covered.

When there is agreement that there are significant benefits to be gained, the project proceeds into phase two. This consists of welding trials at one of our welding application laboratories on samples supplied by the clients.

Phase 2

At the present time, ESAB has two locations (Utrecht in the Netherlands and Göteborg in Sweden) where more advanced tests including robot welding can be carried out. During the tests, the fabricator's situation is copied as closely as possible. If, for example, the freedom is given to test other gases, this is done to see whether any additional benefits can be obtained. Quite frequently, clients have a central gas network supplying a specific shielding gas, so a change of shielding gas is then out of the question. After the welding trials, the results are carefully evaluated and reported back to the clients. Assistance with cost calculations can also be provided in cases where sufficient information has been received.

When the results of the welding trials show for some reason that no additional benefits will be gained by implementing the findings, the project is terminated. When the outcome is positive, it is up to the fabricator to decide if and when he wants to move into phase three, on-site testing. The major benefit provided by ESAB by working in this way is, quite naturally, a minimum impact on the company's own production. The only risk the fabricator takes is the cost of the samples sent to the welding application laboratories.

Phase 3

During phase three, welding trials are performed on site under ESAB's guidance using the company's own equipment and new evaluations, based on the values obtained, are made. The time span of the on-site testing varies. Sometimes a short on-site test is followed by a long-term one. After a careful evaluation of the data that are obtained, it is up to the company to decide whether or not to transfer its process.

Some examples are given below of projects carried out using this approach. As many fabricators, especially in the automotive industry, are not keen on publishing information about their production, we refrain from mentioning the names of the companies involved. Moreover, all the data presented here are values obtained after phase two in the different projects, i.e. after tests at our welding application laboratory in Utrecht.

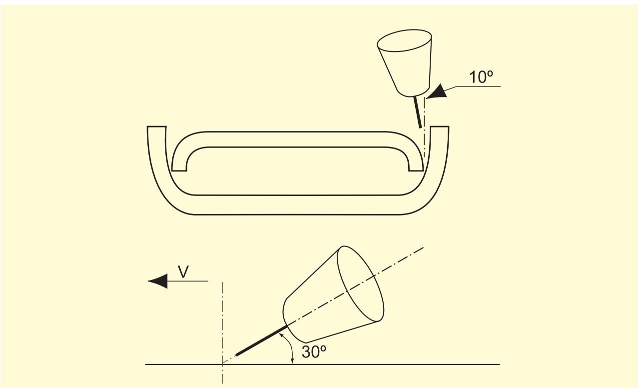


Figure 1. Safety component

Application 1

Welding a safety component for trucks

The problem definition:

- Lack of fusion caused by the torch being directed more towards the inner ring. The reason for this torch position is to avoid melting the outside edge of the sample
- The spatter level is too high, resulting in an undesirable amount of post-weld grinding
- The productivity of the welding station is too low, i.e. it is a bottleneck in the production process

Figure 1 shows a cross-section of a safety component for trucks. The parent material is equal to St 37.2 with an outer diameter of 100mm and a thickness of 4.5mm. These parts have been welded with SG2-type solid wire, diameter 1.2mm, using the pulse technique and a welding speed of 14.5 mm/s.

Like all the other tests described below, the application research was performed with an ABB IRB 1400 welding robot and an ESAB Aristorob 500 power source. Suitable parameters for welding the circular weld were found at 398A/6V/10m/min. at 25mm stick-out length. The travel speed obtained was 1.3m/min. A gas mixture of $90Ar/10CO_2$ was used as gas protection.


Figure 2. Safety component welded with PZ6105R

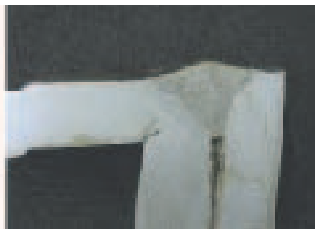


Figure 3. Etched cross-section

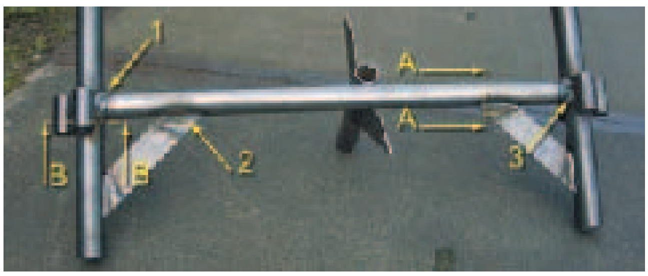
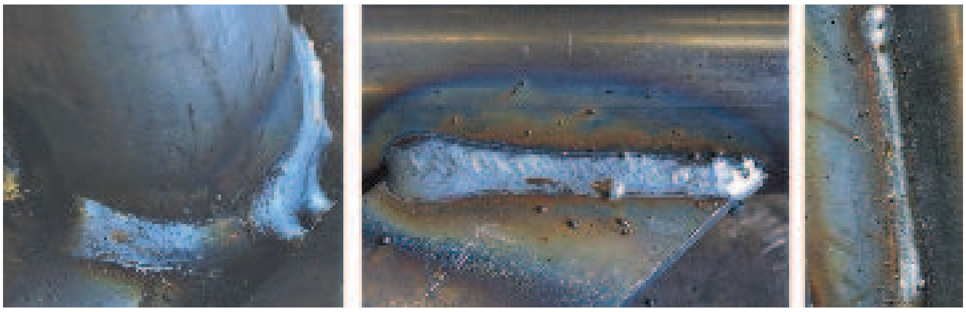


Figure 4. Scaffolding component



Figures 5,6,7. Solid wire welds 1,2,3

Figures 8,9,10. Welds 1,2,3 made with PZ6105R.

Figure 11. Etched cross-section A-A of a scaffolding component welded with PZ6105R.

The results showed a 38% increase in welding speed and the samples were free from spatter. The burn-in profile and bead profile were good without any melting of outer edges, suggesting significant potential for a productivity increase as a result of a reduced scrap and repair rate.

Figure 2 shows the component after being welded with PZ6105R using the above-mentioned parameters. Figure 3 shows a cross-section of the weld. It can be seen that the weld is relatively flat with good penetration, without melting the outer edge, in a series of tests repeatedly meeting all the quality objectives set by the client.

Application 2
Welding scaffolding

The problem definition:

- Excessive spatter level necessitating post-weld cleaning
- The productivity of the welding station is too low, i.e. it is a bottleneck in production

A non-automotive, yet interesting, application, involving the welding of 2.2mm thick tubes to produce scaffolding. The client uses robot welding together with 1.0mm diameter solid wire under 80/20 Ar/CO_2 gas protection, using conventional MIG power sources.

Figure 4 shows a reference sample taken from the client's production. The numbers indicate the different types of weld, whereas the letters show the locations from which transverse cross-sections were taken from samples produced with PZ6105R. Figures 5 to 7 show the solid-wire welds corresponding to the numbers 1 to 3 in Figure 4.

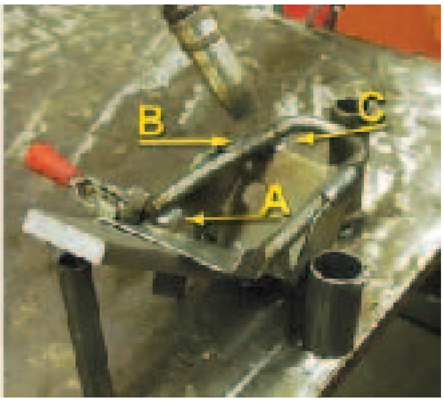
The same welds, now performed with PZ6105R using the same shielding gas, are shown in Figures 8 to 10. The welds are flatter and spatter is virtually absent. A transverse cross-section taken from location A and representative of the type of penetration obtained is shown in Figure 11.

The results showed that the spatter could be almost eliminated. There is potential for increasing productivity by more than 40% and a corresponding cost reduction/ sample of more than 20%.

Figures 12a, b and c show the results of tests performed on another scaffolding component from the same customer. The problem definition is the same as for the previously mentioned component.

Equally good results were obtained in terms of spatter. The productivity increase and reduction in production costs were even larger than the above-mentioned figures.

Figures 12a,12b,12c. Another component (12a) welded with solid wire (12b) and with PZ6105R (12c).



Figures 13,14. Tow eyelet welded with solid wire and special fixture (14) for robotic tests with PZ6105R.

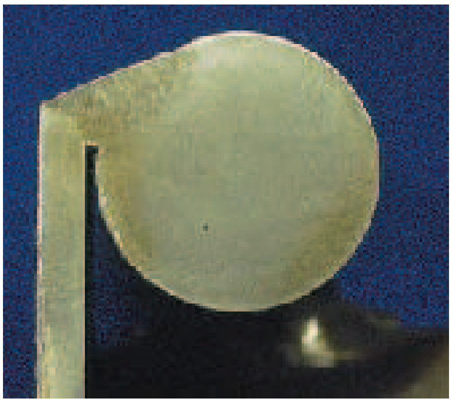


Figure 15. Cross section of weld B in figure 14.

Figure 16. Exhaust pipe hook

Application 3

Welding tow eyelets and hooks for exhaust pipes

Problem definition:

- Productivity at the welding station is too low
- The welding station is a bottleneck in the production process

The third example deals with the welding of tow eyelets with a plate thickness of 2mm (Figure 13). The steel bar which has to be attached has a diameter of 12mm. Oil residue is frequently present on the 2mm plate. This work is currently done at a robot station with 1.2mm diameter solid wire under $90Ar/7.5CO_2/2.5O_2$, using conventional MIG power sources. The welding is done in the PB position at a travel speed of 0.8–1.0 m/min.

To perform the tests, a fixture was constructed for the components (Figure 14). The letters indicate the locations of the different welds. Figure 15 shows a transverse cross-section of weld B. It is clear that the weld quality is good. Suitable parameters were found around 290A/23V/8 m/min. at a travel speed of approximately 1.62 m/min. for welds A to C (20mm stickout), accounting for an increase in travel speed of around 70%.

In combination with the above-mentioned application, another welding trial was conducted on hooks for exhaust pipe systems (Figure 16). This component is produced at another robot station. It was not as urgent for the customer to increase productivity at this station as it was in the previous application. These tests were conducted for future needs. The welding was done in the PB and PG positions. Currently, solid wire ∅ 1.2mm is used under $90Ar/7.5CO_2/2.5O_2$ shielding gas. The welding speed for the major long weld deposited in the PG position is 1.2 m/min.

Welding speeds in the range of 1.4–2.0.m/min were achieved. The higher welding speed is valid for the long weld deposited in the PG position.

Summary

The competition within industry is increasing, forcing companies to re-assess their business situation. Identifying limiting factors has become increasingly important. There are some problems that companies have to deal with when working with process improvements. They include lack of time, limited access to robots and programmers and the risk of lost production associated with running on-site tests during normal production time. ESAB has recognised these problems and works together with a number of clients in a flexible manner, offering minimised risk levels and increasing the probability of success for clients.

For more information, please contact your local ESAB organisation.

About the author

Tapio Huhtala is a product manager for unalloyed cored wires at ESAB B.V. in Utrecht in the Netherlands. He joined ESAB in 1993 and worked as a research metallurgist in Goteborg until 1998.