

Svetsaren



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Repair & Maintenance

Svetsaren

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The repair of aluminium structures

by **Tony Anderson, Technical Services Manager AlcoTec Corporation, USA**

Without a doubt, aluminum is being increasingly used within the welding fabrication industry. We are seeing a major increase in usage within the automotive industry, where the use of aluminum continues to develop. Also within other industries such as furniture, recreation and sporting equipment, shipbuilding, transportation and containers, military and aerospace we see continued developments with aluminum, often as a replacement for steel.

As more components are produced from aluminum, the need for reliable repair work on aluminum weldments is also increasing. Repair work to aluminum structures is conducted extremely successfully on a regular basis, such items as truck body's and boat hulls are repaired after damage from collision or after wear and tear during severe service conditions. This article shall examine some of the more common considerations associated with the repair of aluminum alloys in an attempt to help prevent problems associated with repair work and also to help ensure consistently successful repairs.

Identification of alloy type

Probably the most important consideration encountered during the repair operation is the identification of the aluminum base alloy type. If the base material type of the component requiring the repair is not available through a reliable source, it can be difficult to select a suitable welding procedure. There are some guides as to the most probable type of aluminum used in different applications, such as, most extruded aluminum is typically 6xxx series (AL-Mg-Si).

Air-conditioning systems and heat exchangers, within the automotive industry, are typically made from 3003, 5052, plate and 6061 tubing. Car wheels are often made from 5454, which because of its controlled magnesium (less than 3% Mg), is suitable for temperature applications. Ship hulls are often manufactured from 5083 (5%Mg), which is recognized as a marine material. Unfortunately, if the base material type is not known, or unavailable, there is only one reliable way of establishing the exact type of aluminum alloy, and that is through chemical analysis. A small sample of the base material must be sent to a reliable aluminum testing laboratory, and a chemical analysis must be performed. Generally, the chemistry can then be evaluated and a determination as to the



The most important consideration before repair welding is the identification of aluminum base alloy type.

most suitable filler alloy and welding procedure can be made. It is very important to be aware that incorrect assumptions as to the chemistry of an aluminum alloy can result in very serious effects on the welding results.

There are 7 major types of aluminum alloys which have a wide range of mechanical properties and, consequently, a wide range of performance and applications. Some have very good weldability, and others are considered to have extremely poor weldability, and are unsuitable, if welded, for structural applications. Some can be welded with one type of filler alloy, and others will produce unacceptable,



Special care should be taken when welding high performance components such as car rims.

extremely poor mechanical properties if welded with that same filler alloy. Filler alloy and base alloy chemistry mixture is one of the main considerations relating to welded joint suitability, crack sensitivity, and joint performance. Consequently, without knowing the base material type, you are unable to assess the correct filler in order to prevent an unsuitable filler alloy, base alloy, mixture.

I must definitely recommend that, if an aluminum component is to be repair welded, and after this, used for any structural application, particularly, if a weld failure, can in any way damage property and/or create injury, do not weld it without understanding its alloy type, and being satisfied that the correct welding procedure is to be followed.

The repair of some high performance aluminum alloys

Another problem associated with the repair of a small group of aluminum structures is the temptation to repair high performance, typically high replacement price components, made from exotic aluminum alloys. These materials are often found on aircraft, hand gliders, sporting equipment and other types of high-performance, safety-critical equipment and are not usually welded on the original component. There are a small number of high- performance aluminum alloys which are generally recognized as being unweldable. It can be very dangerous to perform welding on these components and then return them to service. Probably the two most commonly found aluminum alloys within this category are 2024, which is an aluminum, copper, magnesium alloy and 7075, an aluminum, zinc, copper, magnesium alloy. Both these materials can become susceptible to stress corrosion cracking after welding. This phenomenon (stress corrosion cracking) is particularly dangerous because it is generally a type of delayed failure, not detectable immediately after welding, and usually develops at a later date when the



Some automotive components in aluminum that have been repaired by welding.

component is in service. The completed weld joint can appear to be of excellent quality immediately after welding. X-rays and ultrasonic inspection shortly after welding will typically find no indication of a welding problem. However, changes which occur within the base material adjacent to the weld during the welding process, can produce a metallurgical condition within these materials which can result in intergranular micro cracking, which may be susceptible to propagation and eventual failure of the welded component.

The probability of failure can be high, and the time to failure is generally unpredictable and dependent on variables such as tensile stress applied to the joint, environmental conditions, and the period of time which the component is subjected to these variables.

It is strongly recommended that great care be taken when considering the repair of components made from these materials. Again, it must be stressed that if there is any possibility of a weld failure becoming the cause of damage or injury to person or property, do not perform repair work by welding on these alloys and then return them to service.

Base material strength reduction after repair welding: There are considerations relating to the effect of the heating of the base material during the repair welding process. Aluminum alloys are divided into two groups: the “heat treatable” and the “non-heat treatable” alloys. We should consider the differences between these two groups and the effect on each during the repair process. Typically, the non-heat treatable alloys are used in a strain-hardened condition. This being the method used to improve their mechanical properties, as they do not respond to heat treatment. During the welding process, the heat introduced to the aluminum base will generally return the base material, adjacent to the weld, to its annealed condition. This will typically produce a localized reduction in strength within this area and may or may not be of any design/performance significance.

The heat treatable alloys are almost always used in one heat-treated form or another. Commonly they are used in the T4 or T6 condition (solution heat-treated and naturally aged or solution heat-treated and artificially aged). Base materials in these heat-treated tempers are in their optimum mechanical condition. The heat introduced to these base materials, during the repair welding process, can change their mechanical properties considerably within the repair area. Unlike the non-heat treatable alloys, which are annealed and returned to this condition when subjected briefly to a specific temperature, the heat-treatable alloys are affected by time and temperature. The effect from the heating during the welding repair on the heat-treatable alloy is generally a partial anneal and an over-aging effect. Because the amount of reduction in strength is determined largely by overall heat input during the welding process, there are guidelines as to how this reduction can be minimized. Generally, minimum amounts of pre-heating and low interpass temperatures should be used to control this effect.

However, even with the best designed welding procedures, considerable loss in tensile strength is always experienced within the heat-affected zone when arc welding these types of materials.

Unfortunately, it is usually either cost restrictive or, more often, impractical to perform post weld solution heat treatment because of the high temperatures required and the distortion associated with the process.

Cleaning and material preparation prior to welding

Even when welding on new components made from new material we need to consider the cleanliness of the part to be welded. Aluminum has a great attraction for hydrogen and hydrogen's presence in the weld area is often related to the cleanliness of the plate being welded. We need to be extremely aware of the potential problems associated with used component which may have been subjected to contamination through their exposure to oil, paint, grease, or lubricants. These types of contaminants can provide

hydrocarbons which can cause porosity in the weld during the welding operation. The other source of hydrogen which we need to consider is moisture, often introduced through the presence of hydrated aluminum oxide. For these reasons it is important to completely clean the repair area to be welded prior to performing the weld repair. This is typically achieved through the use of a degreasing solvent to remove hydrocarbons followed by stainless steel wire brush to remove any hydrated aluminum oxide. More aggressive chemical cleaning may be required for some applications.

In the case where we are required to remove existing weld or base material in order to conduct the repair. We need to consider the methods available to perform this operation and their effect on the finished weld. If we need to remove a crack in the surface of a weld prior to re-welding we must use a method which will not contaminate the base material to be welded. Care should be taken when using grinding discs, some have been found to contaminate the base material by depositing particles into the surface of the aluminum. Routing and chipping with carbide tools is often found to be a successful method of material removal. Care must be exercised if using plasma arc cutting or gouging, particularly on the heat-treatable aluminum alloys. This can produce micro cracking of the material surface after cutting which is typically required to be removed mechanically prior to welding.

Conclusion: There are many considerations associated with the repair of aluminum alloys. Perhaps the most important is to understand that there are many different aluminum alloys which require individual consideration. The majority of the base materials used for general structural applications can be readily repaired using the correct welding procedure. The majority of aluminum structures are designed to be used in the as-welded condition and, therefore, with the correct consideration, repair work of previously welded components can and is conducted satisfactorily.

About the author

Tony Anderson is Technical Services Manager of AlcoTec Wire Corporation USA, Chairman of the American Aluminum Association Technical Committee for Welding, and member of the American Welding Society (AWS) Committee for D1.2 Structural Welding Code – Aluminum.

Advanced production technology leads to time savings of 25%

Twin-wire submerged arc welding with flux-cored wires

by Martin Gehring, ESAB GmbH, Solingen

Pistons for large diesel engines like those in ships wear out during their lifetime. Larger pistons with diameters of 700 mm are refurbished by welding rather than putting a totally new piston into service. This is usually done by submerged arc welding using a single solid wire.

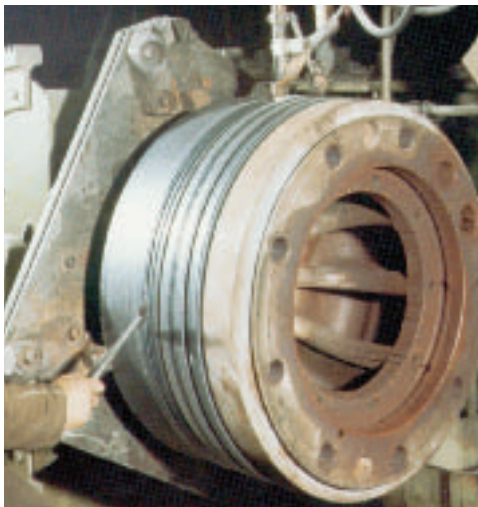


Figure 1.
Previously:
welding in
the piston
ring grooves

Changing the consumables to flux-cored wires in the twin-wire mode (two wires with the same potential in one contact tip) leads to increases in productivity of more than 25% without any increase in production costs.

When the engines are working, the piston ring grooves wear continuously because of the motion of the piston rings. Additionally, the surface of the piston heads wears due to the severe thermal conditions experienced inside the cylinder.

The base materials for these pistons are 34CrMo4 and 42CrMo4. A preheating temperature of 250°C prior to welding is therefore required. Before the customer started a project joint venture with ESAB, circumferential welding was carried out on the edges of the grooves, Figure 1. A solid S2Mo wire with a diameter of 4.0 mm was welded at 620 A. Firstly, the required number of build-up layers were welded, followed by two layers of hard-surfacing. In combination with the silicon and manganese alloying OK Flux 10.80, the hardness of the surface was

approximately 350 HB (~ 37 HRC). The piston heads were also welded in the same way.

Several trials finally led to the decision to weld this application with flux-cord wires in the twin-wire mode. The fluxes and chemical composition of the hard-facing wire were not changed. The change that was made was from solid wire to basic flux-cored wire by replacing the single 4.0 mm solid wire with two 2.4 mm wires. The wire that was chosen was OK Tubrod 15.21S containing 0.5% molybdenum. As it is a basic wire by nature, it has a high degree of cracking resistance.

Nowadays, the faces between the grooves are machined away. This results in a 300 mm wide area that is rebuilt, Figure 2. Positioning the electrodes and controlling the weld bead is much easier. The wires and the set-up permit a tremendous increase in deposition rate. Additionally, the current was increased slightly. It was not possible to obtain a similar result with a single solid wire.

In fact, compared with the previous method, the deposition rate has increased by more than 50%. Welding is performed at 720 A, 29 V with a travel speed of 68 cm/min. Moreover, the change to a 300 mm wide machined area has resulted in fewer welding defects with a more consistent bead deposit. When the welding is completed, the grooves are machined out of the solid material. The piston heads are refurbished with fewer layers at a higher welding speed.

Why flux-cored wires?

The deposition rate for flux-cored wires for submerged arc welding is as much as 20% higher than that of solid wires of same size welded at the same current, Figure 3. Basic flux-cored wires consist of a current-carrying, mild-steel tube with a non-conductive powder filling. Since all the current has to pass along the metal tube, the current density is much higher compared with solid wire. Consequently, the resistance heating is greater,



Figure 2. Today: easy handling. An increase of more than 50% in deposited weld metal

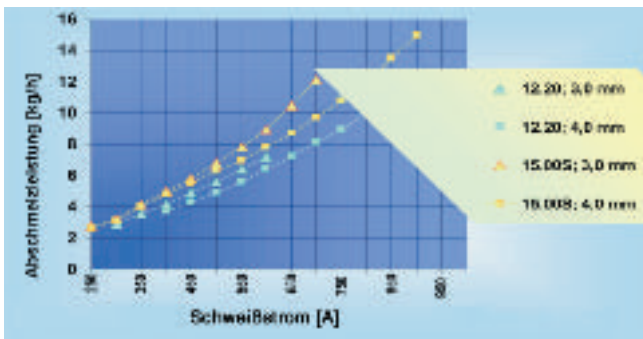


Figure 3. Increased deposition rate using flux-cored wires

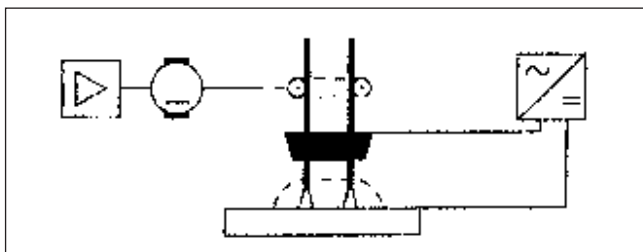


Figure 4. Twin-wire set-up

which leads to a higher melting rate and thereby to a higher deposition rate. Additionally, the basic slag “cleanses” the molten weld pool, reducing the risk of hot cracking.

Why twin wire?

Using two electrodes of smaller diameter results in an increase in deposition rates of up to 20% compared with one single wire of a larger diameter at the same current. Again, the current density is greater with two smaller wires. The wider arc results in a wider weld bead with less penetration. A shallow penetration bead is preferred for the repair welding of base materials with a high carbon content because dilution and sensitivity to cracking are minimised. For twin-wire welding, only one power source, one control box and one feed system with two grooves in the rollers are used, Figure 4. Both electrodes are fed through the same contact tip.

The customer benefits

Prepared cost and time calculations with real parameters revealed reductions in welding times of more than 25%. Although the welded area was larger, there is an additional cost saving of more than 10%. After some time in production with the modified welding process, the customer confirmed the following results.

Previously, the welding time for one particular piston was four shifts. The same piston is now welded in three shifts. The customer therefore saves 25% welding time using this advanced welding technology.

About the author

Martin Gehring works as product manager for consumables at ESAB GmbH in Solingen in Germany since 1994 and focuses primarily on the design of customer-specific systems within SAW and on welding using solid wire and shielding gas.

Consumables for high deposition rates for twin-wire welding

Build-up layers:

OK Tubrod 15.21S 0.5% Mo
 AWS A 5.23: F7A2-EC-A4 (10.71)
 EN 760: SA AB 1 67 AC H5

Diameter

2 x 2.4 mm

Flux

OK Flux 10.71

Hard facing:

OK Tubrodur 15.40 DIN 8555:
 UP1-GF-BCS 189-350
 EN 760: SA CS 1 89 AC

2 x 2.4 mm

OK Flux 10.80

Deposition rate:

11 kg/h

Corrosion- and wear-resistant 17% Cr strip weld overlays

by Martin Kubenka, ESAB VAMBERK s.r.o., and Petr Kuba, ZDAS a.s. Zdar nad Sazavou

Machinery manufacturers are constantly being pressurised by market competitors to sharply reduce the cost of their final products. The sale of very expensive spare parts frequently represents one way of reversing this problematic economic situation.

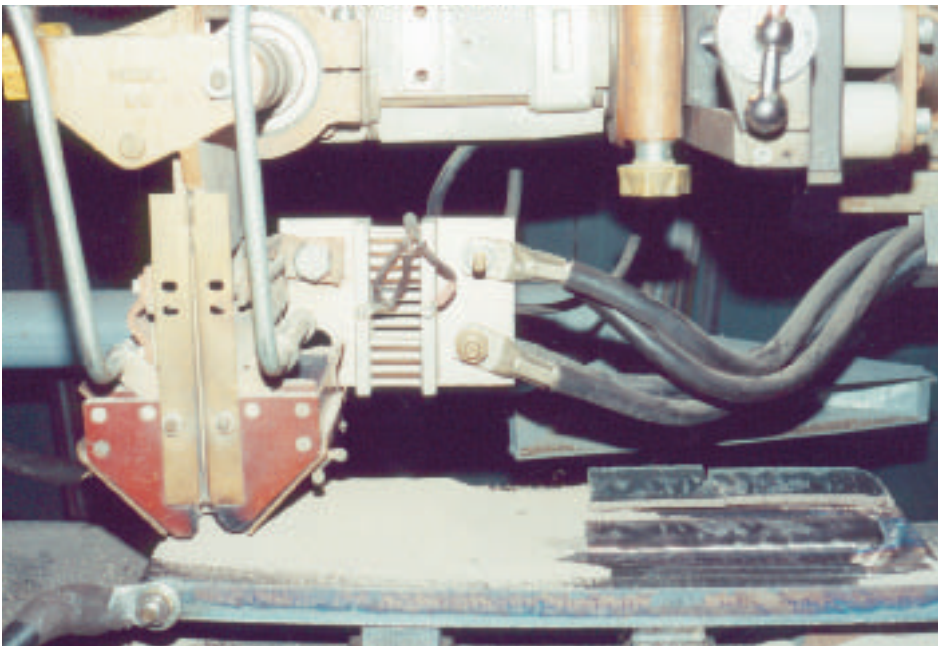


Figure 1. SAW strip-cladding of test piece

Users of the above-mentioned equipment are often burdened by the enormous cost of equipment maintenance and repair due to part replacement.

Welding and weld-overlay techniques have been the most frequently used procedures for the renovation of steel parts for equipment in virtually every industrial sector.

Weld-overlay techniques are a very inexpensive and high-quality way of renovating the parts attacked by some primary and secondary wear factors, such as abrasion, pressure, corrosion, wear caused by metal-to-metal contact and so on.

Designation	C	Mn	Si	Cr	V
CSN 13123	< 0.23	1.2	0.30		0.25
A 406	< 0.1	0.5	0.50	16.0	
E-B 511	0.2	0.6	0.30	13.0	

Table 1. Repaired materials

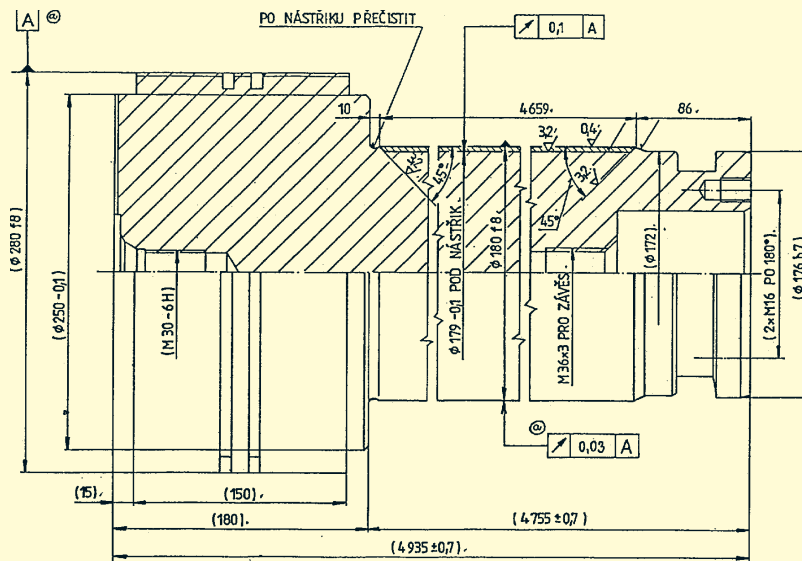
The strip weld-overlay technique basically increases productivity and reduces the likelihood of defects appearing, together with the need for weld overlay.

Customer requirements

During production at ZDAS a.s. Zdar nad Sazavou, a leading company when it comes to the production of heavy hydraulic components, the need to renovate the piston rods in hydraulic surface mining equipment made of forged steel and designed according to CSN 13 123 (see Table 1) became clear.

Originally, the weld overlay had been performed using SAW with wire A 406 (Table 1) produced by ZAZ Vamberk. This weld overlay was then partially removed before renovation could once again take place.

The customer wanted to produce a one-layer weld overlay with a chromium content of above 12% and a minimum hardness of 35 HRC.



Material: polotovár (123.5) (VYKOVĚK)	Finotnost 1020	Mřížko 1:2	St. výřez 2-68 954	3 x 0	Změna	Den	2.6.1996	Podpis
Konstr. KOUTNÝ	Tech. kontr.	Název PÍST S PÍSTNICÍ						
Konstr. Ing. DVORÁČEK	Dotisk	Číslo výkresu 3-206272						
Schválil Ing. PILNÝ	15.12.1994	ZDAS						

Figure 2. Hydraulic piston

Designation	C	Mn	Si	Cr	Ni	Mo	V	Nb
OK TUBRODUR 15.73	0.14	1.2	0.3	13.0	2.5	1.5	0.25	0.25
PZ 6163	0.15	0.5	0.7	17.0		1.0		
OK BAND 11.82	0.06	< 0.5	< 1.0	17.0	< 1			

Table 2
Welding consumables used

Cored wire/strip	Ø mm	Flux/gas	C	Mn	Si	Cr	Ni	HRC
OK TUBRODUR 15.73	3.2	OK FLUX 10.03	0.12	1.0	0.38	8.54	1.60	43
		OK FLUX 10.09	0.11	0.76	0.55	10.08	1.55	43
PZ 6163	1.6	AGAMIX 18	0.20	0.59	0.71	15.57	0.20	29.9
		OK FLUX 10.07	0.11	0.50	0.78	13.94	2.16	48
OK BAND 11.82	30 x 0.5	OK FLUX 10.03	0.05	0.30	0.45	14.47	0.22	33
		OK FLUX 10.07	0.05	0.30	0.48	13.27	2.89	45
		OK FLUX 10.09	0.06	0.25	0.57	12.54	0.52	35

Table 3
Weld-overlay properties

Characteristics of welding procedures

Cored wire/strip	OK TUBRODUR 15.73	OK BAND 11.82
Welding equipment	ESAB 1200A	ESAB 1200A
Current	800 A	400 A
Voltage	30 V	28 V
Welding speed	600 mm/min	160 mm/min
Distance orifice-base material	8 mm	25 mm
Position of orifice	In the axis	15 m before turning point
Number of layers	1	1

Table 4
Characteristics of welding procedures



Figure 3. Piston after welding overlay and machining

Test weld overlay

In collaboration with ZDAS a.s., several series of weld overlay test specimens were produced by the laboratory at ESAB VAMBERK, s.r.o. in order to find the optimum welding procedure and to choose suitable, correct filler metals.

Individual weld overlays were gradually prepared using flux-cored wires designated OK TUBROD 15.73, in combination with fluxes OK FLUX 10.03 and OK FLUX 10.09, plus flux-cored wire PZ 6163 (Table 2) in the gas shield AGAMIX 18 or flux OK 10.07 respectively.

The next test specimen series was weld-overlaid using strip electrode OK BAND 10.82 (Table 2) in combination with fluxes OK FLUX 10.03, OK FLUX 10.07 and OK FLUX 10.09. The test specimens were first buttered using coated electrode E-B 511 (Table 1) and then partially machined in order to simulate weld overlay wear.

Weld overlays were performed on both plates and on the cylinder with a diameter of 174 mm using a table rotary positioner. The weld overlay conditions are specified in Appendices 1 and 2. The test results are shown in Table 3 and Figure 1.

On the basis of results that were obtained, it has been possible to demonstrate that all the customer requirements were totally fulfilled by the combination of OK BAND 11.82/OK FLUX 10.07.

Practical application

The first application of the above-mentioned filler metal combination was made at the SKODA JS a.s. Pilsen welding shop on piston rods with a diameter of 176 mm and a length of 4,659 mm (Figs 2 and 3).

Due to the increase in the deposition rate and in order substantially to reduce weld-overlay defects, strip electrode OK BAND 11.82 and flux OK FLUX 10.07 were chosen for this purpose.

The weld-overlay conditions were the same as in the case of the test specimens.

The weld-overlay trajectory was a helix. During weld-overlaying, it was intensively cooled by air.

Economic evaluation

Materials used: strip electrode OK BAND 11.82
flux OK FLUX 10.07

Strip weight: 77 kg

Flux weight: 77 kg

Strip price: CZK 22,215

Flux price: CZK 12,320

Cost of work: CZK 75,715

Cost of repair: CZK 110,250

ZDAS a.s. saved the sum of:

Price of new part: CZK 281,500

Cost of repair: CZK 110,250

Total savings: CZK 171,250

About the authors

Martin Kubenka works at ESAB s.r.o. in Vamberk in the Czech Republic. He is responsible for technical customer service.

Petr Kuba is a welding engineer at ZDAS a.s. Zdar nad Sazavou.

ESAB: your digital partner for welding and cutting

ESAB has now been on the World Wide Web for some time. New and extended sites for ESAB Europe and ESAB Norway were launched in December 1999 and other ESAB companies followed during 2000. In all, 21 ESAB sites have been launched. These sites are attracting many visitors and there have been words of praise for the mine of information they contain.



As a result of the structured set-up, every visitor is able to find the information he or she wants. You will find a wealth of product and process information, while on another page you can ask who the dealer in your local area is. Obviously, you can also ask questions interactively and it is possible to be kept in touch with our latest news. This is just a random selection of what ESAB has to offer on the Internet!

Start surfing by typing www.esab.com. You now have the option of choosing any of the 21 ESAB regional or national sites.

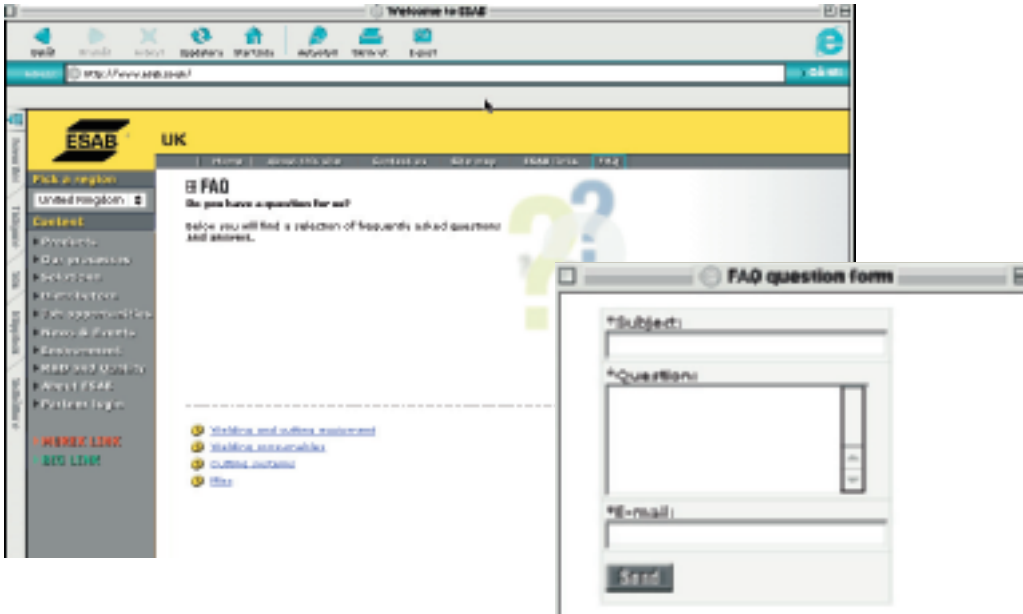
At the top of each site you will find the heading 'Products'.

- Click on Products and you will arrive at the sub-page 'Products'. This page breaks down into four parts: Welding and cutting equipment, Welding consumables, Welding automation and Industrial cutting systems. You can now choose one of the four product groups by clicking on the related picture. It is also possible to use the main menu (left-hand side of the screen) and make your choice there.
- Click on 'Welding and cutting equipment. This page appears with another pop-up menu, consisting in this case of six options.
- The choice this time falls on 'SMAW (Stick MMA)'. When this link is clicked, you reach the level at which ESAB handwelding equipment is presented.
- If you want the detailed data for a 250 A inverter, for example, click on 'Caddy Professional 250'. A brief description of the machine, an illustration, the technical data and ordering information will then appear on screen.



Frequently Asked Questions

If you have specific questions about anything to do with welding or cutting, you can put these questions to ESAB's product specialists (not possible on the regional sites). On the horizontal bar at the top of the page, you



will see the FAQ (Frequently Asked Questions) tab.

- When you click on this tab with your left mouse button, a pop-up list of categorised questions and answers appears.
- Choose one of the subjects and see whether your question is there and has been adequately answered. If this is not the case, it is possible to type it in on the form you can activate by clicking in the framed box showing 'Fill in this form'. Your question will then be sent directly to the product specialist concerned, who will reply to you by e-mail. Your question with the accompanying reply will also be placed under FAQs.

It is also worthwhile regularly visiting the latest news. Campaigns, trade fairs and reference projects are just some of the subjects that can be found here. You do not need to visit our website constantly to keep abreast of the latest news.

- At the bottom right of the homepage (first page), the most up-to-date news constantly scrolls by.
- If you click on the words 'Latest news', you access the news and events page where you can register so that you are automatically notified by e-mail when ESAB has news.

Finally, the Internet as a medium for ESAB is a means not an end in itself. By making use of this medium, we are able to:

- respond to the customer's needs quickly and efficiently
- communicate the latest product information quickly
- offer promotional campaigns extensively and quickly

- respond interactively to questions and problems
- provide considerable background information by linking to both related ESAB pages and external sources
- provide electronic service as a product plus

Bookmark your preferred ESAB site and visit us regularly. You'll find it there.



Stub-ends & Spatter

Railtrac was the only option



At Petron Emirates, an oil and gas industry in Dubai, there was an urgent need to restore the walls of a regenerator. The regenerator converts sulphur into sulphur dioxide, SO_2 , at a temperature of 500°C , which is then used in the processing of crude oil. The inside lining of ceramic is supposed to maintain the SO_2 in gas form, but, due to temperature differences, the lining sometimes cracks and the gas comes in contact with the base metal where it initiates corrosion.

Thin walls

In this case, the metal wall thickness had been reduced from 28.5mm to 11.0mm and it was therefore essential to restore the area. Due to space restrictions, the only method available was welding. ESAB Middle East recommended cladding using OK Tubrod 15.13, 1.2mm. Using two Railtrac F1000 and LAX 380+MEK2+PSF 400, the entire area, with a length of 8 m and a height of 1.5 m, was built up to a thickness of 29.00mm.

Round-the-clock work

The machines were in use 24 hours a day with six welders working in shifts. It took eight days to

complete the job, which required 520 kg of consumables. Stringer beads were deposited to control heat input. The wire OK Tubrod 15.13 was set at 33 V and 240 amps with a stickout of 18 mm. The travel speed was 55 cm/min to 70 cm/min, depending on the desired build-up. The interpass temperature was maintained at 300°C . The weld deposit was checked continuously by UT for cracks and so on

Railtrac once again proved its efficiency and it was a great experience to bring the project to a successful conclusion as man and machine raced against time during the shut-down.

Facts about Railtrac

Railtrac is a modular system with many different components that can be used to create suitable systems and solutions for mechanised welding and cutting. Four basic versions are available as standard:

- Railtrac F1000 Flexi
- Railtrac FW1000 Flexi Weaver
- Railtrac FR1000 Flexi Return
- Railtrac FWR1000 Flexi Weaver Return

The Railtrac tractor runs on a universal rail, which can also be used on bent surfaces. The operator controls the welding from a digital programming box, which can store as many as five different welding programs. Functions include interval welding, weaving and backfill.

ESABs welding guns, wire-feed units and power sources can be connected to Railtrac 1000. Railtrac 1000 weighs six or seven kilograms, depending on the model.

Qingshan Shipyard

In September of last year, ESAB Asia/Pacific managed to obtain an order for duplex consumables for the building of chemical carriers. The customer is the Qingshan Shipyard, in the city of Wuhan, 750 km east of Shanghai. The city is built on both sides of the large Yangtsekiang river, where another river, the Han Shui, also joins the Yangtsekiang.

The order is from a European shipowner and the size of the ship is ~ 6.800dwt, indicating that the amount of duplex consumables will be about 35MT. The plate material is standard 2205 from CLI. ESAB will supply the following consumables: OK 67.62, OK 67.50, OK 67.60, OK 14.27, OK 14.22, OK 16.86 and flux 10.93. The ship is being built according to GL rules.

The project team, consisting of people from different countries, is running extensive support activities for the yard. The programme consists of assisting with pWPSs, training personnel - both engineers and welders, engineering support, production start-up support, 24-hour telephone support and a six-month schedule to make visits to assist.

This is a very good example of practical work according to the "local to global" way of utilising ESAB's resources. So far in the above-mentioned schedule, the engineer and welder training has been completed. It took place last year with support from Singapore, the Netherlands and Sweden.

The project team is looking forward to the progress of this project and will use the experience that is acquired in other similar projects in this region.



From the welder training

Hydro Power Generation PZ 6166 goes Latin American

The hydro-power turbine fabricator IMPSA in Argentina acclaims the PZ 6166 metal-cored wire from ESAB.

PZ 6166 is designed for welding the 410NiMo martensitic stainless steel, which is widely used for hydro-turbine components like runners. PZ 6166 is without doubt the ESAB leading-edge product in this segment.

The very good all-positional operability combined with the resulting defect-free welds are the features the company praises in this product.

IMPSA is also using other welding consumables from ESAB Europe for its hydro-turbine fabrication. In fact, the company has successfully used most of the products ESAB offers for this application in its production operations. For submerged arc welding, it uses our combination of **OK Flux 10.63/OK Autrod 16.79**, the metal-cored **PZ 6166** wire for semi-automatic welding and the stainless, low-hydrogen **OK 68.25** covered electrode. In addition, IMPSA has tested various types of ceramic backing for one-sided welding.

Repair and maintenance electrodes in new VacPac wrapper

ESAB brand coated electrodes for repair and maintenance that are manufactured at our plant in Perstorp, Sweden, will only be available in the new VacPac wrapper from now on. This type of pack offers a remarkable way of storing electrodes on the shelf in your stores for up to three years, if they are kept unopened. An excellent reason for any customer to take a closer look at ESAB R&M quality electrodes.

This is a real benefit because the ageing of the electrodes is inhibited as they are protected from harmful atmospheric content.

The new VacPac is available in three different sizes. 1/4, 1/2 and 3/4 packs.

1. Quarter packs contain the smallest number of electrodes. There are nine 1/4 packs to one carton. The approximate weight of a 1/4 pack is between 0.7 and 1.0 kg and the number of electrodes varies according to the diameter.
2. The half pack is the next size up and there are six so-called 1/2 packs to one carton.
3. The largest VacPac is the 3/4 size and there are four of these to a carton.



For repair and maintenance electrodes, the full-pack 1/1 type of plastic container is now being discontinued.

The smaller dimensions of the most sophisticated types of electrode in the R&M range namely nickel-based electrodes, electrodes for welding dissimilar steels and copper-based electrodes are available in the 1/4 packs. A positive factor for a purchaser as this eliminates the need to purchase more electrodes than are necessary.

Coated electrodes for aluminium welding will still be supplied in the older similar type of VacPac including the plastic container.

The hardfacing electrode dedicated to the sugar cane processing industry

Enormous rollers like the one seen here are used in the sugar cane crushing process and are subjected to excessive wear during the season. They have to be continuously welded, even when the process is in full swing. No stopping the presses here! This means that a welder must be present on a three-shift basis to be able to work the roller surface. The roller, which is located near the end of the crushing process, is smothered in crushed, sludgy cane and its surface is therefore wet. The characteristics of our electrode must be able to accommodate these conditions. Striking an arc

with OK 84-76 is very easy and the welding characteristics are superb in the environment to which the electrodes are exposed.

OK 84.76 is a high chromium-carbide type and contains approximately 4-5% carbon and as much as 35% chromium. The electrode deposits a dispersion of small, hard and very wear-resistant globules that fasten to the side walls of the ridges of the roller.

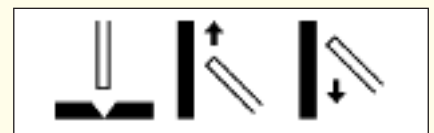
It is used on positive current for DC power sources, whereas it needs an open circuit voltage of at least 65 volts for AC transformers.

OK 84-76 is available with a diameter of 4 mm and a length of

450 mm. The welding current can range between 140 and 220 amps.

The weld metal hardness, as welded, is 55 to 60 HRC.

The welding positions are:



This electrode is tried and tested and it appeals to welders in the cane industry.

For further information, please contact:

ESAB AB, Jeff Ramsay at
e-mail: consumables@esab.se
or fax +46 31 50 91 70



The most sophisticated panel cutting machine!

Chantiers de L'Atlantique is the largest shipyard in France. Its order book is full until 2004-2005. The company specialises in passenger cruise liners and, as such, it has just received an order for the largest passenger ship ever built and called the Queen Mary 2.

Three years ago, the target was to increase productivity on the panel line by 30%. In order to achieve this target, Esab Cutting

Systems designed a panel machine with an integrated grinding device. The grinding head removes paint from the surface (50 mm grinding width) where the stiffeners will subsequently be welded, at a speed of 15 m/min instead of 3 m/min with a "normal" shot-blasting device. This speed guarantees that less than 5 microns of paint will remain after grinding. The machine was equipped with a grinding unit, two

arc markers and two triple-torch head units. The initial target of 30% has been more than met! The machine is used on three shifts, seven days a week!

Today, the new target is once again to increase productivity by 30% compared with the existing machine. This target can be realised by increasing the cutting speed using plasma instead of flame cutting.

The new TXB 25000 machine will be equipped with a grinding unit, two arc markers, one triple-torch head and a dry VBA plasma head. In order completely to extract the fumes that are generated, an exhaust table measuring 20 m x 20 m will be installed. This is a brand-new concept and all the equipment should be installed within three weeks and commissioned at the end of August. ESAB, always a cut above the rest!

For more information, please contact Arnaud Paque at e-mail: arnaud.paque@esab.fr or fax +33 (0) 1 30 75 55 20

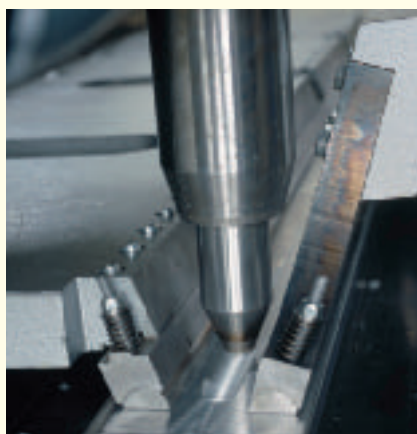
Continued success for ESAB Super Stir™

Interest in the Friction Stir Welding (FSW) technique for aluminium continues to grow. Even if the cost of the investment is substantial, experience acquired from the systems that have been installed so far indicates that good profitability is possible.

The FSW process offers many benefits. The strength and quality are superior to those provided by other welding methods and the process requires no special surface treatment prior to welding. Another of the advantages of FSW is the opportunity to join alloys that could not previously be welded.

During the latter part of 2000, ESAB's FSW team in Laxå, Sweden, signed three new contracts involving deliveries of the ESAB Super Stir™ system.

The first contract was signed with TWI in the UK. ESAB



SuperStir™ equipment will now be installed where the entire process was invented and where Friction Stir Welding actually began. The equipment has a gantry-type design with a welding area of 5 x 8 metres and it is equipped with two heads of different sizes.

The second contract was signed with DanStir ApS in Denmark. This

machine is of the same gantry-type design as the one for TWI, but it is designed for a welding area of 3 x 5 metres and is equipped with one welding head.

The third contract was signed with EADS/Institute de Soudure in France and involved a basic longitudinal FSW machine. This machine is also equipped with a unit for circumferential welding and, furthermore, the welding head is designed not only for normal tools but also for retractable pin-tool and bobbin-tool techniques.

All three systems will initially start with test welding and laboratory operations.

ESAB has previously delivered some ten sets of Super Stir™ equipment to companies in the marine sector and the aerospace and automotive industries.

Repairing cement kilns

North-west of Sofia lies the small village of Vratsa. When the Holderbank Company of Switzerland purchased the cement works there, the plant was in great need of repair. In the past, a total of seven kilns produced cement at this plant, but today only two remain. The things that needed repairing included one of the kilns.



Figure 1. The kiln with a two by four metre opening.



Figure 2. The replacement plate after welding.

The diameter of this kiln is a little over six metres. On a circumferential section in the middle of the above picture, the shell was badly damaged because the fireproof bricks on the inside had collapsed, rupturing the 40 mm thick shell. A two by four metre opening was made in which a new 40 millimetre thick replacement plate would be fitted, see Figure 1.

The plate was cut, bevelled and prepared in the workshop on site at the plant. The joint preparation was an asymmetrical X type with a 3 mm root face and a 60° bevel on each side. The corners of the plate and, later, the opening were rounded. A mobile crane lifted the eight square metre plate 25 metres into position, where

it was fixed in place. The joint was filled with OK 92.26, a nickel-based electrode with high strength properties at high temperatures.

Picture 2 shows the plate in position and welding completed on the outside of the kiln. Two teams of two welders worked two shifts for four days to complete the welding. The welding team was a Sofia-based company which had been commissioned to carry out the work on the kiln.

The finishing touches

The joint was X-rayed and passed 100%. Before assembling the fire bricks, the joint on the inside of the kiln was ground, Picture 3. The new fire bricks were then carefully re-assembled and the kiln was fired up once again. It is now back in production.

Another part of the plant, the ball mill, was also in need of repair. Longitudinal cracks had occurred between the fixing bolts in the 25-year-old mill and they had to be completely eliminated by repairing. Dye penetrant was used to define the extent of the cracks, which were then drilled or gouged out using the OK 21.03 gouging electrode. After thoroughly checking the joints for remaining cracks, they were welded with OK 55.00. This repair work required 37 hours of non-stop welding to complete.



Figure 3. Grinding of the joint on the inside of the kiln.

Submerged-arc strip cladding of continuous casting rollers using OK Band 11.82 and OK Flux 10.07

by Dipl.-Ing. Rolf Paschold, ESAB GmbH Solingen

Continuous die casting systems are very much used in modern steel plants. The continuous die casting technique achieves for a steel plant and the attached rolling mill considerably higher productivity when compared with former standard gravity die casting technique.

Due to gravity, the continuous casting process takes place in a vertical direction, followed by redirection of the red-hot billet into horizontal position in order to be able to carry out the subsequent working operations like cutting to length in the latter position.

Billet guide rollers, so-called continuous die casting rollers, are used for redirection of the red-hot billet (Fig. 1). These are exposed to considerable strain in service:

Thermal load and thermal shock

The surface gets very hot (approx. 950°C) through the contact with the red-hot billet. The roller is subjected to heat, scaling and because of fast local temperature changes to thermal shock. As the temperature fluctuates locally, the rollers circumference and cross-section is exposed to thermal stress. As a result of such thermal load, material loss through scaling and tearing may develop.

Corrosion

The red-hot billet already carries a scale film on its surface. Together with the cooling water sprayed onto the billet, it produces an acidic medium (pH 4–5) which causes roller corrosion.

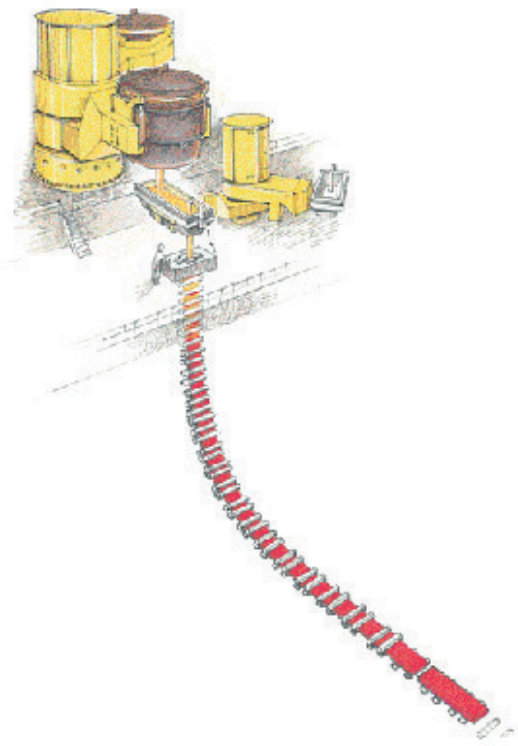
Wear by friction

There is a mixture of rolling and sliding friction at the contact point with the billet. These frictions cause roller abrasion. Mill scale which contains very hard oxides, causes grinding wear (abrasion).

Metal fatigue

To guide the steel billet, the rollers are exposed partly to very high forces. The present reverse bending stress can cause fatigue cracks and, at the worst, roller breakage.

The sum of these strains results in a limited service life of the continuous casting rollers. The system operators usually have at least two sets of rollers of



which one is in use and the other is being re-surfaced. The repair of the rollers is either carried out by an individual unit of the steel plant or by a dedicated external company. Soft martensitic weld metals are commonly used as an alloy for surface welding. They consist of approx. 13% chrome, 4% nickel and about 1% molybdenum. These alloys have been a great success because of their combination of resistance to heat, thermal shock, corrosion and wear.

Different welding processes are applied for surface welding of continuous casting rollers. In some cases, the regeneration is carried out by MAG welding where cored wire electrodes are preferred. Because of its higher deposition rate, submerged arc welding is often used. Wire electrodes used are also cored wires, a typical one is OK Tubrodur 15.73. Suitable fluxes are OK Flux 10.61 and the specially developed OK Flux

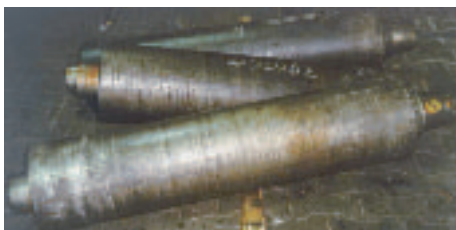


Fig. 2. Worn concast rollers before repair and maintenance



fig 3.

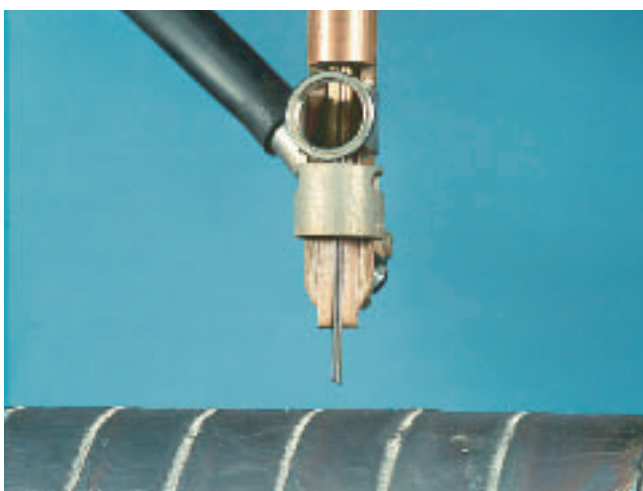


Fig. 4. Sub-arc cored wire surface welding with OK Tubrodur 15.73 and OK Flux 10.37

10.37, which is suitable for sub-arc surface welding of continuous casting rollers. Its application secures outstanding weld surface and slag removal at very high working temperatures.

All previously mentioned methods work with alloyed cored wires in combination with shielding gases or neutral, non-alloying fluxes. Since the production of equivalent solid wire electrodes is quite difficult because of their hardness, cored wire electrodes have been successfully produced for a long time. For sub-arc strip cladding suitable strip electrodes using sinter technique have been made available. However, production of sintered strips is relatively complicated and costly. The more cost effective alternative is a solid strip containing the alloying element chrome along with an alloyed flux which mixes the elements of nickel and molybdenum with the weld metal:

Strip electrode:	OK Band 11.82
EN 12072:	S 17
DIN 8556:	UP X 8 Cr 17
Werkstoff-Nr:	1.4015
Flux:	OK Flux 10.07
EN 760:	SA CS 2 NiMo DC

This is a special flux with excellent welding and self-releasing slag properties also at high working temperatures. It produces even and notch-free plating surfaces.

Alloy mechanism

Metallurgical reactions set-in during sub-arc welding, when material transfers from the wire or strip electrode to the molten pool and when it comes into contact with the slag, or when the molten pool is in contact with slag. These processes depend also on the welding parameters. For example, an increased arc voltage results in a more intensive contact of a droplet with the slag and consequently a stronger reaction. The metallurgical processes during production of a multi-run soft martensitic weld metal with OK Band 11.82 and OK Flux 10.07 are briefly described here. A three-run coating onto mild steel was carried out to show the alloy distribution. OK Band 11.82 was used, dimensions were 60 x 0,5 mm, the weld metal parameters were is = 900 A, Us = 26 V, vs = 13 cm/mm, stick-out length of the strip: 30 mm

Chromium

Chrome is the main alloy element in a soft martensitic weld metal with approx. 13% Cr content. The chromium is added to the weld metal via the strip electrode, which contains approx. 17% Cr. With mixing with the base material or previous runs together with flashburning through oxydic flux components, the chromium content of the weld metal levels out at desired 12–14%.

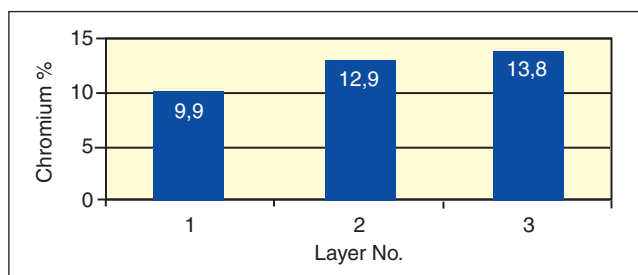


Table 1. Chromium content in weld metal

Nickel

Nickel is exclusively added via flux to the weld pool. With reference to equilibrium reactions, the increase of nickel content becomes smaller with each run. Finally the nickel content levels out at desired 4–5%.

Molybdenum

Adding molybdenum via the flux is similar with that of nickel. With increasing number of runs, the alloy difference becomes smaller, until the equilibrium is reached at about 0,8–1,2%.

Surface cladding of continuous casting rollers is carried out in three runs. As a result, the requested target analysis is achieved and a soft martensitic weld metal is produced. Before machining, the rollers are

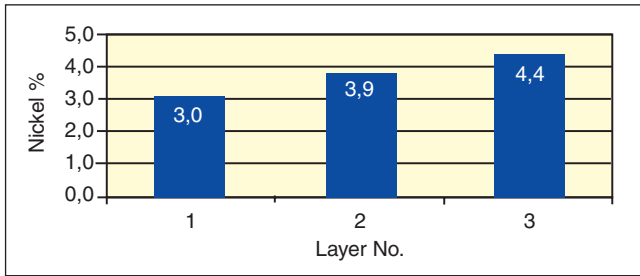


Table 2. Nickel content in weld metal

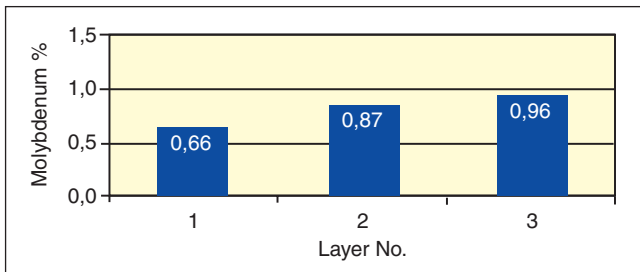


Table 3. Molybdenum content in welding pool

annealed (e.g. 520°C/4h). The weld metal hardness after annealing is 40±2 HRC. However – are there further advantages using sub-arc strip cladding with OK Band 11.82 and OK Flux 10.07 apart from cost-effectiveness? OK Band 11.82 is mostly used as a strip of 60 x 0,5 mm. A welding current of 700–900 Amps is usually used for that strip dimension, which results in a deposition rate of 12–14 kg/h – a very good rate of profitability with surface cladding. In addition it must be considered that the weakest point of clad rollers is the transition between the weld beads. Due to the heat spread from the next run, annealing affects the overlap line. Here the hardness and wear resistance are a bit lower. Using wide strip electrodes, the number of weld bead overlaps is reduced and abrasive resistance is in total better.

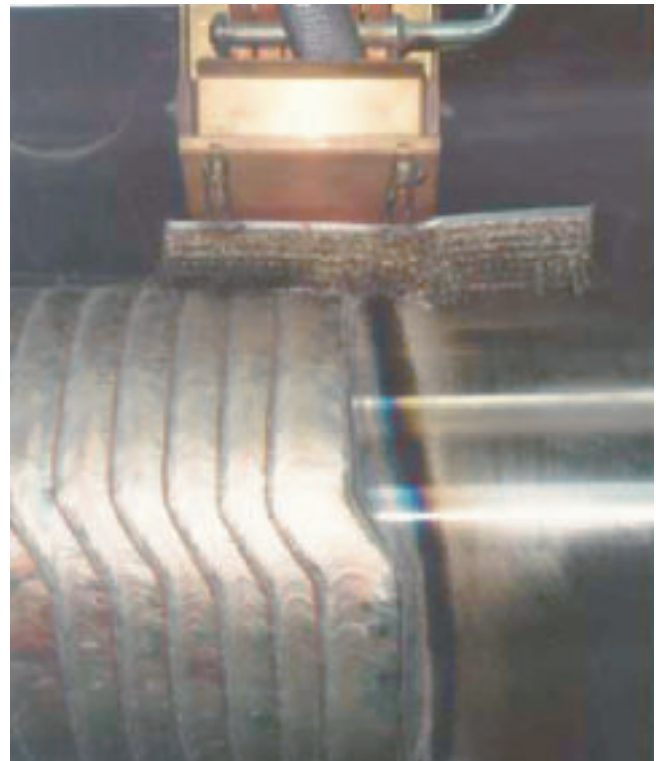


Fig. 5. Strip cladding of smaller rollers with OK Flux 10.07 and OK Band 11.82 dimension 30 x 0.5 mm.

About the author

Rolf Paschold, product manager at ESAB GmbH Solingen (Germany), graduated in 1990 as a mechanical and welding engineer. He joined ESAB in 1991 and is the sales support manager for welding consumables. Mr Paschold has always shown a special interest in tailor-made process applications developed together with the customer.

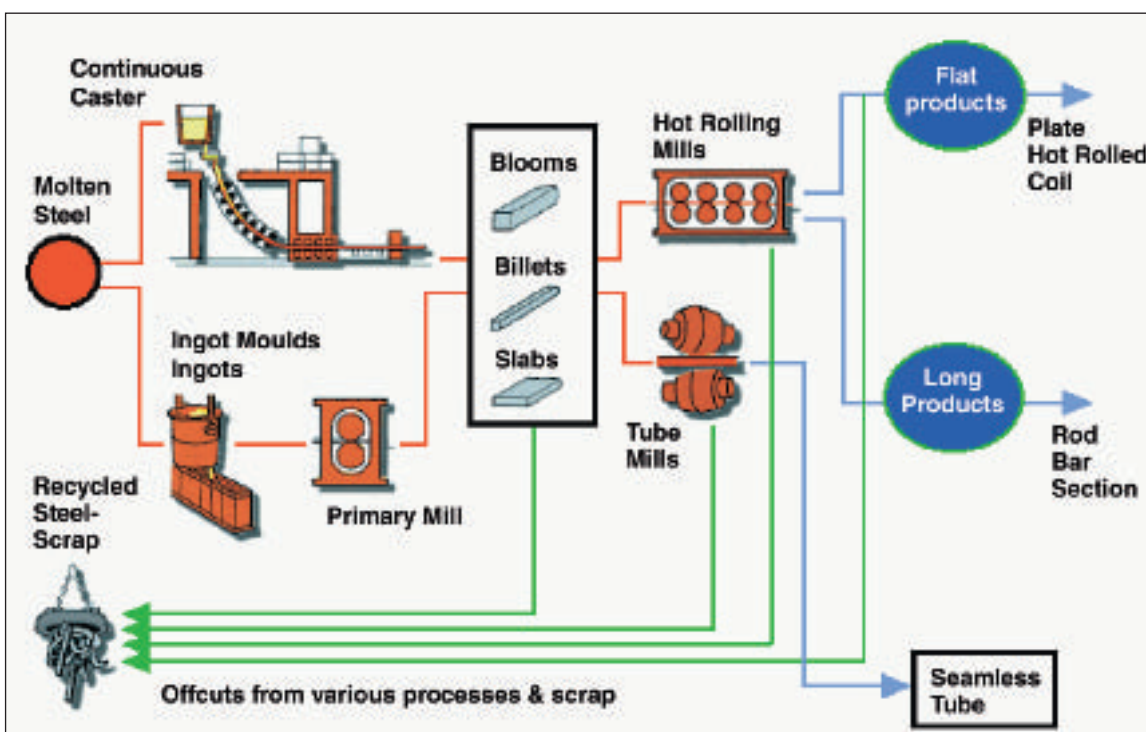
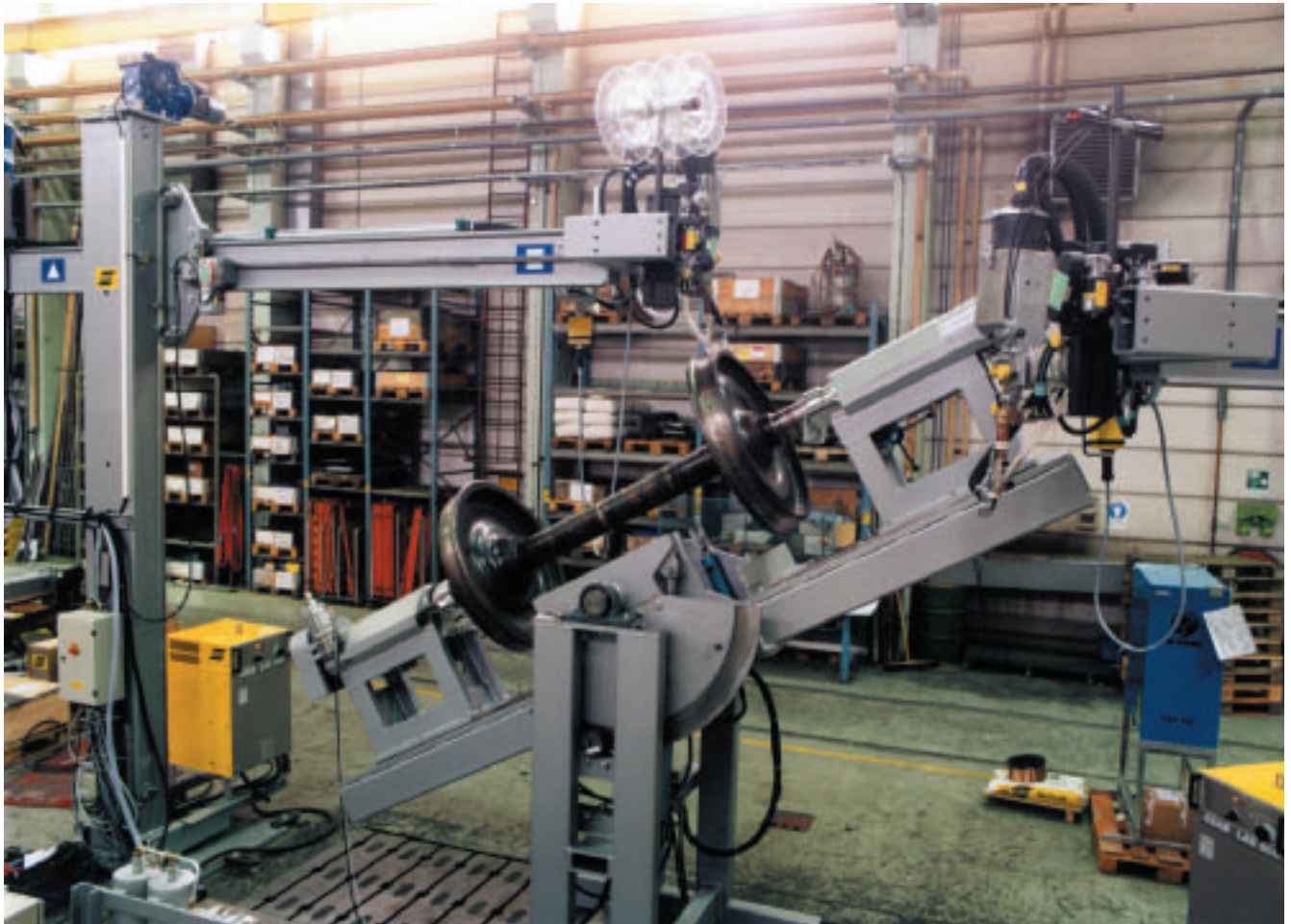


Fig. 6. The principle of continuous casting and hot rolling.



ESAB delivers engineered automatic welding station to Ghana in Africa for build-up welding of worn railway wheels

by Peder Hansson, ESAB Welding Equipment, Laxå, Sweden

The wheels of rolling stock are exposed to extensive wear. Braking, acceleration and passing bends all result in the gradual wearing down of the running surface of the wheels. In particular, the lateral forces generated when a wheel passes a bend cause a great deal of wear in the transitional zone between the “tyre” or running surface of the wheel and the side flange. In most cases, this wear occurs both radially and axially and results in a negative change in the profile of the wheel.

Welding and hardness

Wheel	Consumables	Hardness
C 0.7, Si 0.5, Mn 1.4	OK Flux 10.96, OK Tubrodur 14.71	Face edge 520 HV
C< 0.5, Si 0.3, Mn < 0.9	Ok Flux 10.71, OK Autrod 12.24	Face 200 HB
C< 0.5, Si 0.5, Mn 1.5	Ok Flux 10.71, OK Autrod 12.40	250 HB
C 0.45, Si 0.3, Mn 0.55, Cr 1.1, Mo 1.2	OK Flux 10.71, OK Tubrodur 15.40	32-40 Hrc

The wheel can naturally be given its original profile once again using a lathe turning process. However, one significant drawback of this method is that it involves the removal of a large amount of material that is not worn out. This takes time and also results in a wheel of smaller diameter.

A more effective method involves rebuilding the worn part of the wheel surface by welding. Using a suitable filler material and the correct welding method, the welded material is equally good or even better than the base material and the wheel can then be given its original profile by fine grinding.

The process and the welding equipment

Welding is done without removing the wheel or bearing housings and both wheels can be welded simultaneously using two submerged arc-welding heads.

The axle complete with wheels is rolled in on rails into the bottom of the machine, build-up welding is performed and the axle is then rolled out again.

The manipulator, which is down in a pitch, clamps the axle with the wheels and rotates the wheels.

For welding in the best position, the manipulator and the wheel set can be tilted ± 50 degrees.

The two automatic A6 welding heads are mounted on ESAB MKR columns and booms, allowing the heads to be positioned in the desired position in relation to the wheels.

The welding process is either single wire or twin wire (two wires connected to same power source). The power sources are two ESAB LAF 1250 for a maximum of 1,250 A.

The welding process controller is the ESAB computerized PEH process controller.

Flux is automatically fed from floor level to the welding heads, by means of pressure and hoses with compressed air.

Scope of Supply

- 1 - Tilttable manipulator with head- and tailstock
- 2 - Column and Boom, type MKR 300
- 2 - Welding head, type A6S - Arcmaster for Twin or Single wire SAW
- 2 - Process controller, type PEG1
- 2 - Joint tracking equipment, type A6 GMD
- 2 - Power sources, type LAE 1250
- 2 - Flux recovery units, type OPC
- 1 - Flux feeding equipment, type OPC 75

Spare part set

Consumables, wire and flux

About the author

Peder Hansson joined ESAB in Laxå in 1969 as a mechanical designer. He is now responsible for the sale of engineered solutions within ESAB Automation in Laxå, primarily in the shipyard and pipemill sectors.

Cobalarc: The future of manual hardfacing

A K De, Divisional Manager, Reclamation Consumables, Esab India Ltd.
S Sarkar, Product Manager, Reclamation Consumables, Esab India Ltd.

As the days pass and the pressure on industry to conserve precious natural resources becomes immense, the issue of hardfacing is becoming increasingly important. At the same time, welding technology is moving towards increasing automation.

The regular reclamation applications in the industry, however, do not always permit the use of continuous consumables because of exigencies and the versatility of alloys. Stick electrodes provide the greatest flexibility in terms of the chemical composition and microstructure of the deposited alloys. Bearing all these aspects in mind, it can be inferred that the Cobalarc range of electrodes will be the standard-bearer for manual hardfacing as we look into the next millennium.

Hardfacing with carbides and Cobalarc

Cobalarc is a range of hardfacing stick electrodes manufactured and marketed by Esab India Ltd. These electrodes are mainly used for hardfacing in applications where the prime factor of wear is abrasion. As is well known in welding circles, the major ingredients that provide resistance to abrasion are metallic and non-metallic carbides, owing to their very high hardness. However, this feature also renders them difficult, if not impossible, to use in coated electrodes.

This problem has really come as a blessing in disguise – the launch of Cobalarc electrodes. In this case, these preformed carbides are put into a mild steel tube, which is then subjected to normal manual arc welding. Welding is facilitated by the presence of a thin coating of non-hygroscopic arc stabilizers on the tube. This simple step has revolutionized hardfacing. As high volumes of carbides are packed into these steel tubes, the resultant weld deposit provides excellent abrasion resistance. In some applications, impact, oxidation and/or corrosion is also present, along with abrasion. In such cases, the various types of carbide are packed in combination.

Benefits

Cobalarc electrodes offer the following advantages, the cumulative effect of which is increased life for the hardfaced components at an economical cost to the end-user:

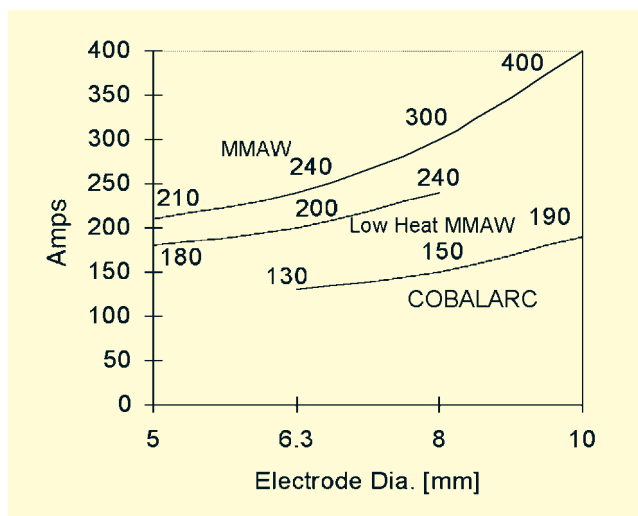


Figure 1.

1. Preformed carbides: In coated electrodes, the formation of carbides to provide a high level of hardness takes place in the weld pool and subsequently as the weld cools. However, in Cobalarc, the preformed carbides are packed into the tubes. So, the deposition of carbides is absolutely ensured.

2. Low heat input: In hardfacing, minimizing the heat input is absolutely essential in order to obtain the best hardness in the deposit. In Cobalarc, the heat input is very low indeed. As Cobalarc electrodes involve burning a mild steel tube with a very small cross-section, the requisite current density is obtained at low amperage. The heat input is therefore low. The adjoining figure (Fig. 1) shows a comparative scenario of heat input involved in different types of stick electrode welding.

3. Small HAZ: The heat-affected zone in the base metal is almost absent or is very small. So the original

component does not have any metallurgical side-effects.

4. Negligible loss due to slag: The slag volume in Cobalarc electrodes is very small. As a result, the metal recovery of the electrode is very high.

5. No deslagging: The arc-on time is at its maximum with Cobalarc electrodes because the welder does not need to remove the slag from the weld bead between two successive runs. The slag is very small in volume and it solidifies at the sides of the bead instead of on top. So any subsequent run without deslagging does not affect the quality and hardness of the deposit.

6. Gaseous protection: The virtual absence of slag does not mean that the Cobalarc deposits are exposed to the atmosphere. The outer coating contains ingredients that burn to generate a large volume of gases, which provide the necessary shield.

7. Minimal butt end loss: One major factor when it comes to losses in manual welding is the thrown-away butt ends. In Cobalarc, the butt ends do not contain any carbide material. So what the welder actually throws away is only a piece of the hollow tube. The butt end loss is therefore absolutely minimum. All these factors add up to high recovery for these electrodes compared with coated stick electrodes. This is evident in the adjacent figure (Fig. 2).

8. Indefinite shelf life: The outer coating contains non-hygroscopic ingredients, which render the mild steel tube rust-free, thus giving the electrodes an indefinite shelf life. The rigid tube also protects the preformed carbides from degeneration over time.

The range

The Cobalarc range consists of the four brands which have been designed for a host of applications, based on the wear factors present. The selection of carbides and their relative proportions are the main aspects for any consumable to combat certain wear conditions.

Cobalarc 1M

Features: Chromium carbide particles are distributed in an austenitic matrix to provide resistance to abrasion. The matrix helps to provide resistance to moderate to medium impact. The presence of a large amount of chromium in the deposit gives it the added advantage of oxidation resistance.

Hardness: 56 – 60 HRC

Applications: The electrode offers excellent wear resistance to austenitic manganese steel and is therefore used on dredger buckets and lips, crusher jaws, bulldozer cutting edges, pulveriser hammers,

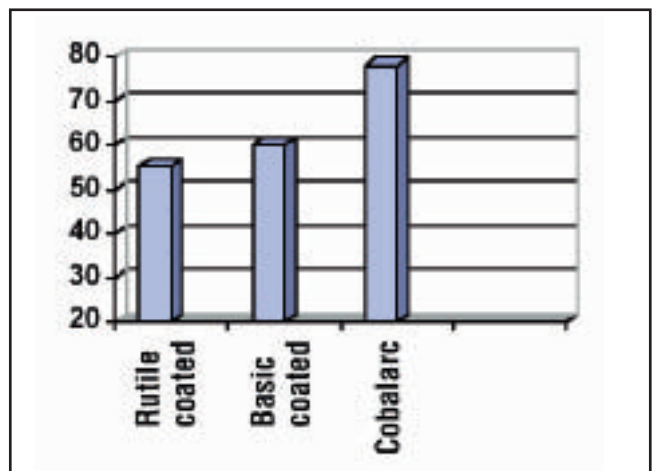
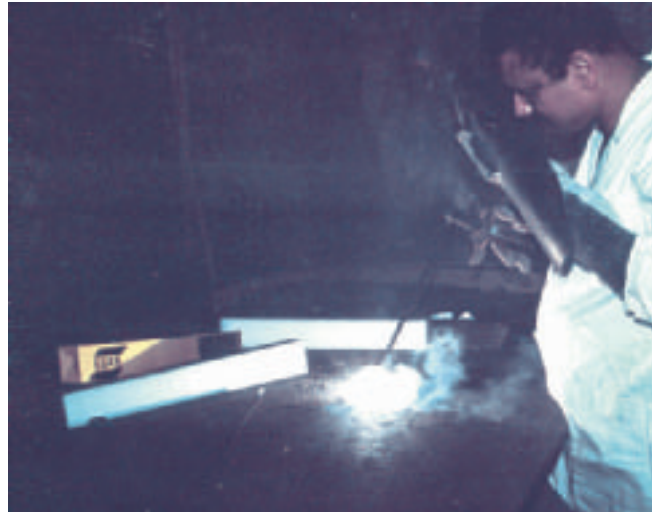


Figure 2.

sizing screens, crane grab shovels, ID fan blades, impeller casings, ball mill liner plates, dragline teeth, agricultural implements and a host of other similar applications. It is also suitable for giving improved abrasion resistance to mild and low-alloy steels where the impact resistance requirement is fairly limited, such as rolling mill guides, muller tyres and so on.

Cobalarc 9

Features: The weld metal which is deposited contains a combination of complex carbides that accommodate compound wear patterns. The main ingredient is once again chromium carbide to provide the abrasion resistance, but some other metallic carbides are added in tandem for high temperature abrasion resistance and oxidation.

Hardness: 60 – 62 HRC

Applications: This electrode is chiefly used in applications requiring resistance to abrasion and moderate to heavy impact, even at higher temperatures. They include coal burner nozzles, ID fans, rolling mill guides, railway tampers, pug mills, augers, pump casings and impellers, brick press screws, tie rods, sizing screens, dredger buckets and lips, agricultural implements and so on. This electrode is also used to hardface steel castings intended for high-temperature applications.



Cobalarc 4

Features: This electrode deposits fine tungsten carbide embedded in a hard, tough matrix. The matrix is a composite of martensite and austenite phases. The matrix-carbide combination provides excellent resistance to severe abrasion supplemented by high stresses. Any other form of abrasion is perfectly taken care of by the weld metal. These properties are exhibited at low to moderate temperatures. In addition, the deposit is resistant to high-temperature oxidation.

Hardness: 59 – 63 HRC

Applications: Drill bits for rock drills, oil well drills and churn drills, scrapers and mixer blades for sand and refractory material mixers, pug mill augers and knives, fan and pump impellers, sand and gravel chutes, choppers, feed screens, post-hole auger feed screws and the like are some of the major applications for this electrode.

Cobalarc MX

Features: The weld deposit created by here is basically stabilized carbides in a matrix that is reinforced by hardeners that lock the grain boundaries to resist movement at higher temperatures. The softening of the primary carbides is also resisted. This produces hot hardness up to about 800°C. The carbides, from metals such as vanadium, chromium, molybdenum and tungsten, are complex in nature and are suited to resist all forms of wear. The carbides are very fine in size and evenly distributed to resist even fine-particle abrasion. The corrosion resistance is also excellent. This is the only electrode in this range that can be welded in the HV position other than the normal downhand position.

Hardness: 62 – 66 HRC

Applications: The most common uses for this electrode are sinter plant components, ash ploughs, conveyor screws and flights, zinc blast furnace parts, copper ladles, exhaust fans handling high-temperature flue gases with ash or catalyst particles and so on.

Welding procedure

The procedure to be followed for depositing hard layers with Cobalarc electrodes is somewhat different from normal MMA welding.

Base metal preparation

- The surface to be overlaid should be cleaned by grinding, wire brushing, shot blasting or machining to obtain the best results. Sharp corners should preferably be rounded off to minimize dilution.
- Carburised or nitrided steels have to be ground off to remove the case.
- Hardened high-carbon steels should be annealed.
- Austenitic manganese steels should not be preheated.
- Prior to hardfacing high-carbon or alloy steels, it is recommended that a tough and ductile buffer layer be applied.

Welding tips

- Use the recommended current. Excess amperage and deep penetration to reduce dilution.
- Direct the arc onto the previous bead to minimize dilution.
- Allow deposits to cool slowly
- In the event of post-weld finishing, use wet grinding to avoid localized heating.
- Relief checks on deposits are normal and desirable.

Conclusion

We can therefore conclude that the hardfacing of machine parts subjected to wear conditions is here to stay and that stick electrodes will also be used for sudden emergencies. The carbide combinations offered by the Cobalarc range of electrodes, manufactured by Esab India Ltd. at its Khardah plant, will be the perfect choice to accommodate the complex wear patterns created by the diverse industrial conditions.

About the authors

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Repair welding of blades for rubber mixing

by Roland Bürgel, Dienst-Apparatetechnik GmbH + Co. KG, Siegen and Rolf Paschold, ESAB GmbH Solingen

When manufacturing tyres for vehicles, it is necessary to produce a special blend of rubber containing several compounds which enhance properties that extend their life span. These chemical additions consist of a certain amount of solid, fine-grained materials like soot.

One of the main steps in production is the mixing process in which raw rubber is “alloyed” with the other compounds. These finegrained materials act as abrasives on the mixing equipment.

As a result, a special kind of wear appears; it is called erosion. After a certain life cycle, the mixing equipment has to be re-built, because of excessive wear to the edges of the mixer blades.

The main task before rebuilding the edges of the mixer blades was to choose a suitable weld metal. It had to be hard enough to ensure wear resistance for one life cycle and strong enough to withstand separation from the base material during operation. The owner of the rubber mixer has already encountered negative results with weld metals consisting of a very high amount of chromium and other carbides that were said to be very resistant to wear. The problem was that parts of the very brittle weld metal broke off during the mixing operation.

Dienst-Apparatetechnik and ESAB preferred a different weld metal. To ensure that the weld metal did not separate from the base metal, it was decided to begin by applying a tough, strong buffer layer before hardfacing. For this reason, **OK Tubrod 15.34** was used to weld the buffer layer on the machined edge of the mixer blade (Fig. 1) and, for the hardfacing layers, **OK Tubrodur 15.81** was chosen, giving a martensitic weld metal including fine-grained, dispersed carbides (Fig. 2). This is important when it comes to creating very high wear resistance to fine-grained abrasives causing erosion. OK Tubrodur 15.81 is also suitable for abrasion from fine-grained materials combined with high pressure or a medium impact load. If a weld metal with large grained chromium carbides in a ledeburitic matrix is used, the matrix between the carbides wears out before the carbide itself. This is avoided by using OK Tubrodur 15.81.

After more than a year in operation, the repaired mixer blades display no significant wear or damage. The owner of the mixer is very satisfied and approved both flux-cored wires and the welding procedure for this application.

OK Tubrod 15.34	EN 12073:	T 18 8 Mn M M 2
	DIN 8555:	MF8-200-CKNPZ
	AWS A 5.22:	E307LT1-G
OK Tubrodur 15.81	DIN 8555:	MF6-60-GP



Fig. 1. First build-up layer welded on the mixer blade with OK Tubrod 15.34.



Fig. 2. Repair welded mixer blade ready for profiling by grinding.



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