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Hybrid strip cladding: The complete solution from a single source

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Lincoln Electric company, through its global multi-arc welding systems specialist, Uhrhan & Schwill Schweisstechnik, has developed a new hybrid electro-slag strip cladding process (H-ESC) for significantly better deposition rates and lower dilution levels on nickel-based and stainless steel cladding applications.

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It is fitting to open 2016 by congratulating all the new SAIW graduates who received diplomas on March 12. Our IIW Welding Engineer, Welding Technologist and Welding Specialist courses, along with our SAIW Level 1 and Level 2 welding inspector qualifications are flagship courses for the Institute and the number of students has continued to grow over the years. We now hold seven graduation dinners per year to accommodate all of our course graduates, three in Johannesburg, two in Durban and two in Cape Town – with a function planned for Secunda in the future as well.

To further enhance this offering, we are modifying our longstanding SAIW Level 1 and Level 2 Inspector courses to bring them into line with the IIW inspection courses. Students have been able to add the IIW Standard Level Inspector certificate to their SAIW Level 2 Welding Inspector qualification if the candidate met the appropriate IIW access conditions. But IIW are currently in the final stages of revising their inspection courses, so it is now an opportune time for us to fully align our courses to the IIW syllabus.

This is in recognition of the need to enhance the value of our training diplomas to qualify SAIW-trained inspectors for work in Africa and overseas. Our courses have always been tailored to the needs of the South African fabrication industry, and this will not change, but with the growth of industry north of our borders and the associated need for personnel with internationally recognised qualifications, we feel this change will enhance the career prospects and flexibility of SAIW graduates.

We are also busy expanding our training offering during 2016, to include some of the modern technologies that are emerging. In the field of welding automation, for example, we are striving to develop closer links with the automotive sector to develop a robotic and automated welding course. The aim is to bring robot programming and welding procedure expertise together to allow robots to do more than follow a weld seam at the correct speed.

On the NDT side, we are making further investments to upgrade our equipment, particularly new UT equipment, in order to enhance the value of our product offering. We will also be installing new NDT equipment in our recently opened KZN branch in Durban to enable us to offer a wider range of courses in that region. We remain determined to establish courses on the modern NDT techniques: phased array ultrasonic's; eddy current testing; time-of-flight diffraction (ToFd); and digital radiography, all of which we hope to be offering in the near future.

The new KZN branch has already been a success and our inspection and NDT courses are now running in purpose built facilities, instead of having to use local conferencing venues. The branch model also enables SAIW to extend its reach to better service industry in different parts of the country and we are looking to extend this model by opening a fourth branch in Mpumalanga to provide a more local service to the region's power and petrochemical industries.

May I also remind all members of our AGM, which will take place on May 20 at the Institute's City West premises in Johannesburg. So if you are passionate about the welding industry and have some ideas about how SAIW can become more relevant to the broader welding industry in these difficult times, we would love to see you on May 20.

Sean Blake

SAIW KZN branch
an immediate success

SAIW's KZN branch in Durban, which was officially opened in December last year, has seen immediate success since starting with a full training programme in January 2016. *African Fusion* visits the Westville premises and talks to training administrator, Elizabeth Shole and branch manager George Walker (below), who have chosen to move to Durban from their SAIW posts in City West, Johannesburg.

SAIW began to deliver courses at the Master Builders Association building near Westwood Mall in Westville, Durban in October 2015. "But the branch wasn't officially opened until December and we have only been fully operational since the middle of January, 2016," begins Walker

Describing his background, Walker says he started out as a welder back in 1978 and, by the time he joined SAIW in Johannesburg in 2006, had accumulated some 30 years of project experience: "In my day, we worked as semi-skilled welders until we had accumulated a few years of service. Then we could apply to do the trade test. I served my time with Fluor, the construction people, initially building Sasol 2 in Secunda," he tells *African Fusion*.

His experience made the trade test relatively easy. "I was told the test would take two days to complete and we all had to book accommodation in Olifantsfontein. But by the afternoon of the first day, I was finished my test, so I went back home. A few weeks later, I received my welder's Red Seal artisan qualification," he recalls.

In the early 1980s with Murray and Roberts, Walker was a TIG welder on the Koeberg construction site and after completing a stint there he returned to Secunda "where they were still busy with Sasol 3". He has worked on power stations from Evander to Matimba and accumulated extensive experience on welding, pipefitting and boilermaking – "working mostly on plant construction projects".

"I originally joined the Institute as a welding instructor in the SAIW Welding School in Johannesburg, but I also took up the opportunity to do the Level 1 and Level 2 Inspector courses. Then Jim Guild asked me if I would be comfortable lecturing. It was a natural migration for me, from welding to weld inspection – and here I am, about to complete my 10th year with SAIW," he says.

As well as taking on the role of branch manager, Walker is taking a lion's share of the lecturing load. "I lecture on Level 1 and Level 2 Inspection courses; Competent Persons, boilers and pressure vessels; ASME 8 and ASME 9 code courses; as well as on the AWS D1.1 Structural Welding Code," he says, adding that he is currently presenting Week 3 of the Level 2 Inspection course.

Describing the available facilities, he says that the KZN branch has two modern lecture rooms, with data projectors and projection screens, as well as a fully equipped NDT lab in the basement, "which we have also fitted with a data projector so that it, too, can be used as a classroom".

At the time of writing, all three of the branch's training rooms were in use. As well as the Level 2 Inspectors course being delivered by George Walker, SAIW's four-day ultrasonic Thickness Testing course was being presented in the basement NDT laboratory by Mark Digby, while second week Level 1 Inspectors were in the second lecture theatre with Errol Anderson.

"The Inspector's courses are organised in one week modules, with Level 1 students attending one week per month for four months and Level 2s having to do five weeks over five months. So while we are teaching L1 and L2 groups every week, the groups are changing all the time. This also means that lecturers from Johannesburg allocated to courses, such as Errol Anderson, can come down for one week a month to meet up with the same set of students," Walker explains.

Why was the branch needed? "With the growth of demand from Durban, lecturers have had to come down from Johannesburg to enable us to offer courses locally. These courses were initially run in Amanzimtoti at the Weaver Conference centre and then we moved across to Royal Durban Country Club. But neither the venues nor the facilities were ideal. We could never do any real NDT, for example, which generally requires a lab with extraction and cleaning facilities," he responds.

"Durban has also emerged as a significant industrial hub. Transnet rail engineering and port terminals divisions are very active in the area, as is the shipping industry. We also have the petrochemical refineries – Shell, Sapref and Engen – and the multi-fuel pipeline terminal. Sappi and Mondi on the pulp and paper side and the KZN sugar industry are also here. These industries are very relieved to have a local training facility for welding related personnel," Walker believes.

"So far this year, we have run two courses per week with, on average, 15 to 20 people in each and we are confident that this can continue," he says

"Durban itself," Walker continues, "is poised for a industrial boom. With

Above: SAIW's George Walker presents Week 3 of the Level 2 Inspection course at the Institute's new KZN branch.

Above right: Mark Digby in the NDT facility uses a UT tester connected to the data projector to explain the principles of ultrasonics to a group of students on the Institute's four-day Thickness Testing course.

Right: Students on the second week of a Level 1 Inspectors course being presented by Errol Anderson.

the extending of the harbour, oil tankers will be able to come between the refineries to allow tankers to be unloaded directly. This could create increased demand for welding inspectors and other personnel," he suggests. Transnet Engineering is busy building some 480 bogies for Bombardier for 240 electric locomotives, and these are all being built to EN 15085, so they will require significant numbers of NDT inspectors to meet quality requirements.

Elizabeth Shole, SAIW KZN's training administrator, sees her role as supporting current and prospective students. "I started at the Institute in Johannesburg in 2011, on contract as an accounts clerk capturing suppliers' invoices and preparing and collecting payments.

"After the five-month contract, I moved into the Certification department doing data capturing of the students and I was appointed to a permanent post in November 2011," she tells *African Fusion*.

"In 2013, I was ask to help the training administrator with some of her duties, organising catering for the courses and issuing SAIW students with their bags, T-shirts and weld measurement tools. It was during this time that I began to help answer student queries, on the phones helping them to choose and apply for SAIW courses, for example.

"Now in Durban, the job is the same, except I deal with them face-to-face as well. Prospective students don't often know that welding, NDT and inspection are three different things. They think everyone has to start out as a practical welder before they can take up the other opportunities, but this is not necessary," she says.

The NDT Laboratory is equipped for ultrasonic testing (UT); visual testing (VT), penetrant testing (PT) and magnetic particle testing. The Institute has bought 12 state-of-the-art Olympus EPOC 650 UT testing machines for training and the data projection allows the UT output to be projected onto the screen at the front during lectures.

The practical area for surface inspection is behind a partition at the back of the NDT laboratory, which is fitted with extraction hoods for PT spray, sinks for washing and a headshot magnetic particle bench for activating magnetic particle test pieces. "We can now deliver almost all of our NDT modules in this facility," says Mark Digby, SAIW's NDT manager, adding that he even hopes to be able to do some radiographic testing in the future.

"Training is very important right now in South Africa and in KZN, in particular. We have been lagging behind

SAIW students have a relaxing tea break in the modern and spacious environment of the Master Builders canteen.

with respect to skills development and I believe it is a duty of all manufacturers to upgrade workers to the point where they can be self-sufficient.

"We need skilled workers who are efficient and who can stand on their own two feet. We need people who are more proactive and less dependent on their superiors. Unless more of our workers are upskilled to the point where they can operate independently and effectively, we are fighting a losing battle. Our industries will never be competitive and sustainable," Walker concludes.

The modern, purpose-built and spacious SAIW KZN branch seems to be the ideal environment for such students to flourish.

South African company chooses quality cornerstone

Efficient Engineering has been certified to ISO 3834 Part 2 for many years and had its first recertification earlier this year. *African Fusion* caught up with the company's quality manager, Louis Smuts (right), engineering, sales and marketing manager, Gerhard van Zyl, as well as managing director for newly formed Efficient Trotech, Mike van der Walt, at Efficient Engineering's Phase IV facilities in Tunney, Germiston.

Efficient Engineering was established in 1968 as a small company manufacturing cabs and operator cabins for forklifts and trucks. Demand for the company's high quality products has seen the business grow into a world-class steel fabrication, machining, manufacturing and heavy engineering works, constituting a total floor space of some 25 500 m^2.

As the official supplier to many national and international original equipment manufacturers (OEMs) in the mining, materials handling and engineering industries, Efficient Engineering has continued to build its business name on a reputation of quality and reliability.

"The company promotes quality excellence from the ground up," explains Smuts "We follow stringent procedures to ensure uniformity. For example, each welder signs off on the quality of his work before an inspector is called. This is what has emerged from honing our products and processes for nearly 50 years," he adds.

Facilities and growth

Having started out as a small-scale engineering firm, the company experienced high demand, which led to the establishment of a new factory in Sebenza and a shift in focus to heavy engineering.

Due to continued demand from major industry players and the need for significantly larger production space, October 2006 saw the development of Phase I of Efficient Engineering's newly established 6 300 m^2 headquarters in Greenhills, which would allow the company to manufacture larger components than ever before while consolidating its machining, blasting and painting capabilities.

Continued increases in demand necessitated the construction of the 4 200 m^2 Phase II development, completed at the end of 2008, followed in March 2009 by its 2 000 m^2 Phase III facility, which is focused on sheet metal fabrications.

Efficient Engineering's Phase IV and V developments, with a combined floor space 13 000 m^2, constitute the latest state-of-the-art facilities.

A heat exchanger for Natref under construction. The welders had to weld 585 U-bend joints per bundle, nearly 1 200 tube-to-tube butt welds, and achieved a very low weld repair rate – an impressive feat when mirror welding has to be employed.

Ownership

The continued success of Efficient Engineering over the decades has drawn keen interest from a number of high profile investors during the company's history. In order to effectively accelerate this growth, Efficient Engineering agreed to sell 26% of the company's equity to investment expert, RMB Corvest, the private equity division of FirstRand Limited, in September 2009. At the same time, B-BBEE private equity company Shalamuka Capital acquired 29%.

Efficient Engineering's non-executive chairman, Tony Cimato, retains a 25% shareholding in the business, while the remaining 20% was offered to senior management as part of an internal buy-in. This ensured improved job security and increased loyalty to the Efficient Engineering brand while enabling the current leadership team to flourish in a corporate environment where they have been exposed to new learning opportunities and decision making responsibilities from within the business.

The net result is B-BBEE Level 4 status with total black ownership of 36.82% and black women ownership of 11.58%, a R400-million turnover for 2013 and 2014, and a likely turnover of R350-million in 2015.

Products and capabilities

Efficient Engineering's activities can be categorised into four main product lines. These include large bulk materials handling systems, such as stackers and reclaimers, mostly manufactured for local OEMs servicing the mining and bulk materials export industries; earth moving equipment, such as dump truck bodies, dragline buckets and excavators, predominantly for the mining industry; process equipment, such as reactors, heat exchangers, columns and pressure vessels, for the oil and gas industry; and, finally, modular and non-modular electrical substations for mining operations, and PV boxes for processing energy generated in photovoltaic applications. "This last offering is a new and exciting area for us. It will allow us to generate our own IP and become a leading OEM in our own right," explains Smuts.

Notable projects

Dump truck bodies, earthmoving equipment and related components still make up a major percentage of the company's turnover. "The smaller dump truck bodies and materials handling equipment is handled in our Phase I workshop, which also houses the machine shop," says Smuts. "But most of the big buckets, for Komatsu 960s, for example, are fabricated in Phase II, which has six 32 t cranes. We strive to do all of the welding on these huge buckets in the flat position, so we needed high shop cranage to turn the buckets.

"This is a differentiator for us. Since adopting this approach, our weld quality has improved significantly," he adds. "We strive to keep our welders as comfortable as possible to give them the best possible chance of producing flawless welds.

"While submerged arc welding is used to fabricate the bucket floors, the majority of the welding on earthmoving equipment is done using flux-cored arc welding (FCAW)."

Efficient Engineering's current flagship project is for the Meerkat antennas for the Square Kilometre Array project (SKA) under construction in Sutherland in the Northern Cape of South Africa. "We received the order for the fabrication and full electrical and mechanical integration of the yokes and pedestals for the first 64 Meerkat antennas," says Smuts. "This involves fabrication of the support pedestals and the yokes to extremely tight tolerances; a dimensional accuracy of 1.0 mm on a 7.0 m length is required on the pedestals, which are fabricated in 50 mm steel and joined using submerged arc welding. This work is currently being done in our Phase IV workshop."

On the oil and gas side in the Phase IV workshop, the company has completed numerous Class A pressure vessels for companies including Sasol and Natref, which typically have to be manufactured to ISO 3834 Part 2 and ASME VIII, Division 1, Appendix 10 quality standards. "We recently completed a heat exchanger tube bundle project for Natref at 24 MPa (240 bar)," notes Smuts.

"Most of the welding for this type of work is done using gas tungsten arc welding (GTAW); autogenously for the root runs and with filler for the seal weld on the surface. We have very good welders for this work, whom we train ourselves."

Smuts explains that his team has also successfully completed a superduplex column for Process Plant Technologies (PPTech) that had to be joined to a titanium lower section, where they applied SASTEC's special specifications for the welding of duplex stainless steels.

"Currently, in our workshop, we are busy with two very awkward finned tube bundle heat exchangers for Natref, which involve a lot of GTAW mirror welding." He goes on to describe how the welders need to manufacture 585 U-bend joints per bundle, which is nearly 1 200 tube-to-tube butt welds, achieving a very low weld repair rate – an impressive feat for mirror welding and illustrative of the training and expertise of the team.

Efficient Engineering has also taken on the fabrication of five 'bullet' LPG storage tanks for Sunrise Energy's new LPG import terminal being built in Saldanha Bay. "We are now responsible for completing the five bullets and delivering them to site. This entails completion of fabrication, non-destructive examination (NDE), heat treatment and final assembly," explains Van der Walt, the recently appointed MD of Efficient Engineering's latest acquisition, Trotech Engineering, now known as Efficient Trotech.

He goes on to note that, "These are the largest vessels we have ever built. At 7.5 m in diameter and 68 m between tan lines, and a wall thickness of 40 mm, the total empty fabricated mass of each vessel is approximately 580 t.

"Since our establishment in the 1960s, our growth and success has been built on ever improving quality standards. We know this is the right approach because people come back to us time and time again," Smuts concludes.

A bulk materials handling system being fabricated in Efficient Engineering's Phase IV facility in Tunney, Germiston.

Efficient Engineering's current flagship project is the fabrication and full electrical and mechanical integration of the yokes and pedestals for the first 64 Meerkat antennas for the Square Kilometre Array (SKA) project.

Welding Inspection graduates:

SAIW's first graduation dinner for 2016 was held in the Crown Reef Room at Gold Reef City in Johannesburg on March 12, at which 124 graduates on SAIW courses received diplomas. *African Fusion* reports and summarises the motivational talk by Gert Joubert (right), chairperson of SAIW Certification's governing board.

At the top of the list of graduates that completed SAIW courses during 2015 are those on SAIW's IIW welding co-ordination programmes. SAIW offers IIW Welding Practitioner, Welding Specialist, Welding Technologist and IIW Welding Engineer qualifications and five IIW welding technologists, including two women, along with two welding specialists graduated at the March dinner.

These qualifications are required by schemes such as ISO 3834 and EN 15085 for people responsible for managing welding processes within fabrication environments. They require specialist knowledge of welding engineering and the control of welding processes – and when things go wrong, these specialists have the knowledge to rectify issues and resolve problems.

In addition, 49 Level 2 Inspectors, 17 of which also received standard level IIW Inspector certificates, while 68 people graduated as Level 1 Inspectors, five of them with distinction.

ArcelorMittal's Gert Joubert targeted his address for the evening at spouses and those less familiar with the daily responsibilities of weld Inspection personnel. "The welding world is about building structures, pressure vessels, boilers and pipelines. To build these structures we need good engineers to design structures that don't fall down. They establish the integrity and the safety of the design. Then you need fabricators to build the structure, construction or vessel – the boilermakers and welders – and the inspectors to ensure that the work has no flaws and that it is done according to the design, at the required quality and to the relevant construction codes," he explains.

Joubert recalls seeing a student welding inspectors carrying an ASME code with yellow post-it notes sticking out from every second page. "He was about to write an open book exam on this code. It's not easy, but inspectors need to learn these standards so that they know exactly what the requirements are," he points out.

Describing the processes involved in producing a simple weld, he says that a boilermaker prepares the joint. "A butt joint, for example, is two pieces of metal that are aligned side by side, typically with a V-preparation on thicker sections. When the V is filled with metal, we call the joint a butt joint.

"The weld fabrication inspector first comes into play to inspect the joint design. After the boilermaker has tacked the joint together, the inspector will check the dimensions – the V-angles, root gaps, and so on.

"This is to make sure that the welder has the best possible chance of making a good weld," Joubert tells us. "Because if he or she cannot produce a good weld, we could have an in-service failure, and on products such as pressure vessels or boilers, this could be disastrous. So the inspectors job is extremely important!" he exclaims.

"Once the joint is inspected, the welder will strike the arc and begin to weld the root run," Joubert continues. "And magic happens. As soon as the arc is struck, plasma is created, which is an intense hot channel of conductive gas that carries the arc current to the workpiece. I wish I could make myself small enough to see what is happening here: how the metal droplets are melted and transferred across from the consumable and into the joint; and how the welder manipulates the placement of these droplets.

"Welders are called artisans because

Princess Kilani and Eliza Dlamini receive their IIW Welding technologist Diplomas from IIW President, Morris Maroga.

bastions of quality assurance

they are really are artists. They deposit molten metal so that when it solidifies it is exactly where it is needed. I have huge respect for welders and the work they do," Joubert says.

Continuing, he says that plasma melts the metal and forms a molten weld pool, almost like casting hot metal into the butt joint – and the solidification of the metal starts immediately "with the purest metal in the coldest part of the weld and moving towards the hottest parts in middle and at the top – and all of the impurities are pushed along the solidification line.

"The combination of these impurities with shrinkage forces can lead to a hot crack in the centre of the weld. To avoid this, the welding inspector needs to know exactly what might happen to the weld the instant it solidifies," he advises the new graduates.

"Shrinkage also causes stress, which remains in the weld. And if there are any hydrogen atoms in the weld, which are the tiniest of all atoms, these can migrate through the metal atoms and accumulate in the heat-affected zone, eventually, along with the stress, causing a hydrogen crack or a cold crack. This needs to be anticipated and, if it happens, seen by the welding inspector. That is why the inspector needs to have – and to understand – the welding procedure, because to prevent hydrogen cracking, for example, you may need to pre-heat the materials at exact levels depending on the material, thickness and consumables being used.

"When the joint is complete, the inspector needs to have look at the weld

Kudzai Mazodze with his spouse (left) displays his SAIW Welding Inspector Level 1 certificate, with Willard Chiweshe – who now holds Senior Welding Inspector Level 2 and Standard Level International Welding Inspector certificates – and his spouse (right). Photos: Neil Forman

profile, to make sure that it has the correct sizes, is properly filled and that there is no undercut. When part of a structure is exposed to fluctuating stresses or fatigue, any small crack or shape deviation can cause a failure, even after several years of service," Joubert warns.

"The people graduating today, those that you have supported during their studies, have learned about all of these matters. By doing these courses, they can relate to metallurgy, hot cracking, cold cracking and embrittlement. They have studied and sweated," he says, adding that an inspector's job is not just about codes and standards. "It's about understanding the world of welding.

"You cannot put up a structure such as a pressure vessel without a welding engineer signing it off. In welding, design-engineering qualifications are defined properly; welder-qualifications are defined properly; and all of you graduates, as weld fabrication inspection personnel, your qualifications are all defined properly. Not all disciplines have standards that say that companies shall have in their employment people with your qualifications. Yours are sought after qualifications with many avenues available to you. If you have a mind to become a higher-level inspector, a weld fabrication inspector or a non-destructive testing inspector, go ahead. Do it! You can do whatever you want to. I urge you not to stop studying. Pursue your career," Joubert advises.

"Our job is all about quality assurance. It's about making sure that the bridge, which millions of people are going to travel on and under, does not ever fall down," Joubert concludes, before congratulating the SAIW graduates and wishing them well in their careers.

Heat treatment for engineers to be presented by Andy Koursaris

SAIW will be running the Heat Treatment for Engineers course from July 18 to 22, which will be presented by former SAIW president and Wits University professor, Andy Koursaris,

Heat treatment is the controlled heating and cooling of metals and alloys in order to manipulate a materials microstructure and enhance its mechanical properties.

The Heat Treatment for Engineering course covers the processes used to manipulate the properties of steel, which, because of its versatility, is the most widely used material and the wide range of properties that may be obtained from steel is largely due to its response to heat treatment.

"This five day course is intended for personnel who are involved in the engineering field and conduct, utilise or specify heat treatment processes for engineering components," says SAIW's training services manager, Shelton Zichawo. "The course will deepen the understanding of the science and technology of heat treatments and their effects on the properties of the material," he adds.

The course will deal with: the nature and basic properties of metals, alloying, metallurgical reactions and microstructures; iron/carbon system and microstructures; heat treatment processes and hardening of steel; martensitic transformation and tempering of martensite; isothermal transformation of steel, TTT and CCT diagrams; quenching and hardenability of steel; surface treatments, induction hardening, plasma and LASER treatments; alloy and tool steels and their heat treatment; cast iron heat treatments; and heat treatment of stainless steels.

For more information or to register contact Laetitia Dormehl: dormehll@saiw.co.za


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SAIW Certification internationally recognised

SAIW Certification, a South African based personnel certification body (PCB), administering the SAQCC-NDT Scheme for qualification and certification of NDT personnel, is proud to announce that SAIW Certification is now registered under the ICNDT Mutual Recognition Agreement: Schedule 2.

This means that holders of SAIW Certification certificates, issued under the SAQCC-NDT certification scheme, are certified by a personnel certification body (PCB) which is registered by the International Committee for Non-Destructive Testing (ICNDT), as meeting international standards, including ISO 17024:2015 and ISO 9712:2012; and all the technical documents referenced in the schedule of conformity issued by the national accreditation body, SANAS, and the ICNDT.

Personnel seeking internationally recognised ISO 9712 Level 1, 2 or 3 certification for Magnetic Testing (MT), Penetrant Testing (PT), Radiographic Testing (RT) and Ultrasonic Testing (UT) can now achieve this through the SAQCC-NDT scheme.

Eddy Current Testing (ECT) and Visual Testing (VT) certification (Level 1, 2 and 3) are currently covered under the scope expansion operating procedure, which require that candidates collect documented evidence as outlined in the scope expansion audit scheduled by SANAS during 2016.

Transition of current SAQCC-NDT certificate holders will be achieved through the normal re-certification process and newly designed SAIW Certificates shall be issued to include the international recognition, after the practitioner has demonstrated compliance with the renewal or recertification requirements.

Internationally recognised certification for all six basic NDT methods is available for the pre- and in-service industrial sectors, which include product sectors such as castings, forgings, tubes, pipe and welds – as well as relevant categories pertaining to specific sample geometries or method application.

ICNDT
The World Organisation for NDT
ICNDT Multilateral Recognition Agreement (MRA) for Personnel Certification in NDT
Certificate of Registration
SAIW Certification (South Africa)

"This is a proud moment for the South African NDT Industry, which has aimed for this achievement since its inception in the late 1980s and we formally adopted ISO 9712 in 2003. We will discuss the route to international accreditation in a future issue, but for now, SAIW Certification would like to express its sincere gratitude towards the various ICNDT structures and individuals who have participated in achieving this success," says SAIW Group systems and quality manager, Harold Jansen.

SAIW Certification would also like to thank all the South African NDT personnel and entities that have been part of SAQCC-NDT since its inception. "Your hard work, dedication and perseverance are much appreciated," Jansen adds.

SAIW AWS D1.1 Construction code course revised

Following the publication of the revised AWS D1.1 Construction code last year and the delivery in January this year of the revamped training course developed by global specialist, Bob Shaw – an active member of the American Welding Society's D1 Structural Welding Committee and a member of the AISC's Specifications Committee – SAIW is now ready for the nationwide roll out the new course.

The 2015 edition of the AWS D1.1 code is a major revision, the first since the 2010 decision to revise the code on a five-year cycle instead of every two years. The most notable change is the reorganisation of the tubular provisions, tables, and figures, which were previously located throughout the code. A new Clause 9, entitled 'Tubular Structures' has now been created to deal these structural requirements.

Clauses 1, 7, and 8 have only been slightly impacted by the reorganisation, but Clauses 2, 3, 4, 5, and 6 have been greatly impacted.

The four-day SAIW course provides an analysis of the AWS D1.1 welding fabrication code and covers the following aspects of the 2015 version: General requirements related to welded steel structures; Prequalified welding procedures; Welding procedure and performance qualification; Fabrication requirements; Inspection requirements – including differences between structural steel and pressurised equipment; and practical exercises in the interpretation of the code requirements.

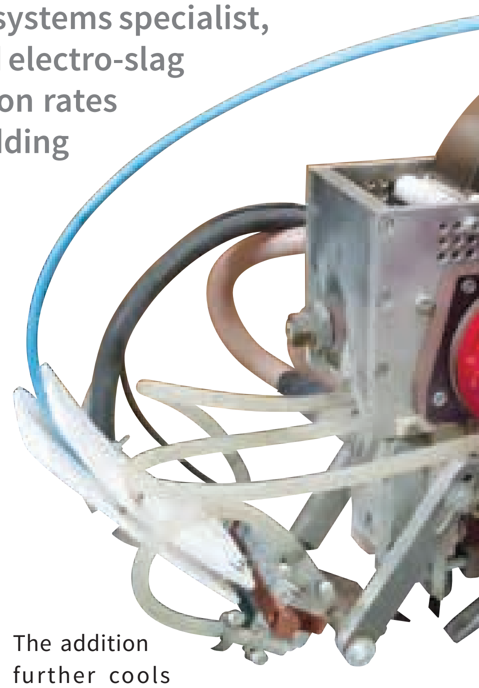
Courses are scheduled in Cape Town from March 29 to April 01 and in both Durban and Johannesburg from May 3 to 6.

For further information, please contact the training department administrator, Laetitia Dormehl.

dormehll@saiw.co.za

A new dimension in strip cladding

Lincoln Electric company, through its global multi-arc welding systems specialist, Uhrhan & Schwill Schweisstechnik, has developed a new hybrid electro-slag strip cladding process (H-ESC) for significantly better deposition rates and lower dilution levels on nickel-based and stainless steel cladding applications.



Cladding is a fundamental process in the Fabrication industry and is applied across the whole spectrum of applications – from the nuclear, oil and gas industries to petrochemicals and steelmaking. Cladding is required on the process side of high-pressure critical process plant equipment (CPE) to provide corrosion resistance against severely corrosive service fluids or to increase wear resistance of a component being subjected to heavy wear and tear applications, such as continuous casting rollers in steel mills.

While carbon-manganese steel substrates, low alloy steels and other materials provide strength and other physical properties; cladding provides the desired corrosion and wear resistance. The result is extraordinary flexibility and cost savings.

While most of the existing arc and electro-slag welding processes can be utilised for weld cladding, strip cladding with submerged-arc and electro-slag welding processes are the most attractive choices for applications that require large surface area coverage due to their substantially higher deposition and surface area coverage rates.

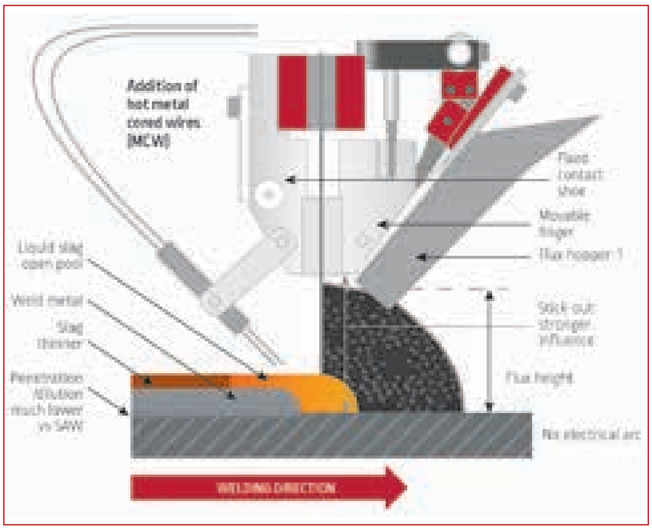
Submerged-arc strip cladding (SASC) uses an arc that runs back and forth at high speed along the strip. The arc causes high penetration into the base material, resulting in dilution levels of approximately 20%. Typical deposition rates are in the region of 12 to 14 kg/h for a 60 by 0.5 mm strip, but this is limited because higher deposition rates can only be achieved by increasing the current, which increases plate fusion causing unacceptably high dilution.

Conventional electro-slag strip cladding (ESC) is an arcless process that uses a conductive flux that melts the consumable via the Joule heating or resistance heating principle. The current passes through the molten slag and the resulting resistance heating melts the strip, depositing it as molten weld metal onto the base material. Lower dilution levels (9 to 12%) are therefore achieved at deposition rates of 22 to 28 kg/hour, giving the process significant advantages over SASC.

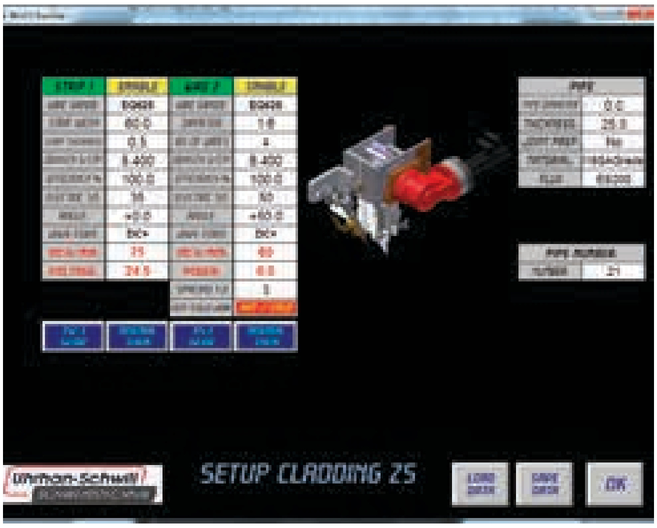
The new state-of-the-art hybrid technique (H-ESC) from Lincoln Electric is a variant of the ESC process. As well as all of the features associated with conventional electro-slag cladding, multiple hot metal-cored wires are added to the molten pool as a third consumable. The addition further cools the weld pool – because of the heat extracted to melt the hot wires (latent heat of melting).

As a result, plate fusion can be further reduced, typically enabling dilution levels for Ni-625 alloys of less than 5% Fe in a single layer. This has been a long-held goal for fabricators of critical process equipment in the petrochemical industry, a goal that is now achievable without having to use an alloyed flux.

Using a custom-designed digital weld control and data logging system, this patent-pending high-speed technique can be used to accurately control the dilution level to achieve the desired cladding chemistry for a variety of appli-



Hybrid electro-slag cladding (H-ESC) adds multiple metal-cored wires to the molten pool as a third consumable. This enables surface chemistry to be achieved in a single layer, even for Ni-625 alloys.



The Hybrid 3D Z5 automatic welding control and data logging system ensures the pre-determined ratio of strip and wire feeding is maintained during H-ESC.

The H-ESC welding head incorporates flux and strip feeding with multiple hot metal-cored wire feeders and a magnetic steering device to neutralise the effect of the strong electromagnetic pull generated by the high welding currents.

cations. Compared to conventional ESW cladding, the process can achieve more than 50% higher welding speeds (27 to 35 cm/min versus 16 to 20 cm/min) and nearly double the weld deposition rate (up to 42 kg/hr).

The new technique offers an ideal solution for high-speed single-layer austenitic stainless steel cladding, where a single standard 18/8 stainless strip can be used with neutral flux to achieve clean weld chemistry for 308L, 316L, 347 and 317 stainless grades, simply by using metal-cored wire consumables with appropriate chemical composition.

Lincoln Idealarc® DC 1000 and 1500 power sources along with NA-5 or NA-3 strip feeding heads and controller are the most widely used combinations across the world for conventional strip cladding. Multiple power sources can easily be connected in parallel to generate welding currents of up to 3 000 A or more.

The Lincoln range of modified new-generation inverter-based Power Wave® AC/DC 1000 SD or Modified Idealarc® DC 1000 power sources are connected in parallel for H-ESC applications in conjunction with the Hybrid 3D Z5 control system. These same combinations can now also be used for conventional strip cladding.

Developed by Uhrhan-Schwill Schweißtechnik to ensure the pre-determined ratio of strip and wire feeding is continuously maintained while depositing H-ESC clad layers, the Hybrid 3D Z5 controller regulates all the critical parameters and functions in the cladding process – currents, voltages, welding speed, strip and wire feeding speeds, crater filling functions, magnetic steering device current, electrical stick-out and more.

Access control features restrict the adjustment of welding parameters to welding engineers. The controller also monitors, records and saves every detail of each of these parameters, thus acting as a high-end data logger. This provides fabricators with an additional tool for data traceability and retrieval.

Special functions and features can also be added to the controller, such as preheat control, laser seam tracking control, live video recording, etc.

3D CladFlux E100 is the improved version of Lincoln's neutral flux, specially designed for H-ESC to produce cleaner weld metal.

Lincoln Electric is able to offer the H-ESC solution as a total solution from a single source. For optimal success of the new hybrid process, the right combination of the following is required:

- Welding consumables, ie, strip, flux and cored-wire.
- Welding equipment: cladding head, magnetic steering devices, welding power sources and strip feeding device.
- Multi-wire hot-wire feeding mechanisms and associated power sources.
- The automatic welding control and monitoring system.

If even one of these key elements is absent, the process is likely to fail to achieve the full benefits on offer. Lincoln Electric is the world leader in this field and can supply top quality solutions and the desired expertise for all the above.

Lincoln Electric's modified new generation inverter-based Power Wave® AC/DC 1000 SD or Modified Idealarc® DC 1500 or DC 1000 power sources are connected in parallel for H-ESC applications in conjunction with the Hybrid 3D Z5 control system.

An investigation of **residual stresses and distortions produced in tubular K-joints**

G Stix and B Buchmayr: Montanuniversitaet Leoben, Austria.

This paper, taken from the proceedings of the 2015 IIW International Conference in Helsinki, Finland, investigates the effects of stresses and distortion on tubular weld joints during the manufacture of lattice boom cranes from modern high-strength materials.

Lattice boom cranes are exposed to heavy loading conditions during service. High inertia forces during lifting and turning lead to high oscillating stresses that are superimposed onto static wind loads. However, the final component performance (fatigue life) is also influenced by the inherent residual stresses, which have to be minimised to achieve better service behaviour.

In this paper, the most influencing parameters, such as geometrical factors, heat input and alternative welding sequences are considered in the prediction of residual stresses in welded tubular K-joints. Special emphasis is placed on the influence of the design parameters of a K-joint, which consists of one chord and two braces. These parameters are the angle between the chord and the brace, the chord slenderness, the eccentricity of the braces and the welding procedure.

For the finite element welding simulation the commercial software Simufact.welding was used. Based on the numerical results, real weldments were done using a robot welding system in order to verify the simulation results. In the welding trials, two tube diameters and wall thicknesses for the braces and one chord diameter and two wall thicknesses are considered. In addition, two different welding sequences (8 and double 3) were compared. By metallographic investigations and measurement of the residual stresses using the hole drilling method with strain gauge rosettes, the simulation tests were compared to the results from the residual stress measurements.

Introduction

For the production of lattice boom cranes, thicker main chords are connected by a high number of welds with thinner braces. These welds have to withstand the resulting forces and torques from the lifting, lowering and turning of loads, [1] and [2].

Hence, it is important to know the implemented residual stresses caused by welding because residual welding stresses can affect the static and dynamic loads during operation.

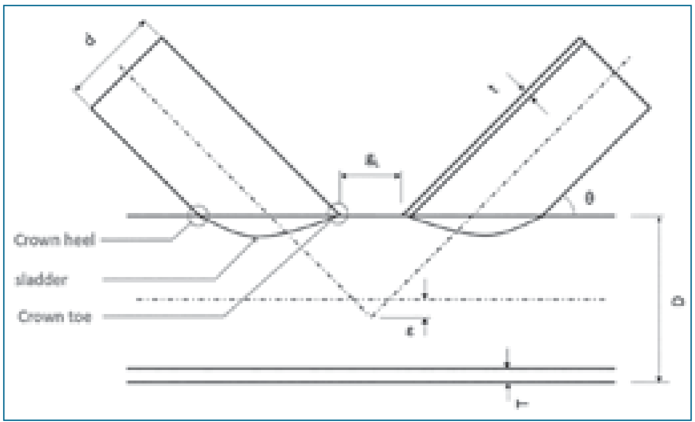


Figure 1: An annotated sketch of a tubular K-joint.

Figure 1 shows an annotated outline of a tubular K-joint with the most important areas for the following considerations: The smaller brace is described by its diameter (d) and wall thickness (t); the chord, similarly, by its diameter (D) and wall thickness (T). Three geometrical factors, eccentricity (ε), angle between brace and chord (θ) and the gap between the two braces (g_L), are drawn. Moreover the specific areas crown heel, sladder and crown toe are marked [3].

Based on the data in Figure 1, chord slenderness (γ) is calculated in (1), taking into account the diameter proportion (2). According to references from Kuhlmann et al [3], chord slenderness must be greater than twelve.

$$\gamma = \frac{D}{2 \cdot T} \quad (1)$$

$$\beta = \frac{d}{D} < 0{,}45 \quad (2)$$

These tubular K-joints can be welded either in one pass by following a figure 8 pattern or in two passes, in the form of back-to-back figure 3 patterns. Figure 2 shows a reduced outline of a tubular K-joint in top view. The continuous seam begins at the starting point (SP) and runs along the marked arrows back to the starting point (SP). Conversely, the seam path when using the 3s pattern runs from the starting point (SP) to the end point (EP) and from there as a new seam after a reorientation back to the starting point. This reorientation results in a break of a few seconds, since the welding wire must be cut off before the welding torch is ready to resume welding.

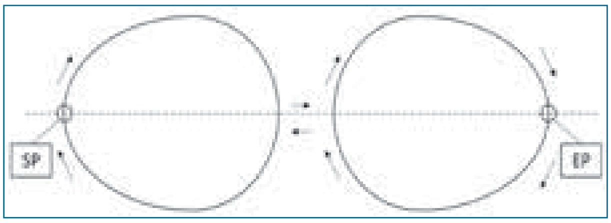


Figure 2: A top view of a tubular K-joint.

Non-continuous welded K-joints are used by manual welders and in welding stations without rotary tables, that is, in situations with low accessibility. An obvious disadvantage of the non-continuous welded K-joints is the doubling of start and end craters.

Due to the number of samples for welding, it was not possible to carry out all experiments twice. A decision was therefore taken that one welding procedure would be extensively investigated with respect to metallography, while the other would focus on residual stresses. Table 1 shows a complete list of materials and dimensions used. The real experiments were only performed with 20MnV6-TT for the high strength chord and S355-TT for the brace.

Steel grade	Outer diameter [mm]	Wall thickness [mm]
S355-TT	73.5	4
S355-TT	101	6
20MnV6-TT	168.3	8
20MnV6-TT	168.3	16
S890QL1	168.3	8
S890QL1	168.3	16

Table 1: A list of materials and dimensions used.

Welding parameters

In order to establish appropriate parameters for the experiments and simulation, a series of tests were done. This section introduces some of these variations. Figure 3 a-g is a compilation of metallographic sections from samples welded at different speeds and currents, while Table 2 gives a list of all these different welding current, welding speed and processes used to produce the samples.

Sample number	Welding current [A]	Welding speed [cm/min]	Process
a	320	70	standard
b	320	90	standard
c	320	100	standard
d	320	110	standard
e	320	70	pulse 3 [Hz]
f	320	70	pulse 10 [Hz]
g	270	50	standard

Table 2: A list of parameter variations for the metallographic sections shown below.

The metallographic sections are necessary to characterise the weld penetration and weld formation, (Figure 3a-g). At first, all micro-sections look similar, but looking into the detail a more homogeneous weld formation and weld penetration can be seen when using pulse GMAW (Figure 3e and 3f).

However, the advantage of pulse welding cannot be modelled in common FE welding simulation software and is therefore only an option for welding experiments.

In addition to weld penetration and weld formation, it is important to consider hardening. These investigations were done according to DIN EN ISO 9015-1:2011-05 [4]. Figure 4 and Figure 5 show the results of standardised testing, which is divided into a measurement close to the surface and another close to the root.

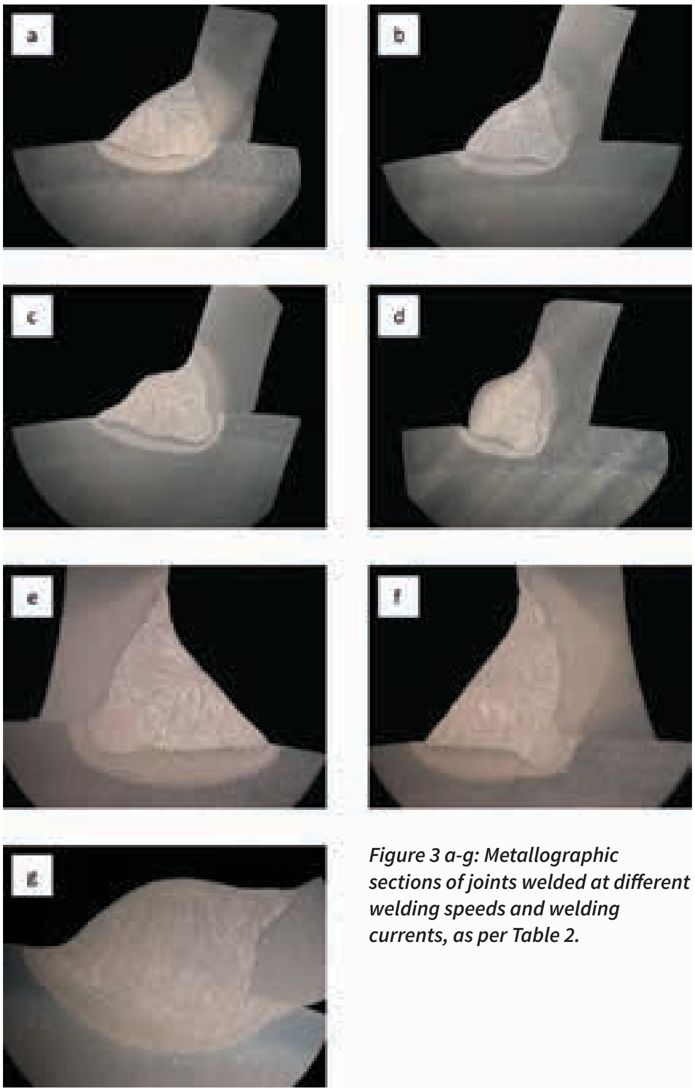


Figure 3 a-g: Metallographic sections of joints welded at different welding speeds and welding currents, as per Table 2.

Considering the area close to the surface it is noticeable that all standard welds are very close to each other and have a similar curve. The pulsed welding is at the same level of hardness as standard base metal S355-TT. In contrast to standard welding, the pulsed welding does not tend to increase the hardness in the heat-affected zone. Vickers hardness values close to the root (see Figure 5), do not deviate from this trend. The pulsed welding is again at a lower level of hardness compared with standard welding at a welding speed of 70 cm/min.

Welding simulation

To save money and time during the development of a K- joint truss

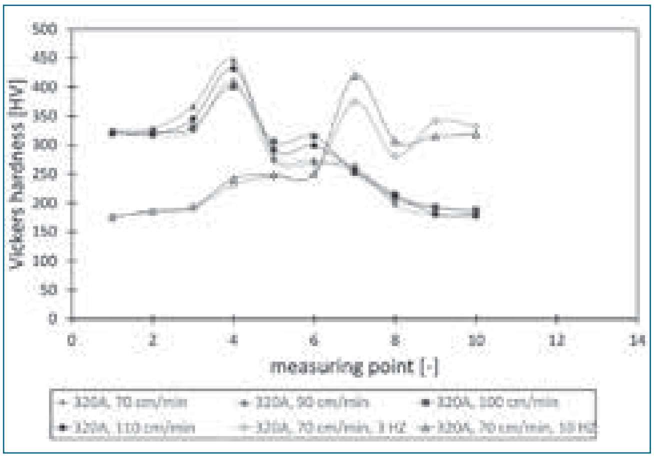


Figure 4: Vickers hardness tests close to surface.

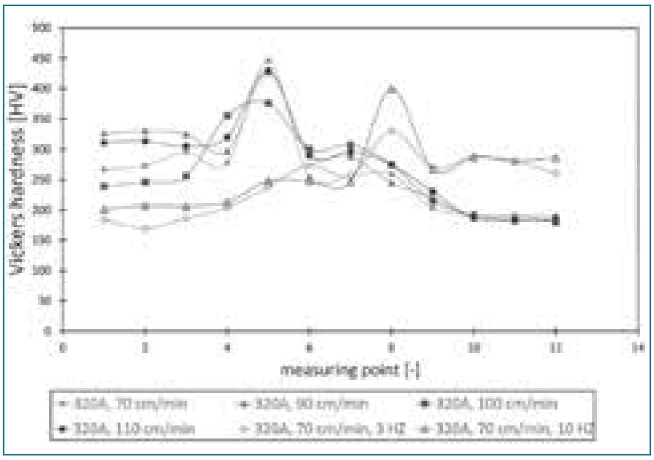


Figure 5: Vickers hardness values close to the root.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construction, it was important to generate a model that is as realistic as possible and which is reliable. However, because computing power is limited, meaningful simplifications had to be made.

To reduce computation time, a simplified outline of a single K-joint of a tubular truss was created, as shown in Figure 6. This simplification consists of a bearing under the chord, two braces fixed by two rings and two clamps on the upper end of the braces. The clamps symbolise the welded joint to another chord. Some preliminary results of the simulations are covered in this section.

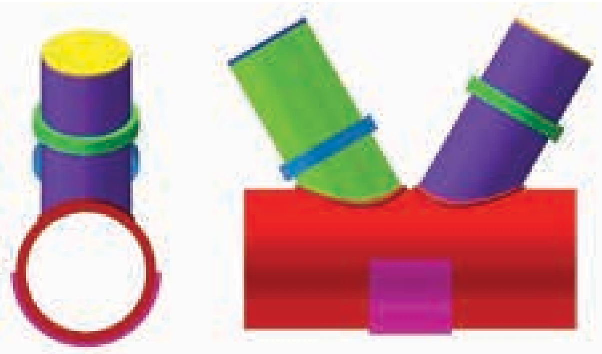

Figure 6: A simplified 3D computer model of a tubular K-joint.

The main points of interest in the evaluation are distortion and residual stresses. The residual stresses are compared with the results from the hole drilling method, but for detecting the distortion no measuring system was available. Due to the strong relationship between residual stresses and distortion, however, a comparison of the stresses gives information about the levels of distortion.

Figure 7 shows an example of the variation of the gap between the two braces. It is apparent that distortion becomes stronger with increasing distance between the two crown toes. The main reason is the relationship between residual stresses and high heat input, because of the longer joint between the braces.

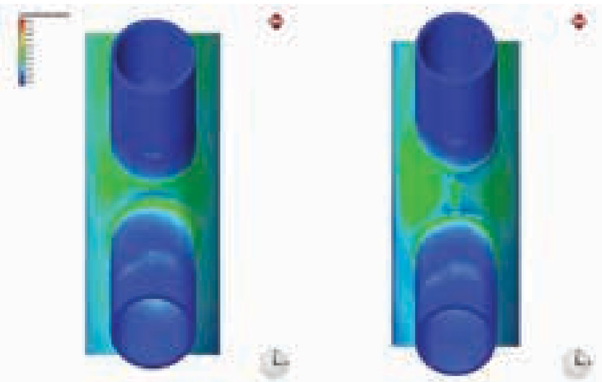

Figure 7: The total distortion for different gaps between the braces.

The residual stresses are shown below. Figure 8 and Figure 9 show the maximum principle stress and the principle stress minimum for two different welding procedures and a varying gap. Limiting both colour legends for a range of +500 MPa to -500 MPa in Figure 8, it is evident that the stress around the weld seams does not differ. Disregarding the area between the braces and only focusing on the crown toe, crown heels and saddler clearly shows that the different welding speeds and welding currents induce almost the same results.

Similar to Figure 8, Figure 9 validates the finding that both welding procedures behave similarly.

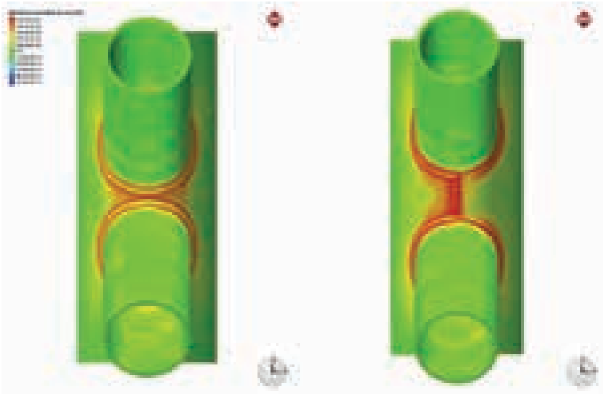

Figure 8: The maximum principle stress of the sample welded at 270 A (right) and 320 A (left) is due to the larger gap between braces.

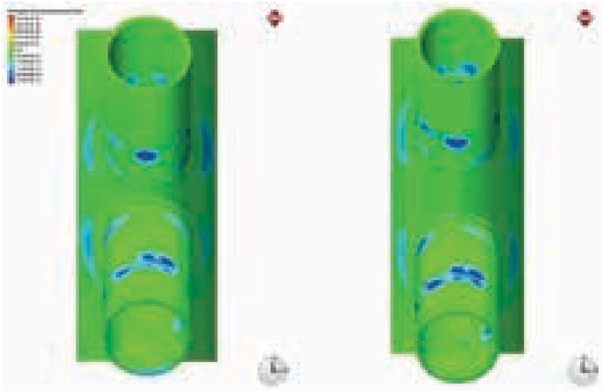

Figure 9: A principle stress minimum of the sample welded at 270 A (right) and 320 A (left) with different gaps.

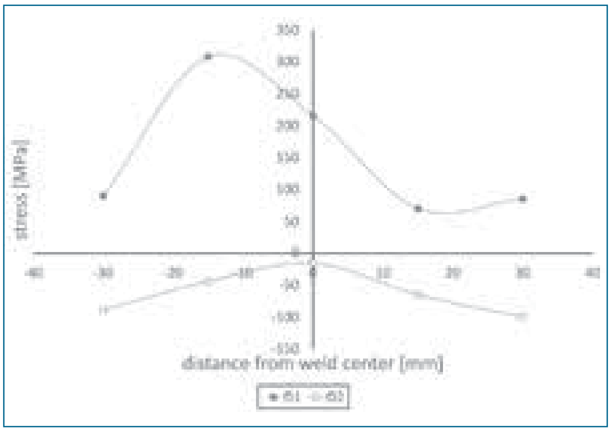

Figure 10: The residual stress along a measuring line normal to the connecting line between the braces (welded at 270 A).

To examine the calculated residual stresses, a measuring line with five measuring points at almost the same position as the hole drilling method (discussed in the next section) was inserted. The results are shown in Figure 10. Maximum principle stress (σ_1) and principle stress minimum (σ_2) are plotted against distance from the weld centre.

Welding experiments

A critical comparison between calculated and measured values can be carried out after manufacturing real tubular K-joints with a robot welding system, as shown in Figure 11. A robot welding system guarantees constant conditions for the whole test series.

Figure 11: A tubular K-Joint after preparation for the hole drilling method.

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The parameter variation used for GMAW with M2.1 shielding gas is shown in Table 2, with different gaps (g_L) and chord slenderness applied. Based on the variations shown in Table 3, the residual stresses were measured using the hole drilling method and these results are presented in Figure 12.

	Chord	Brace	g_L	Welding sequence
K11	thin-walled	big diam.	10	8
K12	thick-walled	big diam.	20	8
K21	thin-walled	small diam.	10	8
K22	thick-walled	small diam.	10	3

Table 3: The parameter variations for hole testing comparisons.

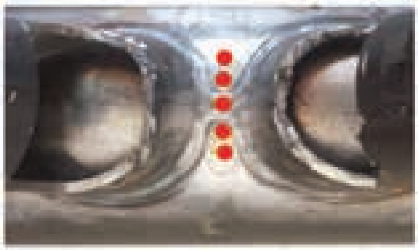

Figure 12: The measuring points for the hole drilling method (red points).

The hole drilling method for determining residual stress involves partial destructive testing. A high-speed drilling machine is used to drill holes without inducing new stresses. Then a three element strain gauge rosette records the strains released through residual stress relaxation for every single step. To obtain the strains at user-defined steps (depth), the drilling system pauses to record the values. After an approximate depth of two millimetres and finished drilling, the residual stress can be calculated using different equations (Hoffmann, Kockelmann, ASTM and others).

The evaluations shown in Figure 13 and Figure 14 point out a similar stress state as already seen in the results from finite element welding simulation. Doubtless, there is a deviation between the curves in Figure 10 and the curves K11_σ_1 and K11_σ_2 in Figure 13 and Figure 14. The hole drilling method is a well-known method to obtain fast results directly from the component, but it is not possible to determine the initial stress state after production processes have occurred on the tube. Due to this fact, actual residual stresses can differ from the measured values, but it is possible to quantify different welding procedures and sequences and compare them relative to each other.

On closer inspection, the measured and calculated residual stresses are closely related. The correlation of the graphs in the area next to the heat affected zone (from +15 to -15 mm distance from weld centre) and in the area of base metal that was also affected (from +30 to -30 mm distance from weld centre) is clearly recognisable.

A particularly striking fact is that the curves of the different welding sequences, the 8 profile path (K12_σ_1, K12_σ_2) and two 3 profile paths (K22_σ_1, K22_σ_2) are in step and they do not have the same gap. This confirms the assumption that heat input has much more of an effect on residual stresses than welding sequence.

Conclusions and outlook

Many experiments and investigations are increasingly being replaced by simulation. Before replacing some of this experiments, preliminary test are necessary to figure out the uncertainties and deviations between simulation and reality.

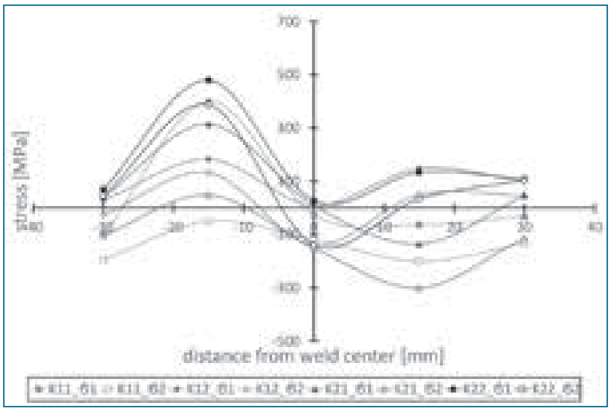

Figure 13: The maximum and minimum principle stresses at a 0.605 mm depth.

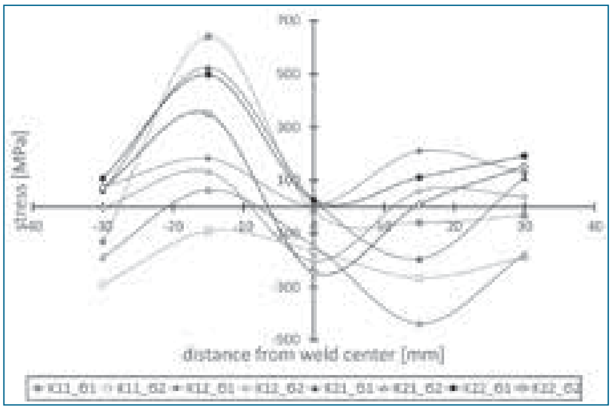

Figure 14: Maximum and minimum principle stresses at 1.125 mm depth.

The saving of money and time evaporates when interpretation of simulation results is not possible and/or transferable to other processes.

During this investigations, no influence of the angle between the brace and the chord (θ) on resulting residual stresses and distortion was found. This is dependant on the equal fixing of the braces on the chord and on the welding table. Therefore, the shifted centre of gravity of the brace will not have an effect. Furthermore, no influence of the chord slenderness (γ) could be determined. Thus, these two factors are clearly due to construction and fatigue.

The determination of residual stresses with FE simulation and the hole drilling method shows similar results. The speed of the measuring technique makes short random sampling measurements possible. An optional validation of the residual stresses is given by the Vickers hardness graph, which follows the same trend.

In the near future, further experiments with different welding sequences and welding procedures will be carried out in order to get a deeper understanding.

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Investigating the electrodes under the welding process of similar and dissimilar materials **in resistance spot welding**

Nachimani Charde, University of Malaya, Malaysia

This paper presents an experimental investigation into copper-chromium electrode caps in the resistance spot welding process. A pair of circular electrode caps of equal size was used to produce up to 900 spot welding nuggets between carbon steel sheets, stainless steel sheets and between carbon and stainless steel. The electrode caps were examined throughout the process for deterioration and mushrooming.

This research presents an experimental investigation of the Resistance Welder Manufacturers Association's (RMWA's) class two (copper-chromium) electrode caps using carbon and stainless steels in the resistance spot welding process. A pair of circular electrode caps of equal size (5.0 mm diameter) was used for up to nine hundred spot welding cycles. The electrode caps were sharpened, when necessary, between welding processes using an electrode dresser, typically after approximately four hundred cycles.

The degrading factors of chromium-copper electrodes influence the weld geometries of carbon and stainless steels weld nuggets, directly impacting on the bonding strength.

When the electrode caps used were subjected to a micro-structural analysis, several cracks were found in their internal structures. The internal cracks only appeared in the movable-upper electrode cap due to the continuous heating and contacting effects from the pneumatic pressures, as compared with the static-lower electrode in the 75 kVA spot welder. Mushroom growth of the electrode cap tips is another problem affecting weld quality, as it reduces the resistance during the welding process.

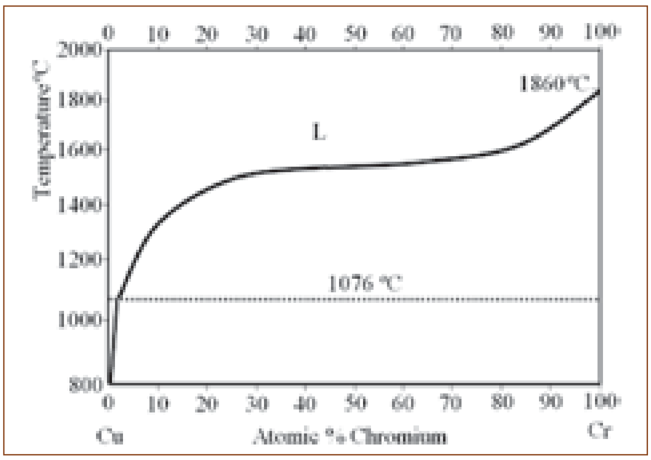

Figure 1: Copper and chromium phase diagram (Chakrabarti DJ, 1984).

In this experiment, the mushroom growth seemed to be higher on the upper side electrode than the lower side. With the increased diameter of the electrode tip due to the mushrooming effect, the weld geometries become irregular, which leads to inconsistency in its appearances and to weld rejections.

Introduction

In joining carbon and stainless steels using the spot welding process, class two alloys are recommended for the electrodes by the Resistance Welder Manufacturers Association (RMWA) [1]. The grounds for this recommendation is that these alloys have superior resistance, heat tolerance and higher corrosion resistance [2]. Without the addition of alloying elements, pure copper is intrinsically soft and fails prematurely in demanding applications [3]. A mixture of substances is, therefore, a good choice for the manufacturing of electrode caps so as to produce superior quality, specifically with respect to their mechanical and electrical properties.

With this consideration in mind, copper-chromium-based electrode caps were practically tested to weld approximately nine hundred weld joints of carbon and stainless steel sheets. Figure 1 shows the copper and chromium phase diagram for copper-based alloys [4]. It shows that the chromium is easily soluble in the liquidus of copper when heated above the 1 076 °C and below 1 860 °C. Once the compound is solidified, it requires equal amounts of heat to re-melt it again [5]. This is significant in the welding of the carbon and stainless steels because the carbon steel melting point falls between 1 426 to 1 540 °C and the stainless steel melting point falls between 1 400 to 1 450 °C. The copper and chromium solubility phases are of the eutectic type. The face-centred cubic (FCC) structure will be formed in the copper, while body-centred cubic (BCC) crystals form in the chromium on solidification of copper-chromium alloys.

Fundamentally, the welding process is governed by its process parameters – welding current, weld time, electrode tip diameters and electrode force [6]. These parameter variations establish the corresponding heat growth for any materials, which in turn give the bonding strength.

While welding, the heat produced in the enclosed areas of the electrode tip will cause the tips' deterioration. Another factor that obviously affects this deterioration is the electrode pressing force, which was primarily supplied via pneumatic pressure in this research. Every time the electrodes are pressed to hold the weldable materials together, the impact effects of the electrode tips on the base metal subject the electrodes to fatigue.

In this experiment the mushroom growth, degradation as well as the deterioration is examined for the copper-chromium electrode caps using a 75 kVA spot welder. Part of this research has been previously published for the simulation, tensile shear strength, hardness distribution and the metallurgical analysis and, therefore, such information is excluded in this paper but relevant references are given in [7].

Experimental procedure

Base metal plates with a thickness of 2.0 mm were prepared in rectangular shapes to a size of 200×25 mm. The chemical composition of the stainless steel sheets was found to be: C–0.046, Cr–18.14, Ni–8.13, Mn–1.205, Si–0.506, S–0.004, N–0.051 and P–0.030. The

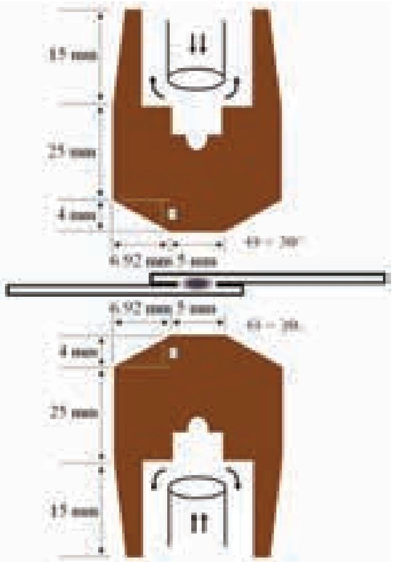

Figure 2: The dimension of electrodes on the welding materials.

CMW Alloy (Class 2)	C18200
Chemical composition	Cu–99.1%; Fe–0.10%; Cr–0.60%, Si–0.10%; Pb–0.05%
Rockwell Hardness (HRB)	70
Electrical Conductivity % IACS@68F	80
Tensile Strength (KSI)	70
Yield Strength (KSI)	55
Elongation % in 2 inch	21
Thermal Conductivity (W/m.K (min))	187
Thermal Expansion (/K)	9.8×10-6

Table 1: Properties of copper-chromium electrodes.

chemical composition of the carbon steel sheets was: C–0.23, Mn–0.095, Si–0.006, S–0.050 and P–0.040.

Hardness of austenitic stainless steels was measured at 86.2 HRB whereas as for the carbon steel, it was about 65 HRB. A pair of water cooled (4.0 ℓ/min) truncated-cone electrodes with 5.0 mm diameters were applied to join these base metals as shown in Figure 2.

Approximately nine hundred welding cycles were completed and the electrode caps were sharpened once to remove the mushrooms after completing about four hundred welds. The electrode caps are then removed from the holder and cut along the central diameter using an abrasive cutter to form flat surfaces.

Once cut, they were mounted using resin powder on a hot press mount-machine to show the cross sectional view of the electrode caps. The mounted samples were then polished using silicon paper, graded as 1 200/800p and 600/200p and also finish-polished using Metadi polishing cloth. This polishing process was conducted for about thirty minutes to an hour on each sample until mirror-like surfaces could be seen.

V2A etchant, consisting of 100 mℓ of water, 100 mℓ of hydrochloric acid and 10 mℓ of nitric acid was used to etch the polished samples. These were immersed for about 45-60 minutes. After that the samples were well rinsed using plain water, dried using an air blower before an anti-corrosion liquid was applied. The samples were then stored in a vacuum chamber for later SEM scanning.

These preparatory steps and the above listed polishing materials were deemed good enough to get reasonable micro- and macrographs for analytical purpose.

Results and discussion

Weld nuggets for the carbon, stainless and dissimilar welds

Classical concerns about the spot welding of carbon and stainless steels are based on the dissimilarity of melting points in individual weld joints and also the heat imbalances in the dissimilar weld joints [7]. In this experiment, both issues were observed for several combinations of process parameters, for example, the variations of welding current levels against the variations of welding time cycles were monitored [7].

Figure 3, 4 and 5 show the carbon-carbon steel, stainless-stainless steel and carbon-stainless steel spot welds performed using the copper-chromium electrode caps. The right of Figures 3, 4 and 5 represent the corresponding SORPAS simulations in which the maximum temperatures are clearly shown before the solidification processes started; whereas the left sides shows the real welds after completion of the solidification processes.

Colour representations are used to distinguish the molten zones and the surrounding heat affected zones. Generally, the copper-chromium electrode caps resulted in the formation of sound welds in carbon, stainless and carbon-stainless materials, even though the caps themselves, deteriorate with time.

Electrode mushrooming and chemical changes

The class-two spot welding electrode caps are primarily made of copper and chromium materials as major components according to RMWA's classification [8]. The material is a dual-phase mixture of chromium and alpha copper as major chemical elements, although

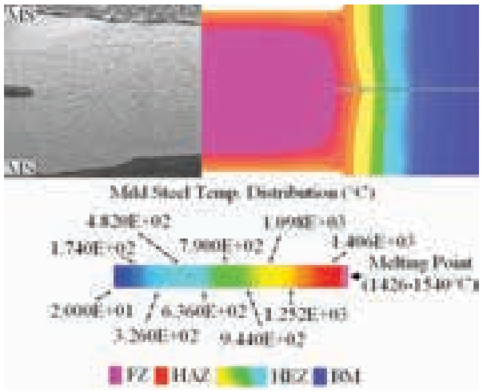

Figure 3: Carbon steel weld (real vs simulation).

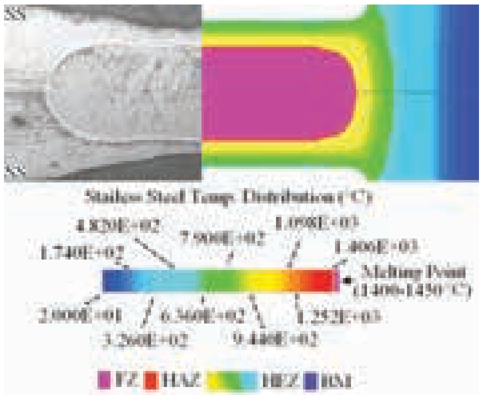

Figure 4: Stainless steel weld (real vs simulation).

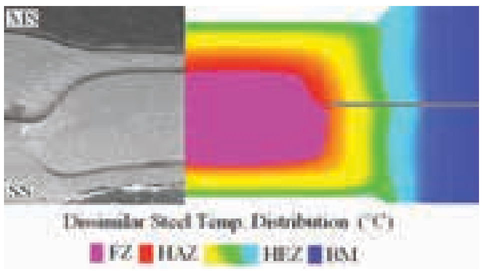

Figure 5: Carbon to stainless steel weld (real vs simulation).

it contains other minor ones. (See Table 1 for the detailed-list of chemical elements as well as other properties of the electrode cap material).

Changes in properties happen at elevated temperatures ($Q=I^2Rt$) due to the precipitation of chromium out of the solid solution. When the electrode is heated together with the metals being welded, it has a high tendency to form

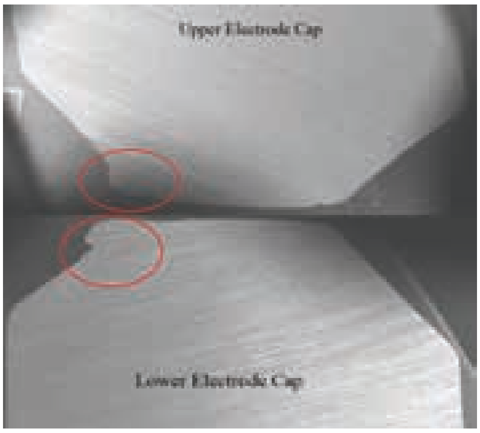

Figure 6: A macrograph of the electrode caps showing one-sided deterioration.

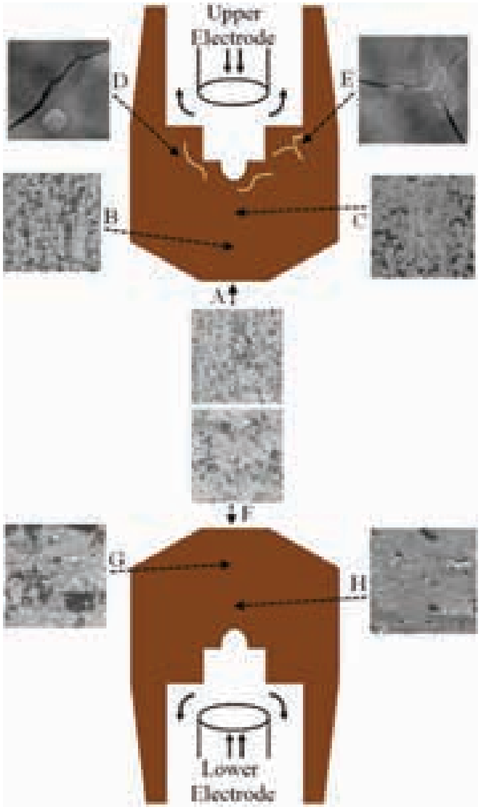

Figure 7: The electrode micro-structural view.

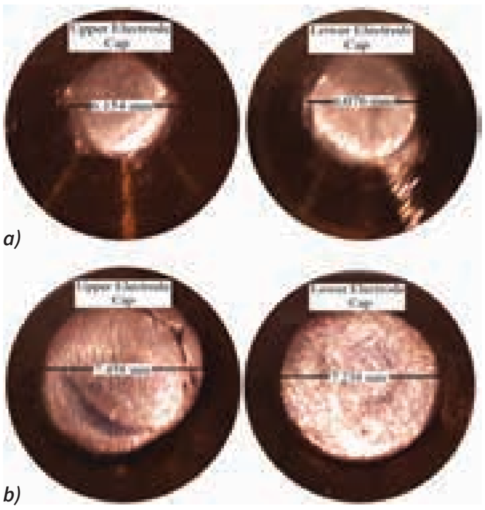

Figure 8: Physical changes to the electrode tips due to mushroom cleaning: a) after 400 spot welding cycles; b) after 900 cycles.

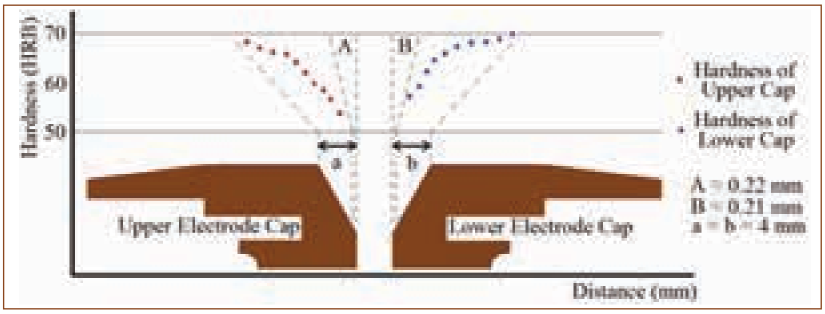

Figure 9: The electrode caps' hardness distribution after nine hundred weld cycles.

new alloys [9] [10]. This is where the precipitation of chromium out of the solid solution is most noticed [11] [12]. This has also been confirmed through the micro-structural examination of the electrode caps as shown in the Figure 7.

As the welding processes are repeatedly being carried out on carbon and stainless steels, the mushrooming effect exacerbates, due to heat exposure at the electrode tip surfaces. This is simply due to the enlarging areas (A) of the cap tips, which cause a drop in the contact resistance (R=ρℓ/A), causing the weld nugget to be adversely affected [13][14].

In this research, the electrode tip on both sides was originally 5.0 mm in diameter and it mushroomed as the number of welding cycles increased. The upper electrode tip diameter was enlarged to 7.458 mm whereas the lower electrode tip diameter was enlarged to 7.238 mm. Figure 6 shows the deterioration of electrode tips, which were used to weld about nine hundred cycles.

Having noted the deterioration that happens on the electrode caps after nine hundred welding cycles; the electrodes were scanned for profound structural changes. Point A of Figure 7 represents the cap's tip at which the base metals' molten heat (max ≈1 600 °C) was directly exposed. Points B and C of Figure 7 are subsequent points leading into the electrode holder, which are exposed to thermal flow but cooled by the internal water cooling system.

The chromium to copper ratio gradually diminishes from point A to C. The micro-structural views reveal that the chromium precipitation is higher at the cap's tip (Point A) due to the direct exposure of heat, which is above the threshold of the melting point of copper-chromium alloys (Figure 1).

The point B, located between points A and C, reveals a balanced chromium to copper ratio. However the difference of cooling rates at point C due to water coolant (4.0 ℓ/min), while preventing chromium precipitation, resulted in internal cracks on the upper electrode cap.

The lower electrode cap shows similar effects (point F, G and H of Figure 7) to that of the upper electrode cap in terms of chemical property changes, but no internal cracks were found because of its static position during the welding process. Theoretically, the heated and cooled tip surfaces encounter similar conditions to that of annealing and quenching processes in metal processing [15]. Annealing in copper-chromium alloys is known to impair ductility over time [16].

The chemical distribution of the copper-chromium alloy has been graphically compared for both electrode caps and found to show gradual precipitation of chromium out of the solid solution.

The electrode tip diameters were measured every hundred weld cycles and illustrative results are shown in Figure 8 to highlight the tips' enlargement. The upper electrode cap's mushrooming effect is slightly higher than the lower one because it has to bear the pressing forces (impact) during plate compression. The severe deformation of the electrode tips was noticed after undergoing the first mushroom cleaning process. The diameter of the tip increased beyond 7.0 mm after nine hundred welding cycles, at which point the combination of process controlling parameters (ie. welding current, welding time and electrode force) had to be increased to achieve successful welds [17].

Hardness distribution

The spot welding process reduces the hardness of the copper-chromium electrode caps over time, particularly in the tip areas. This is possibly because both electrode tips operate in trapped heat during weld formation [18]. Once the surfaces of the two metals are fused and new composite phases are formed, the electrode caps must maintain the holding force for long enough to avoid any escape of molten metals and to avoid over stressing the molten areas [19].

This subjects the electrode tips to direct close contact with hot weld metal [20]. With respect to hardness, both the upper and lower electrode caps were subjected to hardness measurements in distributed patterns. This hardness distribution is shown in Figure 9. Ten measuring points were considered for each of the electrode caps. The thirty-degree truncated electrode caps were then measured along the cone areas, for approximately the first four millimetres, which is shown marked with small letters a and b in Figure 9.

The capital letters A and B represent the worn portions, where no results could be measured. It should be noted that the average hardness of a new, class two copper-chromium alloy is around 70 HRB. This value is significantly reduced at the tip areas and ascends gradually with increasing distance away from the tips and up the cone. (see Figure 9, which is marked with red points for the upper electrode cap and blue points for lower electrode cap.

This pattern supports the previous findings that chromium precipitation is higher at the tips. However, the hardness reduction is still slightly higher in upper electrode cap as compared to lower one. So, at this level of analysis, a conclusion is drawn that the hardness of electrode cap tips (copper-chromium alloy) reduces over a number of repetitive welding cycles during spot welding of carbon-carbon, stainless-stainless and carbon-stainless steel joints. [21].

Conclusions

This paper looks into spot welding electrode cap deterioration and related issues when welding carbon and stainless steels. The research concludes that:

1. The precipitation of chromium out of the solid solution is higher at the electrode cap tips. This happens due to the repeated entrapment of heat at these tips during spot-weld nugget formation.
2. The precipitation of chromium out of the solid solution leads to the deterioration of the tips' surfaces.
3. Up to 400 cycles of spot welding increases the electrode tip diameters by about 23% of its original value, due to mushrooming effects.
4. A further 500 cycles increases the electrode tip diameter by another 26% from the already increased diameter – regardless of the sharpening of electrodes performed at 400 cycles.
5. Overall, a 49% diameter increment from the original value (5.0 mm) was noted on the upper electrode and a 44% increment on the lower electrode tip diameter.
6. The hardness of the upper electrode cap tip is reduced to approximately 54 HRB as compared to its original value of 70 HRB.
7. The hardness of the lower electrode cap tip is reduced to approximately 57 HRB as compared to its original value of 70 HRB.

Acknowledgments

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Quality benchmarking for

DCD Heavy Engineering, a division of DCD Group, has a proudly South African heritage as a niche supplier of bespoke-engineered heavy mechanical equipment for the mining, energy and steel industries. *African Fusion* talks to Rakesh Mohan (left), the company's quality assurance manager, about how the systems the company has put in place are securing global competiveness and quality standards under tough economic conditions.

"I feel that DCD should be declared a national key point because of it unrivalled heavy fabrication capability – if we can't make it, nobody can," begins Mohan. "And while we are subject to the same economic challenges as everyone else in Africa right now, we are on a systematic improvement path towards being leaner, more flexible and globally competitive," he adds.

"In the heavy engineering business, delivery times have always been a challenge, because thicker section steel has to be imported. And since we are a make-to-order company, shipping raw material into South Africa can cause delays.

"Over the past 18 months, we have turned our on-time delivery around, from an average of two weeks late to being two weeks ahead of schedule. We can now accurately predict how long a project will take. What we say is what customers will get and we never sell a delivery we can't meet! This is because work progress is made very transparent through our improved planning and quality systems," Mohan reveals.

Through the active stewardship of investment partner, Investec Asset Management, which strives to support its assets via ongoing evaluation, monitoring and engagement processes, DCD Heavy Engineering has developed and implemented a comprehensive and proprietary enterprise resource planning (ERP) system. "Now all input materials deliveries, work schedules and deadlines are automatically generated and captured on our system, which reveals exactly where we are on every day on any project. And this system is also fully integrated with our quality system," Mohan explains.

On the shop floor, he shows us a display screen of the day's scheduled activities. A dragline base is being fabricated and the list of ongoing and completed tasks, individually allocated to artisans, is on display for all to see. "On projects such as this one, which involves the fabrication of a 17.7 m dragline base in 16 separate segments, every task by every employee is entered into the system, tracked and checked on a continuous basis. So everyone knows exactly were we are with a project at any time," he tells *African Fusion*.

Dragline bases are complicated structures that require significant numbers of internal stiffeners. And after completing the assembly, the accuracy required has to be "within 6.0 mm across the 17.7 m diameter, in terms of flatness and roundness."

In terms of expertise, DCD Heavy Engineering is one of the world's leading manufacturers of ball and sag mills for gold, copper and platinum mining. "We are currently also busy fabricating winding drums for two man winders (6.4 m in diameter and 204 tons each) and two rock winders (7.2 m diameters and 175 t each), which, respectively, require two and four drums per winder," Mohan points out.

On the power side, the company's second core competency, DCD Heavy Engineering has just completed the last of the replacement low-pressure (LP) turbine cases for Kriel Power Station. Six casings were supplied in total, weighing in at 30 t each with a 4.0 m diameter – a notable achievement in that "this is the first time 30 years that these have been fabricated in South Africa". "These were machined and welded here in Vereeniging, with the last two

Left: On DCD Heavy Engineering's shop floor, a dragline base is being fabricated. The list of ongoing and completed tasks, individually allocated to artisans, is on a display screen on the workshop wall. Right: DCD Heavy Engineering is fabricating winding drums for two man winders (6.4 m in diameter and 204 tons each) and two rock winders (7.2 m diameters and 175 t each).

ongoing improvement

Dragline bases are complicated structures that require significant numbers of internal stiffeners. After completing the assembly, the accuracy required has to be "within 6.0 mm across the 17.7 m diameter, in terms of flatness and roundness."

completed last year," he reveals.

But, apart from some potential refurbishment work, the power work has largely dried up and, as a result of the collapse of commodity prices, mining projects across Africa are almost all on hold. "We are, therefore, busy securing work from the mining destinations all over the world.

"We have excess capacity, the skills and the flexibility to take on work that has been non-traditional for us. We are busy with and R&D project on heavy section exotic materials, for example, for petrochemical and specialist minerals processing plant equipment. This is free issue proprietary material and we are exploring how it responds to being manipulated – formed, cut, shaped welded and heat-treated.

"We have ISO 9001 and ISO 3834 Part 2 certifications, so we are also perfectly capable of fabricating pressure vessels, although these are generally made from much thinner materials," Mohan says.

"For us, ISO 3834 is a way of life. We have always had ISO 9001, which we implemented properly, as a manufacturing process and quality standard. But in South Africa, ISO 9001 became more of a commercial tool rather than manufacturing quality system. Hence the need for ISO 3834, which deals directly with fabrication quality requirements," he argues.

DCD is now into its second five-year certification period for ISO 3834 Part 2. "And in terms of auditing, very few ISO 9001 auditors are familiar with weld quality requirements, so the audits are not that detailed and do not focus on a fabricators core competencies. With ISO 3834, the auditors are specialists in welding, which helps our business as their advice is directly relevant to our daily activities.

"Our entire business is built on 'right-first-time' quality. From our ERP systems, planning, scheduling and quality are all integrated and even if we have a to do a repair, the reason is captured and scheduled before being carried out.

"This approach allows us to review and analyse every aspect of a project, enabling us to establish constantly improving benchmarks. I have now been involved in quality management for 19 years and DCD is the only company I know that has such a strong and effective focus on quality control," Mohan concludes.

Lincoln's CrossLinc Technology

Lincoln Electric has launched new CrossLinc™ Technology-enabled welding equipment to provide advantages for the construction, shipbuilding, barge, heavy fabrication and other markets. The Flextec® 350X GMAW power source and the associated LN-25X wire feeder now use a proprietary communications protocol to transfer operator voltage adjustments at the feeder to the power source – which may be 50 m away or more – via standard copper welding cables. No additional control cable is therefore required.

The result is greater safety, quality and productivity for site and large fabrication shop environments.

Lincoln Electric's new Flextec 350X multi-process welding power source delivers premium arc performance for all dc wire, stick and TIG processes and for gouging of plate up to 4.8 mm thick. Engineered for outdoor use and harsh environments, this IP23-rated welder features fully protected components; an output range of 5.0 to 425 A: a 100% duty cycle rating of 300 A at 32 V; and a 60% duty cycle rating of 350 A at 34 V.

A standard model compatible with a greater selection of feeders is available but the Flextec 350X Construction model is compatible with CrossLinc-enabled feeders, such as the LN-25X feeder. Multi-operator 4-pack and 6-pack rack systems are also available, which enable the power sources to be located together in a convenient and safe place, leaving the welders with only simple, reliable and easy to service wire feeders weighing less than 16 kg.

The Xs in the Flextec 350X and LN-25X names indicate that the power source and feeder can communicate using Lincoln Electric's CrossLinc technology.

Flextec® 350X GMAW power sources and LN-25X wire feeders now use Lincoln's CrossLinc™ proprietary communications protocol. Voltage adjustment signals from the feeder are sent through the copper welding cables to the power source – which may be 50 m away or more.

Spray coating and PTA cladding for harsh environments

"The harsh power generation environment is no match for spray coating and plasma transferred arc (PTA) cladding solutions," says Thermaspray's metallurgical engineer, Shaik Hoosain. In this article he explains why, before going on to talk about the use of thermal spray coatings to overcome erosion damage.

Above: Thermaspray thermal spray coatings reduce erosion damage to components, equipment and systems.

Left: The refurbishment of valve seats involves pre-machining, PTA welding and machining to the required dimensions. Thermaspray has also done PTA welding on new seats for the power industry.

Thermaspray is an ISO 9001:2008 and Eskom Level 1 certified company that delivers refurbishing, manufacturing and repair services to a number of power stations around the country.

As a market leader in South Africa's thermal spray and plasma coating industries, Thermaspray's wide range of world-class surface coating and cladding solutions are ideally suited to a host of demanding applications in the power generation industry.

In the steam cycle, equipment and components that handle steam and water (including steam generators, pumps and turbines) operate in very harsh environments and are subjected to extreme conditions such as high pressure steam, high temperatures and wear.

"These components require a variety of control, safety and shut off systems and this is where a lot of wear occurs," says Thermaspray's metallurgical engineer, Shaik Hoosain. He explains: "High pressure steam, high temperatures and metal-to-metal wear at seating areas are the main contributors of wear in steam and water valves. In addition, valve seats and spindles need to inhibit oxidation on the surface, which can lead to adhesion damage at high temperatures."

"Our thermal spray and PTA capabilities enable us to refurbish and repair a wide range of components used by local power stations. These include fan blade and steam side spindles, servo motor and rack spindles, stator pump bearing and accumulator housings, fan blade shafts and liners, pump impellers, nose tip liners, deflector rings, control casings, sleeve and rotation plates, sleeves and bushes as well as a range of valves."

Thermal spray is the method of applying materials onto a prepared base material by heating particles in the stream of a heat source to create a semi-molten state. Particles are then propelled by high velocity onto a prepared substrate where they adhere to the base surface via a mechanical bond; particles continue to build until a specified thickness is attained.

This spray method is considered to be a 'cold' process because, while high temperatures can be achieved in the heated pocket, the temperature of the part itself usually remains below 100°C. This enables worn components to be restored to precise original dimensions with no distortion.

Thermal spray coatings provide increased resistance to high temperatures and oxidation, traction, cavitation, chemicals and corrosion as well as wear resistance from erosion, abrasion and sliding.

"The result, an extension of component service life and subsequent increased uptime and improved production, translate into significant cost savings for the end-user," notes Hoosain.

PTA cladding and hardfacing offer the ideal solution for applications where severe impact and corrosion are prevalent. These coatings withstand such conditions via a fusion bonded layer on the surface.

"This welding process is used to produce high-quality hardfacings of Ni, Co and Fe alloys, as well as tungsten carbide containing grades of the nickel alloys," says Hoosain. "PTA hardfacings are metallurgically bonded to the parent material, which enables them to handle impact, point and/or line loads that thermal spray coatings cannot tolerate."

Hoosain reports on the scope of work for various repairs and refurbishments conducted by Thermaspray at eight power stations: "We completely refurbished a Pentair Semple valve, which involved stripping of the valve, pre-machining, stress relieve, thermal spraying, PTA welding, NDT, final machining, final grinding, and assembly. We also manufactured rings and bushes for the Semple valve from Mehanite material to the client's specification."

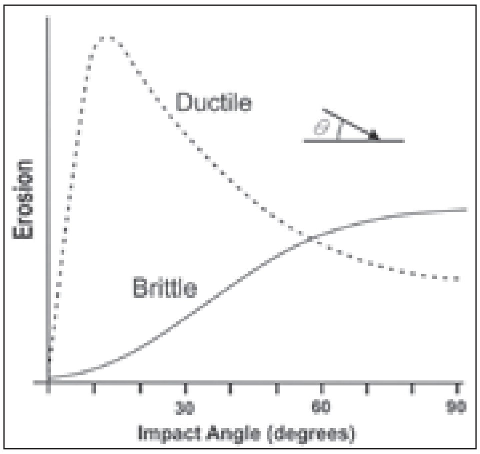
"The refurbishment of valve spindles in partnership with a business partner included pre-grinding, thermal spray coating, final grinding, and NDT (DPI) on the coating. The repair and refurbishment conducted on gland boxes demanded pre-machining, thermal spray coating, final machining, and final grinding."

"To refurbish valve seats we did pre-machining, PTA welding with a cobalt alloy, and finally, machining to the required dimensions. We also did PTA welding on new seats. Our pump refurbishment, which was completed with a business partner (Sulzer), included machining, grinding, thermal spray coating, and final grinding. Electrical run outs have also been conducted on these shafts to ensure the quality required. In addition, we coated butterfly and ball valves to increase wear and corrosion resistance," Hoosain explains.

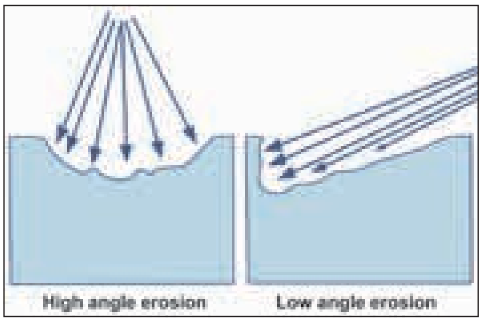
Thermal spray coatings reduce solid particle erosion damage

Thermal spraying allows the production of overlay protective coatings of a

Thermaspray pump refurbishments, completed with business partner (Sulzer), include machining, grinding, thermal spray coating, and final grinding.



Erosion rates of ductile and brittle materials at various impact angles.



The angle of particle impact determines the erosive wear mechanism.

great variety of materials on a range of substrates, almost without limitations as to the components, phases and constituents. Consequently wear and corrosion resistant coatings account for a significant percentage of thermal spray applications.

"Erosion of materials and components caused by the impact of solid particles can be a life-limiting phenomenon for systems operating in erosive environments," says Hoosain. He explains that while erosion testing allows an assessment of the coating toughness and adhesion, erosion behaviour of thermal spray coatings is not clearly understood by South African industry.

Solid particle erosion is a concern for, for example: industrial plants, to manage the flow of solid particles such as coal into equipment; for aerospace systems, which are routinely subjected to sand erosion on helicopter blades, jet engine blades and vanes; as well as for the power generating industries, where exposure of draft fan blades to fly ash can cause solid oxide particles to embed themselves onto downstream turbine blades.

Erosion is caused when a gas or liquid carries entrained solid particles that impinge on a surface with velocity. During flight, a particle carries momentum and kinetic energy, which can be dissipated during impact due to its interaction with a target surface. It has been experimentally observed that, during the impact, the target can be locally scratched, extruded, melted and cracked in different ways. The surface damage will vary according to the target material, erodent particle, impact angle, erosion time, particle velocity, temperature, atmosphere, etc.

Erosion rate – the material loss per unit of erodent mass or volume – versus impact angle is used to distinguish the two main groups of erosion processes: ductile and brittle. During the ductile erosion process (impact at lower angles), the surface damage develops predominantly by plastic deformation during cutting, extrusion, adiabatic shear and forging on ductile materials such as most metals at room temperature.

During the brittle erosion process (impact at higher angles), particle impact produces different types of cracks and chipping, with negligible plastic deformation. However, Hoosain points out that on a sub-micron scale, there is evidence of plastic deformation underneath the target surface. "Other evidences suggest that erosion of materials combines ductile and brittle modes simultaneously, the ratio of them depending on impact angle and material properties," Hoosain adds.

The erosion wastage of thermal sprayed coatings is strongly affected by particle impact angle. However, material behaviour depends on mechanisms of material removal, while hardness seems to be of less importance. Hoosain advises that the following factors must be taken into consideration before considering a coating for an application where erosion damage can be present:

- If the angle of impact < 45°: the coating should be harder and more abrasion resistant.
- If the angle of impact > 45°: the coating should be softer and tougher.
- For high service temperatures: the coating should have high hot hardness and oxidation resistance.
- When the carrier is a liquid: the corrosion resistance of the coating should also be considered.
- For overcoming factors such as thermal shock: the erosion resistant material bond strength should be considered.

Erosion resistance is notoriously complex and its combination of so many variables makes it next to impossible to duplicate and recreate field environments in laboratory tests.

Thermaspray, a pioneer in coating quality and the development of new coatings for specific applications, has designed and built a customised erosion rig according to the ASTM standard G76-13 for the erosion testing of thermal coatings by solid particle impingement.

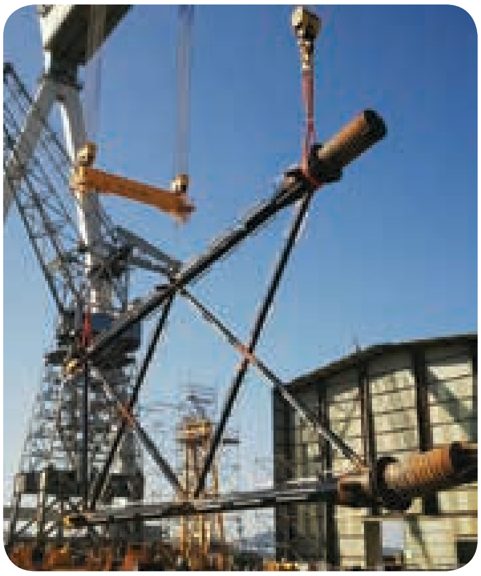
During recent erosion rig tests conducted at its workshop in Olifantsfontein, Johannesburg, in conjunction with a client, coatings were applied onto aluminium substrates, which were sprayed using the high velocity oxy-fuel (HVOF) spray system. Results indicated that among the materials tested, the polymers and the thermally sprayed aluminium showed the highest erosion resistance.

With close to 20 years of experience, Thermaspray is well positioned to provide customers with expert advice in terms of applying the correct coating for a particular application.

Seamless flux-cored wires for large offshore wind project

The Wikinger offshore wind farm in the Baltic Sea.

Seamless flux-cored wire from voestalpine Böhler Welding have been used in the construction of one of the most impressive offshore wind farms in the Baltic Sea.



Undertaken by a Spanish company, seamless flux-cored wire from voestalpine Böhler Welding was used in the construction of the support structures.

All available voestalpine Böhler Welding resources were put into the Wikinger project: local technical advisors; global application technicians; the entire production department; specialised welders; and the Spanish sales network.

The Wikinger offshore wind farm in the Baltic Sea, undertaken by a Spanish company, is one of the most extensive investments of this decade. Seventy wind turbines have been installed close to the island of Rügen. Each wind turbine consists of a four-layer sheath and four pillars used to anchor the turbine to the seabed at depths of between 37 to 43 m. The construction also includes a connecting piece attached above the casing.

The project is due for completion in autumn 2016 and is scheduled to begin generating power in 2017.

In order to support its goal of becoming the technological leader in seamless flux-cored wires, in 2013 voestalpine acquired 90% of Fileur, an international specialist in this segment. A new competence centre was also established in Cittadella, in north-eastern Italy. The product's major strengths include: excellent weldability and welding quality; a whole palette of unalloyed and low-alloy steels; and ease of feeding.

These seamless flux-cored wires were used in the construction of the support structures for the Wikinger offshore project, mainly because the seamless design offers optimal protection against moisture absorption, which significantly reduces the risks of hydrogen cracking.

"The reasons for using these wires are obvious: they are seamless, low hydrogen wires for the best possible protection against hydrogen and moisture absorption during warehousing or during use in workshops. The customers were extremely pleased with the high quality, good performance, and enhanced mechanical properties of these consumables," says José María Miguel of voestalpine Böhler Welding in Barcelona, Spain.

Close networking as a success factor

voestalpine Böhler Welding Spanien S.A. worked closely with the Spanish customer during the entire project. A variety of departments at other companies within the voestalpine Böhler Welding Group were also involved. In addition, the management deployed all available resources and put all its energy into the project: local technical advisors; global application technicians; the entire production department; specialised welders; and the Spanish sales network all supported this major order.

The Spanish company also offered valuable technical advice, which was particularly appreciated by the customer. Consequently, this project represents a major success for the entire voestalpine Böhler Welding Group in the use of flux-cored wire in offshore construction.

All photos courtesy of voestalpine Böhler Welding.

ESAB restructures SA route
to market through Howden Donkin

ESAB has decided to dissolve the relationship with its local BEE partner and to again take more direct responsibility for importing, distributing and servicing ESAB products in southern and South Africa.

Both ESAB and Howden are part of the global Colfax Corporation, the US-based industrial giant, which acquired the companies in January 2012 after completing a US$2.4-billion takeover of their parent company, Charter International.

"In South Africa, because Howden and ESAB are co-owned by Colfax, we are sister companies within the umbrella corporation. So when the need arose to look for an alternative way to service ESAB's needs in South Africa and in the Southern African region, Howden set up a division called ESAB South Africa, a Division of Howden Donkin within the local Howden Africa company. This division will from now on import, sell and distribute all ESAB's products in South Africa," says Kim Brightwell of ESAB Middle East and Africa.

Howden Africa produces a diverse range of large-scale engineered plant and products. The Howden Africa business units include: Howden Power; Howden Fan Equipment; Howden Projects; and Donkin Fans. Howden Donkin has a manufacturing facility in Port Elizabeth, which designs and manufactures pre-engineered fans and accessories.

"ESAB South Africa's head office and central warehouse now sits at Howden Africa's Booysens premises in Johannesburg south, just two minutes off the M1 motorway," Brightwell says.

"Howden Donkin is an ideal partner for ESAB as it has a well-developed import and logistics capabilities that are ideally suited to ESAB South Africa's needs. With infrastructure in PE, Cape Town and Johannesburg on the warehousing and distribution side, we have been able to dovetail our ESAB operations very quickly and effectively," he adds.

In addition, ESAB South Africa is working with Imperial in Durban for

Kim Brightwell

warehousing, distribution, office and workshop space. "Imperial are taking care of the logistics area and we operate a sales office from its premises," he continues.

The existing ESAB Middle East & Africa Team, which is also now based in Booysens and consists of sales and technical support personnel, will continue to assist both ESAB South Africa and their customer to gain the most out of ESAB's extensive range of quality products.

"We have re-established ESAB's formal presence and trading capacity in South Africa. We are now leaner, more experienced and more determined to provide the complete range of ESAB products and services to the South African market," Brightwell concludes.

Gasless Innershield welding benefits

Renttech's Johan Bester talks about gasless flux-cored welding and the advantages of using the company's UniArc Mag200 MC multi-process inverter.

When undertaking MIG/MAG welding outside, such as on a construction site or farm, exposing the weld to the weather may hamper progress and compromise the quality of the final result. Effects of wind or even just a breeze during the welding process can be a serious problem. Put simply, valuable shielding gas can all too easily get blown away: resulting in porosity, excessive spatter and inferior weld quality.

A simple solution is to use the gasless flux-cored welding process with a Lincoln Innershield wire, a process that was originally designed to replace stick or shielded metal arc welding (SMAW). As the name suggests, Innershield wires produce their own shielding gas to protect the weld from the atmosphere. This process is perfectly suited for outdoor use – particularly in extreme operating conditions in industries such as agriculture, construction, shipbuilding, mining or wherever maintenance is required.

"Changing to gasless wires brings many benefits, especially in areas where wind can be a problem – they eliminate the inconvenience and expense of shielding gases being blown away, as is often the case with traditional MIG welding. In addition, they make it easy to weld out of position, including vertical up, vertical down, overhead and horizontally. Gasless wires are also easy to use on both thin and thick gauge material – and they can fill gaps effectively, without burning through the plate or tubing. Welders who weld 1.6 mm tubing using stick electrodes will know a lot about this particular problem," says Johan Bester, welding sales manager at Renttech South Africa.

"In the case of gasless flux-cored welding, the filler metal for the weld is basically an arc-welding electrode turned inside out," Bester explains. "The mild steel tube or sheath becomes the main filler metal to the arc and the flux inside becomes a light slag deposited on top of the weld." He adds that the flux shapes the weld, while protecting it against the atmosphere throughout the solidification period. It also aids in removing impurities in the base material.

The resulting slag keeps the weld from sagging or falling out when welding out of position; and is easily removed with a steel brush or chipping hammer after the weld has solidified.

"Gasless wires are also known for being able to weld over painted, rusted or galvanised surfaces – making this a favourable welding process for maintenance, repairs or modifications on 'used steel'." Bester emphasises, however, that good welding practice should always include removing as much of the coating, dirt or rust as possible.

"Our UniArc Mag200 MC is a multi-process inverter that is especially versatile, offering not only gasless flux-core welding but it is also able to be used for MIG/MAG welding, stick and TIG welding," says Bester. "This single phase 200 A, 230 V machine can take either a 5.0 kg or 15 kg wire spool and weighs only 22 kg."

"If customers already have MIG/MAG/CO_2 machines that can change polarity, they can easily convert to Innershield wires," he adds. "All that is needed are the correct drive rolls, a gasless welding torch and a spool of Innershield wire, and machine is good to go."

"The Uniarc Mag200MC is a great tool to own," adds Bester. "Combine this with the Lincoln Innershield wire and it is now much easier to produce quality welds."

Renttech South Africa specialises in the rental and sales of a wide range of industrial equipment and has the largest fleet of rental welding equipment in the country. Its UniArc welding machines range from single phase 220 V machines to 380 V/525 V three-phase machines, and are generator-compatible if access to electricity is a problem.

"We are extremely pleased to bring such a handy, multi-purpose machine such as the UniArc Mag200MC to our customers working in industry, construction and agriculture. It offers new levels of convenience for the user, especially in a windy, outdoor context.

"This machine is now available at all our branches with our technical staff ready to introduce customers to the world of flux-cored gasless welding" adds Gerrit van Zyl, managing director of Renttech South Africa.

www.renttech.co.za

Renttech South Africa

Renttech SA is a company within the Brandcorp Group with a solid background in the rental and sales of 22 recognised brands of welding, power generation, lifting, rigging and construction-related equipment. The company's successful growth can be attributed to the adoption of the highest levels of integrity, performance and customer service.

Industries serviced by Renttech South Africa include petrochemical, power generation, construction and civils, fabrication/manufacturing, pulp and paper, offshore oil and gas, shipbuilding and marine maintenance, mining, road and rail equipment fabrication and maintenance, and engineering.

The company has the largest fleet of rental welding equipment in Southern Africa. In addition, SA Welding provides a range of specialised welding consumables and KLS Lifting Services manufactures and distributes rigging and lifting equipment, including nylon web slings and endless round polyester slings.

Quality levels are measured through the internationally recognised ISO 9001-2008 standards.

Low cost plasma technologies

Easy to use and set up with low running costs are the hallmarks of Afrox's range of automated plasma cutting equipment. "We strive to implement turnkey profiling solutions that match the longer-term cutting needs of fabricators," says Afrox applications development manager, heating and cutting, Hennie van Rhyn. "Specifically for cutting stainless steels and aluminium, we offer customers a range of packaged plasma solutions built around combining cutting tables from leading European manufacturer Pierce, with Thermal Dynamics' plasma cutting technology.

"We couple Pierce's flexible range of precision CNC profile cutting tables with Thermal Dynamics' water mist plasma technology, which offers an excellent combination of features for metallic materials such as stainless steel, aluminium, copper and titanium," says Van Rhyn.

Pierce RUM or Maxi systems with Thermal Dynamics' water mist plasma technology can accommodate the larger, more demanding steel services segment of the market. These systems are available in South African through Afrox.

The Thermal Dynamics automated plasma cutting range includes the Standard Cutmaster A series, a light duty cycle, entry-level air plasma system that provides an economical and flexible solution. With benefits that include easy set-up and use, along with superior cut quality at up to 120 A, the Cutmaster A series offers solutions for light, medium and heavy applications.

For heavier duties, Thermal Dynamics' Auto-Cut XT series is a high duty cycle standard air plasma system ideally suited to heavy plate cutting applications. "These systems deliver a premium performance on both mild steel and non-ferrous metals and incorporate proprietary Maximum Life parts that lower operating costs, and feature water mist secondary (WMS) technology for low cost, high quality cutting on non-ferrous metals, using N2 as the plasma gas and ordinary tap water as the secondary gas," he adds.

The Ultra-Cut XT series is a high precision plasma system with the flexibility to increase cutting power while providing outstanding parts life, the highest kW output for a maximised duty cycle and cut speed, and a lower current draw.

"The beauty of the Ultra-Cut XT range is that the cut quality is high enough to allow parts to go directly from the cutting table to welding, painting or assembly, eliminating the need for costly secondary operations," Van Rhyn notes.

The Afrox range of Pierce profile cutting systems caters for all segments of the profile industry, from the Sabre, providing optical tracing customers a reliable machine supplied with oxy fuel or plasma cutting options, to the Scorpion, RUR, RUM or Maxi systems, which can accommodate the larger, more demanding steel services segment of the market.

The Pierce Sabre 800 optical trace oxy fuel or plasma cutting machine has a tracing width of 800 mm and a cutting width of 1 450 mm, while the Scorpion 2 000-3 000 machines are light and portable, easy to operate and maintain, even with multi-shift running.

"All our Pierce profile cutting systems are supplied with state-of-the-art Pierce CNC control systems, giving customers the flexibility to select the desired software packages," says Van Rhyn.

"By combining the Ultra-Cut XT series with Pierce CNC cutting tables with customisable widths and lengths, we can offer fabricators HD plasma cutting solutions at a fraction of the price of competing technologies. And by adopting water mist technology, ongoing production costs can be slashed, too," he concludes.

www.afrox.co.za

CrC-lined chutes for power plant

Chromium Carbide (CrC) liner plate specialist Rio-Carb has ensured a saving of more than R100 000 for a power plant in Secunda, after successfully refurbishing three chutes and fitting them with CrC liner plates.

Rio-Carb director Martin Maine explains that the project, which has been ongoing for five years, was extended due to the impressive performance of the R-C 700 liner plates. "Rio-Carb had already installed liner plates in the three 60 m^2 chutes at the plant. We have also been tasked with supplying the utility with R-C 700 pipes, which outlast the current pipes ten-fold."

Rio-Carb has ensured a saving of more than R100 000 for a power plant in Secunda, after successfully refurbishing three chutes using CRC liner plates.

The chutes at the plant were previously fitted with ceramic 2.0 m bolted liners, which were not suitable for the project's specific wear rate, thereby resulting in erosion and blockages in the chutes. Rio-Carb replaced the ceramic liners with 500×500 mm R-C 700 liner plates, which are manufactured to the chute specifications. The refurbishment included sandblasting, welding and refitting. Rio-Carb repaired the holes in the chutes and then standardised the liner sizes to an easy-to-handle weight.

According to Maine, the average chute lasts for at least three years. "Standard refurbishments cost at least R2-million every three months, while with Rio-Carb's R-C 700, it is around R1-million every three years. Using MaxCS technology, Rio-Carb is able to take advantage of the properties of CrC by depositing it via a welding process onto mild steel backing plates. This gives it an optimum hardness of 58 RC and additional flexibility for moulding and shaping."

All Rio-Carb liner plates are also marked with a unique identification number and recorded in the company's database. This enables the customer to get the correct liner plate sizes immediately, and eliminates the need for onsite measurements. "We also provide an obligation-free wear survey consultation by sending a wear specialist onsite to measure the thickness of the liner plate using ultrasonic technology to determine when they need to be replaced. This not only saves costs, it helps to accurately prepare for downtime," Maine concludes.

www.riocarb.co.za

Augmented-reality welding training for Walvis Bay

Kraatz Engineering, situated in Walvis Bay, Namibia, has installed an augmented-reality welding simulator supplied by Sangari SA. The simulator is being used to upskill trainee welders without incurring the costs of expensive material such as welding rods, steel plates and oxygen.

Kraatz Engineering provides services to the oil and gas, mining, fishing and general industrial sectors in Namibia as well as on the western seaboard of Africa.

"The Soldamatic provides a safe environment with no need for special clothing or ventilation. The welding can be done in any environment and it is 100% safe, simply because it is a virtual welding environment and has no gas emissions," says Dirk van Niekerk, MD of Kraatz Engineering.

"The system is sophisticated in providing augmented-reality 3D vision in a workshop environment. Payback for a large training institution is about 18-24 months. The quick payback period is achieved because no consumables are used and there is no wastage," adds Bez Sangari, CEO of Sangari South Africa, sole distributor of the product.

The simulator consists of a hardware unit the size of a standard PC, with a built-in screen that allows the trainer to view the student's progress in real-time, as well as viewing a recording at a later stage. The trainee wears the virtual-reality headgear, which simulates a real welding environment.

The headgear generates realistic welding graphics such as the weld pool and arc. It emits simulated smoke and sparks and simulates heating of the affected area – all through the student's headgear. It also simulates cracks, filler material, gravity and undercutting.

"Welding skills can be trained for specific applications and the student's performance measured in a fair, reliable and unbiased manner. The unit includes 93 different training lessons and customised lessons can also be added," says Sangari.

Both the trainer and trainee are able to analyse and assess the welding performance in a video format afterwards and evaluate skills such as the welding velocity, stick out, travel and working angles. When required, maintenance and upgrades of the software can be done remotely.

The Soldamatic system provides augmented-reality 3D vision of welding in a workshop environment.

The system supports training on SMAW, GTAW and GMAW processes and a variety of welding joints such as V-butt joint, Lap, T-joint, pipe to square butt joints and pipe T-joints, all at a variety of angles.

www.sangari.co.za

SA submerged arc systems adopted for wind towers

Three Starweld Infinity submerged-arc welding (SAW) systems have been delivered to one of South Africa's wind tower manufacturers as replacements for European imports. "Although we import the tractors from overseas, the critical parts, namely the power source and the control panels, are designed and manufactured by Starweld at its Boksburg premises in Gauteng, says Steve Hutchinson, Starweld's marketing manager.

The Infinity 1 000 A Multi-process dc welding inverter with CANBUS communication technology is the flagship of the Starweld range.

"The most significant innovation, is the inclusion of CANBUS communication technology, which is an intelligent two way machine-to-machine communication protocol invented by Robert Bosch for the Motor Industry in the early 1970's," he says.

CANBUS is now present in virtually all new motor vehicles. It reduces the communication wiring harness to a two-wire system that carries instructions and sensor feedback signals to and from the vehicle's central computer and all interconnected components. Components are individually programmed to respond to instructions relevant to them and to pass on those that pertain to other components.

"And our South African Infinity systems are priced from around R 130 000, which represents great value for money when compared to systems manufactured elsewhere.

Significant features include:

- 100% duty cycle at the rated current setting.
- Tunnel cooling, which keeps metal dust off electronic components.
- Full digital amp and volt metering.
- LEM transducer technology that guarantees the accuracy of output settings – what you set, is what you get.
- Multiply auxiliary output voltages (24/42/110 volts).
- Weighs only 92 kg, which makes it ideal to use on girth welders.
- A full two-year warranty that covers all components.
- Economical spare parts – a replacement control board retails at R1 500, for example.

The Infinity 1 000 A Multi-process dc welding inverter is the flagship of the Starweld range, which, as well as being ideal for SAW, can be used for shielded metal arc welding (SMAW or stick welding); gas metal arc welding (GMAW or MIG/MAG welding); flux-cored arc welding (FCAW) and for carbon arc gouging of section of up to 165 mm thick.

www.starweld.co.za

Hydra-Arc delivers its largest ever module for Sasol

On Friday January 25, Hydra-Arc moved its largest and most impressive plant module from its Sky-Hill facility to the Sasol Secunda plant.

The plant module, one of several being manufactured by Hydra-Arc, was Unit 296, the coal tar filtration (CTF) east filter press plant, a 158 t module with a width of 9.7 m, a height of 12.0 m and a total length of 26.2 m.

One of 26 plant modules for Sasol's CTFE plant in Secunda under construction at Hydra-Arc's Sky-Hill facility near Secunda. Inset: A 3D CAD model of Unit 296, the 158 t coal tar filtration (CTF) east filter press plant, the largest and most impressive module yet delivered.

Hydra-Arc has become a proudly South African specialist in the manufacture these modern plant modules for the petrochemical industries, which introduce a novel approach to plant design and construction. The whole plant is broken into interconnectable modules, which maximises the amount of factory-based fabrication and minimises onsite construction time.

"The idea is that each module is fabricated to include all of its equipment, vessels, piping, instrumentation and supporting structures. Then, once the site foundations have been prepared, the modules are simply delivered to site and coupled up to form a functional plant," explains Ewan Huisamen, Hydra-Arc's engineering manager. The full CTFE plant under construction consists of 24 individual modules, which are all being fabricated in Hydra-Arc's Sky-Hill facility outside Secunda. "This is the first time a plant has ever been constructed in this way in South Africa," Huisamen concludes.

www.hydra-arc.com

WeldCube, a new documentation and data analysis system

WeldCube, the documentation and data analysis system from Fronius enables accurate and continuous quality assurance for up to 50 welding power sources.

The documentation and analysis of process data is gaining increasing significance for welding technology. After all, it is only with complete accuracy and transparency that targeted optimisation can become a reality.

With this in mind, Fronius has developed WeldCube, a documentation and data analysis system. WeldCube connects up to 50 power sources and tracks accurate and continuous quality assurance and evaluation data from countless possible parameters. As a result, users are able to significantly improve the output and reliability of their production operations.

The WeldCube solution is based on an industrial PC (IPC) with integrated software, which is used to connect power sources via a network. The system is compatible with all digital Fronius equipment, including the resistance spot welding system DeltaSpot and the intelligent welding system platform TPS/i.

This enables the user to document and evaluate a wealth of data such as current, voltage, wire speed, welding speed and time, arc length and dynamic correction, and job numbers – for both manual and robotic welding processes. This data is visualised in order to achieve an accurate analysis, then output via a web browser, which enables the results to be accessed conveniently from any computer or mobile device.

Thanks to the Plug & Play principle, installing the WeldCube is extremely easy. Once the system is up and running, virtually zero maintenance is required to keep it going. As Fronius further develops and hones the technology, updates will be provided that the user can install. Individual adjustments and programming are easily implemented thanks to a range of packages that can be added to the standard functions. As a result, customised solutions tailored to meet the customer's exact requirements can be delivered.

The extensive functions of the WeldCube enable a wide range of different uses. The actual values for each power source can be documented both in relation to individual machines and total welding output – in real-time. The user is also able to continually monitor and evaluate additional data, including consumption data relating to gas, wire and energy. Set values, such as job data, can also be observed and are recorded by the system for the entire service life of a welding system.

When used in combination with Fronius' new TPS/i welding platform, it is also possible to edit jobs and make comparisons across power sources. All the values can be exported in different file formats or printed directly from the IPC. ***www.fronius.com***

ITER chooses narrow gap welding for its structural sub-assemblies

ITER (the way in Latin) is one of the most ambitious energy projects in the world today. In southern France, 35 nations are collaborating to build the world's largest tokamak fusion reactor, a magnetic device that has been designed to prove the feasibility of fusion as a large-scale and carbon-free source of energy based on the same principle that powers the Sun and stars.

Narrow gap hot wire TIG welding is emerging as an essential technique for joining critical components such as those required for the ITER, mooted to be the world's largest tokamak fusion reactor.

ITER is being pursued to test the integrated technologies, materials, and physics regimes necessary for the commercial production of fusion-based electricity. It will be the first fusion reactor to produce net energy and to maintain fusion for long periods of time.

The project represents a unique challenge for the assembly of workpieces, particularly on site, due to the required precision after assembly and zero-defect end quality.

Critical areas include the pre-conditions required in terms of mechanical preparation, positioning and fixtures, as well as unavoidable deformation that occurs during assembly by welding.

Narrow gap hot wire TIG welding is emerging as an essential technique for joining critical components such these, with large wall thicknesses that need to be completed and assembled on-site. This welding process perfectly meets the constraints involved in the final assembly because of its all-positional capability.

Polysoude can offer two main technological approaches:

- Using a torch with a fixed electrode position.
- A system with an oscillating electrode.

The first technique meets productivity requirements for the preparation of joints with perfectly defined tolerances. The second technique, however, satisfies the need for maximum flexibility in compensating for workpiece preparation and fit up tolerances and for shrinkage during welding.

Torch carriers, such as robots, column and boom and carriage-type welding manipulators, are tools that are adapted to the size and geometry of the joint to be welded. If a well-designed manipulator is incorporated, it is realistic to consider using the narrow gap TIG process to weld sections of up to 400 mm thick, given the numerous relevant advantages compared to competing processes available on the market today.

This technology can also be adopted in all areas of industry, such as the construction of equipment for the energy (hydro-electric, conventional fossil fuel and nuclear power plants), petrochemical and to the manufacture or repair of heavy walled pipes.

Promoting R&D

Polysoude has been creating solutions best adapted to the requirements of the industry since its foundation in the early 1960s. To master arc welding processes and their automation, Polysoude strives to use the latest GTAW, Plasma, GMAW and FCAW technologies, along with all-position orbital welding and mechanised solutions.

The company prides itself on its ability to offer:

- Research and development.
- Testing and feasibility studies.
- Reliability and user-friendly graphical user interfaces.
- Small volume, custom made hardware and software systems with dedicated mechanical and electronic engineering.
- Welding and after sales services.
- Training, commissioning and support services.

The strictest checks are applied throughout the production and assembly process to ensure that Polysoude solutions are competitive and that customers' needs are being met.

Polysoude has been ISO 9001-certified since April 2006. This certification defines the approach taken towards continuous quality improvement of products and the services and also applies to the company's Intranet, TDMS, CAD, CAM, ERP and CRM systems.

www.polysoude.com

IIW International Conference, 2016

The 69th IIW Annual Assembly and International Conference will be held in Melbourne, Australia from 10 to 16 July, 2016 under the theme: *From Concept to Decommission: The Total Life Cycle of Welded Components*.

Welding affects the long-term life cycle and performance of so many of the world's assets, across sectors as diverse as utilities and manufacturing, to mining, oil and gas. Welding is the bond that holds together bridges that link nations, oil platforms that power entire countries, and manufacturing plants that feed entire communities.

The conference aims to explore the entire life cycle of weldments, from initial concept, design and manufacturing, right through to the installation, maintenance, and repair of welded components, as well as life extension and decommissioning.

www.iiw2016.com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