SVETSAREN

THE ESAB WELDING AND CUTTING JOURNAL VOL. 64 NO. 1 2009

TRANSPORTATION

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Svetsaren

TRANSPORTATION

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Photo courtesy Volvo Construction Equipment AB, Sweden - see page 50.

Christophe Gregoir

Dear reader,

The transport and vehicle manufacturing sectors are facing challenging times. The effects of the credit crunch are combining with the growing evidence of economic recession and mounting fears over job security. The knock-on effect on consumer confidence has been dramatic and rapid, leading to a precipitous decline in new car sales.

Additional pressure comes from increasing environmental awareness. To protect our planet, car manufacturers are reviewing their strategy in terms of alternative energy sources, recycling and re-utilisation of waste, hybrid solutions, lithium batteries, fuel cells, 'green' tyres, electrical energy management, "stop and start" systems, etc. These technical innovations may also have an impact on new car sales in the near future.

On the other hand, government bodies are supporting investments in local infrastructure, which has a positive effect on the passenger rail transport segment. Passenger traffic has been growing strongly thanks to a variety of factors such as increasing road and air congestion and major improvements in rail services winning people over from air and road. In a number of regions we can still see the huge investments that are on-going, creating employment and supporting the economic growth of the nation. Rail transport is experiencing a revival.

This issue of Svetsaren features articles and application stories that illustrate the success of our clients, and the in-depth involvement of ESAB as a welding and cutting solution provider for both manual and mechanized-robotic applications in the transport industry.

Good reading,

Christophe Gregoir
ESAB Global Segment Manager Transport

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ESAB corporate newsflash

$1.2M order for robot packages from DANA Argentina. In June 2008, DANA, an automotive manufacturer working for the Volkswagen Commercial Vehicles division ordered Aristo Mig™ robot packages for the retrofit of 81 ABB IRB 2400L welding robots for a new VW pick-up truck to be produced in South America, Europe and South Africa. The order was awarded amidst fierce competition from major international welding equipment suppliers. State-of-the-art inverter welding technology was crucial, but also a maintenance contract - an agreement to keep all ESAB equipment running with original spare parts and no dead times.

ABB offers ESAB arc welding packages on IRB robots. ABB has joined forces with ESAB to offer customers a comprehensive robotics, arc-welding solution with power sources, robot-mounted wire feeders, cable package and Marathon Pac bulk drums with robot quality MIG/MAG wire. Central to the package is ESAB's Aristo robot package which includes the Aristo™ Mig 4000i or 5000i power source - the latest inverter Insulated Gate Bipolar Transistor (IGBT) power source technology – which supports a variety of arc-welding capabilities, including robotic short arc, spray arc, pulsed arc, high speed welding (rapid arc) and the unique SuperPulse™ technology. The robot package can be delivered with separate U8 control unit, or integrated in ABB's IRC5 robot control unit. The new package is available with ABB's reliable IRB1600, IRB1600ID (Integrated Dressing) and IRB2400L robots.

Vestas Wind Towers awards major contract to ESAB. In May 2008, Vestas announced the construction of the world's largest wind tower manufacturing plant in Pueblo, Colorado, USA - a $250M investment. ESAB Welding & Cutting Products was selected to supply equipment for the greenfield production plant for their proven track record, and the ability to design, deliver and service such a large venture. The contract includes several large plasma and oxyfuel cutting machines, ESAB's new telescopic column and boom SAW stations, rollerbeds, portable welding machines as well as a long term supply agreement for SAW wire and flux.

Meyer Werft orders largest TELEREX™ TXB built to date. Birthdays do not get much better. Just in time for the 70th anniversary of ESAB Cutting Systems, in July 2008, Meyer Werft of Papenburg placed an order for the largest TELEREX TXB gantry cutting machine built to date - with a track width of 33 metres. Extensively automated, the high precision TELEREX TXB handles all cutting and marking functions for the production of large-sized sheets for shipbuilding. The unit for Meyer Werft is equipped with automated plate position recognition for error-free tool positioning, controlled via a camera system. Start-up is planned for September 2009. The contract was signed at the highest level by Meyer Werft owner Bernhard Meyer, ESAB CEO Jon Templeman and Achim Dries, Managing Director of ESAB Cutting Systems GmbH.

ESAB opens new factories in China. On the 19th March 2008, an opening ceremony was held to celebrate the inauguration of ESAB's third factory in China - ESAB Welding Products (Weihai) Co Ltd. ESAB chose Weihai, located at the tip of Shandong's North Eastern peninsular, for it's close proximity to the rapidly expanding shipbuilding industry in Northern China. The plant produces flux-cored wire, speciality coated electrodes and agglomerated submerged arc flux.

Another exciting milestone for ESAB in Asia was reached with the grand opening of ESAB's first equipment factory in Asia, for the manufacture of step-controlled MIG/MAG power sources and wire feeders. The factory located in Zhangjiagang, Suzhou province, China, was officially opened by Jon Templeman, CEO ESAB Global, on 25 September 2008. Given ESAB's emphasis on environment, health and safety, the management and staff have made a conscious effort to ensure compliance with ISO14001 and OHSAS18001 environmental, health and safety standards.

ESAB CEO Jon Templeman at the opening of one of ESAB's new factories in China.

ESAB acquires Linkweld. At the end of July 2008, ESAB acquired the former Linkweld MAG wire plant in Terni, Italy - buying all the assets consisting of the 8,000 m^2 building and production equipment. The plant was brought back into operation within 2.5 month and acquired ISO 9001 qualification shortly thereafter. The acquisition is another significant step in ESAB's growth strategy in Europe

AWS Warren F. Savage Awards for ESAB specialists. ESAB employee Dr Leif Karlsson and former employee Dr Enda Keehan recently received 'The American Welding Society Warren F. Savage Award'. This award recognises the paper they published in the September 2006 issue of the Welding Journal, which best represents innovative research resulting in a better understanding of the metallurgical principles related to welding. Leif and Enda shared the award with co-authors Professor Hans-Olof Andrén from the Chalmers University in Gothenburg, Sweden and Professor Harshad. K. D. H. Bhadeshia from Cambridge University in the UK for their paper 'New developments with C-Mn-Ni High strength steel weld metals, Part A – Microstructure'.

The Nordic Council of Ministers has launched a new website that serves as a window to the world for Nordic solutions in renewable energy technology, research and development, as well as political approaches to sustainable energy use. ESAB was invited to participate, and the result can be seen on www.nordicenergysolutions.org

Frost & Sullivan acknowledges ESAB's excellence in customer service

The "2008 Global Welding Consumables Customer Service Excellence Award" has been presented to ESAB.

"ESAB has developed an exceptional product range in response to customer specific needs," notes Frost & Sullivan Senior Research Analyst Archana Chauhan. "The company has one of the largest welding consumables product ranges; it has consumables for every welding application type, but also to cater to particular industry segments such as shipbuilding, automotives, pipelines, and pipe mills. They are manufactured under a strict ISO 9001 quality assurance programme, in factories that are ISO14001 approved, worldwide.

"A global presence and widely dispersed manufacturing facilities have facilitated an extensive reach and more effective response to customer needs. The ESAB group has 26 manufacturing plants across the globe and sales offices and distributors in almost 80 countries, enabling ESAB to provide a truly global experience to its customers. It tracks its customer delivery performance on a global basis and constantly seeks to improve.

"ESAB invests heavily in R&D to enhance the quality and productivity of its consumables, while reducing their environmental impact and improving the working environment of its customers.

"Through its regionally dispersed Process Development Centres, ESAB is able to provide rapid technical support as well as customer training. Its internationally renowned specialists – wherever located - are united in a single department and globally deployed to improve customers' welding productivity.

"ESAB publishes an internationally respected customer magazine 'Svetsaren' that covers major welding industry related issues," comments Miss Chauhan. "The company also deploys user friendly e-marketing and networking strategies. For instance, the ESAB website has all the information necessary to place orders and redress grievances."

The Frost & Sullivan Global Customer Service Excellence Award is bestowed each year upon the company which has demonstrated global excellence in a given business function such as sales, marketing, customer service, product quality and supply chain management.

About Frost & Sullivan.

Frost & Sullivan, the Growth Partnership Company, empower clients to create a growth-focused culture that generates, evaluates and implements effective growth strategies. Frost & Sullivan employs over 45 years of experience in partnering with Global 1000 companies, emerging businesses and the investment community from more than 30 offices on six continents. For more information about Frost & Sullivan's Growth Partnerships, visit www.frost.com.

ESAB in conference

Keynote speakers are representing ESAB in the following welding conferences in 2009:

- AMERICAN WELDING SOCIETY (AWS) 12TH Aluminum AWS-AA Aluminum Conference (May 5-6, 2009), Toronto, Canada.
  Tony Anderson: Conference Chairman & introductory lecture.
  Jay Ginder: Friction stir welding of aluminium - Cutting methods for aluminium alloys - Robotic applications.

- AMERICAN WELDING SOCIETY (AWS). Charting the course in welding for US shipyards – (June 16-17, 2009), Louisiana, USA.
  Tony Anderson: How to avoid cracking in arc welded aluminum alloys used for marine applications.

- IIW ANNUAL ASSEMBLY, 12-18 July, Singapore
  Dr. Leif Karlsson: The effect of purging gas on 308L TIG root-pass ferrite content.
  Dr. Leif Karlsson: Effects of alloying concepts on ferrite morphology and toughness of lean duplex stainless steel weld metals.
  Lars-Erik Stridh: ESW strip cladding and hybridLaser welding of longitudinal seam of cladded pipe.
  Dr. Mikael Soron: Evaluating control solutions for robotic friction stir welding

- THERMEC, BERLIN, GERMANY, August 25-29th.
  Dr. Mikael Soron: Quantifying the usability of a robot system for friction stir welding.

- 1ST INTERNATIONAL WORKSHOP on in-situ studies by synchroton and neutron diffraction, 1-2 September 2009, Berlin Germany
  Dr. Leif Karlsson: Influence of plastic deformation on the residual stress distribution and fatigue behaviour of high strength steels welds.

- IIW REGIONAL CONFERENCE on "Progressive structural materials and their welding and joining technologies", 14-16 October, High Tatras, Stara Lesna, Slovakia
  Dr. Leif Karlsson: Microstructure and properties of high strength steel weld metals.

EMCON TECHNOLOGIES Brazil reduces cycle time for welding catalytic converters with ESAB Arcaloy 409Ti metal-cored wire.

Roberto Luiz de Souza, ESAB Brasil, São Paulo, Brazil

The use of advanced materials, coinciding with a high level of competitiveness in the automotive industry, has led ESAB to forge partnerships with its clients in this segment, with the objective of providing ideal welding solutions with a competitive edge. This is exemplified by a recent project with EMCON TECHNOLOGIES – a major international fabricator of exhaust systems – which introduced stainless steel cored wires for ferritic stainless steel in their production.

Emcon Technologies is a new company resulting from the acquisition of the exhaust systems division of ArvinMeritor in 2007 by OEP - One Equity Partners. Emcon Technologies Brazil has four plants located in: Limeira-São Paulo (the main plant in Brazil), São Bernardo-São Paulo, Camaçarí -Bahia and Gravataí - Rio Grande do Sul. All are involved in the manufacture of exhaust systems and, together, they supply almost all car manufacturers in Brazil, eg, GMC, Ford, VW, PSA, Toyota and Honda.

Acknowledgement
We express our appreciation to EMCON TECHNOLOGIES, in particular to Mr. and Mrs. Luiz Henrique Machado, José Eduardo Lepore and Edson Luiz Geniseli for their support and true team spirit during this project.

Introduction
In the automotive industry, stainless steels are increasingly being used for exhaust systems at the expense of carbon steel. The use of ferritic stainless steel for exhaust systems was first seen in the USA in the mid-70's and has since gained popularity due to its excellent resistance to corrosion, cyclic oxidation, fatigue, high temperatures and thermo mechanics. They are ideally suitable for environments with abrupt changes of temperature, mechanical wear and exposure to gases and corrosive condense.

Technical evolution and work temperature of catalytic converters
In Brazil, stainless steel exhaust systems became standard, from 1991, when a government law forced all cars – domestic or imported – to be equipped with catalytic converters. Since then, the maximum operating temperature of converters has increased, due to developments in the ceramic or aluminium-oxide core (honeycomb) and precious metal coatings, resulting in more dependable and efficient converters (Figure 1).

Figure 2 shows the temperature zones in a complete exhaust system, with the traditional division of 'hot end' and 'cold end'. In the USA and Brazil, ferritic steels are predominantly used for the entire exhaust system – AISI type 439 being a popular choice for hot end applications and the lower alloyed AISI type 409 type for cold end components. In Europe, austenitic types are common for the complete system, although a trend towards the use of ferritic types is being seen.

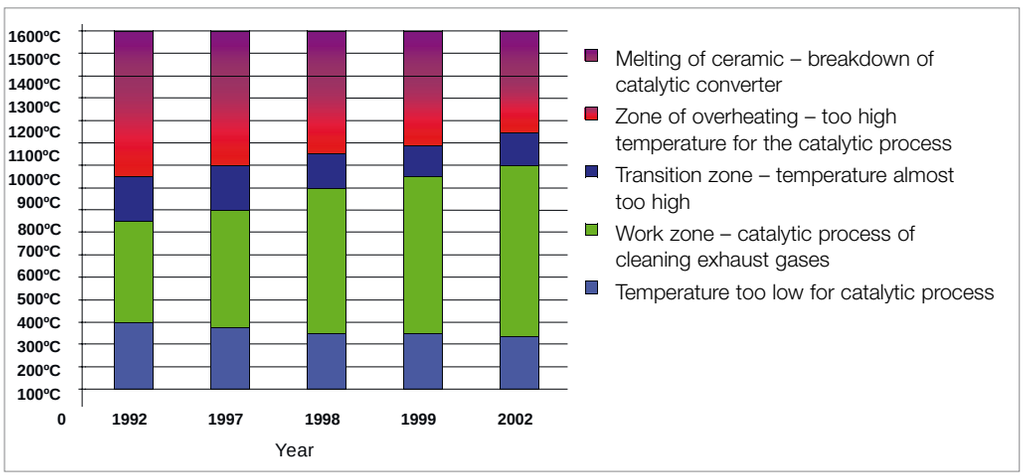

Figure 1. Development in work temperature of catalytic converters.

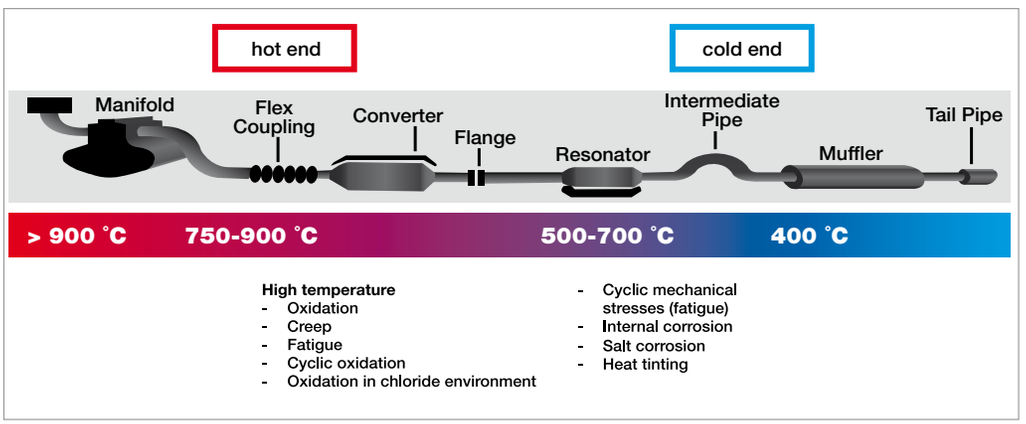

Figure 2. Criteria for material selection.

Consumables
Consumables for welding ferritic stainless steel can be either austenitic or ferritic. Austenitic consumables have excellent weldability and give a weld with an austenitic microstructure and good mechanical properties. The addition of nickel, however, makes austenitic consumables more expensive.
Ferritic consumables contain 11-18% Cr, depending on classification, and are not alloyed with nickel. They are micro-alloyed with Ti and Nb as stabilisers to prevent sensitisation. They have good weldability and provide welds with excellent corrosion resistance and good mechanical properties – also at high temperatures. This group of consumables is ideal for welding as they do not have Ni and yet maintain the quality desired for the welding of vehicle exhaust systems components.

The test programme carried out by EMCON, in close co-operation with ESAB, investigated the advantages, in terms of weld quality and productivity, of replacing AWS ER308LSi solid wire with ESAB's Arcaloy 409Ti (AWS A5.9 EC409) ferritic stainless metal-cored wire, in the production of catalytic converters.

Test programme
The investigation was carried out in three phases, all focussing on a specific area of the consumables' performance:
- weldability and productivity
- weld profile
- chemical composition and micro-structure

All welding was done with a robot cell for the production of catalytic converters – under real production conditions – enabling an exact comparison between the solid and the cored wire (Figure 3).

Weldability and productivity
Arcaloy 409Ti was used successfully. Both wires were welded in the non-pulsing short arc mode in Ar/2%O_2 shielding gas at 220A/18V (ER308LSi) and 240A/20V (Arcaloy 409Ti).

Figure 3. Cell for the robotic welding of catalytic converters.

Figure 4. Detail of converter welded with Arcaloy 409Ti.

The metal-cored wire was impressive, with low level spatter, flat bead profile and uniform and linear welds (Figure 4 and 5). Arc ignition and arc stabilisation were deemed to be excellent - with minimum spatter at starts and stops – greatly improving the final appearance of the catalytic converter.

Economic results were equally convincing, with 45% higher welding speed and a cycle time reduction of 25% (table 1). Obviously, this accounts for an enormous improvement in productivity for a company in the competitive automotive market. The success of Arcaloy 409Ti in the welding of catalytic converters provides a basis for further testing to optimise welding productivity. The next stage of testing will explore the use of pulsed arc welding.

Table 1. Productivity data.

Parameters	Consumable		Difference
Datas	Solid wire ER308LSi	Arcaloy 409Ti	Gain
Base metal	AISI409	AISI409	
Thickness	1.50mm	1.50mm	
Wire diameter	1.0mm	1.2mm	
Shielding Gas	Ar+2%O_2	Ar+2%O_2	
Welding speed (cm/min.)	113	164	+45%
Welding time (s)	48	33	-31%
Cycle time (s)	60	45	-25%

Figure 5. Converter welded with Arcaloy 409Ti.

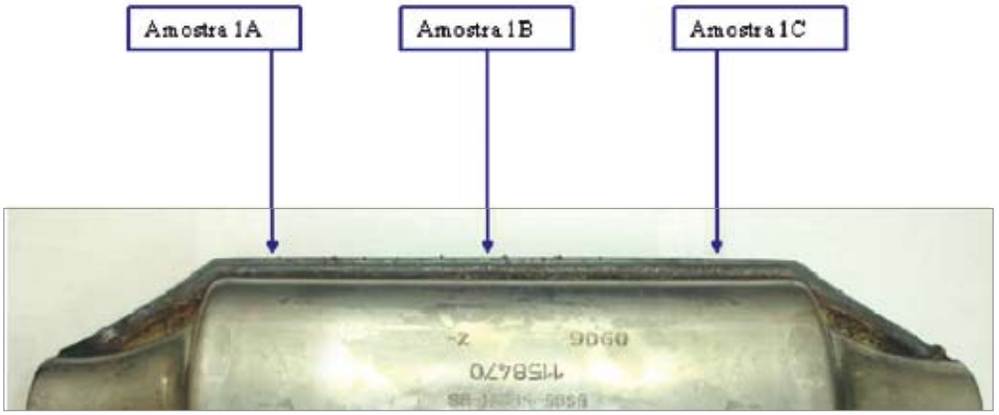

Figure 6. Cross sections for sampling.

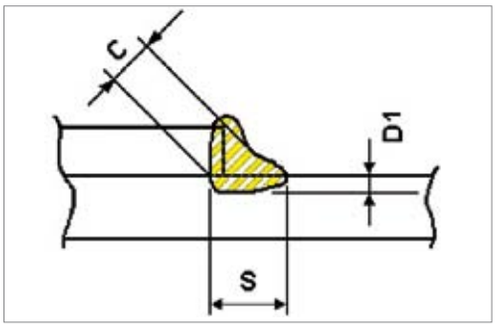

Figure 7. Sample analysis plan.

Weld profile

Macros were taken to verify weld profile and penetration. Figure 7 shows the weld dimensions measured on three individual catalytic converters welded with Arcaloy 409Ti and ER308LSi solid wire, respectively. Figure 6 indicates where the samples were taken.

Tables 2 and 3 show examples of individual values measured on test pieces welded with Arcaloy 409Ti and ER308LSi solid wire and Table 4 gives the average of three test welds for both wires.

From these results, it can be concluded that Arcaloy 409Ti shows a wider penetration “S” and “D1”. This is because it has a less concentrated electric arc than solid wire. The wider penetration profile is beneficial in the avoidance of lack of fusion defects - particularly important for this industry. On average, the penetration depth “C” was smaller than from the ER308LSi solid wire. This is also beneficial as it involves thin-plate welding with a potential risk of burning-through.

Chemical composition and micro-structure

Figures 8 and 9 compare the micro-structure of welds made with both wires, the result being predictable. The weld metal structure is austenitic for the ER308LSi wire and ferritic for the metal-cored wire. The microstructure of the base material and HAZ remain comparable in type and

Table 2. Sample welded with metal-cored wire Arcaloy 409Ti.

	D1	C	S
1A	0.50	2.54	5.19
1B	0.43	2.09	5.57
1C	0.44	1.96	4.40

Table 3. Sample welded with ER308LSi wire.

	D1	C	S
1A	0.32	2.74	4.85
1B	0.26	2.49	4.50
1C	0.21	1.26	4.95

Table 4. Weld penetration - average of three test welds.

Samples	Average of penetration Difference (%) Wire Arcaloy 409Ti versus solid wire ER 308LSi		
	D1	C	S
1A	+56%	-7%	+7%
1B	+65%	-14%	+23%
1C	+109%	+55%	-11%

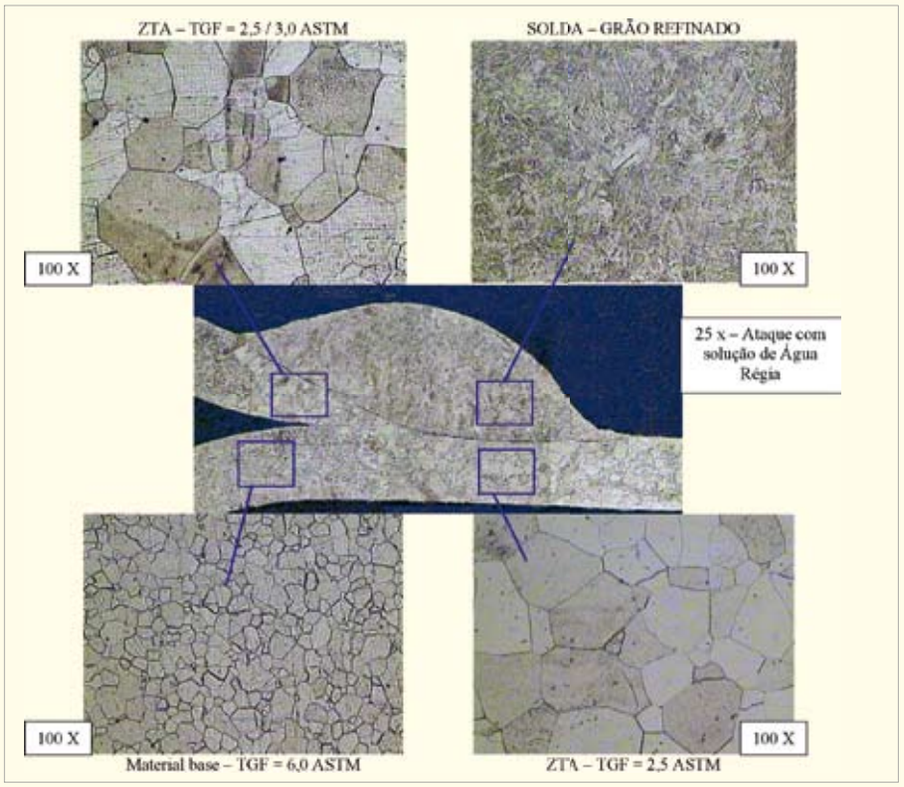

Figure 8. Joint welded with solid wire ER 308LSi.

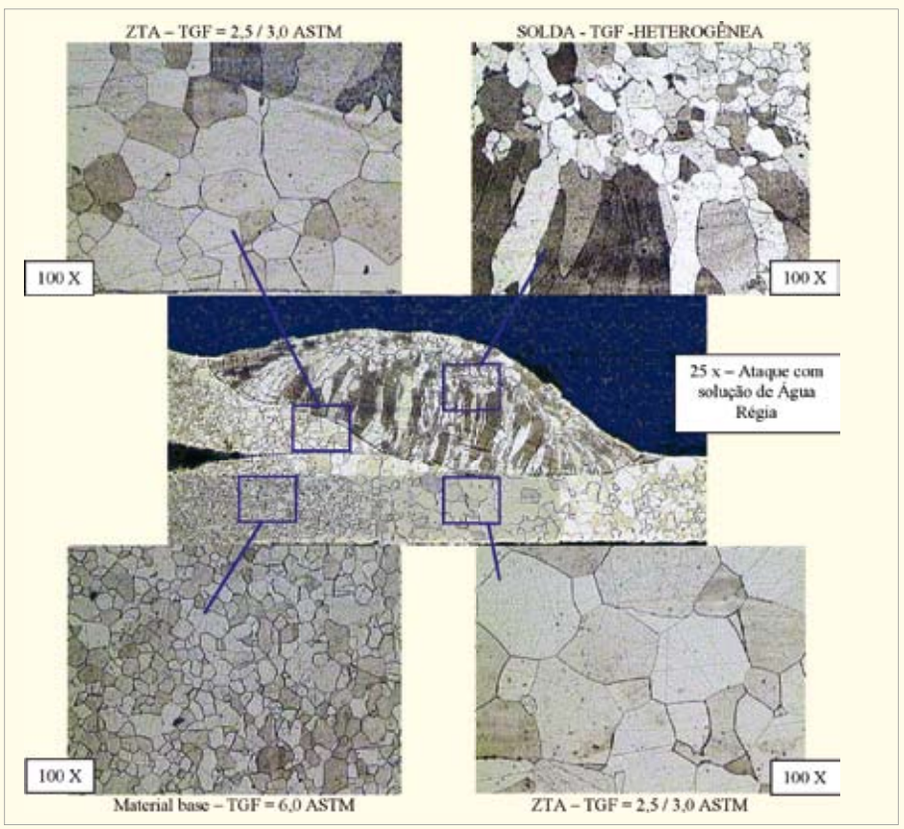

Figure 9. Joint welded with Arcaloy 430Ti.

grain size. Tests with oxalic acid did not reveal any sign of sensitisation at the grain boundaries. Also visible is the wider weld bead with less reinforcement produced by Arcaloy 409Ti – in line with the findings of Table 4.

Conclusion

ESAB's partnership with EMCON TECHNOLOGIES in a test programme for the replacement of ER308LSi solid wire with Arcaloy 409Ti metal-cored wire in the robotic welding of catalytic converters, resulted in a dramatic reduction in cycle time, as well as a more favourable penetration profile for thin-plate welding. It formed the basis for wide-scale introduction of Arcaloy 409Ti in EMCON production and paved the way for the application of another type of ferritic metal-cored wire, Arcaloy 430LNb.

About the author:

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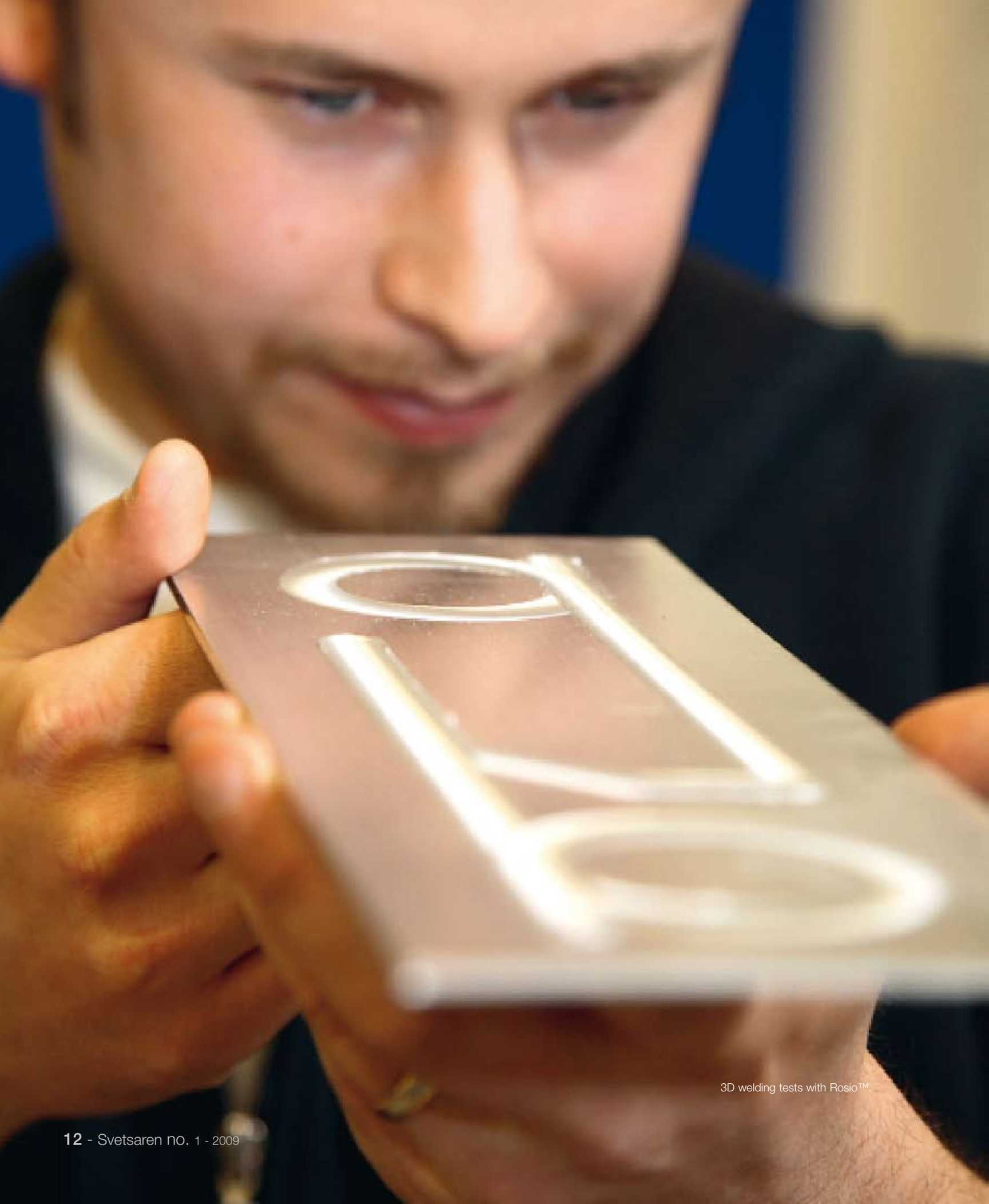

3D welding tests with Rosio™.

Robotic friction stir welding of complex components using Rosio™

Dr. Mikael Soron, ESAB AB Welding Equipment, Laxå, Sweden
Kari Erik Lahti, PhD, MSc, MBA, ESAB AB, Gothenburg, Sweden

The joining of multidimensional joints has been a challenge for friction stir welding (FSW). This is because machines are predominantly built to manage process requirements rather than enabling motion flexibility. By using high-payload industrial robots, a new field of applications for friction stir welding can be created. Meeting the requirements of 'on-road, on-track, in the air industries' for high quality and repeatability, and providing the flexibility of traditional welding robotics, robotic friction stir welding is ready to face the challenges. This article reviews ESAB's research and development in bringing to the marketplace the latest member of the ESAB FSW family: Rosio™ - robotic friction stir welder.

Figure 1. Welding tests on Rosio™ Friction Stir Welding robot.

Introduction

Friction Stir Welding (FSW) has been used for the high quality joining of aluminium since its invention in the early 1990's. The superior joint quality results from a solid-state procedure, where no filler material or shielding gas is used. The joint is the result of a rotating tool being forced into the material and traversed along the joint line.

The material, suppressed by the tool's shoulder, becomes plastic and reforms homogenously leaving a solid bond between the two pieces. The technique was developed at TWI (The Welding Institute) in the early 1990's, when ESAB joined a group-sponsored project aiming to develop the process. Commercialisation of the process started a few years later with successful installations at Marine Aluminium (Haugesund, Norway), in 1996, and at Boeing (Wichita, Kansas, USA), in 1998. FSW has gained a sound reputation within the welding community as an easy-to-use, defect-free process.

Figure 2. The world's first industrial FSW machine; installed at Marine Aluminium in 1996 and, since then, producing panels for marine applications.

However, FSW still faces some challenges. One of these is the limited work envelope of the machines. If the workpiece is not positioned inside the machine's work envelope, the resulting weld quality is not guaranteed. Additionally, as the forces required to produce the weld are relatively high (ranging from approximately 1kN up to 100kN), the focus in machine design has been on support of high forces while maintaining stability.

As a result, weld joint geometries using stationary machines are, typically, straight or circumferential. This has led to an interest in using industrial robots for friction stir welding for developments outside the 'comfort envelope' of traditional planar machines.

ESAB has been developing robotic FSW since 2003 and, after a successful evaluation period, ESAB FSW Rosio™ is now available for various welding applications.

Power game in FSW

The main advantage gained by using an industrial robot for FSW is the 3-dimensional workspace. But along with the axis configuration needed to achieve this workspace, compliant behaviour is unavoidable. As the robot comes into contact with a rigid object, the structure compresses and leaves erroneous encoder readings. As those readings are fed back to the control system to be used in the continuous planning, the applied motion will not correspond to that intended. And, as the force experienced during FSW may be at the outer limits of the system's performance, such behaviour will cause instability and most likely cause the operation to fail.

A common solution to such a problem is force control. By disregarding positional readings in the active direction of the tool and, instead, reading the contact force and regulating it according to a desired value, contact stability is ensured. It is obviously a difficult task, requiring not only experience in robot system dynamics, but also the process. It has, none-the-less, been recognised as a suitable solution not only for FSW, but also in many other in-contact operations in which robots are used.

The ESAB robot prototype

ESAB has chosen to utilise a standard industrial robot for friction stir welding, whilst acknowledging the known challenges of force capacity, instability, etc. In order to keep the process entry level threshold low, it was decided that a standard, widely available industrial robot is used as building block for Rosio™.

In order to minimise the effects caused by the process, focus areas for development have been in implementation of adaptive control by mechanically reconfiguring the robot so that the maximum downforce of 500kg can be fully utilised.

The actual welding head consists of a tool adapter, a spindle and a motor. It is dimensioned to apply maximum torque of 40Nm and rotation speed of 3000rpm. This is sufficient for friction stir welding AA6000-series aluminium alloys in thicknesses up to 5mm.

When integrating the welding head with the robot, two main areas need to be considered. Firstly, the operating area of the robot should not be affected by the addition of the friction stir welding head. Secondly, with a constant distance between the FSW tool and the robot's wrist, stability is increased and the position of tool centre point is better controlled.
Minimum mechanical re-configuration of the robot is needed. However, for FSW the 6th axis is more or less redundant, so the space occupied by that axis is used for housing the welding equipment. This increases stability by locating the FSW tool closer to the wrist.

As previously mentioned, there is always a need for an advanced control system when performing FSW with a robot. This is due to the fact that robots are typically not designed for in-contact operations, and very rarely – if ever - for the contact forces experienced during FSW. With elastic deformation always existing in the system under load, process control is very demanding.

In FSW, operations can be divided into both planar and complex welds. Planar weld seams

Figure 3. 3D welding tests with Rosio™.

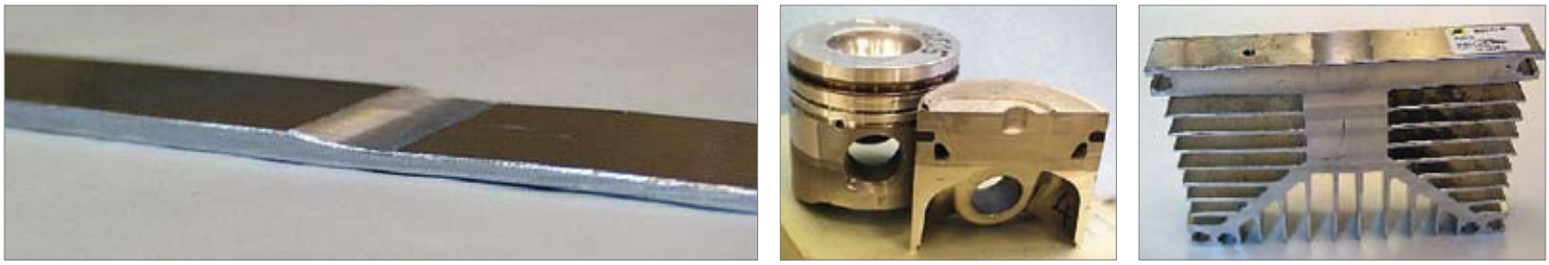

Figure 4. Applications for Rosio™: Tailor-welded blanks, FSW processing, joining of cooling blocks.

are performed by traditional machines, or any other 2-dimensional welding technique. Complex weld seams are applied on objects having curved surfaces. The major difference between the two, in terms of path planning, is that the motion of a planar weld may be planned according to a pre-defined fixed coordinate system. The system internally calculates how to orientate the tool in order to apply a tilt angle defined by the user - like a welding parameter - just by being given the positional coordinates from, for example, teach-programming. The robot system also features the ability to apply a proper tilt or travel angle with relative ease. By implementing welding instructions for the robot's programming language, including the algorithms to apply the tilt angles for a set of common operation, the operator may program the robot as with any standard robot operation.

The journey has started – join us!

Applications

One of the early users of robotic FSW is the automotive industry, where relatively soft aluminium alloys - AA5000 and AA6000-series - are used in thicknesses under 3mm (REF. [2-3]). In these applications, forces under 5000N and tool rotating speeds below 3000rpm are typical. Successful butt- and overlap-joints on AA6063, AA6082 and AA5754 have been performed in order to verify the performance of Rosio™ - first in 2D or planar applications and, later, in a real 3D environment (Figure 3). For the 3D tests, programs were generated automatically from the CAD-drawings for concave-convex-concave objects as off-line programming.

Welding speeds in the tests were approximately 100cm/min for each of the combinations. The location and orientation of the actual workpiece needs to be calibrated for each workstation. This needs only to be done once if the clamping and fixtures are made properly.

Table 1. Rosio™ technical data.

Force capacity	13 kN
Spindle torque capacity	44 Nm.
Spindle rotational capacity	3000 rpm.
Reach	2.55m from the origin
Control features	hybrid force/position control mode
Tool interface	Weldon interface with 25mm diameter
Process monitoring	Force (x, y, z); Torque (ix,iy,iz); Position (x,y,z); Tool orientation (q1,q2,q3,q4); Spindle rotation (rpm)
Mains	3ph. - 400V, 50Hz
Weight	Robot ~ 2500kg, control cabinet ~ 250kg
Connections	2 Ethernet connections (1 service), RS232 terminal

Summary

ESAB has developed the Rosio™ 3D welding system for Friction Stir Welding. It is suitable for welding soft aluminium alloys in thicknesses up to 5 mm with good repeatability and quality.

Substantial research has been carried out since 2003 in order to be in position to utilise a standard industrial robot for this demanding process. Modifications in mechanics and complex control algorithms have enabled development that makes robotic friction stir welding a viable process for the manufacturing industry.

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ESAB supports mobile crane specialist HIAB

Ingvar Gustavsson, ESAB AB, Sweden.

In 2004, HIAB AB in Hudiksvall, Sweden - manufacturer of truck-mounted loader cranes - embarked on a project to robotise the majority of their welding operations within a period of three years. ESAB was invited to join-in as strategic partner.

A remote-controlled crane mounted on a truck to make holes in the roof of a burning building to release hot combustion gases – the solution to one of the most dangerous tasks facing firemen.

About HIAB
HIAB is part of the Cargotec Corporation - the world's leading provider of cargo handling solutions for ships, ports, terminals, distribution centres and local transportation links. HIAB specialises in on-road load handling solutions with a complete product offering for loading and delivering goods. It has production plants in 11 countries, sales offices in 34 countries and importers and distributors in 100 countries around the world. HIAB's world famous brands include HIAB loader cranes, MULTILIFT demountables, MOFFETT and PRINCETON PIGGYBACK® truck-mounted forklifts, ZEPRO, AMA, WALTCO and FOCOLIFT tail lifts, and LOGLIFT and JONSERED forestry and recycling cranes. HIAB AB in Hudiksvall produces truck-mounted cranes with a lifting capacity of up to 28 tons.

Welding optimisation at HIAB AB
This project - to robotise the majority of welding operations within three years, as from 2004, was part of a wider programme of production improvements. Earlier - as part of a major project towards faster, cheaper and higher quality production - robotised welding had been introduced on a smaller scale in conjunction with the laser cutting of components to give the required cut quality and tolerances.

In 2003, HIAB management decided to step-up robotised welding to an unprecedented level for this type of industry, in reaction to a competitive market and an increasing product portfolio requiring flexible and efficient manufacturing. This resulted in the challenging objective to raise the level of robotising or automation from 23% of 65,000 welding hours in 2004 to beyond 70% of 80,000 welding hours, within a period of three years.

ESAB work in Partnership
From the start, HIAB wanted ESAB to be involved as a strategic partner and supply welding expertise to the project – the reward would be the associated supply of welding consumables and equipment. To reach HIAB's objectives, a clear set of responsibilities was defined for ESAB:

- To introduce new methods and consumables
- To give recommendations for each application
- To optimise welding parameters
- To educate operators

The next step was a meeting at HIAB AB between ESAB specialists and HIAB production management to review existing production and decide on a test programme. This resulted in the definition of two sub-projects which, when successful, would provide a sound basis for further robotisation and contribute significantly to HIAB's objectives.

Test programme
Figure 1 shows the principal components of a truck-mounted loader – the base, loader body, first boom, second boom and extensions.

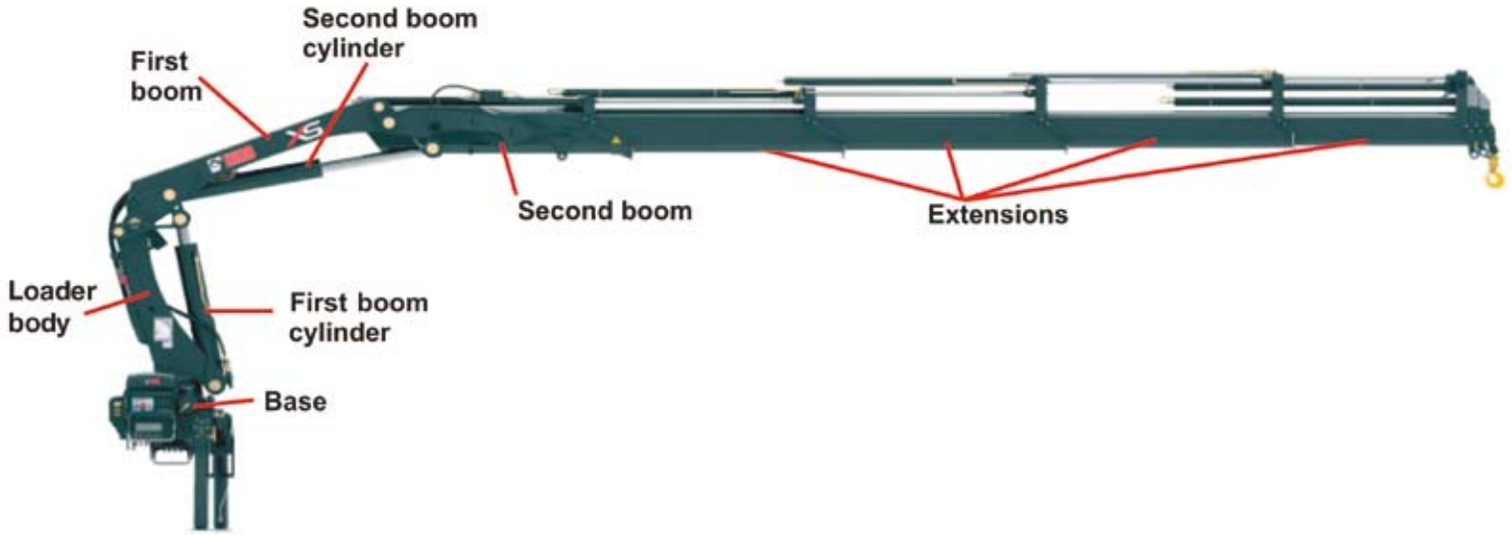

Figure 1. Principal components of a truck-mounted crane.

The test programme reviewed the manufacturing of the following components:

- ***The loader body.*** This involved the production of loader bodies for 10-15 different types of cranes. The objective was to replace manual welding with solid or cored wire by robotised welding with the OK Tubrod 14.11 ø 1.4mm metal-cored wire (SFA/AWS A5.18: E70C-6M H4/EN758: T42 4M M3 H5), advised by ESAB. This is largely concerned with fillet welds - the throat thickness depending on the loader body type. Three loaders where sent to the ESAB Process Centre for testing, to determine parameters for robotic welding with a new ABB robot cell.

- ***The first boom.*** This was one of the components already welded by robot, but using solid wire. HIAB was not satisfied with the performance of the solid wire, especially the arc ignition. Frequently the robot would shut off, because of poor arc ignition, and the operator needed to start-up the process again. This problem could not be overcome satisfactorily by precise regulation of the arc characteristics. Also the amount of spatter and the associated cleaning of work pieces were disadvantages. The objective was to increase productivity and, at the same time, to improve the start/stop behaviour by using a new consumable. Again OK Tubrod 14.11 ø 1.4mm was proposed by ESAB and 3 beams were sent to the ESAB Process Centre for testing.

An additional test involved the manual welding of the most critical weld in the base – an area of high fatigue load – with OK Tubrod 14.11 ø 1.4mm. Weld quality in this safety component is essential and ESAB was able to provide better weld penetration and tie-in, and so improve security.

Figure 2. Robotic welding station for welding 2nd booms. Consumable OK Tubrod 14.11-1.2mm from MarathonPac. Manipulator robot ABB IRB 7600 and welding robot ABB IRB 1400B.

Green light for cored wire

The tests in the Process Centre - witnessed by HIAB welding staff - gave positive results for all components. Optimal parameters were selected and programs were written for the robotic welding of the individual components. Weld appearance, tie-in and weld penetration fully met HIAB's quality standards. The start behaviour of OK Tubrod 14.11 was good. The arc establishes faster and with less spatter than experienced in production with solid MAG wire.

Gaining a higher welding productivity had been the most important aspect from the onset. HIAB staff and managers were pleased to see that the change from solid wire to OK Tubrod 14.11 ø 1.4mm resulted in a substantial reduction of the cycle time for welding first booms. In a later stage of the project, after implementing the cored wire fully into production, HIAB quantified this improvement to be 20-40%, depending on the component.

Figure 3. OK Tubrod 14.11-1.2mm applied for welding loader bodies with limitations to the amount of weld metal deposited. A mix of small fillet welds and circular welds.

Figure 4. Manual welding of crucial safety components in the crane base with OK Tubrod 14.11-1.4mm. These welds need to have a full penetration and a perfect tie-in to provide high fatigue resistance. This joint is 100% US and X-Ray tested.

Implementation

During the early stages of the project, ESAB dedicated one of its robotic welding specialists to support HIAB in implementing OK Tubrod 14.11 ø 1.4mm into production and train the operators. The focus of the first visit, in April 2004, was to find optimal parameters for welding loader bodies and program the new ABB IRB 2000 robot. Programs were devised for a variety of loader bodies with fillet weld sizes ranging from a-3 to a-7 at travel speeds of 120 to 42 cm/min - in 92%Ar/8%CO_2 shielding gas.

During the second and third visits in May 2005, operators for new robot stations were trained and all robotic cored wire welding was reviewed to see if welding parameters could be further optimised to increase the welding speed. However, most of the parameter settings appeared to be good, needing minimal changes for optimisation.

It's all robots today

HIAB AB reached its target of robotising 70% of all welding within a period of three years and, with 9 robots in operation today, the level has exceeded 80%.
In addition, much attention was given to the organisation of an efficient internal work-flow, to get the most out of the productive robot stations. Systems are in place to provide the flexibility needed to produce the wide product portfolio. Components for a great variety of truck-mounted cranes are recognised by the welding robots through bar codes or optical scanning and welded with the correct program.
ESAB's OK Tubrod 14.11 ø 1.4 metal-cored wire is now universally applied and fed to the robots from Marathon Pac bulk drums. Components with joint types that can only accommodate a limited amount of weld metal are welded with 1.2mm diameter wire.

Everyone of HIAB's welding staff is pleased with the performance of the cored wire - giving consistent feeding, minimal spatter and, above all, high deposition rate. They report lower cycle times (20-40%), and less post weld work (30-40%).

Unit production savings

One component, for example, needed to be produced in a quantity of 8800 pieces per year. In the previous set-up with solid wire, it was not possible to produce these within two-shifts. This meant some 400 extra hours overtime were needed each year, requiring the purchase of an extra robot to solve this bottle-neck.

With OK Tubrod 14.11 ø 1.4mm the cycle time went down from 12 minutes to 8 minutes and it became possible to produce the required quantity within standard two-shift production and without having to invest in a new robot and without dedicating any floor space.

Figure 5. Straight welds or circular welds – OK Tubrod 14.11 is flexible and delivers a good weld appearance.

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MARATH
PAC

ABB robotics partners team-up for Nefaz

Andon and ESAB provide complete robotic welding solution for dump truck walls.

Philip Holst, Andon Automation, Örebro Sweden and **Alex Jiroflé,** ESAB Holdings Ltd., London, UK.

Russian automotive company Nefaz, a manufacturer of buses, tanks for tank trucks and a supplier to KAMAZ trucks, is implementing a strategy for the automation and robotisation of their, mainly, manually welded production. As a first step, robot integrator Andon Automation provided six gantries, each having two suspended robots, equipped with ESAB's W8 Robot Package – a welding solution specially developed for ABB's IRB 1600, 1600ID and IRB 2400L industrial welding robots. Andon was responsible for the full project – from design through installation to start-up.

Figure 1. The KAMAZ 6520 dumpster truck. Note the lateral wall with reinforcements for which the robotic welding stations have been designed.

Andon Automation

Andon is an independent robot integrator and strategic partner with ABB for robot based automation. The company has its roots in ABB and, earlier, in the robotics division of ESAB. It develops total robotic solutions - outside ABB's standard portfolio - for the global market. Since the beginning of 2004, Andon has supplied 130 systems to 105 customers in 19 countries - some 60% being exported outside their Swedish home market.

Many were turnkey projects involving planning, design, build/delivery and production start-up.

25,000 dump truck containers a year

Contact between Nefaz and Andon was established through EuroTechProm, a Russian confirming house with its head office in Hamburg, following a lead from ABB Germany which recognised the need for a specialised robot integrator and business partner. Nefaz' objective was as straightforward as challenging: "we want to increase our output to 25,000 dump truck containers a year".

The company is located in Neftekamsk, some 200km from the Kazachstan border, and employs

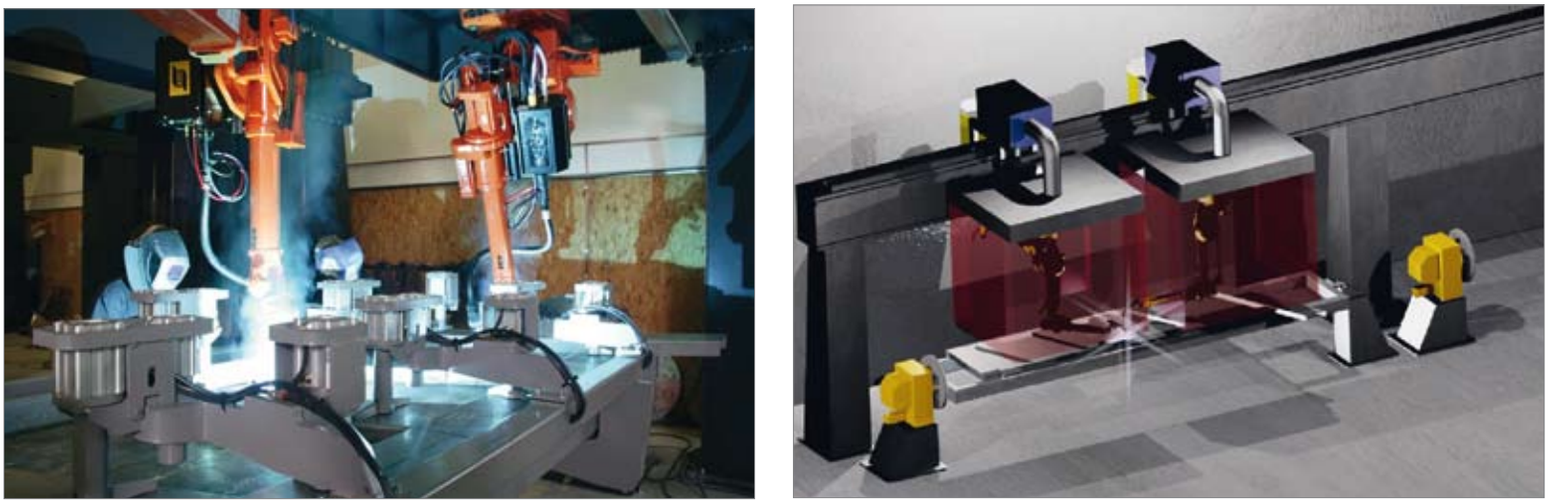

Figure 2. One side of a gantry welding station during test welding at Andon. The complete station consists of two welding tables with fixtures, one gantry, two suspended IRB2400L ABB robots equipped with the ESAB W8 Robot package, including two Marathon Pac bulk drums with 250 kg of OK Autrod 12.51 MAG wire.

around 2000 welders in its 11,000 workforce. It drastically needs to step-up production to meet the explosive growth demand of their most important client, truck producer KAMAZ.

Nefaz manufactures the walls - two lateral and one rear – and mounts them on three different types of KAMAZ trucks (Figure 1).
The reinforcements on the lateral walls are similar to troughs used to reinforce bridges and are fillet welded onto the wall - with the astonishing total weld length being 1709 km per year.

Nefaz had in mind the following objectives for this project:
- To ensure output of 25,000 containers a year
- To introduce robotic production welding
- To improve production standards
- To obtain a consistently high weld quality
- To reduce the number of welders working in harmful conditions

This is a great challenge for a company not familiar with automated and robotic welding and they quickly recognised that the right partners would be crucial to the success of the project.

Six robot stations can do the job
Andon did not have to begin from scratch. Nefaz management and commercial partner, EuroTechProm, provided full information and ideas for production automation - which was particularly helpful in the initial stages of the project. Following various detailed discussions in both Örebro, Sweden, and on site in Neftekamsk, Andon's wide experience in automation, and capability to think outside the existing production situation, resulted in a solution based on six gantry stations, each equipped with two suspended ABB IRB2400L robots (Figure 2).

Each station consists of two tables: one for tacking/welding and one for unloading/loading. When ready, the gantry with the two robots moves to the other table to start tacking and welding the next container wall, while the completed container wall is being unloaded and new components are loaded.

The robotic production lay-out is designed for optimal work flow. Components for the lateral and rear walls are lifted by crane to their corresponding locations in the aisle of the hall, while completed walls are unloaded to the perimeter of the fabrication area for transportation.

System details
Robots are of the 6-axis ABB IRB2400l type; one of the world's most popular industrial welding robots. By suspending them in a portal a 7th axis is created. The IRB2400l robot is specifically developed to optimise the efficiency of robotic welding. Its form, arm length and movement pattern are completely dedicated to arc welding with 1.8m reach and 7kg load capacity. It offers increased production rates, reduced lead times and long intervals between maintenance.

The robots are equipped with ESAB's W8 Robot package which is described in detail on page 25 of this issue of Svetsaren. This is an integrated solution for ABB robots. It uses an adapted version of ESAB's Aristo Mig 5000i power source with the latest IGBT inverter technology (photo page 25). It communicates (CAN bus) with ABB's IRC5 robot control unit through the W8 interface which is mounted on the back of the power source and is connected to the robot's cabinet by the W8 connection cable. The system has the advantage of using a minimum amount of cables, which increases operational reliability. All programming is via the IRC5 control unit (Figure 3).

Other components of the W8 Robot package are the Aristo™ Robofeed 3004w ELP wire feeder and the Marathon Pac™ bulk wire drum. The wire feeder is an encapsulated type with windows for

Figure 3. All programming, both for the robot and the welding equipment, is done with the IRC5 control unit.

visual inspection of the feeding mechanism. It has the ELP (ESAB Logic Pump) switch that ensures water-cooling is only provided when a water-cooled torch is connected.

The Marathon Pac bulk drum provides an uninterrupted supply of 250 or 475kg of welding wire for minimal downtime for wire renewal. The endless Marathon Pac system is an option for zero downtime. For the Nefaz installation, Andon has opted for the 250kg version, placed on platforms on the gantry, see photo page 20. The welding wire is 1.2mm OK Autrod 12.51.

The welding system has a number of advanced accessories; the SmarTac seam finding sensor, the Advanced Weld Controller (AWC) for seam following and a torch service centre.

SmarTac (Figure 4) is a flexible, versatile system that searches for and locates weld positions to adapt the programmed path of the robot to correct for any misalignment of the workpiece. It energises the gas nozzle with an electric charge when in the search mode. When the nozzle and the workpiece make contact, it sends a stop signal to the robot's control system. After comparing the actual position of the workpiece with the programmed position, the welding program is adapted to the actual position. With SmarTac, quality problems due to misalignment are largely avoided. Since SmarTac is based on electrical contact between nozzle and workpiece, it can only be used for unpainted, conductive materials.

AWC is a combined process controller and "through the arc" joint tracking system integrated in the robot's controller (Figure 5). It is designed to track welding joint variations and monitors and controls tracking, weld movement and the welding process. AWC follows weld joints by sampling the welding current and voltage signals synchronised with the robot weave pattern and provides vertical and horizontal correction signals

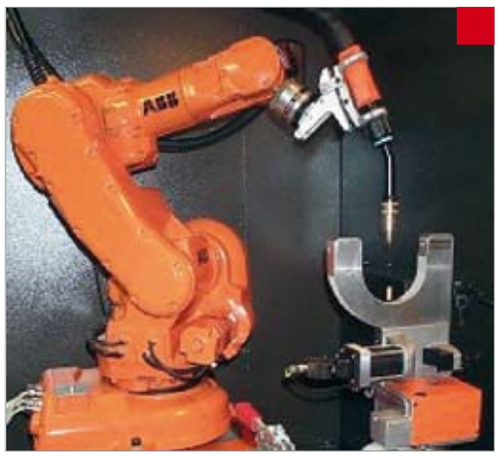

Figure 6. The ABB Torch Service Centre

to the robot controller to ensure a consistent fill of the weld joint.
The Torch Service Centre (Figure 6) has three different functions built into one unit:

- The torch cleaner is an integrated system for the mechanical removal of spatter that is fully controlled by the robot control unit to make sure the cleaning won't start until the torch is

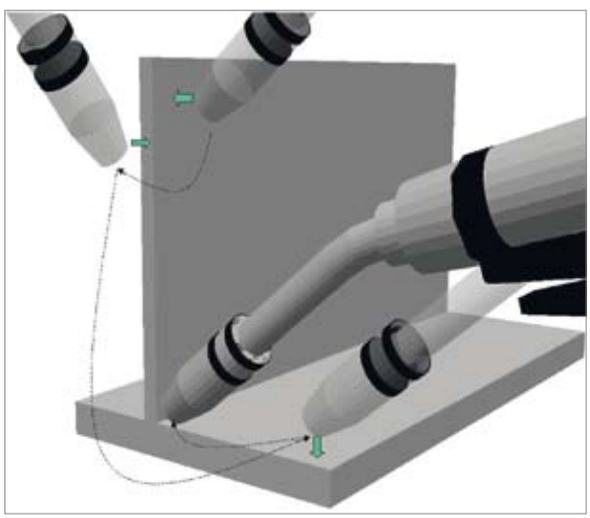

Figure 4. The SmarTac seam finder corrects for any misallignment of the workpiece.

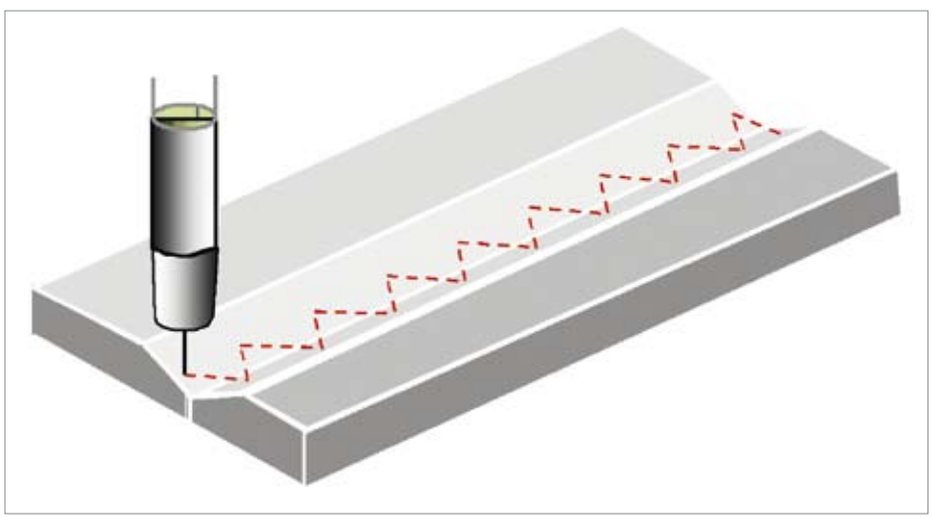

Figure 5. AWC; a combined process controller and joint tracking system.

securely clamped, and to avoid accidental starts and associated risks for the operator.
- The wire cutter provides constant wire stick-out for good arc striking and avoidance of oxide inclusions in weld starts.

- The BullsEye is a tool used for the automatic checking of the Tool Centre Point (TCP). Regular TCP checking is needed because the torch may be out of position due to:
  - a robot crash caused by improper programming
  - the robot hitting a fixture clamp left in the wrong position
  - changes in ambient temperature, eg, morning vs afternoon
  - a worn contact tip that causes mis-positioning of the weld

Each time the robot goes to the BullsEye, quality production will continue if the TCP is within the pre-defined tolerances. Otherwise, BullsEye will stop the robot and inform the operator.
The stationary gantry, welding tables and fixtures, are all designed by Andon.

Nefaz actively involved
This type of project requires intensive co-operation between the robot integrator and the customer to make sure the design is based on the right data and meets the objectives. Nefaz was involved throughout the project. They provided full data for Andon to create the correct design and calculate the number of stations needed. This was then confirmed by the welding productivity data based on samples of lateral and rear walls sent to Sweden for testing.
They calculated if there was enough time – within a welding cycle – to unload the welded truck wall from the table and to load new components plus the quantity of workers needed to do this. Nefaz also calculated the shielding gas consumption and organised the logistics and prepared the electricity supply for the stations.

Nefaz production management was present in Sweden during the test welding and supervised the programming of the welding sequence on production samples carried out by an ESAB robotic welding specialist.

A very important aspect of the project was the three week “train the trainers” course organised by Andon for station operators, in Sweden. They received basic technical system knowledge and were trained to program the robots – preparing them to be the teachers in the factory.

Installation, start-up and service
Installation was carried out in three steps, two gantries at a time, in order to get production started as soon as possible. Technicians from Andon, with assistance from Nefaz-personnel, installed the systems in an already prepared part of the factory. By the time that the last two were being installed, Nefaz already had production up and running in the first two - a big step towards the production goal of 25,000 containers a year.

The rate at which Nefaz learned to program and use the system is testament to the expertise level of the technicians, as well as the ease of use of the interface in the ABB-control with the power source integrated. Since both ABB and ESAB have service organisations in Russia, Nefaz need have no worries about the availability of spare parts and support of qualified personal, if needed.

Close cooperation between Nefaz and Andon has resulted in a highly productive system, based upon high quality products and support from ESAB and ABB. With the management vision at Nefaz, and the immense potential in the production facilities, all signs indicate that more robots will soon be implemented.

About the author:

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Figure 7. The six welding stations installed at Nefaz.

The ultimate welding robot with superior welding technology

Alex Jiroflé, ESAB Holdings Ltd, London, UK.

ABB and ESAB, have joined forces to create the ultimate arc welding robot - designed for 'plug and play' within half a day.

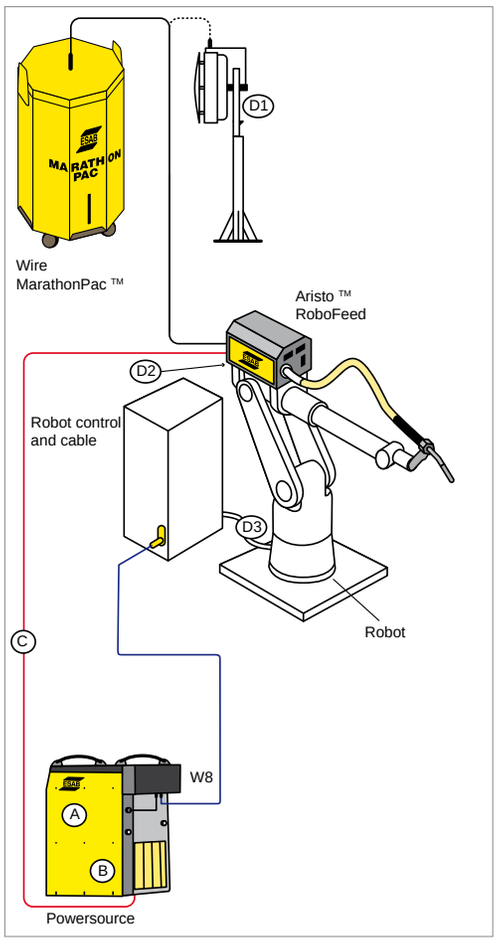

Figure 1. The ESAB W8 Robot package.

Combining the best of each partner's expertise in welding and automation, the new, comprehensive package includes ABB's versatile, high performance IRB1600, IRB1600ID or IRB2400L robots, ESAB's Aristo W8 robot package and the client's preferred choice of torches. The robots are available direct from ABB's factory in Västerås, Sweden, and are ideal for the welding of carbon steel, stainless steel and aluminium.

Figure 2. The Aristo™Mig U5000iw.

The robots feature ESAB's Aristo W8 robot package - a complete set of welding equipment and consumables, based on ESAB's latest digital power source technology. The package consists of:

- The Aristo™Mig U5000iw inverter.
- The Aristo W8 interface which communicates with ABB's IRC5 robot control unit.
- The Robofeed 3004w ELP encapsulated wire feeder.
- Cable packages.
- The Marathon Pac bulk drum with robot quality welding wire and separate bobbin holder.

The Aristo™Mig 5000iw inverter.

This inverter represents ESAB's latest generation of digital power sources with up to 500A/39V at 60% duty cycle, designed specifically for robotic MIG/MAG welding in metal fabrication industries. It supports a variety of arc-welding capabilities, including robotic short arc, spray arc, pulsed arc, high speed welding (rapid arc) and the unique SuperPulse™ technology. The power sources are compact and sturdy, based on inverter Insulated Gate Bipolar Transistor (IGBT) technology and an advanced process regulator. Combined, these offer reliability with outstanding welding characteristics, providing excellent control with a minimum of spatter - even at high welding speeds.

It is an easy to use power source with the user-friendly control facilities built-into the ABB's IRC5 robot control unit, communication with the robot cabinet being through the W8 interface on the back of the power source and the W8 connection cable (CAN Bus/Device Net).

It features the full library of ESAB synergic lines for un/low-alloyed steel, stainless steel, aluminium and MAG -brazing and, in addition, the ABB synergic lines developed for thin-plate welding. This is important for both new robots and retrofitting because the same synergic lines can be used.

The Aristo™Mig U5000iw is a multi-process power source which can also be used for manual welding, eg, tack welding, TIG dressing and gauging. A reserve power source, used for

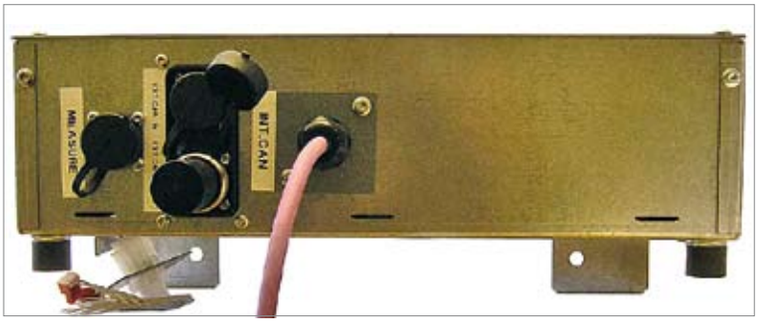

Figure 3. W8 interface on back side of powersource.

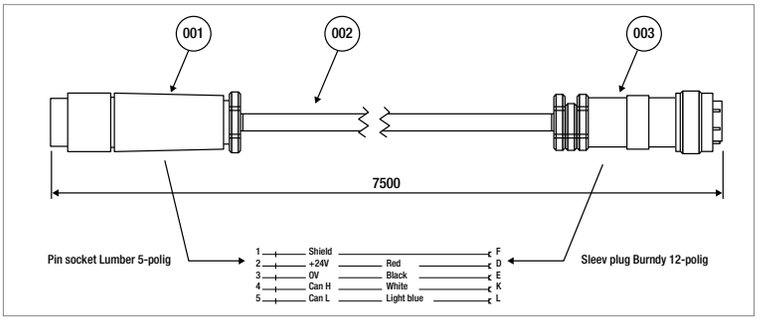

Figure 4. W8 connection cable to IRC5 robot cabinet.

manual welding, is optional for robot installations.

The Robofeed 3004w ELP encapsulated wire feeder

This encapsulated, robot mounted wire feeder is 4-wheel driven. The digitally controlled, twin-motor feed unit provides accurate speed control by using a pulse encoder in the range from 0.8 to 25m/min. It is available with Ø30mm rollers for wires up to Ø1.6mm. It has all important functions for robotic welding such as manual forward and reverse inching, shielding and cleaning gas purge, gas sensor, air test and anti-collision detection, which are accessible through the IRC5 control unit via Can bus communication. ESAB's TrueArc-Voltage™ system is built-in for continuous measurement of the arc length. Windows in the casing allow visual inspection of the feeding mechanism without having to open the feeder.

The wire feeder is easy to connect/disconnect by using quick connectors for gas, liquid, control signals and welding current, as well as a Euro connector for the welding torch and a quick connector for Marathon Pac.

The Robofeed 3004w ELP features the ELP (ESAB Logic Pump) switch that ensures water-cooling is only provided when a water-cooled torch is connected.

The units are equipped with mounting bolts with rubber absorbers to protect the components from the robot's high acceleration and retardation forces. Standard and custom mounting plates are available. Robofeed 3004w ELP features:

- Gas test (also from robot and U8)
- Reverse wire (also from robot and U8).
- Inching (also from robot and U8).
- Outlets for watercooling and air cleaning.
- Lamp shows 42V power is on.

Remote Outlet for:

- Gas test, reverse wire, inching from the torch.
- Push-Pull.
- Connection of the anti-collision signal.

Cable packages

Cable packages connecting the Aristo Mig 5000iw power source to the Robofeed 3004w ELP wire feeder are available in 7.5m and 10m lengths for the ABB IRB 1600, IRB 1600 ID and IRB 2400L welding robots. Other lengths are available on request.

MarathonPac

The ESAB Marathon Pac family offers a choice of three drum sizes for a variety of wire types - including robotic quality wires such as OK AristoRod, Matt Stainless types and OK Tubrod 14.11 –1.2mm - all of which can be incorporated in the W8 robot package. Marathon Pac minimises downtime for wire renewal. There is, in addition, an endless version which completely eliminates downtime for wire changing. With Endless Marathon Pac, a new drum is connected to the one in use, while the robot continues to weld.

Marathon Pac provides trouble-free, low-force wire feeding, allowing the use of a lightweight wire feeder and reducing wear on both the feeder and the robot.

The Marathon Pac™ family – wire grades and filling content.

W x H	Standard Marathon Pac 513 x 830 mm	Jumbo Marathon Pac 595 x 935 mm	Mini Marathon Pac 513 x 500 mm	Endless Marathon Pac 2 x standard or jumbo
Non- and low-alloyed steel				
Solid wires	250 kg	475 kg		2 x 250 kg
	(Ø 0.8 mm: 200 kg)	(min Ø 1.0 mm)		2 x 475 kg
Cored wires	Depending on type			
SAW wires		Ø 1.6 mm: 475 kg		
		Ø 2.0 mm: 450 kg		
Stainless steel				
Solid wires	250 kg	475 kg	100 kg	2 x 250 kg
	(Ø 0.8 mm: 200 kg)	(min Ø 1.0 mm)		2 x 475 kg
Cored wires	Depending on type			
Aluminium				
Solid wires		141 kg		
Copper-based				
MIG-brazing wires	200 kg			

Improving fatigue life with Low Temperature Transformation (LTT) welding consumables

Leif Karlsson, ESAB AB, Gothenburg, Sweden

As a method of increasing fatigue life, the use of Low Temperature Transformation (LTT) welding consumables has been proven theoretically and in laboratory tests. However, the step from laboratory to real fatigue loaded construction has still to be taken to make the LTT-approach successful. This article discusses the technical philosophy behind LTT-consumables.

Fatigue cracks often initiate at welds as a consequence of large residual stresses and changes in geometry acting as stress concentrators. Typically, the weld root (Figure 1) and the weld toe are critical points. A promising concept in improving welded component fatigue life is the use of so called LTT welding consumables. These modify the residual stresses at welds and can even replace the large tensile stresses normally found with compressive stresses. Some aspects of welded component fatigue are discussed in this paper and the concept of LTT-consumables is introduced using results from earlier and ongoing studies.

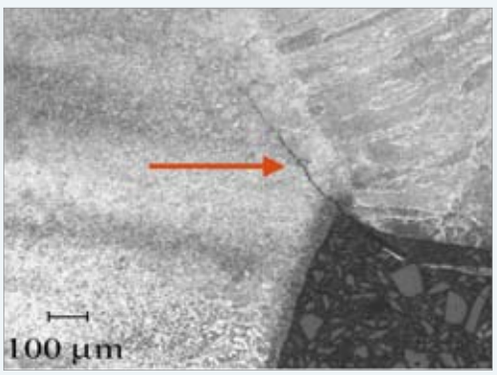

Figure 1. Fatigue crack growing from a weld root.

Why higher strength doesn't increase fatigue life?

Using high strength steels and corresponding high strength welding consumables would seem the obvious and simple answer to demands on decreased energy consumption and increased load-bearing capacity of vehicles. This, unfortunately, is only partly true since strength in itself is only one parameter that needs to be taken into account in designing fatigue loaded constructions. Most of a welded component's fatigue life is usually spent in propagating a crack. Since the crack propagation rate is determined by the elastic behaviour of the steel, which is similar for steels of various strength levels, strength will have little effect on fatigue life. As illustrated in Figure 2, fatigue strength of an unwelded component will increase with strength but will remain more or less constant for a welded item.

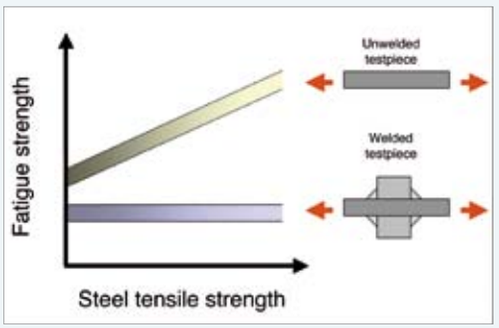

Figure 2. Effect of tensile strength on unwelded and welded component life.

Improvement of fatigue life

Apart from obvious factors such as cracks, lack of fusion or other weld imperfections, there are basically two main reasons for the deleterious effect of welds on fatigue properties. Firstly, a weld inevitably introduces a change in geometry and, consequently, a stress concentration, typically at the root or the weld toe. The sharper the transition between the weld and the parent material, the higher the stress concentration will be and thus the greater the effect on fatigue life. The weld profile can be improved by, for example, TIG-dressing or grinding to reduce the stress

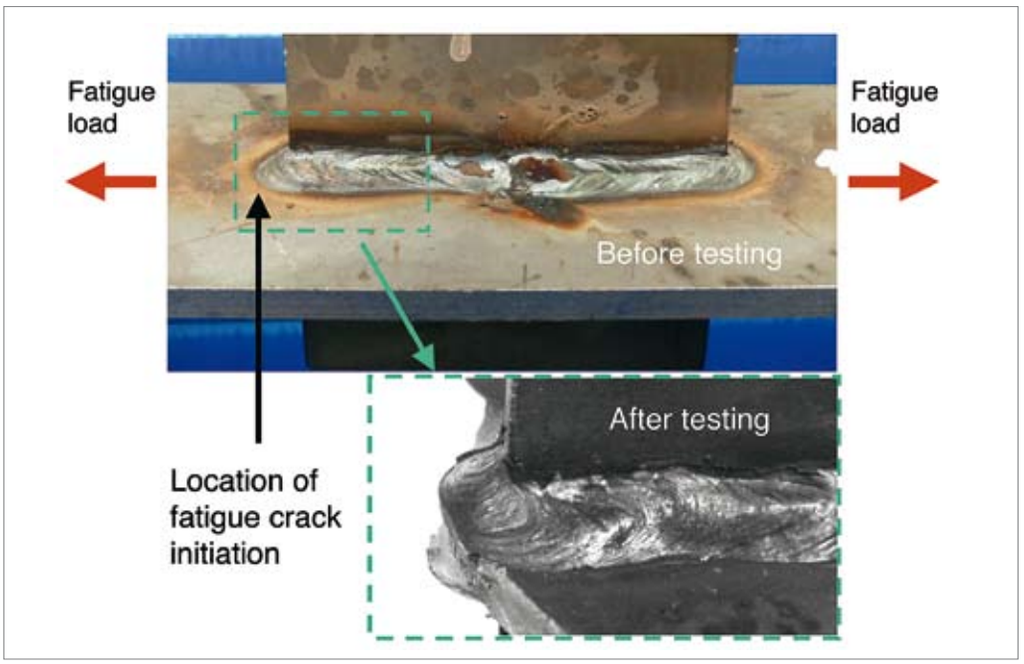

Figure 3. Example of fatigue test specimen with fillet welds. When fatigue load is applied in the longitudinal direction (arrows) fracture is commonly found to initiate at the fillet weld toe The enlargement shows one half of the separated test specimen.

concentration factor. However, in fillet welds, particularly, it is not possible to completely eliminate the geometrical effect of a weld. An example of a fatigue test specimen showing crack initiation and failure at the fillet weld toe is shown in Figure 3.

Secondly, welds contribute to shortened fatigue life because welding introduces tensile residual stresses. This is a consequence of shrinkage during cool down from the liquid state to room temperature. These stresses are significant and often of the order of the yield strength. The conventional way of coping with high weld residual stresses is to reduce design stresses, or to conduct a post-weld heat treatment to relieve the residual stresses. Another approach is to introduce surface compressive stresses by locally deforming the surface by, for example, shot- or hammer-peening. Stresses can also be redistributed by plastic deformation, ie, overloading a construction. All these techniques are efficient in increasing fatigue life but require additional work after welding.

Effect of stress distribution

Redistribution of stresses by plastic deformation has its limitation in practice, as many constructions are not easily deformed in a well-controlled manner. However, the technique is well-suited for studies of the influence of stress distribution at welds, since the welding procedure and, thereby, weld metal composition, structure and properties, can be kept constant.

The example below, from an ongoing ESAB-study, illustrates that there is ample scope for improvement of fatigue life of welds by reduction of residual stresses. An 800 MPa yield strength parent material was welded with slightly undermatching consumables to produce fatigue test specimens (Figure 3). One set of specimens was fatigue-tested in the as-welded condition and one set after straining. Plastic deformation was controlled to about 0.2% at the weld toe to avoid significantly affecting mechanical properties.

Residual stresses of as-welded and pre-stressed specimens were measured 2.5 mm below the plate surface along the specimen centre-line using neutron diffraction (1). As seen in Figure 4, longitudinal stresses changed significantly and decreased with up to 600 MPa in the region around the weld toe. The same trend was found for the other stress components although not quite to the same extent.

The effect on fatigue properties of modifying the stress distribution was striking. As seen in Figure 5, fatigue strength increased significantly and the effect was larger for lower loads. For example, at

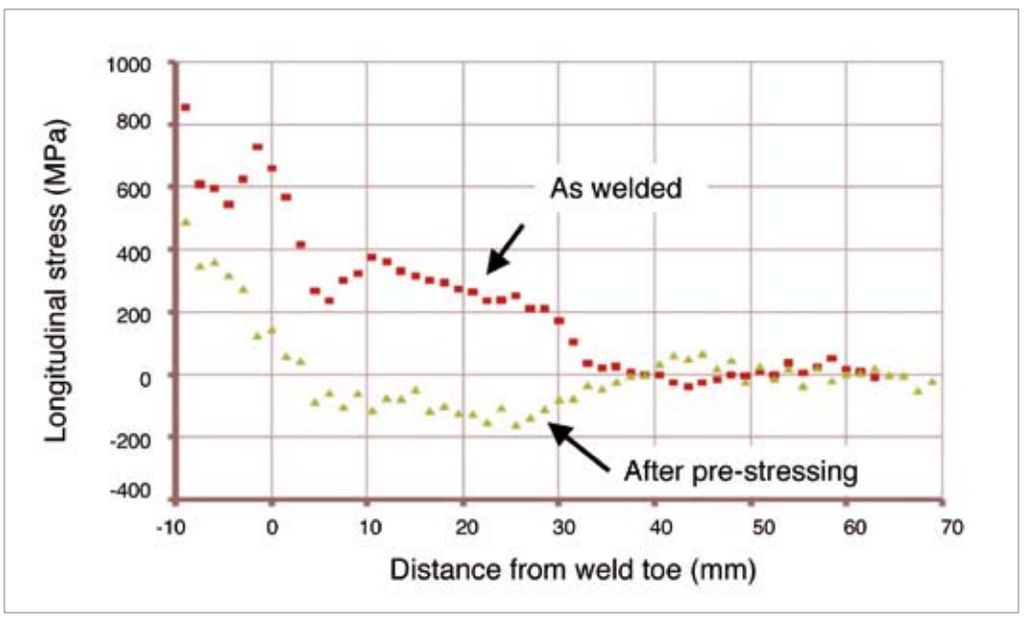

Figure 4. Comparison of residual longitudinal stresses at fillet weld in as-welded condition and after pre-stressing causing a local plastic deformation of approximately 0.2% near the weld toe.

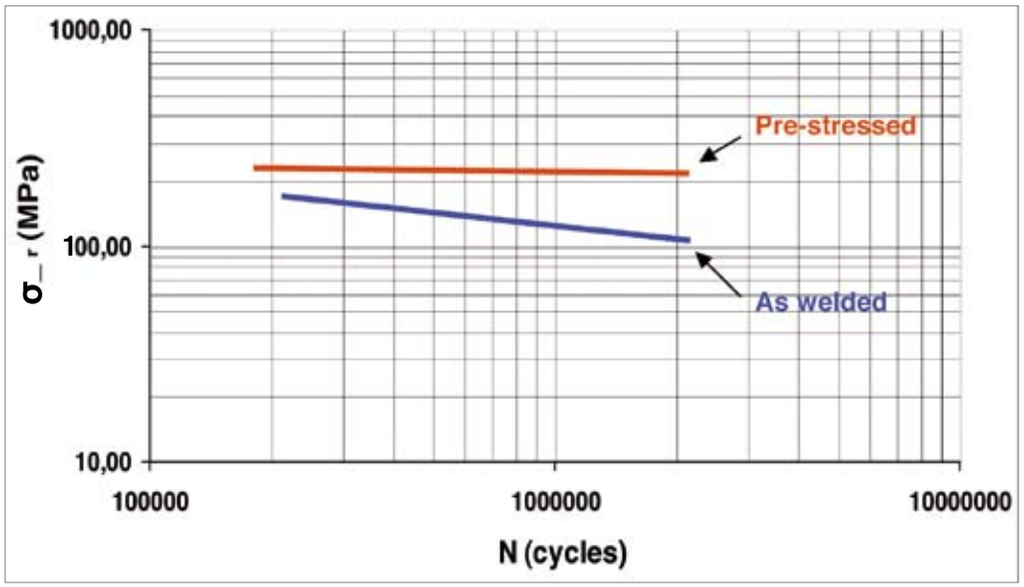

Figure 5. Effect on fatigue life of modification of residual stresses by pre-stressing. Specimens were loaded axially in pulsating tension with stress ratio R=0.1.

2,000,000 cycles fatigue strength was approximately doubled.

Low Temperature Transformation (LTT) consumables

Welding introduces tensile residual stresses as a consequence of shrinkage during cool down from the liquid state to room temperature. These stresses are significant and often of the order of the yield strength. The shrinkage is to some extent compensated by a volume expansion as austenite transforms into ferrite, bainite or martensite. However, typical steel welding consumable compositions have transformation temperatures around 400-600ºC. As a consequence of further shrinkage on cooling to room temperature the net effect is a contraction resulting in significant tensile stresses.

LTT welding consumables are formulated to have a composition giving a much lower transformation temperature. Typically the aim is to produce mainly martensite with a Ms temperature in the range of about 150-250ºC. The lower transformation temperature combines three effects to be beneficial in reducing the final residual stress level (2).

1) Since the thermal expansion coefficient of austenite is greater than that of ferrite, the volume expansion due to transformation is larger at lower temperatures, allowing a greater compensation of the accumulated thermal contraction strain.
2) If transformation is completed much before ambient temperature is reached, then it is the ferrite that contracts on cooling. Ferrite has higher yield strength than austenite (at low temperature) and hence there is a lesser compensation of contraction strain by plastic relaxation.
3) When transformation occurs at low temperatures there is a greater accumulation of stress before the low transformation temperature is reached. This leads to a greater bias in the microstructure in constrained specimens, making the shear strain more effective in counteracting thermal contraction.

Several alloying concepts using various combinations of, mainly, Ni, Cr and Mn, producing a low Ms temperature have been suggested and tried in the last decade (3-10). Fatigue testing has shown very promising results with increase in fatigue life, often of 25 times or more, and increased fatigue strengths of 50% or more.

An example is presented in Figure 6 giving some results from reference 5. In this study, specimens for fatigue testing were out-of-plane gusset fillet welded joints in 7 mm thick 700 MPa yield

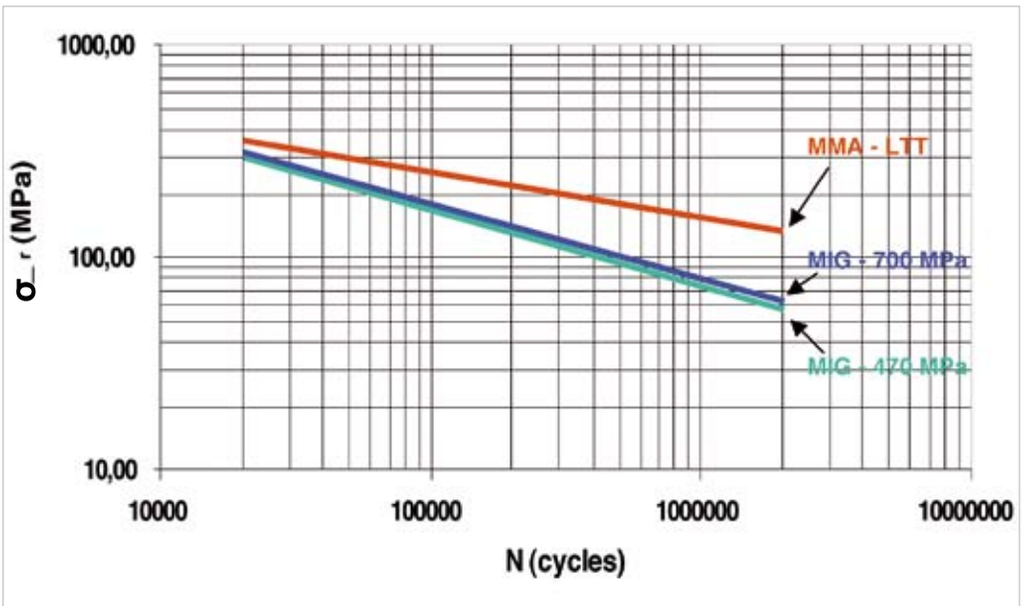

Figure 6. Fatigue life of a 700 MPa yield strength steel welded with undermatching and matching strength consumables and matching strength LTT consumables (see reference 5 for details).

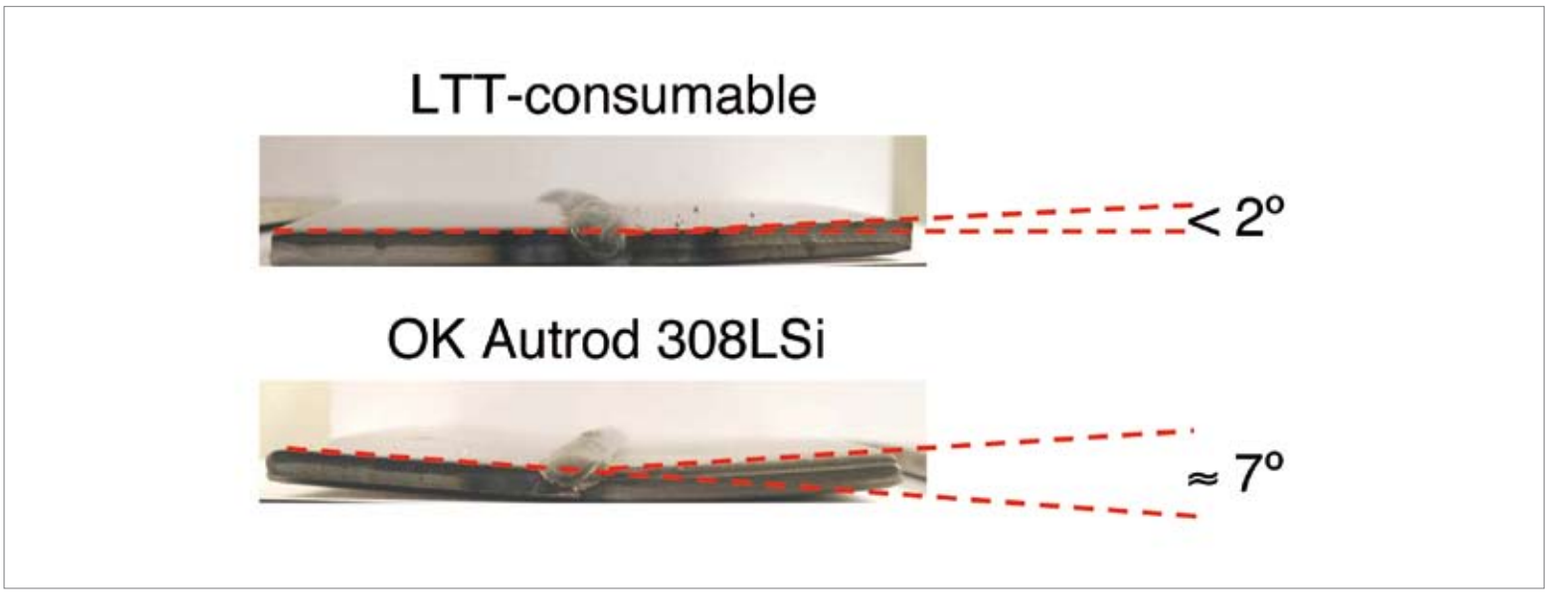

Figure 7. Deformation of unrestrained mild steel plates (200x50x6 mm) joined with a single pass weld in a square butt joint using two types of consumables.

strength plate material (see Figure 3 for geometry). Specimens were welded with conventional matching and undermatching strength consumables and with matching strength LTT-consumables with a composition of 12.5Cr 6.5Ni 2.5Mo. Testing was done with axial loading in pulsating tension with stress ratio R=0. Waveform was sinusoidal and the frequency varied between 5 and 10 Hz depending on load level. About 10 specimens were tested for each type of welding consumable.

The results confirm both that consumable strength in itself has no effect on fatigue properties and that the LTT-effect can be significant.

Deformation

Another practical aspect, rarely discussed in connection with LTT consumables, is welding induced deformation. Deformation can be a major concern causing problems with fit-up and requiring additional work to straighten components. As shrinkage is the reason for deformation, LTT consumables can be used to counteract this. Figure 7 gives a simple example for two unrestrained mild steel plates (200x50x6 mm) joined with a single pass weld in a square butt joint. Even though a stainless 308 type consumable would not normally be used for welding mild steel, it serves the purpose of illustrating how the choice of consumable can have a large effect on welding induced deformation.

Concluding remarks

Some questions still remain before it can be concluded whether the use of LTT-consumables is a practical method of increasing fatigue strength and minimising welding induced deformation. Effects of multi-pass welding, dilution with parent material and spectrum loads on resulting fatigue properties, needs to be studied further. It also remains to define suitable LTT-alloys that, not only modify the stress distribution, but also provide required static strength and useful impact toughness.
Hot cracking could potentially be an issue when using primarily Ni as an alloying element to suppress Ms as this will shift the weld metal into austenitic solidification. Other alloying concepts might, therefore, be safer from the practical point of view.

Nevertheless, LTT-consumables show promise as an important method for reducing the risk of welded component fatigue failure. Compared to most other techniques, it has the advantages of being a “one-shot” method, ie, no further treatment is required after welding. As a bonus, it reduces deformation and decreases the risk of cold cracking (11). This, therefore, is not only a time and cost saving approach, it is also particularly attractive when other techniques such as PWHT or shot peening are not feasible, as is often the case in field repair welding.

A valid objection against LTT consumables is that the effect will decrease or disappear if the construction is subjected to an overload causing plastic deformation and redistribution of stresses. However, this holds equally well for other techniques used to introduce compressive surface stresses and is a common problem, rather than specific to the LTT-concept.

In conclusion, the potential of the LTT-approach as a method of increasing fatigue life has been proven theoretically and in laboratory tests. However, to make it a success story, it still remains to take the step from laboratory tests to real life applications in fatigue loaded constructions.

Acknowledgement
The author wishes to thank Dr L. Mraz (VUZ Welding Research Institute – Industrial Institute of Slovak Republic), Professor H. K.D.H. Bhadeshia (Cambridge University, England), J. Eckerlid and T. Nilsson (SSAB Tunnplåt AB, Sweden) and Eva-Lena Bergquist (ESAB AB, Sweden) for comments, stimulating co-operation and providing some of the figures.

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OK Tubrod 14.11 1.2mm

Metal cored wire for high speed thin plate welding applications

Frank Tessin, ESAB GmbH, Solingen, Germany.

In Svetsaren 1/2008, page 70, we introduced OK Tubrod 14.11 diameter 1.2mm – a new metal-cored wire for high speed thin plate welding applications, which provides full information on product data and welding performance. The present article discusses the welding performance and economic benefits of OK Tubrod 14.11 1.2mm for robotic welding.

OK Tubrod 14.11 ø1.2mm is a new metal-cored wire for non- and low-alloyed steel which has been specially developed for the high speed welding of thin plates (1-4 mm). Treated with ESAB's revolutionary cored wire surface technology, it sets new standards in the reduction of welding costs, especially in mechanised and robotic stations.

Metal-cored wires have been available for more than twenty years, but their use in industrial applications has, so far, remained limited - the main reason being the relatively high consumables price compared with G3Si1/ ER70S-6 solid wire. Metal-cored wires will only be applied in situations where their higher weld quality and welding speed can be seen to be of benefit and can be calculated to be economical. This is the case for OK Tubrod 14.11 in many applications.

The difference in welding performance in the thin-plate area, compared to solid wire, is striking. Many applications can be welded with travel speeds above 150 cm/min, regardless of whether it is thin fillet welds (a=2-2.5 mm) or overlap joints. Here, OK Tubrod 14.11 tends to produce welds without undercut and with nice wash to the plate edges.

Low spatter

OK Tubrod 14.11 Ø1.2mm operates in the spray arc mode at a current level as low as 160A providing the widest possible envelope for low-spatter welding with a fine droplet transfer. This is a major advantage compared to Ø 1.0 and 1.2mm solid wires, which can only be used in the short arc or globular arc mode when welding thin plate.

Figure 1. Circular fillet weld. t=2mm, 280A, 22V, 150cm/min.

Faster welding

Reduction of welding time is key to lower welding costs in mechanised applications. This can be realised through higher welding speed.
With common solid wires, however, options are limited in thin-plate welding. High welding speeds are mostly achieved at the expense of weld quality and mechanical properties, which is the reason why the majority of applications are welded in the short arc or globular arc mode, at travel speeds typically below 100 cm/min.
With OK Tubrod 14.11 Ø1.2mm, however, travel speeds of 150-250 cm/min are feasible – not only for straight joints, but also for small radius circular welds.

Low-heat input welding – welding of zinc coated plate

Because of high welding speed and an extraordinarily low arc voltage, heat input into the welded part is very low. Fillet welds in 1.5mm thick plates can be welded at travel speeds of 200cm/min. or more, in PB position - at a heat input below 2 kJ/cm!

Figure 2. Weld penetration of an overlap joint in a cross support beam. t=2mm. 225A/130cm/min.min.

This makes OK Tubrod 14.11 Ø1.2mm an alternative to modern, so called ,"cold arc" welding processes in processing non- and low-alloyed steel.

These advantages also provide benefits in welding zinc-coated plate, where OK Tubrod 14.11 Ø1.2mm stands comparison with very low porosity and spatter.

Figure 3. Overlap joint in 1.2mm zinc coated plate (layer thickness < 10µm). Shielding gas: M20 (92%Ar / 8% CO_2); 240A, 21V; Vs=170cm/min.

Secure arc ignition

Short welds with many starts and stops can also be welded at a low spatter level with OK Tubrod 14.11 Ø1.2mm. A stable arc is established a split second after ignition.

Gap bridging

Very often, the limited gap-bridging capabilities of wire electrodes present a problem in spray arc welding at high travel speeds. OK Tubrod 14.11 Ø1.2mm, however, is very forgiving with respect to poor fit-up, bridging gaps even at very high travel speeds - resulting in less post weld repair work and less rejects in serial fabrication.

Easy parameter setting

Parameter setting with OK Tubrod 14.11 Ø1.2mm is uncomplicated. In the thin-plate area, the arc voltage is between 22 and 24 V – whether one welds at the lowest wire feed speed of 7m/min or the highest of 14 m/min. Parameter setting is further reduced by pre-programmed synergic lines in ESAB Aristo power sources.

Secure penetration in shielding gas mixtures

OK Tubrod 14.11 Ø1.2mm can be welded with various mixed shielding gas compositions.
The best bead appearance and spatter level are obtained in EN ISO 14175: M20 with 92% Ar and 8% CO_2, but also the standard 82%Ar/18% CO_2 (EN ISO 14175: M21) mixed gas gives good results. Weld penetration is not noticably influenced by the amount of CO_2 in the shielding gas, see Figures 4 and 5. However, the higher amount of silica islands with a higher amount of CO_2 is to be taken into account.

Numerous applications

The application of OK Tubrod 14.11 Ø1.2mm can potentially bring cost savings in any application involving mechanised or robotic welding of sheet metal up to 4 mm thickness where the welding station forms a bottleneck in production.
The cycle time for a station can be substantially reduced, due to the significantly higher welding speed. This enables a productivity increase of 20-40% and a corresponding decrease in welding cost. Applications are found in the fabrication of thin-walled components for the automotive and transport industries in general, but also in, for instance, the furniture industry.

Table 1. Typical welding parameters for overlap and fillet welds in thin plate. Shielding gas: M20 (92% Ar/8% CO_2)

Joint type	Plate thickness mm	Wfs m/min	I A	U V	Vs cm/min
Overlap weld	1.5	7.0-8.5	225-250	22.5-24	130-180
Fillet weld; a=2mm	2-3	13-14	310-340	22.5	220
Fillet weld; a=4mm	> 8	13-14	310-340	26.5	70

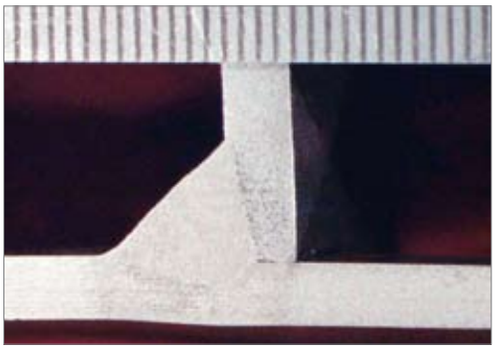

Figure 4. Weld penetration profile fillet weld. a=2 mm; t=2 mm; Vs=150cm/min. Shielding gas: 92% Ar/8% CO_2.

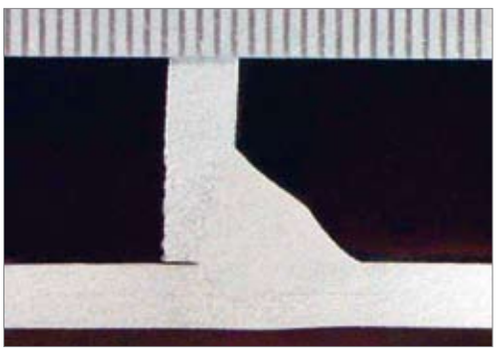

Figure 5. Weld penetration profile fillet weld. a=2mm; t=2mm; Vs=150cm/min. Shielding gas: 82% Ar/18% CO_2.

Cost calculation

As indicated earlier, the use of metal-cored wires needs to be proven to be economic in practical situations in terms of cost. The basis for this calculation is the status existing welding station data when using solid wire:

- the arc time in seconds or minutes
- the welding speed
- weld metal weight per component
- hourly rate of welding, including operator

The higher price of the metal-cored wire in Euro/kg – resulting in higher consumables costs per component – must, at least, be compensated by lower fabrication costs resulting from the reduced cycle time.

Calculation of production savings:

Δ_{PCS} = Welding station costs, including labour cost [Euro/h] X Cycle time reduction [s] / 3600

Calculation of consumables cost increase per component

The consumable cost increase, when using cored wire instead of solid wire, is around 0.002 Euro/g. Per component this amounts to:

Δ_{CCI} (1) = 0.002 Euro/g X GWM

Alternatively, the consumables cost increase per component can be calculated through the wire feed, which can be retrieved from the wire feed unit or from the welding parameter log of the power source. The effective consumable usage per component is obtained by multiplying the length of wire used per component by the specific weight of the wire (7.8 g/m for OK Tubrod 14.11). This method has the advantage that burn-off and spatter loss is also taken into account.

Δ_{CCI} (2) = 0.002 Euro/g X WFc X SWW

Calculation of welding cost savings per component.

Δ_{C} = PCS - ΔCCI(1/2)

Fabrication of axle components

The following example is based on data obtained from an automotive indudtry application. .

A robot station with a cost of 60 Euro/h, operator included, is used to weld overlap joints in 2mm plate at a travel speed of 12mm/s (72cm/min), using G3Si1 1.0mm solid wire. The total weld length per component is 2500mm. The weight of weld metal per component is 300g (weight difference welded and non-welded). The arc time is 208s (2500 mm / 12 mm/s).
With OK Tubrod 14.11 1.2mm, the travel speed increases to 25mm/s (150 cm/min) – reducing the arc time per component to 100s (2500mm / 25mm/s). Idle time (robot movements, turning of manipulators) remains the same.

The cycle time reduction due to the use of OK Tubrod 14.11 1.2mm amounts to 108s, giving a production cost reduction of:

Δ_{PCS} = 60 Euro/h X 108s / 3600 = 1.80 Euro

The consumables cost increase per component due to use of cored wire is:

Δ_{CCI} = 0.002 Euro/g X 300g = 0.60 Euro

This gives a cost saving per component of:

Δ_{C} = 1.80 – 0.60 Euro = 1.20 Euro/kg

Calculating with a total cycle time, including idle time, of 240s (solid wire) and welding costs, including consumables of 4.50 Euro/component, the above brings a saving of about 27%.

Table 2. The following symbols are used in the calculation formula:

Symbol	Unit	Explanation
Δ_{PCS}	Euro	Production cost saving per component
G_{WM}	g	Weld metal weight per component
Δ_{CCI}	Euro	Consumables cost increase per component due to use of cored wire
W_{Fc}	m	Wire feed per component
SW_{W}	g/m	Specific weight of wire
Δ_{C}	Euro	Cost saving per component

Conclusion

The example shows that productivity can be significantly increased at lower total welding costs, notwithstanding the higher consumables costs of OK Tubrod 14.11 1.2mm. Not taken into account is an extra saving on shielding gas. Although cored wires are welded with a slightly higher gas flow rate at about 15 l/min, this is more than compensated by the much shorter arc time.

The higher productivity is not the only benefit fabricators derive from OK Tubrod 14.11. Better weld quality results in additional cost advantages. ESAB offers fabricators an excellent opportunity to fullfil their needs for a more cost efficient welding solution.

Figure 6. OK Tubrod 14.11 1.2mm.

Welded Transport at Sea

The aluminium Ferries to Hokkaido

Jerry Mirgain, ESAB Global Aluminium Product Line & AlcoTec International Sales

The world's largest, most fuel-efficient, diesel powered high speed catamaran ferries - Natchan Rera and Natchan World – have recently entered service, plying the Tsugaru Straight between Honshu and Hokkaido islands, in Japan. Built half a world away, by Incat, in Hobart, Tasmania, these two aluminium vessels are affectionately known as 'hull 64' and 'hull 65'.

Acknowledgement
Thanks are extended to Mr. Robert Clifford, AO, Chairman of Incat Board, and also Mr. Maurice Harvey, R&D, Shipyard and Welding Manager for permission to take and use photographs and write this article. The photographs were taken by the author over several visits to Incat's shipyard and ships over several years. Other photographs of completed vessels in service were made available for use in this article by Incat.

The luxuriously appointed Natchan Rera and Natchan World have been custom-designed to carry up to 800 passengers per voyage, although the standard Incat 112m catamaran design can accommodate up to 1500 people and 355 cars, or 193 cars and 450 lane-metres of trucks. A 3000 tonne fast ferry of this type has the same passenger and car carrying capacity as a 10,000 tonne conventional steel vessel. The Natchan sisters' passage takes two hours - about half the time of a conventional vessel - allowing twice the number of voyages, daily.
These 'Made in Australia', 112.6m long, 30.5m "Panamax" wide, 3.9m draft vessels, are capable of weathering full sea state conditions and must, justly, be called ships. They are also amongst the largest welded aluminium constructions ever built.

Incat Australia
A visit to Incat's shipyard, today, might find them busily building 'hull 66' after earlier last year making rush delivery of Natchan World, to meet Higashi Nihon Ferry's urgent operational service requirements. That rush delivery left Incat's three-ships-long final assembly building empty for the first time since being built. Incat's first 74 metre, all-aluminium high speed 'wave piercing' catamarans, accommodated 198 dead weight tonnes. The 112 metre vessels accommodate more than 7 times that amount. From 74m to 78m, then 86m, 91m, 96m, 98m and now 112m

Figure 1. Nachan World's highly efficient wave piercing bows produce very low wake.

Figure 2. Spacious passenger areas on Nachan Rera and Nachan World.

Figure 3. Incat's genesis: the 1975 Derwent River Tasman Bridge disaster created an urgent need for Hobart ferry service.

Figure 4. Weld designs for heavy sections include milling radii to relocate welds from fillet to butt positions.

Figure 5. To match butt weld leg dimensions and facilitate even heat distribution heavier legs are tapered. Run-off tabs are used as appropriate.

designs, Incat now has 29 such vessels in service around the world, capturing an estimated 40% global market share.

Incat anticipates increasing global demand for such vessels, not only from Europe and the Atlantic but, in future also from Asia and the Pacific. A joint venture partnership exists with Bollinger Shipyards, USA, with whom Incat are presenting their specially designed vessels for possible future military logistics service.
Since its founding, in 1975, by Robert Clifford, A.O., the company has taken an interesting voyage to arrive at its current position.

- The first ferry was built to operate in the Derwent River, in Hobart, filling an urgent river crossing need after a section of the Tasman Bridge was destroyed in a shipping accident, in 1975 - virtually cutting Hobart in half. When the bridge reopened, two years later, the direction of Mr. Clifford's business changed from operating to building ferries.

- The catamaran type vessel was chosen from the outset but demands for operation on longer, open water crossings, challenged Incat to develop their wave piercing hulls.

- Incat was one of the earliest builders in the high speed ferry business to design and build all-aluminium vessels. Aluminium provides light weight without sacrificing strength.
  The exceptional dent resistance and toughness of aluminium contributed to seaworthiness and safety, while its high corrosion resistance reduced maintenance and overhaul expenses.

Incat's avant-garde ship design and building methods evolved, in-house, through repetition, monitoring, maintenance and adoption of accumulated improvements from vessel to vessel. Additionally, Incat has built symbiotic partner relationships with many of its key vendors including Pacific Industrial Supplies, ESAB and AlcoTec for supply of aluminium welding wire.

Originally, the principal material used to build Incat wave piercing vessels was aluminium base alloy 5083, which is traditionally welded with its companion welding filler material 5183. A few years ago, Incat evaluated and then adopted 5383 alloy as a replacement base material to 5083. The improved strength of this material allowed further design enhancements but placed additional weld quality, strength, and porosity control demands on the filler metal to be used. AlcoTec worked with Incat to provide a 5183 type welding wire with tighter controlled porosity limits, chemistry, and diameter than described by nominal Standards Australia or American Welding Society specifications.

In 100% radiographed welds, joints are typically designed to avoid fillets, by milling radii on heavy corner sections and butt welding. Techniques such as material tapering to match butt weld thickness and using run-off tabs, are commonly employed.

Uniform welding techniques assure uniform weld appearance and quality throughout the yard. As the business was developing, Incat worked with the state of Tasmania to establish a Technical and Further Education campus adjacent to site. Here, welders were taught the principles of aluminium

Figure 6. Mr. Maurice Harvey, Incat's welding manager, inspects hull 65 forecastle work.

Figure 7. Hull 64, Nachan Rera, clears Tasman Bridge, Hobart, bound for open sea.

Figure 8. Uniform welding techniques, throughout the yard, produce uniform weld bead appearance and uniform weld quality.

Figure 9. The 5383 base material with higher strength to weight than 5083 material, is welded with 5183 type welding wire from AlcoTec.

Figure 10. Separately mounted superstructure visible above sturdy sea frame cross bracing.

Figure 11. Rubber mounts isolate superstructure from sea frame.

Figure 12. Rigid wave piercing bows have some skin sections up to 25mm.

Figure 13. To manage propulsion nozzle flange distortion welding operations are performed before milling.

Figure 14. At the final assembly location "panamax" width hull 65 fully occupies Incat's 112m design shed height and width.

welding - alongside Incat's own company welding techniques - before being allowed to weld in the yard. Interestingly, carpenters were often the preferred choice of candidate for training as they were considered to be easier to train, correctly, rather than undertake retraining of steel welders!

Welders are the first-in-line for quality assurance control. If any operator experiences a problem or observes a possible discontinuity, they are expected to stop welding and involve yard supervision in evaluating the situation. Such methods and policies ensure Incat's cost-effective quality control and productivity.

Design features

Generally, as each vessel has slightly different topside requirements from a base vessel design, Incat produces a standard sea-frame for the main hull. This sea-frame has strength stiffness and integrity separate from the superstructure. Since it is desirable to separate passenger spaces and bridge from the machinery and dynamics of a vessel transiting the open ocean at 75km/hr, the superstructures are separate structures mounted on rubber brackets on the sea-frame.

Along with the centre forward bow, the wave piercing bows are important elements in the ship's design. The hydrodynamics and aerodynamics of these bows demand that they be particularly rigid elements. There are areas in these bows where the skin thickness is up to 25mm.

The ship's propulsion jet room assemblies are welded aluminium, as are the propulsion nozzle connecting flanges. To avoid distortion, the flanges are welded first and then milled in place.

Figure 15. Incat's final assembly building hull troughs are flooded for hull 65 to slip the shed.

The Holy Grail of Passenger Transportation

As with other forms of passenger transportation, the Holy Grail all are seeking is the right combination of safety, speed, comfort and efficiency. It seems clear that for high speed ferry design and construction, Incat may have their Holy Grail in sight. As partners, Pacific Industrial Supplies, ESAB Australia and AlcoTec Wire Corporation, are pleased to have been able to contribute to Incat's quest.

About the author:

Jerry Mirgain lived 25 years in Australia and has had a long relationship with Incat. He remains a member of the Welding Institute of Australia - Aluminium Welding Panel, and is on the editorial committee of the Australasian Welding Journal. He joined ESAB, in 1984, as Consumables Division Manager in Australia. He now resides in USA and has dual responsibility as Aluminium Global Product Line Manager for ESAB AB and as International Sales Manager for AlcoTec.


14:44
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3% more shock absorbers for PSA Peugeot Citroën

Automated production benefits from Marathon Pac

Joel Perrin, ESAB France, Paris

The UMS factory in Sochaux-Montbéliard, in the French province of Franche-Comté, produces suspension systems for Peugeot and Citroën cars. Introduction of ESAB Marathon Pac bulk wire systems has improved productivity and reduced fabrication costs.

Figure 2. Shock absorber housings with welded assembly ring.

Sochaux-Montbéliard is the cradle of Peugeot, the leading brand of PSA Peugeot Citroën – the automotive company with 14% market share in Europe and over 5% worldwide. Here, in 1810, the Peugeot brothers, descendents of a family of millers, converted a corn mill into a steel foundry to supply springs to the local clock industry. Soon the portfolio was extended with bandsaws, tools, coffee mills, frames for hoop skirts and, eventually, in 1886, the production of bicycles in the city of Montbéliard.

Figure 1. Shock absorber cross-section.

The private car venture started in 1889, when the company exhibited a steam driven three-wheeler at the Paris world exhibition. A chassis factory was built in 1912, in Mandeure, and in the same year Peugeot bought the land on which the UMS factory stands, today. Some 12,500 people are employed on the 265 hectare site. Activities are two-fold: deep-drawing, assembly and painting of chassis in one section; mechanical construction, development and testing in another section. In addition to suspension systems, the UMS factory produces some 45,000 shock absorbers a day - mainly for Peugeot Citroën cars, but also for other brands (altogether 180 models).

Automated production

Car suspension system shock absorbers - regarded as safety components - have high weld quality demands (Figures 1 and 2). The housings of the absorbers are MAG welded with 1.0mm diameter EN 440: G3Si welding wire in 82%Argon/18% CO_2 shielding gas protection.

Weld metal consumption per housing averages 6g which, at a daily production of 45,000 absorbers, equates to 270 kg. The MAG process is fully automatic, the equipment consisting of two 4-head, one 3-head, four 2-head and two 1-head installations, and a robot. In total, 22 welding heads are to be fed with welding wire.

Before the introduction of Marathon Pac, the company used wooden spools with 100kg or 200kg welding wire with a mechanical pay-off

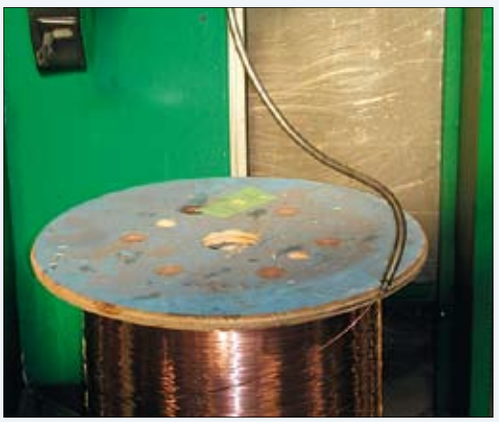


Figure 3. Wooden spool with 100 or 200kg welding wire and a mechanical pay-off system.

system (Figure 3). It involved a rather complicated method of wire feeding, consumed a lot of space and hindered operations. What's more, the dimensions of the spool remained the same - full or empty – and they needed to be transported and stored before being returned to the supplier.

The main reason for considering Marathon Pac, however, is that the welding wire from the previously used wooden spools maintains the mechanical deformation (cast & helix) it receives when it is spooled onto the spools. The result is the so called dog-tailing of the wire extension when the wire leaves the contact tip. This is a big problem in automated production with precisely pre-programmed weld paths, resulting in wrongly positioned welds and increased contact tip wear.

Towards the end of 2005, the idea emerged for a production test using one Marathon Pac drum on the SERDA 2 production line - motivated by ESAB's claim that this system overcomes the dog-tailing problem.

The Marathon Pac system

ESAB France supplied a Marathon Pac drum with 250kg of 1.0mm diameter OK Autrod 12.51 and installed it on the SERDA 2 line, to run a test until the drum was empty. Success was so overwhelming that production management immediately ran a wider test and, soon after, introduced Marathon Pac at all welding stations.

Wire in Marathon Pac is pre-twisted before being spooled into the drum, to compensate for the limited mechanical deformation it receives in the spooling process. As a result, the wire extension is virtually straight when the wire leaves the contact tip for exact positioning of the weld. This results in better weld quality and lower defect rate. It also reduces contact tip wear and the associated maintenance of the welding gun, resulting in less downtime.

No accessories are needed for the supply of the wire. The system works with the wire feed unit, which is less subject to wear because of low feeding forces.

PSA UMS Sochaux also purchased a number of Marathon Pac accessories - lifting yokes, trolleys and re-inforced liners with quick connectors - for easier internal transport, installation and reduced maintenance.

Figure 4 shows how the Marathon Pacs are positioned for a four-head welding installation (not visible). The liners are arched over the pathway and are – in this way – easily accessible for maintenance. Available in lengths from 0.6m to 12m, they are adaptable to any workshop situation. The spare drum (in the foreground) is ready to be installed when one of the four connected drums is empty.

Figure 4. Four active Marathon Pacs, and a spare supplying a four-head installation for the welding of shock absorber housings.

Figure 5. Marathon Pac connected to a robot.

OK Autrod 12.51 is a high quality copper-coated welding wire with a more stringent chemical analysis than required by the European norm G3Si. This assures consistent mechanical properties from delivery to delivery.

Increased production

PSA UMS Sochaux calculates a 3% increase in shock absorber housing production resulting from the use of Marathon Pac, compared with the wooden spools. This is due to significantly lower downtime for spool exchange and, annually, 60 hours less downtime for maintenance – a significant figure in automated mass production.

About the author:

Joel Perrin is Key Account Manager at ESAB France, Paris.

Tramtrac™ II rail repair solution for Riga's tramways

Janis Cerbulis, Rigas Satiksme, and Maris Zvirbulis, ESAB, Riga, Latvia

SIA Rigas Satiksme is a publicly owned body that operates public transport and vehicle hire in the Latvian capital Riga and its surrounding areas, which has over 700,000 inhabitants. It is the largest provider of public transport in Riga, operating buses, trolleybuses and trams. Trams are one of the city's principal modes of transport, with Rigas Satiksme operating 252 trams on 11 routes across the city with a length of 120 km. In 2010 they will start using modern, low-floor trams on one city route, for which the infrastructure is now being pre-paired.

Figure 1. Small, lightweight and portable. Tramtrac™ II applied on tram rails in the streets of Riga together with the OrigoMig™ 410 power source.

New track is embedded on noise reducing rubber pads, which also give better electro isolation and less vibration. One disadvantage with concrete embedded rails is that they are not so easily re-placed as rails embedded in cobblestones or tarmac.

In Riga, tramways last 20 to 25 years, depending on the intensity of traffic. Tramway curves wear faster than straight track because of side-wear, depending on the radius and frequency of use.

Tramtrac™ II

For Rigas Satiksme, the ESAB Tramtrac II welding tractor provides a cost-efficient solution for repairing curves embedded in either concrete or tarmac, avoiding more costly total replacement. In addition, other parts susceptible to wear, such as tram stops and switches, can be repaired efficiently with this portable system based on the FCAW process using self-shielded wires.

The FCAW process allows Tramtrac II to be small and ultra lightweight. It is easily stored and used from, for example, a pick-up truck, together with a petrol/diesel generator and welding power source. The tractor can be hand-carried and is easily installed and removed from the rail, allowing welding to take place between successive trams.

The FCAW process gives Tramtrac™ II a high deposition rate and a high duty cycle, due to quick installation and easily removed slag. Tramtrac II is operator friendly with a four-wheel drive carriage that rides the single rail, a wire feeding unit for 1.2 or 1.6mm Ø wires and adjustable traction wheels to fit most worn flanges and railheads. The control box, on top of the feeder encasement, features clearly marked symbols for wire feed speed, travel speed and

Figure 2. The curved slide on which the welding head is located enables easy and exact positioning of the wire extension.

Figure 3. Deposited weld before and after slag removal.

start and stop welding functions, as well as wire inching.

The curved slide on which the welding head is located enables easy and exact positioning of the wire extension between 0 to ± 65°, while the horizontal and vertical slides enable positioning in the x- and y-planes. Tramtrac II takes a 42V AC control voltage from an Origo™ Mig 320 or 410 power source featuring 40 voltage settings. Control and welding cables – 10 metres in length - allow the tractor to travel a distance of up to 17m when the power source is positioned close to the rail.

Consumables

The need to weld embedded grooved rails in cities makes preheating of rails impossible. With rail grades ranging from 700A (R220) to 900A (R260), consumables for difficult to weld steels are recommended with a weld deposit that can accommodate high carbon migration without cracking. ESAB OK Tubrodur 15.65 and OK Tubrodur 14.71 are two wires that have been successfully used by tramway repair contractors for many years. Once the beads have been deposited, there is no need to grind to the final profile of the rail.

Rigas Satiksme uses 1.6mm diameter OK Tubrodur 15.65 (Table 1) for the repair of the Russian T62 type tram rails, which are very common in Riga. The rutile, self-shielded cored wire has a very good weldability and excellent slag detachability.

The weld metal is austenitic-martensitic work-hardening (Figure 4), with excellent metal to metal abrasion and impact resistance.

About the author:

Maris Zvirbulis is Country Manager for ESAB in Latvia.

Janis Cerbulis is Chief Track Department at Rigas Satiksme, Riga, Latvia.

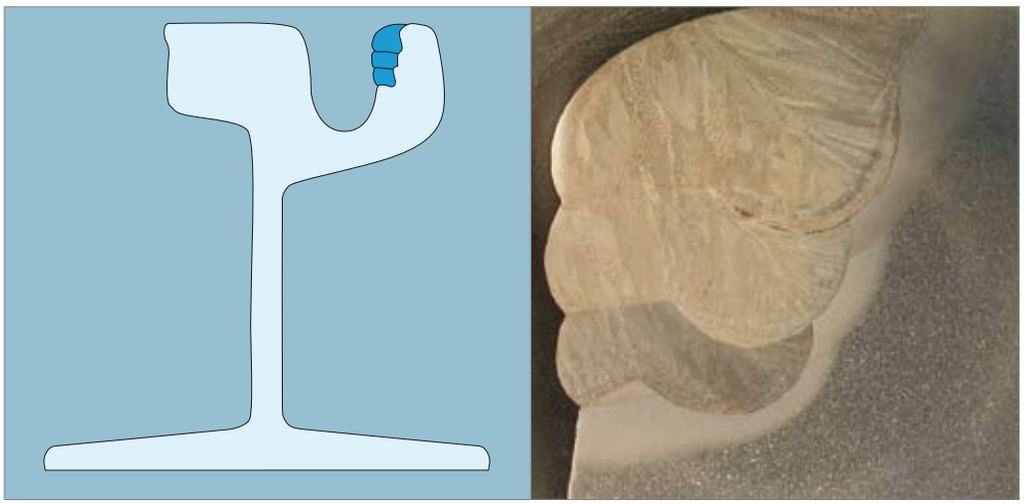


Figure 4. Cross section of rail repaired with Tramtrac™ II.

Table 1. Product data Tramtrac™ II and OK Tubrodur consumables

Tramtrac™ II	Control voltage	Power	Welding speed	Dimensions (l x w x h)	Weight without consumables		
	36-46 V AC	90W	30-100 mm/min.	600 x 300 x 150 mm	12 kg		
Ordering information	Tramtrac™ II	Connection cable 10m	Origo™ MIG 410	Origo™ MIG 320	Magnetic earth return cable & clamp	OK Tubrodur 14.71, 1.6mm	OK Tubrodur 15.65, 1.6mm
	0814 721 880	0457 360 884	0349 302 408	0349 303 562	0000 500 415	1471 167 730	1565 167 730

	Classifications & approvals	Typical chemical composition all weld metal (%)					Hardness HB	
OK Tubrodur 14.71		C	Si	Mn	Cr	Ni	as welded	work hardened
Type: Rutile Polarity: DC+	EN14700 T Fe 10	0.03	0.5	5.1	19.1	8.7	200	400

A stainless rutile 18.8.6Mn, self-shielded cored wire for cladding and joining 13% Mn steels and steels with limited weldability. It is also useful for buffer layers prior to hardfacing. Supreme welding characteristics and excellent slag detachability.

	Classifications & approvals	Typical chemical composition all weld metal (%)						Hardness HB	
OK Tubrodur 15.65		C	Si	Mn	Cr	Ni	Mo	as welded	work hardened
Type: Rutile PolarityL: DC+	EN14700 T Fe 9	0.03	0.6	13.5	15.5	1.8	0.8	250	450

A stainless rutile self-shielded cored wire depositing a martensitic-austenitic, work hardening deposit, used for the rebuilding of mild, low-alloy and 13%Mn steels. The weld metal combines excellent metal to metal abrasion and impact resistance. Supreme welding characteristics and excellent slag detachability.

Table 2. Typical weld metal composition of two samples welded with OK Tubrodur 15.65

	C	Si	Mn	P	S	Cr	Ni
	%	%	%	%	%	%	%
Rail	0.28	0.25	1.43	0.021	0.028	0.024	0.02
Weld	0.31	0.19	10.7	0.014	0.012	8.0	0.05

Fabrication of truck axles at Arvin Meritor's Cameri plant.

Perfect welding for truck axle housings

Cesare Fondrini, ESAB Saldatura SpA, Mesero, Italy.

With products in virtually every vehicle on the road, ArvinMeritor is a leader in advanced solutions that focus on enhancing vehicle stability and reducing harmful emissions. The company's 100,000 m^2 plant in Cameri, Italy, has around 600 employees and produces axle housings for trucks built by world leading manufacturers such as Iveco, Renault and Volvo and must, of necessity, be robust and of the very highest quality. A recent decision to adopt ESAB AristoRod 12.50 wire for exclusive use in the plant has resulted in significant improvements for the production and assembly processes.

Acknowledgement
We thank Alberto Caramellino, Manufacturing Engineering Manager and Fedele Bozzella, Manufacturing Engineer, at the Commercial Vehicle Systems Division of Meritor HVS for facilitating this article.

The origins of the Cameri plant go back some 100 years. Established in 1909 both as a flight school and an airport, the early days were rather humble: a wooden, single-floor house for the offices, and a wooden aircraft hangar. In 1912, the Turinese artist and painter, Giuseppe Gabardini, who had already designed several innovative aircraft including the Idroaeroplano and the Gabarda monoplane, took over the plants, the airport and the flight school.

Operations ceased between 1929 and 1932, when Gabardini resumed activities on behalf of the government, overhauling and inspecting fighter and bomber aircraft. After Gabardini's death, in 1936, Cansa took over management, including overhaul and inspection activities for Fiat aircraft, and also engine assembly. These activities again ceased in 1944, when the Cameri workshop produced disparate products such as bicycles, electric heaters and kitchen furniture. In 1946, production of buses and trolley buses, and of engines for the first Cucciolo motor bicycles, began.

In 1953, Cansa was absorbed into Fiat and in 1968, the Cansa name disappeared, and the company became Fiat, then Fiat Veicoli Industriali and, subsequently, Iveco. During this time, the Cameri plant became involved in bus production and assembly, receiving the bus chassis and manufacturing the framework, which was mounted, plated, painted, fitted-out with interior furnishings and road testing operations. At the end of the Seventies, bus production moved to Southern Italy.

The recent years
In Cameri, where the plant had been significantly enlarged in the meanwhile, a refurbishment project began, leading to the creation of a joint-venture between Iveco and the American giant Rockwell International: Omevi was founded and the Cameri plant became the centre for the manufacture of axles for medium-heavy vehicles.

The involvement of Rockwell resulted in a significant technological evolution, in which the Cameri plant gained state-of-the-art production and control equipment. At the beginning of the

Figure 1. Typical heavy truck rear axle, with disc brakes.

Figure 2. Starting point of the hot pressing line.

Nineties, manufacturing lines were reorganised and redesigned with the integration of more and more automated equipment.

In 1997, Rockwell International was split. The Automotive sector assumed the name Meritor and the Cameri plant changed its name to Meritor HVS Cameri SpA. Meritor was strongly focused on Europe. It had acquired the Lindesberg Volvo plant, in Sweden, devoted to the manufacture of axles. It also acquired the Lucas Varity Brakes Division, with a plant in England. Headquarters were established in Amsterdam, some functions were centralised and the Aftermarket Europe Division was created, with offices in Zurich.

Figure 3. Hot-pressed parts ready to be welded together.

The merger of industry leaders Arvin Industries and Meritor Automotive in July 2000 created ArvinMeritor, now one of the world's largest automotive component manufacturers and suppliers, with 36,000 employees and 140 plants, worldwide. Arvin brought to the merger an international reputation as one of the leading manufactures of automotive components, in particular products for drive control, filters and exhaust gas systems. Meritor's strength was as a world leader in the light vehicles sector, its portfolio comprising axles, brakes, transmissions, driving systems, transmission axles, roof systems and suspensions.

Current production

"ArvinMeritor has an important presence in Europe, because its main customers – Iveco, Renault and Volvo – are the biggest world manufacturers of trucks," says Alberto Caramellino, Manufacturing Engineering Manager, Commercial Vehicle Systems Division of Meritor HVS Cameri. "Our plant has the largest ArvinMeritor design team outside the United States, followed in importance by the Lindsberg team in Sweden, and the Lyon plant where cast iron closed axle housings are produced.
In Cameri, we produce the 'fabricated' axle housing that is hot pressed and then assembled. All the component parts are wire welded, with the exception of the wheel hub, which is friction welded."

Axle design is fully contained within the Cameri plant. "The design and the sizing of drive-shafts, ring gears, pinions, planetary gears, satellites and carriers (the cast iron parts that enclose the differential gear) are our responsibility from beginning to end," comments Fedele Bozzella, Manufacturing Engineer, Commercial Vehicle Systems Division of Meritor HVS Cameri.
"All products are tested within the plant by our specialised testing department. Generally, we tend to have highly automated lines, with the exception of some niche production that still requires manual operations."

In both welding and hot pressing departments, the manufacturing lines are based on sequential architecture. The only functions that require the intervention of an operator are the loading of parts at the beginning of the line and middle line positioning by robots and magnetic systems of parts that will form the axle and end of line inspection systems (sizes, welding quality, aesthetic appearance, etc). "The influence of welding on the quality of the finished product is critical," says Mr. Bozzella.

A fundamental process

In the Cameri plant, welding is clearly a process of paramount importance. "Our product can be likened to a vessel composed of nine assembled pieces, it must be robust and consistent with specifications," reports Mr. Bozzella. "All the welds must be sealed and some of them are also safety welds. The welding wire is an essential component for quality production."

This is the background to the decision to adopt

Figure 4. The two halves tack-welded.

Figure 5. Full penetration by one-sided welding.

ESAB AristoRod 12.50 wire, but how was this choice achieved?

“Our decision stemmed from dissatisfaction with the quality of the wire we were previously buying from a ‘historical’ supplier,” says Mr. Bozzella. “The supplier began to have significant quality problems. Moreover, new requirements were arising, such as having clean, spatter-free welding. We also wanted to reduce fume emissions, especially in the tacking and setup positions. Finally, we had a further problem to solve: the wire we were previously using was copper-coated and it was inclined to peel off, the loose external particles then obstructing the wire feeding system. This was causing line stoppages that we wished to eliminate.”

The company, therefore, started looking for an alternative that would eliminate the problem. “We were aware of technical features of AristoRod wire and, in May 2008, reached the decision to adopt this wire,” adds Mr. Bozzella.
AristoRod 12.50 is a copper-free wire that, thanks to the unique ASC (Advance Surface Technology) surface treatment allows smooth wire feeding, without friction and residues.

“We were immediately able to verify that ESAB AristoRod 12.50 wire fully eliminated welding spatter and was satisfactory in all its other features,” says Mr. Caramellino. “For its part, ESAB also provided two bulk drums with wire straighteners. The production lines were stopped for fitting the welding positions and, following early tests, very satisfactory results were achieved. We could clearly see that the wire behaviour was excellent: no spatter could be seen with the naked eye,” he stresses.

Other benefits became immediately apparent. For instance, with the new AristoRod wire there was no need to change the optimised welding parameters. “Both simple and more complex welds immediately appeared perfect,” concludes Mr. Bozzella. “For example, in a given step of the working cycle we must execute a joint with weld metal support. In practice, the material is grooved and a welding ream is realised at the inside weld. This is a very important joint for us and with the AristoRod wire we are able to perfectly execute it. Also, productivity has been significantly increased because the AristoRod wire never causes any problems.”

The adoption of AristoRod 12.50 also produced other benefits, such as improved arc stability, better welding appearance and lack of spatter.

A single standard

AristoRod 12.50 wire, in 475 kg Marathon Pacs, is used for all automatic and semi-automatic welding at the Cameri plant. The only variant is the diameter: on automatic machines 1.6mm diameter is used; while in manual operations, from simple tacking welds to more sophisticated welds, 1.2mm diameter is used. Manual welding with 1.6mm wire would mean using currents greater than 380A at 32V, with a very strong thermal radiation and tiring of the operators. In the line, on the other hand, currents of 420-470A at 32-34V are reached for specific welds and currents of 360A at 30-32V for other simpler procedures on softer materials. Finally, in the axle housing assembly operations, currents are varied depending on the part to be welded; the range, both for deep and surface passes, is typically 310 to 360A to guarantee consistent penetration inside the box.

The advantages can be clearly seen by all: after welding, the axle housing is very clean and requires no manual trimming operations; excellent penetrations are achieved; and productivity has been improved.

Figure 6. After welding, the axle housing is clean.

Figure 8. Robotic welding of customisation.

Figure 7. Good appearance of all welds.

Figure 9. Rear axles ready to be assembled.

About the author:

Cesare Fondrini is Product Manager MIG/MAG and Marathon Pac Wires at ESAB Saldatura SpA, Mesero, Italy.

Volvo takes short-cut to robotised welding

An ABB Flexarc cell with ESAB welding kit was up and running in one weekend

Stig Andersson, ESAB AB, Gothenburg, Sweden.

Robotisation need not necessarily be a long winded process with many costly obstacles on the road. Not with careful planning and the right partners and correct solutions. At Volvo Construction Equipment AB, Cab Division, in Hallsberg, Sweden, they decided to robotise the welding of a variety of components for the construction of cabins – one was the wheel fenders or mud screens. Partners in Volvo's robotisation project were ABB, ESAB and robot integrator ROBOT AKADEMIN AB, all working closely with the Volvo technicians and production personnel.

The production of cabs for heavy wheel loaders and dumpers is one of the main applications at Volvo Construction Equipment AB, Cab Division. These cabins reflect the Volvo brand and all it stands for – quality, safety and environmental care. Volvo assembles the cabs from many individually produced components which mostly require welding. This also applies for the mud screens which, until recently, where produced manually with semi-automatic MAG welding. As part of a broader project to reduce manufacturing costs, Volvo decided to robotise also this part of the production and purchased a third Flexarc robot cell equipped with ESAB's Aristo Robot package to be installed by ROBOT AKADEMIN AB – a concept that had worked extremely well with earlier robot projects.

The Flexarc robot cell

ABB's Flexarc cell (Figure 1) is the ideal solution to the robotisation needs of Volvo Construction Equipment AB, Cab Division. It fulfills their most important requirements being compact in space, easy to program and start-up and equipped with state-of-the-art welding equipment. The cells make optimum use of the space available, and

Figure 1. The Flexarc robot cell – quick to install and move between departments.

can be positioned close to other production units for an efficient work-flow.

Flexarc includes all the components necessary for productive robotic arc welding - single or multi-robots, the IRC5 robot control system, unique error handling software, positioners and Volvo's preferred choice of welding equipment - ESAB.

Plug and play

All components of the Flexarc cell are mounted on a common base, eliminating the need for on-site engineering work. Software has been pre-configured for simple setup. All the customer needs to do is unwrap the package, place the cell in the desired location, connect the power cable, air pressure and shielding gas hoses, program the robot and start working. The Flexarc cell can be moved within or between different production facilities, which enables flexible production.

The whole system is designed to be efficient and cost-saving. There are time saving options built-in such as the ability to develop new programs offline, via ABB's Robot Studio (using a virtual replica of the robot) while the actual robot remains in operation.

Simplified fault management saves time and money. For example if a weld error occurs, the operator doesn't have to enter the cell. The robot will automatically direct the torch to a service window – and after maintenance by the operator – it moves back to where it stopped and re-strikes the arc.

Volvo Construction Equipment AB, Cab Division, in Hallsberg, has a strong preference for ESAB welding equipment and specifies all robot cells to be equipped with the ESAB Aristo Mig™ robot package, ensuring the latest inverter welding technology. The package consists of:

- The Aristo™ Mig 4000iw or 5000i inverter.
- The Aristo W8 interface which communicates with ABB's IRC5 robot control unit.
- The Robofeed 3004w ELP encapsulated wire feeder.
- Cable packages.
- The Marathon Pac bulk drum with robot quality welding wire and separate bobbin holder.

The control unit of the welding package has been integrated in ABB's IRC5 robot control unit, so that all programming is accomplished within the unit. The Aristo Mig robot package is described in detail on page 25 of this issue of Svetsaren.
Volvo Construction Equipment AB, Cab Division currently has three Flexarc robot cells in operation: one Flexarc K and one Flexarc R cell - both equipped with IRB 1600 robots - and one Flexarc D cell with an IRB 2400 robot. The last is used for producing the mud screens.

From manual to robotic welding over the weekend

The speedy installation and start-up of the robot cell for mud screens is a good example of the user-friendliness of the Flexarc robot cell. On Friday at 1 o' clock manual production stopped and specialist robot integrator ROBOT AKADEMIN AB started to install the robot cell and program it in co-operation with the Volvo operators. By Monday morning the robot cell to weld mud screens was completely ready for production.

The mud screens are made of relatively thin steel sheet and assembled with forty short welds

Figure 2. Mud screen assembled with short intermittent welds with good cosmetic appearance.

(Figure 2 and 3). The robot cell is equipped with a positioner with fixtures on both sides for simultaneous robotised assembly welding and manual tack welding of the next mud screen.

Shielding gas is Mison 8 and the welding wire advised by ESAB for this application is OK Autrod 12.64 diameter 1.0mm. It is an AWS A5.18: ER70S-6 type wire with a slightly higher manganese and silicon content for increased weld metal strength and is classified G4Si1 according to EN 440. More important for this application, however, is the softer arc and the lower sensitivity to surface impurities, giving smooth and sound welds. The wire is fed from Marathon Pac bulk drums containing 250kg of welding wire (Figure 4).

Essential to the successful robotised welding, according to ROBOT AKADEMIN AB, is the avoidance of arc blow. The solution was found in low-voltage pulsing for which the programming features of the Aristo Mig 5000i power source were extremely well suited. This setting is like balancing on the edge. The pulse parameters are so low that the arc type gets close to short arc welding – the objective is to keep the work piece cold and give spatter no chance to adhere. The result is remarkable. Any spatter formed simply rolls away, leaving the work piece clean.

The side for manual tack welding is equipped with an Aristo Mig 4000i power source with an Aristo Feed 3004 wire feed unit. The MA6 panel on the power source provides the most advanced welding functions available from ESAB, including the full library of synergic lines.

The production cycle time was brought down from around 20 minutes with manual welding to just 5-6 minutes with robotised welding. It should be noted that, in this case, the robot is not used at full speed because the front loading and tacking are limiting factors.

About the author:

Stig Andersson is Area Sales Representative at ESAB AB, Sweden.

Figure 3. Overview of mud screen assembled with many short welds.

Figure 4. Aristo Mig 5000i inverter and 275kg Marathon Pac installed outside the Flexarc robot cell.

Figure 5. Manual tack welding. Aristo Mig 4000i power source located outside the Flexarc cell.

Fork truck maker boosts productivity with ESAB OK AristoRod

Ricardo Madriga and **Juan Jose Lopez,** ESAB MEXICO, S.A. DE C.V., Monterrey, Mexico

At the Mexican plant of fork lift frame producer NMGH, the use of ESAB OK AristoRod copper-free MAG wire is driving down costs and improving productivity.

Just five years after its launch, the advantages of ESAB's OK AristoRod copper-free welding wire are being widely recognised in a variety of industries around the world, making it a truly global product. In this article, ESAB Mexico reports on the great improvements achieved by NMHG Inc.
NMHG is one of the three core businesses of NMHG Industries, Inc., a publicly-held company with headquarters in Cleveland, Ohio.

World Leaders
NMHG designs, engineers and manufactures materials handling equipment, including warehouse trucks, counterbalanced trucks and large capacity cargo and container handling trucks. All lift trucks are marketed under the Hyster® and Yale® brand names. The company is one of the world's largest lift truck manufacturers. In addition to a worldwide distribution network of independent Hyster® and Yale® retail dealerships, NMHG operates wholly-owned dealerships in certain markets.

Today the people and facilities that make up NMHG do not support just one product line or brand, but can flexibly respond to demands of several product lines, regardless of brand. This centralised efficiency now makes them one of the industry's lowest cost producers of lift trucks and components, including replacement parts for other manufacturers' trucks.

NMHG Mexico
As part of the group restructuring plan, in 1997 the subsidiary facility NMHG Mexico, S.A. de C.V started production in Ramos Arizpe, Mexico to manufacture lower cost forklift frames for other facilities in North America. Since the start up in this plant, the company has used GMAW-P as the main welding process in state-of-the-art robotised cells.

NMHG has a team-oriented environment where employees can expand their skills and meet their career goals. Employees are encouraged to be key contributors. That is why Juan Francisco Limones, responsible for welding processes and robotic equipment in Ramos Arizpe facility, decided to initiate an investigation on how to reduce welding cost associated with unexpected equipment downtime due to poor performance of

Figure 1. Forklift frame welded with GMAW-P process, using OK AristoRod 12.50 copper-free wire, diameter 1.2 mm in 90% Ar/10% CO_2 shielding gas. The low spatter level helps to keep the weldment, fixtures and welding equipment clean.

Figure 2. Two octagonal Marathon Pacs with OK AristoRod 12.50 (AWS class ER70S-6) copper-free wire installed behind a robotised welding cell 25 feet away from the contact tip without feeding issues.

copper-coated wire. Mr. Limones found that welding cost had been affected by frequent equipment stoppage and that copper-coated wire was responsible for higher welding costs due to elevated consumption of contact tips, diffusers and liners.

ESAB Advice

Mr. Limones called in the ESAB region sales representative Ricardo Madrigal who immediately proposed the OK AristoRod 12.50 copper-free GMAW wire in Marathon Pac bulk package as a superior alternative to the competitor's copper-coated wire.

AristoRod 12.50 is a copper-free wire that, thanks to the unique ASC (Advance Surface Technology) surface treatment, allows smooth wire feeding, without friction and residuals

Cost Savings

After an exhaustive test of OK AristoRod in several robotised welding cells, Mr. Limones gathered all the information required to compare process costs. He has estimated that the change from copper-coated to copper-free wire will generate potential cost savings up to 19% that includes cost reduction in MAG gun spare parts and downtime.

All those who know the welding process at the NMHG facility in Ramos Arizpe realise the inconvenience from the use of copper-coated wires. The gradual build-up of copper dust and flakes can cause clogging in the feed system and

It all adds up to better overall productivity

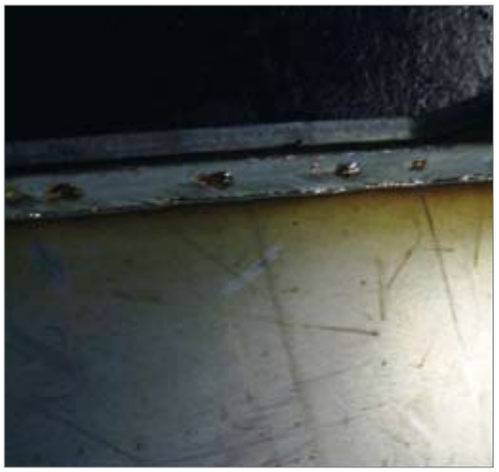


Figure 3. Typical filets welds are 6, 8 and 10 mm in leg length.

lead to increased spatter and poor weld finish and, eventually, to a complete breakdown of the welding process.

Regular maintenance and cleaning of the feed system is absolutely necessary to avoid feeding problems. However, this is time consuming and particularly costly as it causes downtime of the robotic welding systems. By removing the dust and flaking associated with copper, ESAB has removed the biggest contributor to the clogging of guns and liners and, with it, a major cause of production stoppages and increased cleaning schedules. In addition, greater arc stability results in less spatter, improved weld quality and finish and, consequently, leads to reduced need for weld cleaning.

Figure 4. Juan Francisco Limones (right) and Ricardo Madrigal (left).

Welding operators and supervisors can clearly see the advantages of ESAB OK AristoRod at every stage of the welding process:

- Low contact tip wear means fewer replacement stops.
- Consistent feedability means improved production speed.
- Lower feed force required for long distance feeding.
- Fewer maintenance stoppages due to absence of dust and flakes in liners.
- Fewer spatters due to better arc stability.
- Higher welding quality.

Juan Francisco Limones and Ricardo Madrigal are continuing with this investigation and now gathering the information to quantify the cost reduction due to improvements in welding quality and less cleaning time – two other advantages observed during application of ESAB OK AristoRod 12.50 – a product that creates savings in a global marketplace.

About the authors:

Ricardo Madrigal is Sales Representative at ESAB MEXICO, S.A. DE C.V., Monterrey, Mexico.

Juan Jose Lopez is Application Engineering Manager at ESAB MEXICO, S.A. DE C.V., Monterrey, Mexico.

How many more BMWs come out of a Marathon Pac?

Hydro Automotive Norway speeds-up robotic welding of aluminium cross beams for BMW 1-series

Ben Altemühl, Editor of Svetsaren

By simply changing over from 7kg wire spools to ESAB MarathonPac bulk drums – for all its robot stations – Hydro Automotive AS obtained a substantial increase in production output. In this article, auditing of the station that produce the cross beams for BMWs 1-series personal cars, has shown dramatic improvements…

Hydro Automotive AS, based in Raufoss, Norway is part of the Automotive Structures division of Norsk Hydro – a group with production sites in Norway, Sweden, the US, France, the UK, Denmark and Germany. It specialises in the fabrication of aluminium components and supplies major car manufacturers such as Saab, Renault, BMW, Jaguar, Porsche and Audi.

There are six Kuka robot stations for various automotive components and a manual station for repairs – all using AlMg4.5 Mn0.7 type MIG welding wire. Two years ago, Hydro Automotive stopped using 7kg wire spools on the wire feeders, after advice from ESAB, and changed over to the new ESAB MarathonPac with 141kg of OK Autrod 5183 high quality welding wire. Since the changeover the company has enjoyed efficient storage and handling of consumables, savings on downtime for spool exchange, a lower repair rate, gas cups that require less cleaning and - above all – increased production output. This article examines the scale of that production improvement.

Figure 1. Welding station for cross beams.

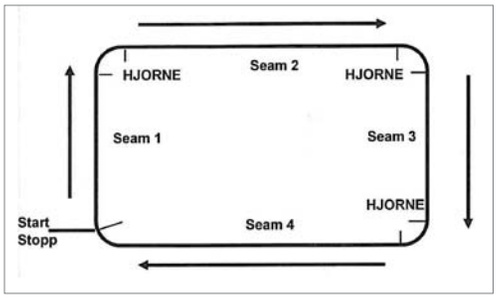


Figure 2 shows the welding procedure for this component, welded with the pulse MIG process. Sides and corners are rotated into best position and welded with pre-programmed parameters. Power sources, and the Marathon Pacs are placed outside the robot cell. This, for reasons of safety and convenience, is common practice in the automotive industry (Figure 3). The robots are equipped with push-pull wire feeders on the torch.

The robot station

Cross beams for the BMW series –1 personal car are produced at a station with two robots welding two sides of the beam simultaneously (Figure 1). The beam consists of a box structure to be connected, on both sides, to a node for connection to the chassis. During welding, a new component is manually loaded on the other side of the turntable, which rotates along its length axis.

Increased output from Marathon Pac

Hydro Automotive and ESAB calculated the savings due to the use of MarathonPac bulk drums, instead of the previously used 7kg wire spools. These required, on average, 15 minutes for spool exchange for each of the two robots which have equal weld metal consumption.

The weld metal consumption per robot/year is 4900kg, or 9800 for the complete (two robot) welding station.

Table 1 gives a welding cost calculation for the use of 7kg wire spools versus Marathon Pac. With spools, 700 spool changes per robot/year are needed (1400 for the welding station). This gives a total replacement time per year of 350 hours. For the same annual weld metal consumption, Marathon Pac requires a total replacement time of 17.5h. At an operational cost for robot and operator of 200Euro/h, this reduced downtime equals a saving of 68,250 Euro/year.

For Marathon Pac with robot quality aluminium wire, fabricators pay a higher price/kg than with

Figure 3. Robot operator programming outside the robot cell.

7kg spools. For aluminium wire, in general, 0.5 Euro/kg is an average which can be used in calculations. In the case of Hydro Automotive, this would result in an extra consumables cost of 4,900 Euro/year, which must be deducted from the savings on downtime.

Reduced downtime and rejects

A second important saving obtained by Hydro Automotive is a scrap rate of rejected components which is reduced from 0.5 to 0.3%. The major reason for this reduction is the continuous supply of 141kg of wire without abrupt ending in the middle of a welding sequence, as frequently occurs with 7kg spools. There is a window in the drum where the operator can easily see when the drum is almost empty and stop the station smoothly in time.
In addition, the company reports less rejects because of a more stable process with reduced spatter.

Table 1. Cost calculation for Hydro Automotive robot station. Weld metal consumption: 4900kg/robot/year

Type of packaging	7kg spools	Marathon Pac	Cost difference
Weight of wire (kg)	7	141	
Wire consumption per year (kg)	9800	9800	
Number of spool changes/year	1400	70	
Total replacement time /year (min.)	21.000	1050	
Total replacement time /year (h)	350	17,5	
Cost related to spool replacement			
Operational cost robot+ operator (Euro)	200	200	
Cost for spool replacement/year (Euro)	70.000	1750	68.250
Additional cost for Marathon Pac			
Extra purchasing price/kg (Euro)		0,5	
Extra purchasing price/year			4.900

Figure 4. Each Marathon Pac is filled with high quality aluminium welding wire, and uses a special reverse coiling technology to ensure the wire comes out straight and perfectly positioned, resulting in greater process stability and a significantly reduced risk of spatter. Use of the ESAB pear ensures that the wire can never get entangled during wire feeding.

This calculation shows the savings for one robot station. Marathon Pac, however, is applied at all six stations where similar cost savings are obtained. It is also important to note that there may be a slight difference in the consumables price per kg.

How many more BMWs come out of a Marathon Pac?

This interesting question can, of course, not be answered in this article. However, what can be shown is how many more BMW cross beams can be produced, due to the use of Marathon Pac.

The clocked cycle time for each cross beam is 47 seconds (33 sec welding + 14 sec turning). The duty cycle of the station is 65%.

The use of Marathon Pac brings (350-17.5) x 3600 x 65%= 778,050s extra net robot time, which equals 16554 extra BMW cross beams a year on which a full sales profit is earned. For Hydro Automotive, this has been a major step in their “lean manufacturing practice” needed to survive in the highly competitive automotive industry.

About the author:

Ben Altemühl is Technical Editor within ESAB’s Central Marketing Communication Department and Editor in Chief of Svetsaren.

Product News Equipment

NEW RANGE OF MULTI-OPTION MACHINES WILL TRANSFORM ARC WELDING

The new Origo™/Aristo™ range of CC/CV welding machines has been designed to give the high level flexibility required by such market sectors as energy and civil construction. All the new Origo™ and Aristo™ machines are supplied with proven ESAB control units that enable different weld types to be produced. The units also enable many process parameters to be set before welding starts. This facility also allows the parameters to be changed during welding.

Origo™ Tig 3001i, TA23/TA24 - for advanced industrial use and for repair and maintenance

- **Pulsed TIG welding**- easy control of heat input and the weld pool (Origo™ TA24).
- **ESAB 2-program function** – provides the opportunity to pre-program and change program during actual welding for increased productivity (Origo™ TA24).
- **Strong, reliable 300A inverter power source** - one machine for all types of demanding applications.
- **Easy to use** - parameter presentation easy to understand.
- **HF or LiftArc™ start in TIG.**
- **MMA welding** – handles all electrodes up to 5mm.
- **ArcPlus II** – better welding characteristics in MMA, simplifies work and gives better weld quality with less after treatment.
- **True MMA welding** – Hot start and Arc force setting.

Applications

- Repair and maintenance
- General fabrication and civil construction
- Process industry
- Shipbuilding and offshore
- Power generation
- Transport and mobile machinery

Panel (MMC) functions	Origo™ TA23	Origo™ TA24
Welding methode MMA/TIG	X	X
Remote on/off	X	X
ESAB 2-program function	-	X
HF or LiftArc™ start	X	X
2/4-stroke	X	X
Gas pre/post-flow	X	X
Slope up/down	X	X
Pulsed TIG	-	X
Micro Pulse TIG	-	X
Digital amp-meter	X	X
Digital V/A-meter	-	X
Arc force (MMA)	(X)	(X)
Hot start (MMA)	(X)	(X)
Droplet welding (MMA)	(X)	(X)
ArcPlus II (MMA)	X	X

Origo™ Arc 4001i, A22/A24 - optimum welding solutions

- **Outstanding welding characteristics** - high efficiency, high quality welding.
- **Efficient Man Machine Communication** by user-friendly Origo™ A22 and A24 control panels.
- **The Origo™ A24 allows the choice of electrode type: rutile, basic or cellulosic** for optimal welding qualities and has an easy to read digital display to indicate current/voltage.
- **Adjustable Arc force and Hot start** to optimise the welding (Origo™ A24).
- **Enclosure class IP 23.**
- **Dust filter to handle tough,** dirty environments by prevent grinding-dust and metal particles from entering the machine.

Market Segments

- Civil construction and field erection
- Energy generation
- Pipeline contractors
- Earth moving and mining
- Offshore and shipbuilding
- (Hire fleets)

Applications

- Outdoor heavy installation on site
- Outdoor maintenance and repair on site

Panel (MMC) functions	Origo™ A22	Origo™ A24
Welding method MMA/TIG	X	X
Welding method MIG/MAG (CV)		X
Remote ON/OFF	X	X
Selection of electrode type		X
Arc Force	(x)	X
Hot start	(x)	X
Droplet welding	(x)	(x)
Min current setting TIG	(x)	(x)
Step-less inductance (CV)		X
Digital amp-meter	X	
Digital V/A-meters		X
Memory, 2 set		X

Origo™ Mig 3001i and 4001i, A24 - MIG 3001IW/4001IW - optimum welding solutions

- **Reliable,** smooth starts and ends supported by efficient Hot-start and crater fill functions.
- **Efficient Man Machine Communication** by the user-friendly Origo™ MA23 and MA24.
- **Wide range of pre-programmed synergic lines in MA24**.
- **Memory for three parameter sets.**
- **ESAB LogicPump,** secures automatic start of water pump when a water-cooled welding torch is connected.
- **TrueArcVoltage System™,** measures the correct arc voltage value independent of the length of the connection cable, return cable or welding torch.
- **Dust filter to handle tough,** dirty environments and avoid grinding-dust and metal particles inside the machine.
- **QSet™** - automatic setting of short arc parameters

Market Segments

- Civil Construction & Field Erection
- Energy Generation
- Pipeline Contractors
- Earth Moving and Mining
- Transport Equipment
- Offshore and Shipbuilding
- (Hire Fleets)

Applications

- Auto-repair
- General metal fabrication
- Tack welding
- Civil construction
- Mobile machinery
- Pipe workshops

Panel (MMC) functions	MA23	MA24
2/4 stroke	X	X
Gas pre/post flow	X	X
Digital V/A-meters	X	X
Gas purge/wire inching	X	X
Memory 3 set	X	X
QSet™		X
Crater filling		X
Creep start		X
Pre-programmed synergic lines		X

Aristo™ Mig 3001i/4001i and Mig 3001iw/4001iw - optimum welding solutions

- **2/4 stroke**, simplifies handling of the welding torch.
- **Creep start, gas pre-flow and hot start** provide a soft and more direct start with less spatter.
- **Crater filling, adjustable burn-back time and post gas** provide a smooth finish, extend the lifetime of the contact tip and guarantee no cracks at the end.
- **Pre-programmed synergic lines,** to ensure optimum settings with a wide choice of materials, wire dimensions and gas combinations.
- **Possibility to create synergic lines (Aristo™ U82)**
- **Memory for 10** (Aristo™ U6) **or 255** (Aristo™ $U8_2$) **parameter sets**
- **Quick connectors -** shortest possible set-up times.
- **ESAB LogicPump,** secures automatic start of water pump when a water-cooled welding torch is connected.
- **TrueArcVoltage System™,** measures the correct arc voltage value independent of the length of the interconnection cable, return cable or welding torch.
- **SuperPulse™,** the welding process with the ability to control heat input (Aristo™ $U8_2$).
- **QSet™** - automatic setting of short arc parameters

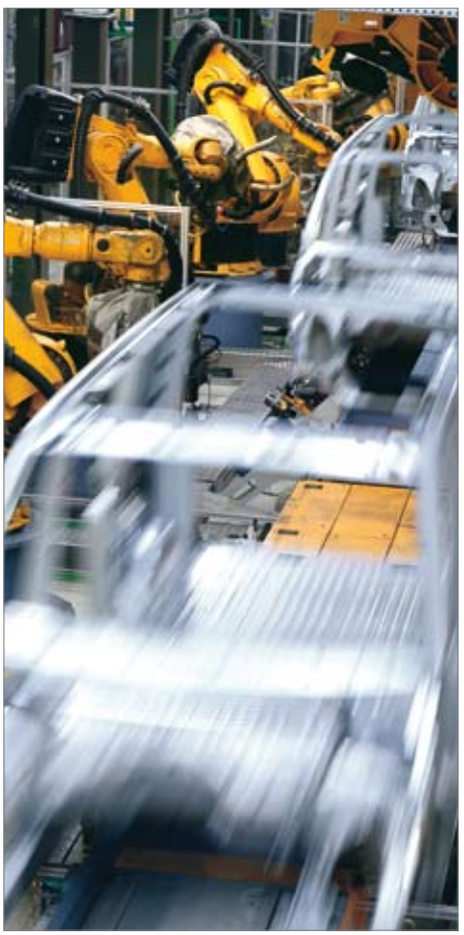
Market Segments

- Advanced mild and stainless steel fabrication
- Advanced aluminium fabrication
- QA Applications
- Prefabrication of Ni based material
- Advanced mild and stainless steel fabrication
- Advanced aluminium fabrication
- QA Applications
- Prefabrication of Ni based material

Panel (MMC) functions	Aristo™ U6	Aristo™ $U8_2$	Aristo™ $U8_2$Plus
QSet ™	X	X	X
2/4 stroke	X	X	X
Crater Filling	X	X	X
Creep start, Hot start and adjustable burn-back time	X	X	X
Gas pre/post flow	X	X	X
Digital V/A-meters	X	X	X
Pre-programmed synergic lines	X (60)	X (92)	X (>230)
Gas purge/wire inching	X	X	X
Memory, 10 set	X		
Memory, 255 set		X	X
Pulse/synergicpulse	X	X	X
Limit editor, set and measurment values		X	X
Create synergic lines			X
SuperPulse™			X
Production statistics			X
Auto save mode			X

Aristo™ $U8_2$ – The new way to connect your welding universe

Leading-edge R&D and close cooperation with key industries throughout the world has placed ESAB at the forefront of welding technology. The introduction of the radical Aristo™ $U8_2$ control unit presents a whole new universe of welding possibilities: enhanced functionality, extended communication and WeldPoint™ – a logical, user-friendly Windows-based interface. Whatever the application, MIG/MAG (manual, mechanised or robotised) welding, TIG or



MMA, the Aristo™ $U8_2$ unit will do the job. And its add-on modular design and preselected synergic lines for special materials ensure exceptional flexibility. Designed as forward compatible, ongoing software upgrades will keep WeldPoint™ and the Aristo™ $U8_2$ control unit future-proof. Why wait? It's time to master the welding universe!

Aristo™ $U8_2$
Basic version featuring all essential functions. Forward compatibility assured through future software upgrades.

- Support manual and mechanised applications
- Extended range of languages
- Large display
- Dials to adjust wire feed speed and voltage
- Dial to scroll menu
- USB connector
- QSet™
- Limit editor set and measured values
- Release pulse
- LAN (via Aristo™ $W8_2$)
- WeldPoint™
- Basic package synergic lines (92)

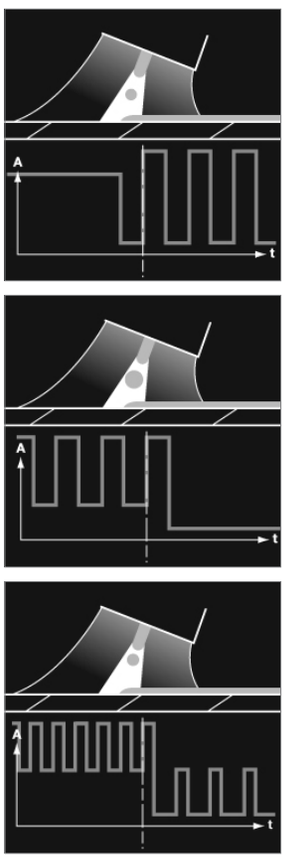
Aristo™ $U8_2$ Plus
Complete software suite with full functionality.

- Support manual and mechanised applications
- 17 languages, including Chinese
- Large display
- Dials to adjust wire feed speed and voltage
- Dial to scroll menu
- USB connector
- QSet™
- Limit editor set and measured values
- Release pulse
- LAN (via Aristo™ $W8_2$)
- WeldPoint™
- Complete package synergic lines (>230)
- SuperPulse™
- Filemanager
- Auto save mode
- User defined synergic lines
- Production statistics

User friendly
The new-generation Aristo™ $U8_2$ creates a whole new universe of possibilities – maximum functionality, minimum complexity. Five function buttons, single menu and 'Enter' button and three setting wheels cover every option. Large, bright easy-view LED display and knurled setting wheels for simple gloves-on, visor-down operation. Aristo™ $U8_2$ or Aristo™ $U8_2$ Plus, the all-new $U8_2$ control unit is the key to a fully integrated welding system. Full USB connectivity and a broad choice of advanced Aristo™ $W8_2$ add-on modules for comprehensive Fieldbus (DeviceNet, CANopen or Profibus) and LAN (Ethernet) communication. Optional synergic-line packs for special materials.

Multilingual
In the global welding community, ESAB technology is the benchmark for flexibility, efficiency and consistent quality. Ingenious software, intuitive interfaces and logical controls have greatly simplified the welding process. Even so, language remains critical in understanding and utilizing the full potential of such advanced welding systems.
With an expanded memory and updated display, the Aristo™ $U8_2$ supports seventeen world languages, including Russian and Chinese (with original Cyrillic and Chinese characters). Manuals available in all seventeen languages. The Aristo™ $U8_2$: say goodbye to poor displays and confusing manuals.

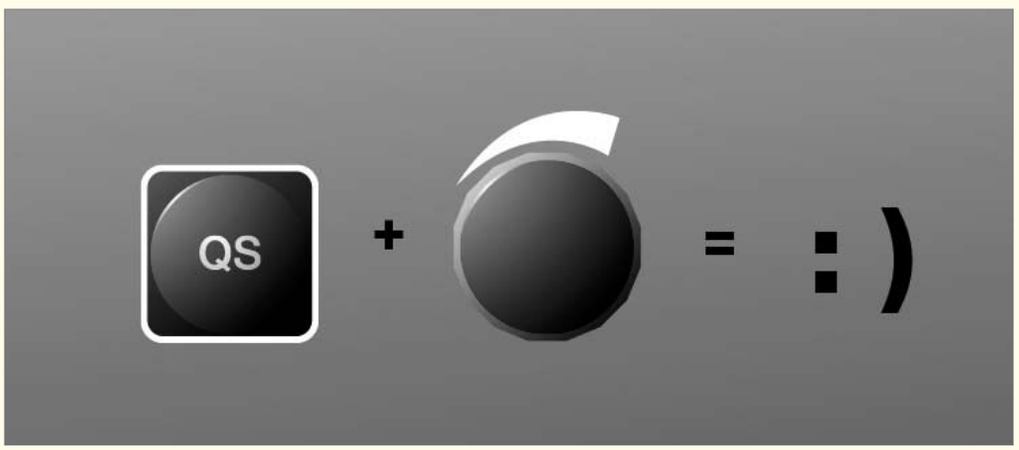
SuperPulse™
Promoting partial solidification of the weld pool between each pulse, the SuperPulse™ function improves control of the weld pool and solidification process, for a higher quality result. Essentially, the process involves a programmed changeover between two MIG/MAG settings, in which time intervals are determined by the primary and secondary-phase time settings. SuperPulse™ benefits include reduced sensitivity to variations in the root gap, better control of the weld pool during position welding, better control of penetration and penetration profile, and reduced sensitivity to uneven heat evaporation.



WeldPoint™
Our new proprietary WeldPoint™ software puts 'back office' operations up front! Ideal for the multiple robotic welding lines typical of the automotive industry, WeldPoint™ can enhance, monitor and maintain consistent weld quality from the welding or production engineer's PC. Simultaneous connection of up to ten welding machines via TCP/IP, with sophisticated display and storage of all weld data. All weld schedules and production statistics, with the quality log, error log, system configuration, limit setting and measure limits, can be converted into HTML or text format for export. Other innovative advances include an online quality-data viewer (real-time quality data from each welding machine, with automatic or manual update) and an online weld-schedule editor. You can also view downloaded weld data set files, as well as combining different weld data sets to form an entirely new set.

QSet™
Set and forget! A few seconds test welding, and the short arc stabilizes as you watch. The QSet™ function sets and stores the optimal welding parameters automatically, maintaining consistent arc stability, regardless of wire-feed speed. You can move the contact tip away from the welding seam in sharp corners and other tight spaces without losing the ideal arc. Change of wire spool and/or gas mixture? All it takes is another test weld to optimize the parameters again. These consistent welding results mean less spatter, less cleaning – and higher productivity.

- Speedy set-up
- One-knob control
- No preset synergic lines
- Automatic arc optimization
- Less spatter, less after treatment
- Increased productivity



Product News Automation

GMH -AUTOMATIC JOINT TRACKING SYSTEM FOR MOST JOINT TYPES

The GMH joint tracking controller together with ESAB servo slides and a sensor unit forms a robust and easy to use joint tracking system for automatic welding.

The GMH system minimises repair welding and adjustments after welding thanks to that the arc is always in the optimal position. The general quality will be kept on an even level and the operator does not need to focus on the weld head and its position.

The operator can then keep an eye on the entire installation and contribute to a non-interrupted welding production by adding flux and prepare for changing the wire spool well in advance.

System contents
The welding head is mounted on a motorised double servo slide where the head can be moved up-down and left-right. The sensor is the most vital part in the system which gives information to the control system how to adjust the slides to keep the arc in the optimal position. There are a number of different mechanical sense fingers for different applications. Inductive sensors can also be used.

Operation
The operator uses the joystick to guide the welding head and mechanical sensor finger into correct position. No programming at all is required. The unit is set in track mode and the welding can start.
Curved details can as long as they are within the working range of the servo slides be welded fully automatic with GMH as the guiding tool.

Applications
- Shipbuilding (panels, sub-components)
- Power generation (wind towers, boilers, vessels)
- Infrastructural components (beams, bridges)
- Off-road vehicles (excavators, dump trucks)

GMH is available in three versions:
• With control panel on the front
Suitable for ESAB's A2 / A6 tractor automats and A2 / A6 beam travelling carriage. Automatic solutions with short distance between welding head and GMH control box and where the operator has a good overview of weld joint and welding head without moving around.

• With remote control (no panel on the front)
Suitable for Column & Booms and large automatic installations with long distance between welding head and GMH control box and when the operator must move around in order to get a good view of the welding joint.

• Without control panel and remote control
Suitable for customized solutions where the customer's own remote control is adapted to the GMH control box.

- Easy to use, no programming required
- Robust
- Flexible with a remote control
- Very short set-up times
- Convenient for the operator
- Minimises operator errors.

Product News Automation

PAV- Positioning system

The PAV control box together with the servo slides forms a manual positioning system for the welding head

PAV
The PAV system makes it easier to keep the welding head in optimal position and it also makes it easier for the operator to make a good job with less welding faults and costly repairs.
The operators ergonomic safety is in focus.
The PAV allows the adjustment of the welding head to be done fully remotely. There is no need to climb or stretch to reach and operate the manual slides for adjustment of weld positions. The operator can all the time keep the focus on the welding process and do adjustments just by using the joystick.
By using the PAV with the controls mounted on the remote box the operator can be more flexible and move along a larger object and still have full control over the position of the welding head.

Operation
A PAV control box can control one or two servo slides. With the joystick on the control box or the remote control you can manually control the movement of the welding head up/down or left/right. With a push button you can choose between low or high speed of the movement. When high speed is activated the push button lights up.

Applications
- Shipbuilding (panels, sub-components)
- Power generation (wind towers, boilers, vessels)
- Infrastructural components (beams, bridges)
- Off-road vehicles (excavators, dump trucks)

PAV is available in three versions:
• With control panel on the front
Suitable for ESAB's A2 and A6 beam travelling carriage. Automatic solutions with short distance between welding head and PAV control box and where the operator has a good overview of weld joint and welding head without moving around.

• With remote control (no panel on the front)
Suitable for Column & Booms and large automatic installations with long distance between welding head and PAV control box and when the operator must move around in order to get a good view of the welding joint.

• Without control panel and remote control
Suitable for customized solutions where the customer's own remote control is adapted to the PAV control box.

- Operator friendly
- Ergonomic
- Easy to use
- Shorter set-up times
- Higher quality
- Improved working environment

Product News Cutting

New features for m³ plasma™ cutting system

ESAB's m³ plasma™ cutting system, introduced in 2006 and described in Svetsaren 1/2006, enables high-quality precision cutting and marking and high current/thick plate cutting with the same PT-36 plasma torch - replacing up to three single-purpose torches while consuming fewer wear parts.
m³ plasma™ offers an unsurpassed level of reliability, economy and productivity.
The system now features a number of innovations that widen the application scope and enhance cutting quality:

- PT-36 torch, upgradable for very thick stainless steel and aluminium.
- Use of a secondary gas around the plasma arc.
- 'R2' mode for round top edges.
- Suitable for underwater cutting.

Figure 1. m³ plasma™ with torch PT36

m³ plasma™ continues its advance
Small to medium-sized metalworking and manufacturing companies can now benefit from the advantages of plasma cutting thanks to the constant enhancements and ever-falling costs of the technology. In terms of precision, speed, flexibility and economy, modern plasma cutting is unsurpassed. The potential of the m³ plasma™ cutting system is such that it will establish plasma cutting as a viable process with new customer groups. It is a complete high-performance system that is quick and easy to install, demands little in terms of operation and maintenance, offers a broad range of functions and can assist the full automation of the cutting process, including marking and labelling.

The characteristics of m³ plasma™
The PT-36 torch can handle cuts in the widest variety of geometrical shapes, bevel cutting with a weld bevel angle of 0 to +/- 45° as well as the most common marking and labelling tasks - without changing tools. The cutting area depends on the m³ plasma™ current source used (cutting current 30 – 200A, 35 – 400A, 35 – 600A according to version) and ranges between two and a maximum of 60mm in construction steel, stainless steel and aluminium. As an option, the PT-36 plasma torch can be upgraded for cuts up to 150mm in stainless steel and aluminium.

The m³ plasma™ system is ESAB's first use of so-called shield gas technology, in which a secondary gas (eg, oxygen or nitrogen) is used alongside the plasma gas, circulating around the arc and providing it with a protective, stabilising shell. The result is an exceptionally fine, accurate arc that has greater density and stability in comparison to conventional processes, and leads to higher cutting speeds, more precise cut edges and brilliant cut surfaces.

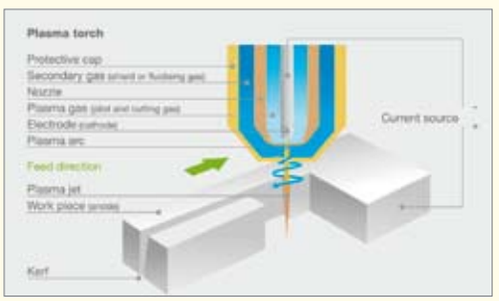


Figure 2. ESAB's shield gas technology, in which a secondary gas is used alongside the plasma gas

In many cases, underwater cutting is a sensible alternative to dry cutting with less noise, reduced emission of dust, aerosols and UV and a smaller heat affected zone around the cut. m³ technology allows underwater plasma cutting; even marking and labelling is no problem.

The 'R2' mode (Radius 2) is designed to meet the specifications of the International Maritime Organisation (IMO) for the standardised curvature of round top edges of varnished components. This mode in particular shows the close connection between ESAB and the international shipbuilding industry.

Another innovation with the m³ plasma system is the option to pre-select, and switch between, four different quality levels even during the cutting process. (see Table).

Figure 3. R2- a new quality mode for varnished components.

QUALITY MODES

01 » Precision	02 » Production	03 » Cross cut	04 » R2 NEW!
For highly accurate precision cutting.	The sound compromise between economy and cut quality.	For economical bulk cutting.	The special mode for round top edges.
Result: Meets ISO 9013-3 or higher. Flat cut surfaces. Sharp edges on top and bottom. Virtually no burr formation (with appropriate material).	Result: Meets ISO 9013-3 or higher. Flat cut surfaces. Sharp edges on top and bottom. Virtually no burr formation (with appropriate material).	Result: More steeply bevelled edges. Rounded top edges. Slight burr formation. Highest cutting speed.	Result: Meets the specifications of the International Maritime Organization (IMO) for optimum varnishability. Top edge radiusing: accurate radius of 2 mm.

Special software for automatic cutting processes

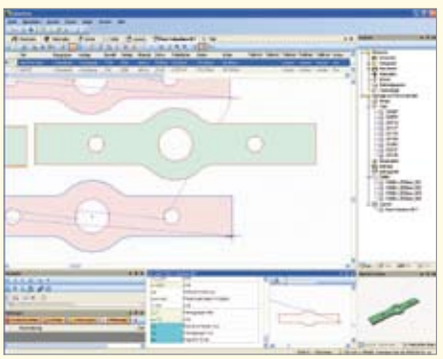
Columbus.NET™ and PDM from ESAB

The latest generation of Columbus.NET™ programming software enables quick, easy creation of even the most complex cutting programs. This ESAB innovation is based on the Microsoft .NET developer platform and thus has an ensured future. Companies that invest in .NET are safeguarding their investment against future technological changes. COLUMBUS.NET is a genuine 32-bit program and runs under the Windows XP and Vista operating systems.

The practical advantages of the new software include the option of fully automated program and nesting generation. According to adjusted values and criteria, Columbus.NET automatically selects the flame-cut parts, provides the nesting and technology data and selects the most suitable plates. For weld edge preparation - an increasingly important function - the operator can choose between bevel types V, X, Y and K. With Columbus.

NET, individual bevel types, with contours cut up to five times, can be produced. The graphic user interface is extremely helpful, especially where different cutting and marking tools are combined. The operator can see at a glance how Columbus operates all tool combinations and automatically generates the required traverse paths between different tools. Operating errors are virtually ruled out thanks to an ingenious plausibility check. Columbus.NET also displays the entire program structure in Columbus Explorer, arranged optionally on one or two screens.

ESAB also announces an enhanced PDM (production data management) system for use as a data link between production and existing planning systems. PDM connects existing systems via interfaces, thus creating consistent and current data transparency. Optimal integration into production planning can be achieved by connection to the COLUMBUS programming system. For that purpose, control of the workflows within the production process (control station technology) has also been integrated into the modular functionality of PDM. The PDM system thus creates ideal conditions for reducing operating costs, shortening cycle times and increasing overall productivity. Instead of impractical, cost-intensive local solutions, PDM ensures that the whole production process becomes transparent – from planning through production all the way to delivery.



Product News Cutting

QUATTROJET™ - THE INNOVATIVE OXYFUEL TORCH

ESAB has introduced QUATTROJET™ - a completely new type of oxy fuel flame-cutting system that makes this process even more economical and paves the way for full automation.

With automatic flame monitoring, the new QUATTROJET oxy fuel torch recognises any possible cutting break and automatically stops the gas supply. So, unlike traditional systems, the cutting machine does not require permanent monitoring by an operator, while fuel gas and oxygen cannot escape unhindered. The flame monitoring responds to any faults in the cutting material or disturbances to the cutting tool.

This monitoring system enhances the safety of operators and workforce, the environment and machinery - whilst also improving the quality of automatic cutting.

To ensure the correct distance between the cutting nozzle and blank, QUATTROJET features integrated height sensing, thus eliminating the need for an additional sensor system installed separately on the torch. Conventional systems such as spacer rings wear out very quickly and thus need regular replacement.
Other features of the compact, slim QUATTROJET oxy fuel torch are an internal ignition system protected against dirt and damage, and a device for rapid, tool-free nozzle changes.

SAFESET™, A COMPLETE RANGE OF PRODUCTS FOR CENTRAL PLASMA GAS SUPPLY

SAFESET™ is an ESAB contribution to easier working, improved productivity and enhanced operating safety. It is a new, complete range of products for the central gas supply of plasma cutting lines. The key components of the modular-structured system are various drawing stations in a space-saving panel designed for wall mounting close to the cutting machine. They are connected via a loop system to the central store (single cylinders, cylinder bundles or tanks), which is located outside the working area. Precisely attuned to each type of machine, the drawing stations provide optimal gas pressure and ease of operation right next to the workstations.

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ISO 14001 18001 OHSAS

ESAB®

We have now gained OHSAS 18001 group certification from DNV. Our group Environmental, Health & Safety Management System was already IS14001 certified. This is believed to be the most comprehensive certification achieved by any global company to date. It includes all production operations, sales and central functions within ESAB at 1 July 2007.

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