AFRICAN FUSION

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FEATURES

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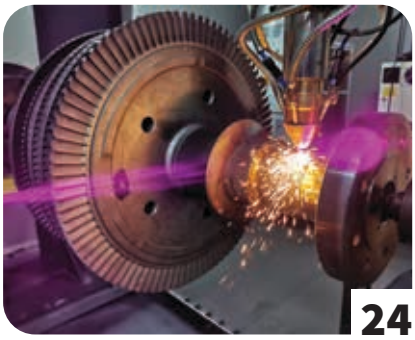

Lead the charge into the 4th Industrial Revolution with an SAIW Robotic Welding qualification

The SAIW's Robotic Welding Operators Training course is to start from April 2021. With space for only two candidates on each course, this is an ideal opportunity to join the welders of the future.

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SAIW
Southern African Institute of Welding

SAIW and SAIW Certification

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I am very pleased to report that we are now in the advanced stages of launching the Welding Federation of Africa (WeldFA) as a non-profit company with eight founding members from countries across the African continent. We have all agreed on a Memorandum of Incorporation (MOI), which is now with the attorneys, and we expect our first board meeting to take place within the next few weeks.

Due to COVID, we have learnt to employ low-cost and effective communication through virtual meeting and conferences, with participants dialling in from their own offices and countries. We intend to continue to leverage this for technology transfer, including cross border training and board meetings, which, we believe, will considerably reduce the need to travel. So an Africa-wide welding federation becomes a much more viable entity in today's world.

WeldFA will be used to help develop welding capability across Africa, to enable the drive towards industrialisation and growth on our continent. According to the African Development Bank's 2020 Annual Development Effectiveness Review (ADER), the last decade has seen manufacturing growth in Africa outpacing the global growth rate. In 2019, Africa's industrial GDP expanded by 17% to $731-billion (in 2010 dollars), with the value-add of manufacturing surging by 39%.

But around two-thirds of value-added manufacturing takes place in just five nations: Algeria, Egypt, Morocco, Nigeria, and South Africa. Also, the COVID-19 pandemic has upended economic growth, disrupted trade and financial flows and triggered losses of millions of jobs. This makes the drive to industrialise Africa all the more urgent, and welding and related technologies are key to the success of such industrialisation.

The MOI details the different membership categories, starting with National members, which include nationally recognised bodies for welding and joining and formally incorporated groups or welding associations in African States.

Regular members will include any organisation in Africa involved in and carrying out welding and welding related activities and programmes, such as training, inspection, research, development, fabrication, construction and installation. Individuals are also welcome if they are involved in the practice or business of welding and related technologies, while associate members who have an interest in promoting welding related development will also be welcomed.

The key day-to-day activities envisioned as the core business for the African Federation include the promotion of goals, policies, systems and programmes for the development of welding technology in Africa, and the harmonisation of personnel training, examination and certification systems.

In addition, we aim to promote collaboration; organise seminars, workshops and conferences; represent Africa in the international welding community at all formal IIW meetings; and encourage the formation of welding societies and national welding bodies in countries where such organisations do not yet exist.

We hope to see more African participation in regional research and development activities and to provide a platform for the exchange of scientific and technical information, and innovative research in Africa. This will be supported by a system of honorary awards to recognise exceptional contributions made to Welding in Africa.

With its incorporated office in South Africa, we at SAIW will be striving to help make WeldFA a continental champion of industrialisation: supporting engineering, science and the application of joining technologies; providing a networking forum for scientists, researchers, industry and educators; and disseminating leading-edge information and best practices.

I invite any organisations or individuals interested in participating to join us, through the SAIW or directly though WeldFA (info@weldfa.org).

John Tarboton

SAIW's rigorous and reinvigorated

African Fusion talks to SAIW executive director, John Tarboton, and Herman Potgieter, the chief executive officer of SAIW Certification, about the Institute's ISO 3834 Welding Manufacturer Certification Scheme, and why the SAIW is the only service provider worth considering by companies seeking to participate responsibly and competitively in the African and South African welding industries.

"As SAIW, we go to ISO 3834 companies with the aim of creating long-term partnerships, first to achieve the initial ISO 3834 certification, but then to maintain that certification while helping companies to achieve ever better weld quality and to become more competitive in the international arena," begins Tarboton.

"On issuing an ISO 3834 Certificate as part of the SAIW Welding Manufacturer Certification Scheme, we invite that company to enter into a partnership with the SAIW so that, together, we can raise welding quality, productivity and safety standards and steadily move our welding industry towards international benchmarks," he adds.

An investment in ISO 3834 by a welding manufacturer, believes Tarboton, is the same as an investment in the Institute by an SAIW Member, in that the Institute is accessible to any certified company or SAIW Member for support, advice and help so that its welding related endeavours can succeed.

"Compared to other service providers, the big advantage we have at SAIW is that we have people who have been steeped in the local welding industry. Our three auditors, Herman Potgieter, Renier Mostert and Riaan Loots are all South Africa welding industry experts with more than 80 years cumulative experience in the fabrication industry. They are not simply trained auditors. They know how the industry works, what is possible and what is not. They are not going to ask to see the label from a pack of electrodes used six months ago to tick the 'traceability' box," Tarboton tells *African Fusion*.

Herman Potgieter continues: "ISO 3834 is a welding management system and welding is a competency. From the very start, everything has to be done properly with set checks and balances throughout the manufacturing process and this matters most on the shop floor," he says. "You have to be able to manage the detail of every weld at shop floor level to produce safety critical products such as pressure vessels with good quality welds. You cannot do it simply by checking documentation from the safety of an admin office," he advises.

"This is SAIW's key strength. Our auditors have the shop floor experience to understand what is important and how to best manage and control these things at this fundamental level," he says.

In an initial survey by SAIW Certification of its ISO 3834 accredited companies, 75% of respondents rated their overall ISO 3834 satisfaction with SAIW as World Class, while a total of over 95% rated their satisfaction as exceeding expectations.

In addition, the SAIW is the only ISO 3834 service provider in South Africa that has a local industry representative body to approve ISO 3834 company certifications. "Other certification bodies have to use overseas representatives, who don't necessarily know much about the local welding environment. We strive to do right by South African industry as a whole and that means seeking general approval from industry at large," explains Tarboton.

Potgieter elaborates: "The ANBCC: (Authorised Nominated Body for Company Certifications) is appointed to oversee our work, so when we go out to audit a company, we can't simply issue a certificate. The ANBCC board has to approve every company certification based on our recommendations. And our board members are truly representative of South African industry, they are not overseas imports. They have local knowledge and can quickly assess a recommendation and validate it."

SAIW's ISO 3834 ANBCC board consists of twelve qualified people, each chosen for the knowledge and experience they can offer the process. "These people have first-hand experience of the South African fabrication industry and, should something go wrong at a certified company, they are able to assess the situation quickly and respond appropriately," Potgieter notes, adding that this makes the standards, oversite and quality assurance of every ISO 3834 certification much more robust.

In reinvigorating the Manufacturer Certification Scheme, Tarboton says that company certification now comes coupled with everything else the SAIW offers. "As soon as a company is certified according to our scheme, it become eligible for free SAIW Membership and all of the associated benefits and discounts: free seminars, access to our Laboratory, Technical, NDT and Training services and a lot more."

He adds that, to make it more affordable for fabricators to adopt the scheme, several payment options are being introduced: "Once audit and certification fees have been paid, we are now offering a subscription-based service, where companies pay a monthly fee to maintain their certifications and SAIW membership. This fee covers all future audits and it includes full SAIW Company Membership for certified fabricators.

As well as securing access to the SAIW, this payment options makes ISO 3834 an ongoing expense, which, according to Tarboton, is often preferred by small and

ISO 3834 offering

large companies because it makes their planning and cashflow easier to manage.

"We also offer the option to pay for initial and repeat audit and certification expenses over a three month period. No matter what payment option is adopted, however, SAIW involvement and support is available at any time," Tarboton assures.

SAIW is currently developing a one day hybrid seminar/webinar to encourage and enable interested fabricators to adopt ISO 3834 Certification and, if feasible, to give them the opportunity to see the SAIW's state-of-the-art facilities for themselves. "This will be offered free to those interested in the process of adopting ISO 3834 Certification.

"As a certification body, we cannot go into a company and 'fix' the problems they have. What we can do, however, is use our considerable experience to highlight areas of focus for preparing for certification. In our ISO 3834 webinar, we will run through some of the common implementation difficulties and give guidance on all 14 key elements of ISO 3834.

"Some companies just want certification to win a tender and deliver on a job, and that is the limit to the benefit they see. Our initial surveys of certified companies, however, have been exceptionally positive, with many reporting improved productivity and quality. This goes a long way beyond simply getting the next job," suggests Tarboton. "Among all of the certified companies we have spoken to, we have never heard anything negative about our ISO 3834 offering, and we now have over 300 certified companies," he adds.

"Instead of viewing ISO 3834 as a license to tender for work from the likes of Eskom and Sasol, we have to get to the point where our fabricators can rub shoulders with international competitors. This is particularly important for doing work across Africa, where competition is going to be fierce," Potgieter adds.

As well as offering independent verification of compliance to ISO 3834 by the world's leading authority on welding, through the SAIW/IIW Manufacturer Certification Scheme, SAIW is also accredited locally to SANAS 17021: Quality Systems for Company Certifications; and SANAS is a recognised member of the International Accreditation Forum (IAF). "This means that we have authorisation to certify welding fabricators from any country in Africa and these certifications are Internationally recognised.

"So any fabricator certified by SAIW to ISO 3834 can tender for welding-related projects requiring company certification anywhere in the world. This is huge for African Industrialisation!" he exclaims.

In addition, the Pressure Equipment Regulation and SANS 347 specify ISO 3834 as a requirements for any vessel where welding is the dominant construction method used.

"At the heart of our offering is a commitment to helping the companies we certify to succeed. As the leading technical institution on the continent dedicated to furthering standards in welding-fabrication and related technologies, we are here to assist all of our partners, members and certified companies.

"The SAIW/IIW ISO 3834 Manufacturer Certification Scheme is already a huge success, and we haven't yet started to spread it to the local mining industry or into the African countries North of our borders," Tarboton concludes.

High integrity welding taking place at Necsa Nuclear Manufacturing: an SAIW Member; an ISO 3834-certified company under SAIW's Welding Company Certification Scheme; and the only ASME III nuclear-accredited facility in sub-Saharan Africa.

Comments from certified companies

As a company, we have greatly benefitted from being an ISO 3834 accredited entity. The systems and procedures that are in place assist in ensuring that our day-to-day manufacturing operation is conducted in an almost flawless manner. This has also hugely improved our welding processes and the control thereof. We are fully supportive of ISO 3834 Certification.

ISO 3834 is all about the welding process, which is the core function of any fabrication, be it in a shop or in the field. It is a hands on control system that, if done correctly, will benefit any company. The system is not just procedures written into a file that is lying in someone's office. The important part is that it is run by people that know how welding works and are involved in the process of welding.

Mobicred payment options introduced for SAIW training

A student-centric, flexible approach is available for the payment of SAIW courses. The SAIW now offers long-term payment options via the online revolving credit service Mobicred.

Students will be first be required to register and apply for a particular course on the SAIW Student Management System on the SAIW website. This will be followed by an application checking procedure to confirm the acceptance requirements.

Students will then be emailed a quotation with a choice of payment options that include an immediate EFT or credit card payment; or a longer term Mobicred instalment plan.

The Mobicred plan means that, instead of having to save up R47 520, for example, to attend a Level 1 Inspectors Course, students can opt to do the first module, which costs R11 880, by splitting this payment into budget friendly instalments over a six month, one- or two-year period. The student will be registered to attend the first module as soon as the first instalment is paid.

Future modules or further courses can then be funded in the same way, keeping the training costs more easily manageable. ***www.saiw.co.za***

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TÜV SÜD invests in SA youth

In celebration of Youth Month, TÜV SÜD South Africa, and more especially TÜV SÜD Pro-Tec, recently sponsored three candidates on a Level 3 workshop at the SAIW. This initiative, while sponsored by TÜV SÜD, was supported and facilitated through a selection process by the Vaal University of Technology and the SAIW.

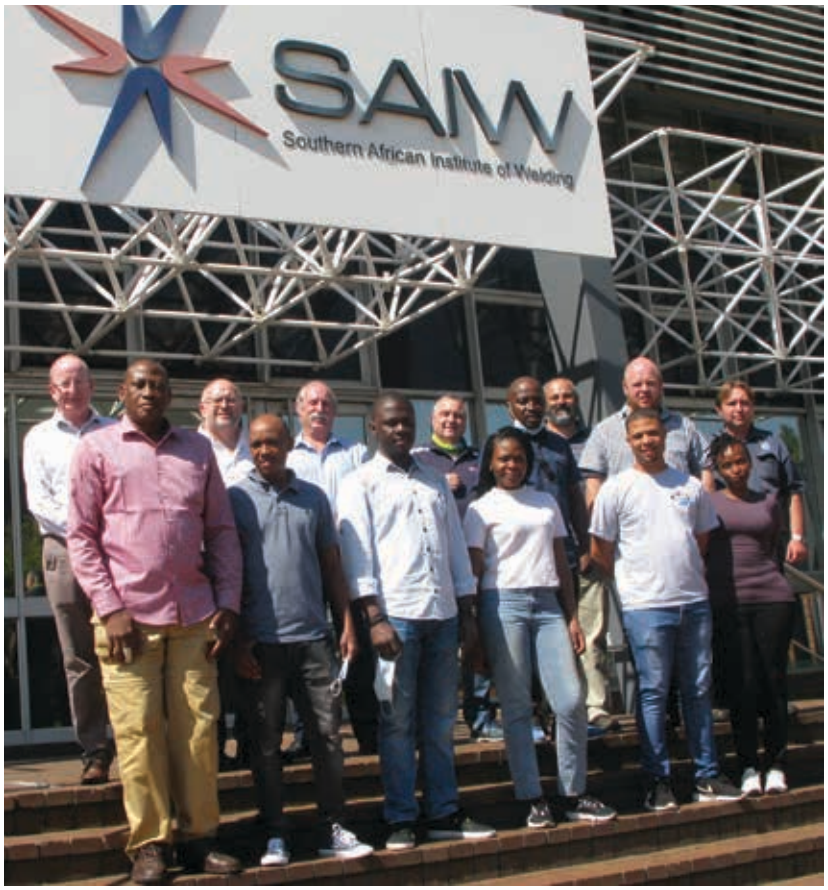
TÜV SÜD takes this opportunity to congratulate the participants, first of all for being selected for the sponsorship and then for successfully completing the programme. Matlale Wonder Motebejane and Xolile Carrol Masuku passed the Basic and Magnetic Particle Testing Level 3. Tyson Moyagabo Makhura passed the Magnetic Particle Testing Level 3 and Ultrasonic Testing Level 3 and intends to do Visual Testing Level 3. A fourth candidate who was already selected will enter the programme in August and, apart from this a further eight candidates will also be sponsored for the programme in August 2021.

This sponsorship and training have enhanced the careers of these young students and provided them with the possibility of being appointed and upgraded from Level 2 to Level 3 in the respective methods passed.

TÜV SÜD is actively engaged in training and empowering NDT personnel, as this will help to keep the lights on in an aging plant environment. While this current initiative is part of an Eskom requirement to have Level 3 qualified personnel in order to be awarded a national contract, it makes complete sense, as there is a serious shortage of Level 3 qualified technicians across the country. TÜV SÜD intends to sponsor training for approximately 30 Level 3 NDT technicians over the four year period of the contract.

It is vital to empower and capacitate our youth with the right skills to keep South Africa going.

Bottom row: TÜV SÜD sponsored students, Matlale Wonder Motebejane (right) and Xolile Carrol Masuku (centre) passed the Basic and Magnetic Particle Testing Level 3, while Tyson Moyagabo Makhura (left) passed the Magnetic Particle Testing Level 3 and Ultrasonic Testing Level 3 and intends to do Visual Testing Level 3. Top row: Gerrit Maritz, TÜV SÜD NDT manager; and Mark Digby, the SAIW's NDT training manager.



Back row from left: John Tarboton, Harold Jansen, Jan Cowan, Mark Digby, Tyson Makhura, Riaan Loots, Jaco Venter all of the SAIW, and Gerrit Maritz from TÜV SÜD). Front row: from the Cameroon IAEA are Paul Massing, Luc Mboua and Arnaud Ebola; with Wonder Motebejane (VUT), Errol Minnie (Detect) and Carrol Masuku (VUT).

TÜV SÜD and TÜV SÜD Pro-Tec

TÜV SÜD established its presence in South Africa in May 2010. Committed to investment and empowerment in South Africa, it is a fully compliant B-BBEE company with partner Kapela Investments. It is headquartered in Cape Town, with regional offices in Johannesburg and Middelburg. It provides its services through many divisions and legal entities including TÜV SÜD Inspection Authority, a government approved AIA; Lift and Escalator Consulting and Inspection Services; Management and System Certification; Mobility Services, which includes Remarketing Appraisals of Vehicles and Roadworthy Testing.

Non-destructive testing (NDT) services form part of the TÜV SÜD Pro-Tec portfolio of services, which is at the forefront of providing testing and inspection services to industry, mainly in the power generation environment. In 2011, TÜV SÜD South Africa acquired Pro-Tec Boiler Inspection & NDT Services, a well-known industry leader in this field, and so became the number one provider of non-destructive testing and inspection services for the power generation industry in South Africa. This division is based in Middelburg.

www.tuvsud.com

Brimis Engineering embraces ISO 3834

African Fusion talks to Brimis Engineering's Mphephu Nengovhela, operations manager, and Meshi Hamese, chief engineer, who are both Professional Engineers (Pr Eng), about the company's valve and pump refabrication capabilities for the power and mining industries and its imminent ISO 3834 accreditation.

Brimis is moving towards the use of semi-automatic gas shielded metal arc welding (GMAW), especially for hardfacing using exotics such as Inconel 625 and Stellite.

Brimis Engineering's speciality is the refurbishment, maintenance, supply, installation and distribution of valves and pumps, along with parts and accessories, most notably for the power industry in South Africa. "Our current core business involves repairing, servicing and refabricating the pumps and valves in use at power plants and paper mills around Mpumalanga," begins the company's chief engineer, Meshi Hamese, speaking from one of the company's onsite facilities.

"We also offer general engineering from our Middelburg facility: fabricating chutes, hardfaced chute liners and bins for coal handling plants; rebuilding and repairing shafts; and hardfacing components such as the rocking arms that support the mill rollers on the pulverised fuel crushing plants," continues Mphephu Nengovhela, speaking from Brimis' Middelburg fabrication facility.

"For the valves and pumps used at power stations, we do extensive amounts of hardfacing work using exotic materials such Stellite – on the valve trims, for example – to restore the functionality of these products to OEM specifications and raise the reliability levels of the electricity grid," he says.

Describing the company's typical refurbishment cycle, Hamese says that the starting point is usually onsite. "We will first assess the condition of components and measure these against the expected performance. We then recommend a refurbishment programme to restore these components to the specifications required by the client. Once this is agreed, we work to industry and OEM standards, codes and practices to refabricate the unit. And, before a pump or valve is returned to service, we perform a pressure test and sign off on all of the quality control certificates," he adds.

Nengovhela says that feedwater, ash handling and fire pumps are routinely passed through Brimis' facilities. "Ash slurry is highly abrasive and it can cause accelerated wear. If certain contact areas of the pumps and valves are not hardfaced, the pump can be lost in a matter of hours. This is also the case for the rocker arms for the PF crushing mills. Parts directly exposed to coal must be hardfaced to extend their wear life.

"On the valve seats, any wear will cause the valve to leak, so many of these are hardfaced using Stellite. We typically deal with parallel slide valves on the feedwater side, non-return valves (NRVs) and knife gate valves for controlling the steam flowing though the soot blowers, for example," he tells *African Fusion*.

A refabrication of an ash handling centrifugal pump, he adds, will often require the entire impeller to be recast and machined, while the worn casing may need to be built-up using welding before being hardfaced in the contact areas and machined back to its dimensional specification.

Brimis Engineering's current head office in Middelburg has 800 m² under roof, where custom engineering, in-house machining, valve testing and reverse engineering is done. "Significant amounts of our welding and hot work currently has to be outsourced, however, notes Nengovhela. "We are currently also limited to using A-frame cranes for lifting, but we are looking to procure a new facility with overhead cranes to increase our capacity," he adds.

Brimis Engineering's core business involves repairing, servicing and refabricating the pumps and valves in use at power plants and paper mills around Mpumalanga.

Welding and ISO 3834

For hardfacing and weld build-up work, which varies considerably from unit to unit, Brimis' fabrication workshops in Middelburg and at the Kriel and Tutuka power stations are mostly using Manual Metal Arc (MMA) welding electrodes. "We are currently moving towards the use of semi-automatic gas shielded metal arc welding (GMAW), especially for hardfacing using exotics such as Inconel 625 and Stellite, though," says Hamese, adding: "For highly specialised work or when we run out of capacity, however,

we currently have to contract out parts of a refurbishment."

The process to become certified to ISO 3834 is a key step in bringing more of this specialist work into Brimis' own fabrication facilities. "In April, we received Readiness Approval for ISO 3834 certification from the SAIW. We have since submitted our application package, which has been accepted and the SAIW has completed and is happy with the preliminary review of our procedures. We have formally qualified our most critical welding procedures and we are now awaiting the final physical audit of our Middelburg facilities," Nengovhela tells *African Fusion*, adding that he expects the facility to be accredited before the end of June.

"This will give us ISO 3834 Part 2 accreditation and registration as an ISO 3834 Certified Welding Fabricator on the SAIW's scheme," he says.

"In the niche repair market for industrial valves and pumps that operate at higher temperatures and pressures, any fabricator using fusion welding processes for refurbishing such equipment must now be accredited to ISO 3834. We already have the know-how and, once accredited, we will be able to bring in more of this work, making us more cost competitive, more flexible and reducing lead times," Hamese notes. "This accreditation has become essential for us to retain and expand our client base and to extend our offering," he adds.

"We understand the pain points on power stations and industrial plants. We know what needs to be done and how important it is be more flexible, more agile and more productive. Brimis has adopted a non-traditional approach to engineering. We are striving to be an engineering partner of choice for the wide range of services needed by plant operators," Hamese tells *African Fusion*.

Brimis is also currently expanding its facilities and its service offering. Nengovhela explains: "As well as expanding our fusion welding capability through ISO 3834, we are also investing in our machining capability to enable us to meet the global standards required by our target clients. In addition, we are talking to local foundry partners with a view to starting to cast the components we need to refabricate client equipment.

"As a result of COVID, we are struggling to source alloy materials, particularly when it comes to the exotics. In partnership with local foundries and forging houses, we are seeking rapid ways to service our customers. We had a recent enquiry from the petrochemical industry, for example, for the refurbishment of some 400 valves, but the contract specified that we had to turn them around within 30 days. We were not able to deliver at that rate, so we had to turn the contract away.

"With the new expansion, we hope to be able to turn a valve around within a single 12-hour shift, which is the kind of speed and agility that we know we are capable of. In addition, our ISO 3834 accreditation will assure our industrial clients that all the welding and hardfacing work we undertake meets international quality standards," Nengovhela concludes.

www.brimiseng.com

Brimis Engineering's current head office in Middelburg has 800 m² under roof, where custom engineering, in-house machining, valve testing and reverse engineering are done.

The process to become certified to ISO 3834 is a key step in bringing more of this specialist work into Brimis' own fabrication facilities.

Once refurbishment programmes have been agreed, Brimis artisans work to industry and OEM standards, codes and practices to refabricate units.

ARCAL™: reliable, smart and simple shielding

African Fusion talks to Mwali Kawawa and Michael Ashley of Air Liquide about the advancement of Air Liquide's ARCAL™ range of gases and the reasons why this set of four exceptional shielding gas mixtures continues to transform the welding market.

"Our ARCAL™ New Generation gas offer puts the simple back into arc welding, without taking away any of our quality and safety promises. We remain committed to delivering premium quality and high performance, but we see the way forward for advancing the welding industry as coupling these with simplicity," begins Mwali Kawawa, Air Liquide's national business developer for welding and cutting.

"At the heart of the ARCAL™ New Generation product line are four shielding gas mixtures: ARCAL™ Prime; ARCAL™ Chrome; ARCAL™ Speed and ARCAL™ Force, which have been meticulously developed over many years to suit the broadest possible spectrum of gas shielded welding applications in industry. We have found that there is now seldom any need to seek out more complicated gas mixtures," he assures.

"For TIG welding of duplex stainless steel, for example, there is an argument for using 2% nitrogen in an argon gas mixture to improve pitting resistance. We can, of course, still supply this and other special mixes, but for the vast majority of stainless steel fabrication requirements, ARCAL™ Chrome is ideal for MAG welding, while ARCAL™ Prime, our high purity argon gas – more than N5.0 pure – is the established go-to gas for all TIG welding of steels, stainless steels, aluminium and most pure metals and exotic alloys," Kawawa tells _African Fusion_.

"Where active gas mixtures are required for the MAG welding of steels, we have discovered that, for almost all applications, three part gas mixes, which typically consists of argon, carbon dioxide and oxygen, are detrimental in some ways and, in most cases, removing the oxygen offers great benefits. None of our ARCAL shielding gas mixtures contains oxygen. The decision to go this route was motivated by a careful R&D programme to evaluate the effects of the elimination of oxygen, which were surprisingly positive," he relates.

Kawawa says that the first discovery was that oxygen makes it more difficult to weld in overhead and other awkward positions. This is because the oxygen in the gas raises the fluidity of the weld pool, making it more difficult to control the molten metal against gravity.

Oxygen also raises fume emission levels because it readily reacts with high temperature metal oxides to form fume, which can be carcinogenic. By removing the oxygen, therefore, welder safety is improved. In addition, the weld profile oxidation factor of carbon dioxide may be up to tenfold lower than oxygen. A mixture of 5% CO_2-3% O_2 in argon, for example, has a factor of 5+30 = 35, whereas a simple mixture of 8% CO_2 in argon has a factor of only 8. "By removing the oxygen we substantially reduced the tendency to form non-metallic oxides on weld bead surfaces, therefore producing a cleaner and brighter finish that requires very little or no cleaning," he says.

In the autobody repair industry, for example, where high speed with low spatter levels and fume are important, ARCAL™ Speed is the ideal gas.

Oxygen in the shielding gas also raises the concentration of iron oxide. Kawawa explains: "Iron has a high affinity for oxygen thus an undesirable iron oxide FeO can form, which may negatively influence the microstructure of the weld metal, therefore also affecting the mechanical properties of the welded joint," he adds.

In terms of weld integrity, he explains that research suggests that no negative effects are related to the removal of the oxygen. With welds performed according to approved welding procedures (WPSs), there was no change in the mechanical properties of the welds completed using ARCAL™ gas mixtures compared to welds completed using equivalent three-part shielding gases. This, he assures, has been corroborated many times. "So for most common materials of construction, the simpler ARCAL™ New Generation gases offer several benefits and very few disadvantages," Kawawa tells _African Fusion_.

Summarising the specific shielding applications for each of the four ARCAL™ New Generation gas mixtures, Kawawa notes:

- **ARCAL™ Prime** is the primary inert gas solution for a wide range of welding applications, materials and processes, including: TIG and plasma welding of all materials; MIG welding of aluminium and copper alloys; and root shielding

Above: Using Air Liquide's EXELTOP™ cylinder solution, a welder can be ready to weld in four steps: connect the hose, check that the graduated handwheel is at zero, open the on/off lever and set the outlet pressure and/or flow rate.

Left: Air Liquide's ARCAL™ New Generation gas mixtures have been developed over many years to suit the broadest possible spectrum of gas shielded welding applications.

and back purging of all materials. This is a very high purity ISO 14175 I1 classification welding gas.

- **ARCAL™ Chrome** is Air Liquide's 'brilliant' gas solution for stainless steels, including: all-purpose MAG welding of austenitic and ferritic stainless steels with chromium compositions of above 10%; and other corrosion resistant materials such as chromium and chromium-nickel alloys. It offers clean and bright weld surfaces and meets the ISO 14175 M12 classification.
- **ARCAL™ Speed** is a high-performance gas solution for high-speed, high deposition rate MAG welding of carbon steels. It offers very low spatter and fume levels and is ideal for spray, pulsed transfer and high speed robot welding. ARCAL™ Speed meets the ISO 14175 M20 classification.
- **ARCAL™ Force** is the 'powerful' gas solution for MAG welding of heavy steel structures. It is an all-purpose shielding gas for thicker section carbon steels that is highly tolerant of fit-up variations and rough surface preparations. It is ideal for automated welding in the construction and shipbuilding industries and for use with flux-cored wires. It is an ISO 14175 M21 classification gas.

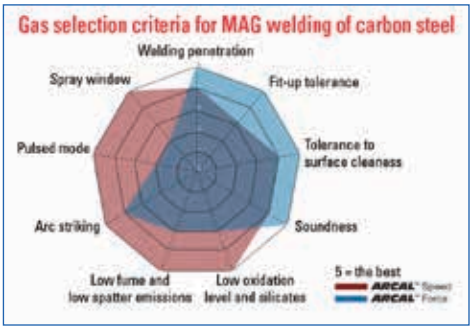
According to Michael Ashley, by adopting and focusing on this simplified range, Air Liquide is able to offer a more efficient delivery and supply service to its customers. "As the ARCAL™ New Generation range of gases improves and gradually supersedes our more traditional range of gases, we are better able to distribute the range more widely across South and Southern Africa, improving access, availability and delivery efficiencies," he says.

In a market featuring myriad similar products, he says that Air Liquide aims to go further in helping its customers with smart solutions. "We believe that smart does not have to be complex. In fact, simple is a lot smarter. Our ARCAL™ New Generation gas range enables customers to concentrate on the issues that truly count. We offer the certainty that comes from a gas solution that's reliable, simple and always high performing," he assures.

With production efficiency key in modern organisations, Air Liquide's ARCAL™ New Generation offer also includes several add-ons and different gas delivery options. "While our ARCAL™ gases are freely available in standard cylinders, forward thinking companies will be most interested in our ARCAL™ gas range with EXELTOP™. EXELTOP™ cylinders offer the benefit that they arrive with built in regulators and flowmeters, so there is no need to purchase and manage these separately," Ashley continues.

EXELTOP™ is a smart gas cylinder that comes with an advanced two-stage built-in regulator; a clearly visible on/off lever for easy shut-off; a permanently attached and protected pressure gauge, all built into a proprietary shock-absorbing protective cap. It also features Air Liquide's Quick Connect gas hose system and an adjustable handwheel for setting and maintaining a precise flow rate.

"In organisations where production time is meticulously optimised and every kilogram of material is accounted for, ARCAL™ gases in EXELTOP™ cylinders are ideal. Cylinder changeover time, for example, usually involves having to find a spanner to loosen a hose nut and then reconnect it, which we estimate takes 12 to 15 minutes, on average, and production stops for this period. The Quick Connect system on our ARCAL™ EXELTOP™ cylinders allows instant connection, enabling our customers to save almost all of that lost time," he says.



A diagram comparing the key features of ARCAL™ Speed and ARCAL™ Force for welding carbon steels.

Various bulk delivery options are also available for ARCAL™ New Generation gases, starting with 16-cylinder manifold bundles of any of the four mixes.

Air Liquide's dynamic onsite mixers are tamper proof and pre-set to deliver the chosen ARCAL™ gas to within ISO 14175 tolerances. Two thousand litre high purity argon tanks can be coupled to a carbon dioxide manifold. "Our Dynamic On-Site Mixer solutions enable the use of ARCAL™ Prime for TIG welding as well as any one of the active ARCAL™ gas mixtures," Ashley explains, adding that other mixing panel solutions are also available for those wishing to use more than two of the four gases.

"In collaboration with the SAIW metallurgical testing laboratory, we are continuing to certify our different wire and ARCAL™ gas combinations, which further supports the volumes of global evidence that the ARCAL™ New Generation shielding gas range is of premium-quality.

If used as part of an approved Welding Procedure Specification (WPS), it will consistently deliver clean, bright and flaw-free weld seams that will match or better the quality, weldability and mechanical properties that other gas mixtures can deliver.

ARCAL™ is the future of welding," Kawawa concludes.

The influence of Ti and Nb on solidification cracking of ferritic stainless steels

DS Konadu, University of Ghana; PGH Pistorius, University of Pretoria; and M Du Toit, University of Wollongong

First published in *Welding in the World*, this paper details work carried out by DS Konadu at the University of Pretoria on the susceptibility to solidification cracking of ferritic stainless steels. The study used Houldcroft self-restrained samples to compared unstabilised stainless steel grades with mono and dual stabilised (Ti and/or Nb) steels.

The susceptibility to solidification cracking of ferritic stainless steels was studied using the self-restrained method. Unstabilised steel was compared with mono and dual stabilised (Ti and/or Nb) steels. Autogenous gas tungsten arc welding at a speed of 6.0 mm/s, 3.0 mm/s, and 1.0 mm/s was done. All the specimens cracked at a welding speed of 6.0 mm/s.

The weld metal of both the unstabilised and the stabilised steels contained a mixture of columnar and equiaxed grains. At a welding speed of 3.0 mm/s, all the specimens except the unstabilised grade cracked. The weld metal microstructures were mostly columnar, and the dual stabilised grades showed equiaxed grains.

At a welding speed of 1.0 mm/s, the Nb stabilised and the dual stabilised steel containing Mo cracked, whilst the other alloys did not crack. At the 1.0 mm/s, the weld metal was dominated by columnar grains and the cracks were interdendritic. The crack surfaces were enriched in Nb, Ti, Mn, Si, Al, Mn, and Mo. The unstabilised ferritic stainless steel was resistant to solidification cracking whilst the stabilised steels were not. Low melting point eutectic phases associated with Ti and Nb might have contributed to solidification cracking.

Introduction

Ferritic stainless steels have ferrite as the dominant metallurgical phase and are used for their good resistance to stress corrosion cracking, pitting corrosion and crevice corrosion where moderate strength is required. Their applications are mostly in chemical plants, pulp and paper mills, refineries, automobile trim, catalytic converters and general decorative purposes [1]. Ferritic stainless steels are a cheaper alternative to austenitic stainless steel because Ni is not added as an alloying element [1-5].

Ferritic stainless steels are generally more difficult to weld than austenitic stainless steels. This is mainly due to significant grain growth and the possible formation of martensite in the heat-affected zone (HAZ). The ferritic stainless steels are also susceptible to intergranular corrosion after welding due to sensitization [1].

Sensitization is the dropping of the grains due to the destruction of the grain boundaries. Chromium-rich carbides precipitate as $M_{23}C_6$ or M_7C_3 or M_6C. These carbides have a rich chromium content typically in the range of 42 to 65%, resulting in chromium depleted zones adjacent to the grain boundary precipitates. If the depletion is below 12 wt%, intergranular corrosion attack progresses along the chromium depleted grain boundaries since the corrosion resistance is significantly reduced. Thus, the grain boundaries are destroyed leading to sensitization [1, 3].

Sensitisation can be prevented by reducing either the carbon and nitrogen amounts below certain levels or using titanium (Ti), niobium (Nb) or tantalum (Ta) as stabilizers [1, 5, 6]. Among the ferritic stainless steels, type AISI 430 is not stabilised, AISI 441 is dual stabilised using Ti and Nb, AISI 444 is dual stabilised with Ti, Nb and it contains Mo, while AISI 436 and 439 are Nb and Ti mono-stabilised respectively [7]. Lippold & Kotecki [1] state that the additions of Ti and Nb, and high impurity levels in ferritic stainless steels can decrease resistance to solidification cracking susceptibility. This is due to the solute elements segregating to grain boundaries to form low melting point phases.

Solidification cracking occurs in the fusion zone during the last stage of weld solidification, when the strength of the almost completely solidified weld is lower than the tensile stresses developed across the adjacent grains, leading to cracking in the weld metal [3, 5, 8, 9]. During the initial stage of solidification, a region known as the mushy zone exists. In this region, the solidification cells and dendrites have enough liquid for 'healing', making solidification cracking unlikely. In solidification studies, the mushy zone is the region where solid and liquid is present at the same position. With further cooling, a rigid network is formed as solids begin to interact with each other. Strain accumulates with further bridging of solids leading to solidification cracking [5, 6].

High welding speeds produce columnar grains, which impinge at the weld centre and can cause solidification cracking [5, 6, 10]. Research on the solidification cracking of stainless steels has been largely limited to duplex and austenitic stainless steels [11-13]. The research of welding ferritic stainless steels has focused on the mechanical properties and the microstructure of the welded steel [14, 15]. Kah and Dickinson [16] reported on the weldability of ferritic stainless steels using type AISI 430 and 444L materials. It was concluded that the hot cracking susceptibility of these materials was at least partially dependent on the composition and was promoted by sulphur, carbon, nitrogen, niobium, titanium, phosphorus and manganese alloying elements.

Test methods for measuring sensitivity to solidification cracking can be grouped as self-stressing (self-restrained), which uses restraint or stress within the sample to cause cracking; and where external stresses are applied. Self-restrained Houldcroft is one of many self-stressing methods for measuring the susceptibility to solidification cracking of materials [3, 17-19]. The Houldcroft test (also known as the fishbone test) uses a specimen with slots of different depths in a progressive manner. The gas tungsten arc welding (GTAW) process is used to deposit a weld bead. Complete penetration is necessary. Solidification begins as the heat source starts to move inwards from the starting edge of the test sample. Solidification cracking starts from the starting edge and propagates along the centreline. The weld metal is strained in a direction transverse to the welding direction. Cracking of the weld metal occurs because of expansion from the starting edge due to continued heat input to the specimen. The stress along the

length of the specimen can be decreased by reducing the width. The susceptibility to cracking is quantified by the crack length from the starting edge [5, 20]. The current investigation was conducted to establish the susceptibility to solidification cracking of the unstabilised, mono- and dual-stabilised ferritic stainless steels using the self-restrained Houldcroft method.

Experimental procedure

Materials

Five (5) experimental alloys (A to E) were produced by Small Alloys and Metallurgical Services (SAMS). Two (2) commercial alloys, one being dual stabilized (F) and the other a dual stabilized alloy containing Mo (G) from Columbus Stainless in South Africa were also used. Chemical compositions is presented in Table 1. Sample A: 0Ti; 0Nb is unstabilised, B: 0.7Ti is Ti-stabilised, C: 0.6Nb is Nb-stabilised; D: 0.4Ti; 0.6Nb, E: 0.4Ti; 0.9Nb and F: 0.1Ti; 0.4Nb are Ti+Nb stabilised with different elemental contents; and G: 0.1 Ti ;0.5Nb; 2Mo is dual stabilised containing Mo.

The experimental alloy E has a higher Nb content but similar Ti compared with alloy D, and F has lower Ti and Nb contents.

Self-restrained Houldcroft method

The Houldcroft test is not standardized by ASTM as researchers have used different shapes, dimensions and number of slots for their work [5, 20-23]. The dimensions of a Houldcroft sample are given as 76×44 mm and have 9 equal slots of 0.8 mm [5, 20, 24]. Samples of 2.0 mm thickness were wire cut from the alloys A, B, C, D, E, F, and G to dimensions of 90×36 mm with each having eight slots of 1.0 mm (Figure 1).

Automatic autogenous gas tungsten arc welding (GTAW) bead on plate using a Lincoln Electric Square Wave TIG-355 welding equipment was employed. The shielding gas was 99.99% argon. The welding started on a run-on tab of the same ferritic stainless steel before continuing on the Houldcroft sample. Care was taken to ensure that welding was done in the centre of the Houldcroft specimen. Complete penetration for Houldcroft samples meant different heat inputs were used for the welding speeds of 6.0 mm/s, 3.0 mm/s and 1.0 mm/s. The welding parameters are presented in Table 2. The average arc efficiency (η) of 0.48 [20] was used to calculate the heat input from Eq. 1.

$$\text{Heat input} = \eta VI/v \qquad \text{Eq. 1.}$$

where η is the arc efficiency, V is the welding voltage, I is the current and v is the welding speed [20].

Table 1: The chemical composition of the ferritic stainless steel alloys. Steels A to E are experimental alloys, while steels F and G are commercial grades.

	Material sample composition (mass %)						
Element	**A: 0Ti; 0Nb**	**B: 0.7Ti**	**C: 0.6Nb**	**D: 0.4Ti; 0.6Nb**	**E: 0.4Ti; 0.9Nb**	**F: 0.1Ti; 0.4Nb**	**G: 0.1Ti; 0.5Nb; 2Mo**
C	0.006	0.006	0.012	0.017	0.011	0.013	0.015
Si	0.6	0.61	0.42	0.4	0.44	0.51	0.53
Mn	0.51	0.5	0.33	0.37	0.37	0.44	0.44
P	0.019	0.018	0.024	0.022	0.025	0.024	0.033
S	0.008	0.007	0.007	0.001	0.004	0.013	0.0033
N	0.069	0.069	0.07	0.069	0.067	0.013	0.0175
Cr	18.03	17.94	18.81	18.12	18.17	17.66	18.10
Nb	0.01	0.003	0.58	0.62	0.92	0.422	0.535
Ti	0.001	0.68	0.03	0.41	0.36	0.146	0.096
Ni	0.23	0.24	0.23	0.35	0.37	0.15	0.16
V	0.007	0.04	0.05	0.11	0.11	0.13	0.13
Cu	0.01	0.02	0.06	0.06	0.07	0.05	0.08
Al	0.2	0.18	0.03	0.02	0.02	0.012	0.014
Mo	0.02	0.02	0.02	0.02	0.02	0.014	2.00
Fe	Bal	Bal	Bal	Bal	Bal	Bal	Bal

Table 2: Houldcroft welding parameters.

Speed (mm/s)	**6.0 mm/s**	**3.0 mm/s**	**1.0 mm/s**
Current (A)	250	180-190	90-120
Voltage (V)	18	15-16	12-13
Arc length (mm)	2	2	2
Gas flow rate (ℓ/min)	15	15	15
Electrode diameter (mm)	3.2	2.4	2.4
Heat input (kJ/mm)	0.3	0.4-0.5	0.5-0.8

The repeatability of the self-restrained Houldcroft method was tested by evaluating two samples of the same base metal using the same welding parameters. The samples that cracked started at the edge of the sample and propagated parallel to the welding direction into a region of lower restraint. A SMZ-10A stereoscope magnification was used to mark the crack tip, and a Vernier calliper was used to measure the cracked length. The weld bead sizes were measured for any correlation with the solidification crack.

Microstructure and fractography

The samples were characterised after welding by sectioning close to where the crack occurred (Figure 1) and, where there

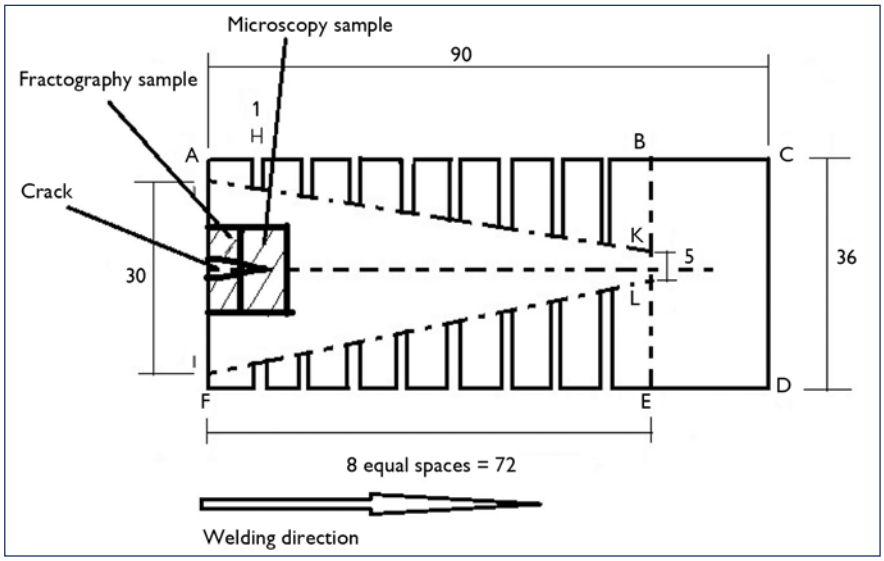


Figure 1: Dimensions of the modified Houldcroft sample. Locations of the sample for microstructural and fractography examination are also shown.

was no crack, near to the start of the weld. The sectioned pieces were hot mounted in Bakelite and polished to a 1.0 µm surface finish. The polished samples were etched with mixed-acid etchant comprising equal parts of nitric acid (HNO_3), hydrochloric acid (HCl) and acetic acid [1].

An XM-15 optical microscope mounted with an Olympus U-TV0.5XC-3 camera was employed for microstructural analysis of the etched samples. A JEOL JSM-IT 300 scanning electron microscope (SEM) with EDX at a voltage of 15 kV, which uses Aztec software, was used for fractographic studies of the samples. Thermo-Calc version 2015b (TCFE6 database) software was used to determine some of the precipitates through thermodynamic equilibrium and phase diagram calculations using the full chemical composition.

Table 3 presents the possible precipitates from the samples used for this study. From Table 3, it can be observed that the differences between the liquidus and solidus temperatures were similar (40-67 K) except for the C: 0.6Nb steel, which was 110 K. The exception of C: 0.6Nb steel having a low solidus temperature of 1 660 K might be due to the Nb, which forms a eutectic with Fe at 18.6% Nb at the melting point of 1 646 K [3, 25]. The eutectic value and the Thermo-Calc value were very similar.

Results

Cracked length

The top and bottom surface crack lengths were not the same, and the average crack lengths between the two are shown in Table 4. All the ferritic stainless steels cracked at a welding speed of 6.0 mm/s with varying crack lengths between the different grades (Table 4). The unstabilised ferritic stainless steel did not crack whilst the other grades cracked at a welding speed of 3.0 mm/s (Table 4). At 1.0 mm/s welding speed, the Nb-stabilised and the dual-stabilised steel containing Mo cracked whilst the other alloys did not crack (Table 4).

The differences between the average top and average bottom crack lengths are also presented in Table 4. Generally, the top surface crack lengths were longer than the bottom surface crack lengths. Figure 2 shows a photograph of sample D: 0.4Ti; 0.6Nb, which cracked at the welding speed of 6.0 mm/s. For the steels characterised, the crack length increased with Ti+Nb content and with welding speed, which was more prominent than the stabilisation content as circled (Figure 3). Table 5 shows the weld bead sizes of the top and bottom surface of the alloys. Comparing Tables 4 and 5, there was no relationship between the crack lengths, welding speed and the weld bead sizes.

Table 3: Results of Thermo-Calc modelling of the samples.

Experimental alloy	Liquidus temperature (TL) (K)	Solid state phases in equilibrium with liquid metal	Solidus temperature (TS) (K)
A: 0Ti; 0Nb	1773	Ferrite and MnS	1706
B: 0.7Ti	1773	Ferrite, TiN, and Ti4C2S2	1721
C: 0.6Nb	1770	Ferrite, NbC, and MnS	1660
D: 0.4Ti; 0.6Nb	1773	Ferrite, Ti(C,N), and Ti4C2S2	1721
E: 0.4Ti; 0.9Nb	1773	Ferrite, TiN, and Ti4C2S2	1706
F: 0.1Ti; 0.4Nb	1773	Ferrite, Ti(C,N), and Ti4C2S2	1737
G: 0.1Ti; 0.5Nb; 2Mo	1763	Ferrite, Ti(C,N), and Ti4C2S2	1723

Table 4: The average top and bottom crack lengths (in mm) and the difference between the top and bottom surface crack length, as measured using the self-restrained Houldcroft method as a function of welding speed and steel grade. Note: a negative sign means the bottom surface was longer than the top surface crack length.

Experimental alloy	Average crack length (mm)			Top–bottom surface crack length (mm)		
	6.0 mm/s	3.0 mm/s	1.0 mm/s	6.0 mm/s	3.0 mm/s	1.0 mm/s
A: 0Ti; 0Nb	5.7	0.0	0.0	0.9	0.0	0.0
B: 0.7Ti	25.0	17.8	0.0	1.0	1.3	0.0
C: 0.6Nb	34.4	12.3	4.6	1.0	1.0	−0.6
D: 0.4Ti; 0.6Nb	31.1	15.0	0.0	0.7	3.0	0.0
E: 0.4Ti; 0.9Nb	32.1	11.3	0.0	−2.4	−0.4	0.0
F: 0.1Ti; 0.4Nb	26.0	8.5	0.0	2.1	0.9	0.0
G: 0.1Ti; 0.5Nb; 2Mo	4.0	12.2	7.5	−7.9	4.3	5.8

Microstructure

The unstabilised ferritic stainless steel showed columnar grains, which impinged at the weld centreline (Figure 4a). With the addition of Ti or Nb, there was no change in the grain structure (Figure 4b). In Figure 4b, it was observed that there were some equiaxed grains at the crack tip of the C: 0.6Nb stabilised alloy. With the addition of dual Ti+Nb stabilisation content, the solidification structure was found to contain mostly equiaxed grains in the weld centreline for all dual-stabilised steels (Figure 4c), except for the commercially produced F: 0.1Ti; 0.4Nb grade (Figure 4d), which showed columnar grains. Figures 4c and d showed that the cracks might be discontinuous. Figure 4c also showed that the crack appeared to pass through an equiaxed grain.

At the welding speed of 3.0 mm/s, an axial grain, which was perpendicular to the weld pool boundary grew between columnar grains in the unstabilised A: 0Ti; 0Nb alloy (Figure 5a). This sample did not crack. The mono-stabilised steels and dual-stabilised steel containing D: 0.4Ti; 0.6Nb showed columnar grains adjacent to the weld centreline crack. The dual-stabilised steels containing E: 0.4Ti; 0.9Nb, F: 0.1Ti; 0.4Nb and G: 0.1Ti; 0.5Nb; 2Mo showed equiaxed grains next to the crack. The crack in the dual-stabilised steels containing E: 0.4Ti; 0.9Nb, F: 0.1Ti; 0.4Nb and G: 0.1Ti; 0.5Nb; 2Mo might be discontinuous (Figure 5b). At a welding speed of 1.0 mm/s, the weld metal microstructure consisted of columnar grains (Figure 5c, d).

Fractography

Interdendritic structures were found in all the cracked steels. The steel containing D: 0.4Ti; 0.6Nb at a welding speed of 6.0 mm/s showed high fraction eutectic liquid (Figure 6a), and the rest showed low fraction eutectic liquid (Figure 6b, c) [6]. At a welding speed of 3.0 mm/s, the steels containing C: 0.6Nb and E: 0.4Ti; 0.9Nb fracture surfaces contained precipitates in the dendrite arms. SEM-EDX semi-quantitative analysis revealed that the particle of the C: 0.6Nb ferritic stainless steel contained mostly Nb and C elements (Figure 6d). The EDX elemental analysis of the fractured surfaces showed the elements Nb, Ti, O, Mn, Al, Si, Mo, S and Ni to have contributed to the solidification cracking for all welding speeds (Figure 6e, f).

Discussion

For the measurement of solidification cracks using Houldcroft method, the crack

starts from the starting edge and propagates along the centreline of the weld [5, 17, 20, 24]. All the cracks were observed to have started from the starting edge of the samples, and this implied solidification cracking. For the specimens that cracked, there was usually a difference in crack length measured on the top and on the bottom surface. This difference was not consistent, with the crack on the top surface sometimes longer and sometimes shorter than the crack on the bottom surface. The degree of restraint played a role in the difference between the bottom and top surface crack lengths. The longer lengths might have been caused by greater restraint [5]. This restraint is internal and is caused by the volumetric reduction (shrinkage) during solidification. The properties of the surrounding HAZ and base metal and the weld bead shape affect the internal restraint [6].

The magnitude of the difference was, in most cases, significantly smaller than the average crack length (Table 4). The difference in the crack length on the top and the bottom surface did not affect the results of this investigation. The weld bead sizes (Table 5) showed no correlation between the alloys, crack lengths and the welding speed.

Using the weld bead size, influence on strain could not be determined. Literature shows that it is the weld pool geometry that has been used to evaluate solidification cracking [5, 26]. The effect of weld bead shape, concave or convex, can affect solidification cracking in a multipass weld [5]. Measurement of strain is not possible with self-restrained tests, which includes the Houldcroft method. The tests developed to measure critical strain rate are 'the variable deformation rate (VDR) test, programmable deformation crack (PVR) test and controlled tensile weldability (CTW) test [27].

From Table 2, the heat input decreased significantly as the welding speed increased (1.0 mm/s, 0.5 to 0.8 kJ/mm; 3.0 mm/s, 0.4 to 0.5 kJ/mm; 6.0 mm/s, 0.3 kJ/mm). This showed that the risk of solidification cracking increases with a lower heat input. This is in agreement with Ankara and Ari [28].

The unstabilised steel A: 0Ti; 0Nb cracked at the welding speed of 6.0 mm/s with the lowest crack length. This might be due to the high welding speed as columnar grains impinged to cause solidification cracking [5, 6] (Figure 4a). The steels B: 0.7Ti and C: 0.6Nb also cracked at this welding speed. Ti forms a low melting eutectic phase at 14% Ti at 1 562.15 K, and Nb also forms a eutectic with Fe at 18.6% Nb with the melting point at 1 646.15 K [3, 25]. The high welding speed and the eutectic phases might have caused the steels B and C to crack.

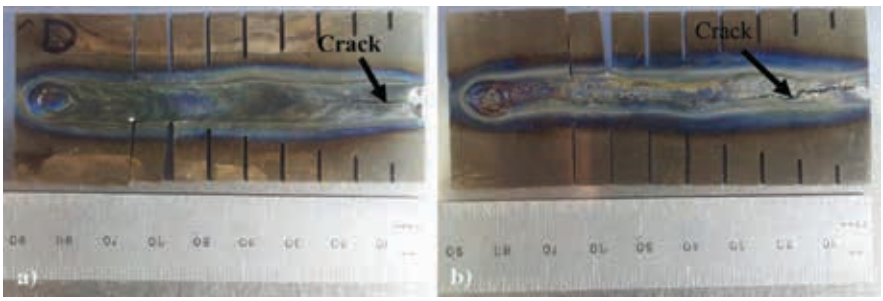


Figure 2: A photograph of cracked sample D: 0.4Ti ;0.6Nb at a welding speed of 6.0 mm/s a: top surface; b: bottom surface.

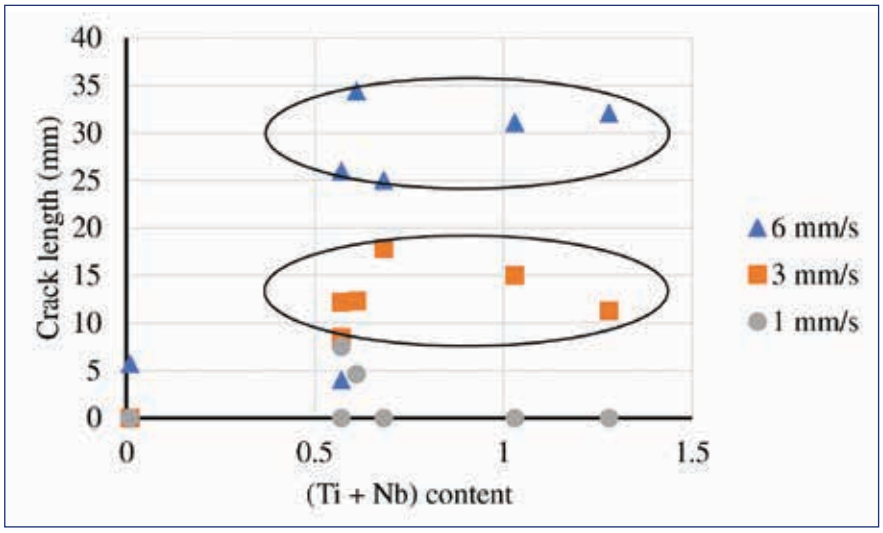


Figure 3: Average crack length against Ti+ Nb content for the welding speeds of 6.0, 3.0 and 1.0 mm/s.

The weld metal of the unstabilised and Ti- and Nb-stabilised steels revealed columnar grains at a welding speed of 6.0 mm/s. This is in agreement with literature [5, 6, 20] as high welding speeds produce a teardrop weld pool shape, which in turn produces columnar grains that are mostly straight.

The resistance to solidification cracking is increased when more grain boundaries per unit volume exist for smaller grains [29]. That is, welds with finer equiaxed grains are less susceptible to solidification cracking [5, 6, 27, 30]. The dual-stabilised D: 0.4Ti; 0.6Nb and E: 0.4Ti; 0.9Nb steels cracked at the welding speed of 6.0 mm/s. The dual (Ti+Nb) stabilisation showed mostly equiaxed grains in the weld metal, and this is contrary to some published literature [5, 6, 20]. On the other hand, the presence of equiaxed grains in the weld metal confirmed observations by Villaret *et al.* [31]. The observed equiaxed grains in the dual Ti+Nb-stabilised steels could be due to Ti and Nb containing precipitates acting as nucleation sites for equiaxed grains.

The solidification crack associated with equiaxed grains does not confirm literature, as it has been stated that equiaxed grains resist solidification cracking [5, 6, 25, 27]. The crack in the equiaxed grains showed that neither equiaxed nor columnar grains could resist the propagation of solidification cracks in the Houldcroft samples [6]. The crack, which seemed to pass through an equiaxed grain (Figure 4c) was considered not to be representative of the microstructures, given that the SEM image (Figure 6a) showed the crack path to be intergranular. This crack was observed at the tip of the whole crack length. From Figure 1, the experimental diagram for analysis for fractography was such that investigations were not conducted at the crack tip to confirm this fracture through the grains.

The commercial F: 0.1Ti; 0.4Nb steel revealed columnar grains with the crack adjacent to the weld centreline. The columnar grains might be due to the low Ti+Nb content as the high content produced equiaxed grains. Villaret et al. [31] reported that columnar grains of ferritic stainless steel changed their structure to equiaxed grains for contents above 0.15 wt% Ti.

At the welding speed of 3.0 mm/s, the unstabilised A: 0Ti; 0Nb alloy showed an axial grain. The axial grain might be due to it initiating from the fusion boundary from the start of the weld and continuing along the weld length, thereby blocking the columnar grains from impinging [5, 6]. This might have contributed to steel A: 0Ti; 0Nb being resistant to solidification cracking.

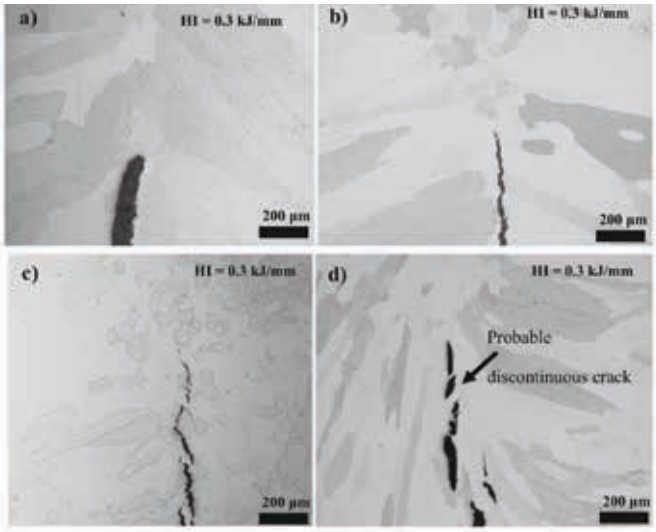


Figure 4: The crack at the weld showing: a) columnar grains of the unstabilised ferritic stainless steel; b) columnar grains of the C: 0.6Nb-stabilised ferritic stainless steel; c) mostly equiaxed grains of the D: 0.4Ti; 0.6Nb-stabilised ferritic stainless steel; d) columnar grains of the F: 0.1Ti+0.4Nb-stabilised ferritic stainless steel – all at a welding speed of 6.0 mm/s. Heat input (HI): 0.3 kJ/mm.

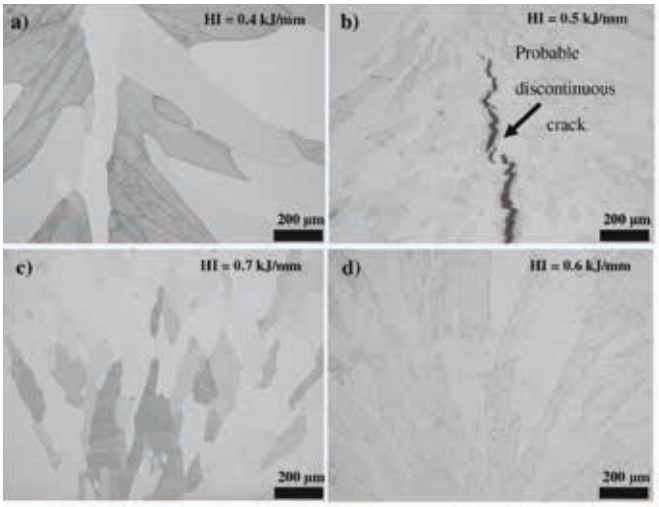


Figure 5: The microstructure of the weld revealing: a) axial grains among columnar grains of the unstabilised A: 0Ti; 0Nb-ferritic stainless steel at a welding speed of 3.0 mm/s; b) a crack in the E: 0.4Ti; 0.9Nb-stabilised ferritic stainless steel at a welding speed of 3.0 mm/s; c) columnar grains of the F: 0.1Ti; 0.4Nb ferritic stainless steel at a welding speed of 1.0 mm/s; d) columnar grains of the E: 0.4Ti; 0.9Nb ferritic stainless steel at a welding speed of 1.0 mm/s.

The zero stabilisation of Ti and Nb in ferritic stainless steels also contributed to the resistance of steel A: 0Ti; 0Nb to solidification cracking [1]. The other steels (steels B to G) cracked at the welding speed of 3.0 mm/s. The high welding speed [5, 6] and the Ti and Nb stabilisation contents [1] were a contributory factor to the susceptibility to solidification cracking of these steels.

Columnar grains were seen in the weld metal at the welding speed of 1 mm/s. During low welding speed, the weld pool shape is elliptical and this caused the trailing boundary to be curved, thereby making the columnar grains to grow perpendicular to the pool boundary [27, 29]. Low welding speeds are not susceptible to solidification cracking due to the columnar grains that do not impinge [6]. That might have contributed to the steels A, B, D, E and F not cracking. The steels C and G cracked, and this might be due to the Nb content of above 0.5 wt% in these steels.

The interdendritic structures found with all the cracked steels implied solidification cracking. The low fraction eutectic has been found to have a relatively low fraction (< 5%) of eutectic liquid, and the fracture surface reveals a very clear dendritic structure. The fracture surface of high fraction eutectic liquid, on the other hand,

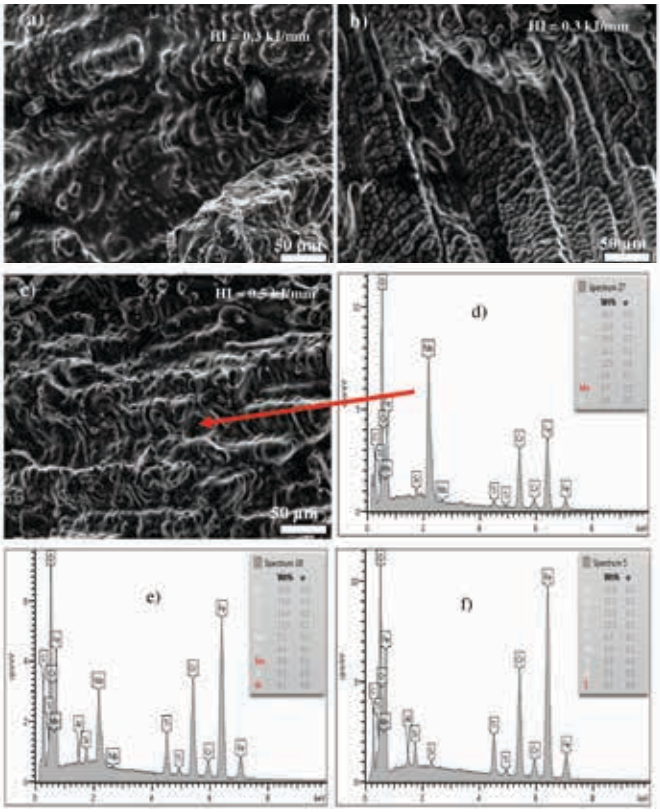


Figure 6: Secondary electron microscope (SEM) image of solidification cracking morphology of: a) D: 0.4Ti+0.6Nb-stabilised ferritic stainless steel showing high fraction eutectic at a welding speed of 6.0 mm/s: b) B: 0.7Ti-stabilised ferritic stainless steel showing low fraction eutectic at a welding speed 6.0 mm/s; c) C: 0.6Nb-stabilised ferritic stainless steel at a welding speed of 3.0 mm/s; d) EDX spectra of the precipitates in C: 0.6Nb-stabilised ferritic stainless steel fracture surface at a welding speed of 3.0 mm/s; e) EDX spectra of the precipitates in D: 0.4Ti+0.6Nb-stabilised ferritic stainless steel fracture surface at a welding speed of 3.0 mm/s; f) EDX spectra of the precipitates in B: 0.7Ti-stabilised ferritic stainless steel fracture surface at a welding speed of 6.0 mm/s.

Table 5: The weld bead size of the top and bottom surface of the alloys.

Experimental alloy	6.0 mm/s		3.0 mm/s		1.0 mm/s	
	Top (mm)	Bottom (mm)	Top (mm)	Bottom (mm)	Top (mm)	Bottom (mm)
A: 0Ti; 0Nb	6.6	5.2	8.4	6.4	9.5	9.6
B: 0.7Ti	6.5	6.1	7.0	8.1	9.0	7.2
C: 0.6Nb	9.3	6.5	12.2	10.6	9.0	8.5
D: 0.4Ti; 0.6Nb	8.6	6.8	9.1	6.7	8.1	7.7
E: 0.4Ti; 0.9Nb	9.7	6.1	8.5	7.3	8.3	6.8
F: 0.1Ti; 0.4Nb	7.8	5.2	8.6	6.5	6.2	4.7
G: 0.1Ti; 0.5Nb; 2Mo	8.8	7.4	12.7	9.1	11.0	8.0

is obscured by the backfilling liquid. This liquid coats the dendrites and has been shown to be about 10% eutectic liquid [6].

Some of the steels at a welding speed of 3.0 mm/s were found to contain precipitates in the dendrite arms. From the literature, such precipitates are considered to contribute to solidification cracking (Figure 6c), for example. Lippold [6] reported the presence of second phase particles on the fracture surface of a Nb-bearing Ni-base alloy due to eutectic reaction. As solidification began, the solute elements were rejected from the liquid into the mushy zone. At the later stage of solidification, the rejected elements acted as impurities to weaken the boundary layer, thereby resulting in cracking along the grain boundary. Nb has also been found to form eutectics [3]. The C: 0.6Nb ferritic stainless steel contained mostly Nb and C elements. This particle was likely to be a NbC precipitate as the Thermo-Calc simulations predicted NbC to be a precipitate from the C: 0.6Nb alloy (Table 3).

The EDX elemental analysis of the fractured surfaces showed the elements Nb, Ti, O, Mn, Al, Si, Mo, S and Ni to have contributed to the solidification cracking at all welding speeds. These elements were seen as being ejected to the grain boundary during solidification to form impurities which eventually caused the solidification cracking.

Conclusions

The seven alloys investigated to ascertain the susceptibility to solidification cracking of the ferritic stainless steel revealed the following:

1. The unstabilised ferritic stainless steel can be said to be resistant to solidification cracking. The addition of Ti slightly increased the susceptibility to solidification cracking, as the samples cracked in welding speeds 6.0 mm/s and 3.0 mm/s. The addition of Nb to the ferritic stainless steel resulted in a significant increase in the susceptibility to solidification cracking as there was cracking at all three welding speeds of 6.0 mm/s, 3.0 mm/s and 1.0 mm/s. The addition of Ti and Nb to the ferritic stainless steels increased the length of the solidification crack.
2. The solidification structure of the unstabilised A: 0Ti; 0Nb; stabilised B: 0.7Ti and C: 0.6Nb; and the commercial F: 0.1Ti; 0.4Nb dual-stabilised ferritic stainless steels revealed columnar grains. The experimental dual-stabilised ferritic stainless steels – D: 0.4Ti; 0.6Nb and E: 0.4Ti; 0.9Nb – showed mostly equiaxed grains at a welding speed of 6.0 mm/s. The dual-stabilised plus Mo alloy –G: 0.1Ti; 0.5Nb 2Mo – showed equiaxed grains in the weld region for speeds 6.0 and 3.0 mm/s. It seems that the weld solidification structure does not contribute to the susceptibility to cracking as both columnar and equiaxed grains cracked in ferritic stainless steels.
3. Elemental analysis revealed Nb, Ti, O, Mn, Al, Si, Mo, S and Ni as associated with the fractured surfaces of all the alloys at all the welding speeds.

Acknowledgment

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Everyone's talking about it,
BUT WHAT IS ERP?

The Information Technology industry is renowned for acronyms which are often widely used but not fully understood.

ERP, for example, is an acronym for Enterprise Resource Planning. Broadly speaking, it refers to a category of business management software - typically a suite of integrated applications - that organizations use to collect, store, manage, and interpret data from its many business activities.

A good ERP system becomes the central nervous system of a company, continuously sending millions of messages to and from its various parts to ensure the whole is functioning at its peak. It does this by providing an ever updated view of core business processes by coordinating business resources - cash, raw materials, production capacity - with the status of business commitments - orders, purchase orders, and payroll. The applications that make up the system share data across the various departments such as manufacturing, purchasing, sales and accounting.

An ERP system has multiple benefits that help with overall business performance management for any organization - by providing intelligence, visibility, analytics and efficiency across every aspect of a business's supply chain, giving one source of truth, and enabling seamless digitalization as and when new technologies emerge.
There are countless reasons for businesses to adopt an ERP system. Here are the most important:

Reduce costs and save money in the long run. By reducing administrative and operational costs through automated processes, ERP allows users to proactively prevent delays, stoppages, wasted time, resources and expenditure.

Streamline business processes and operations. Because data is available in a centralised location with complete visibility across all functions, decision makers can track processes and accurately determine and maintain optimum inventory levels.

Improved consolidation. Without ERP, many businesses are forced to use different programs in different departments. By using common databases maintained by a database management system ERP eliminates this.

Supply chain visibility and optimisation. A robust ERP system provides a real-time picture of the entire supply chain and connected processes, making it easy to reduce planning cycles and control production scheduling.

Respond faster to market conditions. ERP provides data analysis and reporting that assists businesses to rapidly react to changing market requirements and unforeseen events, then make informed decisions and determine realistic forecasts.

Traceability. ERP has the capacity to track all stock – anywhere along the supply chain - including defects and hazards, down to the smallest levels of individual parts and ingredients to mitigate the risk of recalls.

Improve customer satisfaction, service and relationships. Implementing ERP enables you to keep your promises by producing enough of the right product, at the right price, at the right quality, at the right time.

Digitally transform your business with mobility and flexibility. As technology advances, your ERP system will seamlessly incorporate it and adapt it to your changing needs, whether on premise, in the cloud or even on a mobile App.

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Bolt and Engineering Distributors delivers cutting-edge fabrication services to Klerkscale

By investing in a solutions-driven approach, through continuous, personal interactions and outstanding customer service, B.E.D. ensures long-standing and strong relationships, with notable achievements in operational efficiency.

Bolt and Engineering Distributors Group (B.E.D.), which supplies a vast product range to a wide variety of industry sectors, including agriculture, mining, materials handling, working at height and welding, believes its commitment to a solutions-driven approach has resulted in many robust service accomplishments over the years.

"In particular, B.E.D.'s consistent interaction with valued industrial weighing equipment manufacturer and supplier Klerkscale for more than 30 years has created a resilient relationship of mutual respect," says B.E.D. Klerksdorp Sales Representative Pieter Joubert.

Founded in Klerksdorp in 1958 to meet the high demand for weighing machines, local manufacturer Klerkscale specialises in advanced technology for industrial weighing systems, such as those for on-road and off-road vehicles, axle-, rail- and container-weighbridges, and heavy-duty platforms.

"As a single source supplier, B.E.D. has been able to steadfastly provide Klerkscale with the day-to-day supply of fasteners for their weighbridges, tools and personal protective equipment (PPE), significant industry knowledge; as well as several welding and cutting equipment solutions that have enhanced the customer's operational success and continuity," explains Joubert.

Recently supplied products and solutions include technologically advanced, premium welding and cutting equipment to Klerkscale, such as high-quality Fronius TransSteel CO_2 welders for the company's manufacturing facility in Klerksdorp; a plasma cutter with a 3×6 m plasma cutting table believed to be one of the largest in South Africa; as well as a Hypertherm XPR300 power source, screw compressor and software.

Thanks to their ability to provide excellent welding quality and higher welding speeds resulting in faster production and lower operating costs, Fronius TransSteel CO_2 welding equipment has become the standard for Klerkscale's manufacturing processes.

"The plasma cutting solution, meanwhile, has enabled significant productivity increases, as opposed to manual cutting with oxy-acetylene torches. This has resulted in reduced material waste, increased manufacturing efficiencies and improved project delivery times," says Klerkscale director, Robert Stephenson.

B.E.D.'s Welding and Cutting Product Specialist Sean Christian also recently conducted a straight line welding demonstration at Klerkscale. In this demonstration, a Messer Portacut straight line cutter was specially converted for welding applications, yielding excellent preliminary results.

"This automatic cutter allows for enhanced manoeuvrability and economic and flexible cutting: in a straight line, for contours, strips and bevel cutting, while in converted form, the machine can produce continuous welds of up to 4.0 m in length," Christian points out.

As cutting and welding are essential to fabrication and manufacturing across most industries that require the highest levels of efficiency and quality, B.E.D. strives to offer customers the perfect welding or cutting fit, through an impressive and comprehensive portfolio of world-class international and local suppliers: including Fronius, Messer, Hypertherm, Zenweld and Castolin Eutectic.

"Armed with this portfolio, full global support from our suppliers on all product solutions and complex applications, a solid track record and pool of experience built up over our 37 years of service to the market, as well as a dedicated welding support team with more than 75 years of experience in the welding and cutting industry, B.E.D. knows what 'makes the cut'," says Joubert.

"Drawing on the strength of these skills and knowledge, we also facilitate knowledge transfer to our customers for enhanced productivity, financial benefits and, ultimately, peace of mind in terms of business longevity and growth," he adds.

"Based on our personal relationship, we can trust that B.E.D. will always give us the attention and service when and where we need it. Moreover, reliability is ensured, as there is never a reason to think B.E.D. will not follow through. These efforts to provide great customer service experiences are what differentiates B.E.D. in the market," adds Stephenson.

B.E.D. proactively invests in knowing its customers' businesses, consistently taking 100% responsibility for ensuring it provides the right solution – whether it be product supply or training – to ensure the most efficient results. "By assessing and analysing our customers' businesses, and focusing on any challenges or potential improvements, we can assess the important issues and come up with products and solutions – helping customers to 'tip the scales' in their favour, by strategically streamlining, adding to and improving production processes.

"We are extremely honoured to have been able to serve our valued long-term customer Klerkscale for the past three decades, and look forward to many more years of helping them to get the balance right," Joubert concludes.

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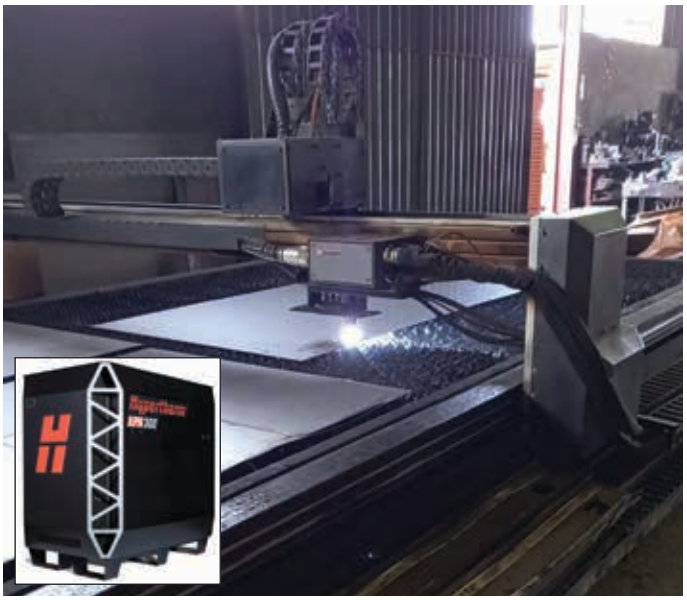


Klerkscale's manufacturing facility in Klerksdorp has recently installed a 3×6 m plasma cutting table with a Hypertherm XPR300 power source (inset), screw compressor and software.

ESAB launches new FE300 and ProStage gas regulators

African Fusion talks to Eugene van Dyk of ESAB about the launch of the new ESAB FE300-series single-stage industrial gas cylinder regulators, and the ProStage double-stage regulators in South Africa, Africa and the Middle East.

"We are currently in the process of launching our new F-series single-stage gas regulators into our local markets to replaces the G-series, which is to be discontinued. The new GCE FE300 regulars meet all the requirements of the G-series, but they come from a state-of-the-art new gas equipment factory in the European Union, which offers us more competitive pricing with more consistent manufacturing quality," begins Van Dyk.

"Better costing and manufacturing volumes enable us to pass on supply and cost benefits to customers. Most notably, though, these regulators comply fully with the ISO standards that specify the safety and quality of gas welding equipment for welding, cutting and allied processes: ISO 2503 for pressure regulators, with and without flow-meters; and ISO 5171 for pressure gauges," he notes.

Van Dyk adds that ESAB is the only welding and cutting equipment manufacturer with triple certification: ISO 9001 for quality management, ISO 14001 for environmental management; and ISO 18001, the international health and safety management standard.

ESAB's global triple certification is issued by DNV, the world-renowned testing, certification and technical advisory service. This triple DNV certificate applies to all ESAB's global facilities that develop, design, produce, distribute and sell welding and cutting products and associated services. "Every ESAB product that comes out of any one of our facilities is covered by the certificate, which means that, wherever a product ends up, it remains traceable back to its manufacturing origins for its entire lifetime," Van Dyk assures.

The recently launched ESAB GCE FE300 single-stage gas cylinder regulators fit into the medium- to high-tier product segment for use for oxy-acetylene or propane heating or cutting: Above: a 300 bar FE300 oxygen cylinder regulator. Red: a 40 bar acetylene cylinder regulator.

With the acquisition of Gas Control Equipment (GCE), a European leader in gas equipment, ESAB offers an even more complete range of quality pressure and flow control equipment for high pressure gases, along with cutting torches and manipulators for manual or mechanised gas cutting and welding equipment.

Turning attention back to the new ESAB GCE FE300 series regulators, he says that the new unit specifications are similar to the existing G-series. "The ordering numbers are nearly the same as well, but the FE300 product item numbers all start with the letters FS," he adds.

The new range of single-stage regulars fits into the medium- to high-tier product segment and are typically bread and butter products for use by anyone using industrial gas cylinders for oxy-acetylene or propane heating or cutting; and any of the gas shielded welding processes.

Key features of the FE300 high-performance single state regulator range include:

- Safety focused pressure regulator de-

signed according to ISO 2503.

- Durable construction saving costs of spares and replacements.
- Encapsulated regulating technology for precise and stable control.
- Ergonomic arrangement makes for easy handling by operators.
- Side and bottom entry design variants are available to fit on all types of cylinder valves.
- Three scale pressure gauges certified to ISO 5171 are incorporated with high contrast pointers for better gas pressure clarity.
- Gas colour-coded handwheels are used for simple gas content and hazard identification.
- GCE FE300 regulators are manufactured in the EU in a modern new factory.

These regulators are ideal for fabricators, onsite contractors, scrap metal merchants and any jobbing shop using industrial gases for cutting, welding or heating. "In this price sensitive market segment, these ESAB products offer among the best value for money/quality balance available," Van Dyk tells African Fusion.

GCE ProStage: the premium tier option

The new flagship premium tier regulator in ESAB's range is the GCE ProStage range. This is a double stage regulator, which offers better safety as well as a more accurate and consistent outlet pressure that will not need to be regularly adjusted as the cylinder empties.

"The GCE ProStage is the new member of the PRO-Series of cylinder regulators for industrial applications. It is a two-stage regulator designed for users requiring high accuracy outlet gas pressure and flow. This product completes our product range by providing a solution at the highest level of the industrial gas segment," notes Van Dyk.

Key features include:

- Two-stage regulation for constant and precise outlet pressure and flow.
- High-performance for the specific needs of industrial gas applications with up to 300 bar cylinder pressure.
- Designed with prolonged lifetime in mind, saving costs related to services and spares.
- Easy handling for the operator with an ergonomic arrangement of the three-scale pressure gauges for better gas pressure adjustment and clarity.
- Robust rubber gauge protection for preventing damage to gauges.
- Repairable eco-design with an available range of spares.
- An on-line manual is made readily accessible to operators on a smart phone or tablet by scanning the product-specific QR code permanently printed on each regulator.
- Manufactured in the European Union with a safety focused design that meets EN ISO 2503 specifications.

Most notable applications for ESAB's ProStage industrial gas cylinder regulators include: plasma cutting with modern systems from Hypertherm, Kjellberg, Thermal Dynamics and others; industrial applications of compressed gases with low working pressures of below 2.0 bar; and applications requiring precise outlet pressure settings that remain constant while the gas cylinder empties.

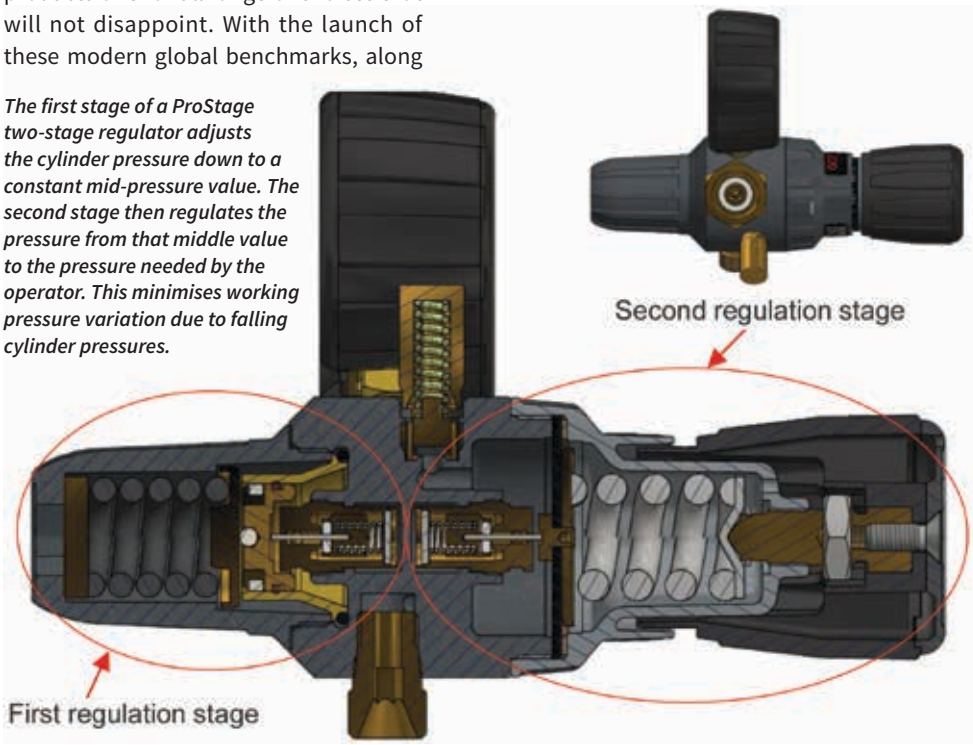
"As with all ESAB gas equipment, safety is of primary importance and the main philosophy underpinning product design," notes Van Dyk, adding that all regulator components are carefully designed based on more than 100 years of experience with gas pressure regulation.

With respect the ProStage range, he notes: "Oxygen hazards are very well known and ProStage resistance has been tested in our newly accredited oxygen laboratory at the GCE Chotebor facility in Czechia. As well as routine ISO 2503 type-testing, 300 bar cylinder pressure has been set as the standard for the ProStage range, while the robust forged brass body makes for a stable and resistant safety platform for internal parts," says Van Dyk.

"In an increasingly competitive market, the new FE300 and ProStage gas regulation products offer a full range of choices that will not disappoint. With the launch of these modern global benchmarks, along with local expertise, support services and backup, we look forward to taking an ever greater share of the Southern African gas equipment market," he concludes.

www.esab.co.za

Most notable applications for ESAB's GCE ProStage double-stage industrial gas cylinder regulators include: plasma cutting; low pressure (below 2.0 bar) applications; and applications requiring precise outlet pressure settings. Top image: a 313 bar ProStage regulator for inert gases such as argon, (Ar). Above: The QR code permanently printed on each ProStage regulator gives users direct access to the relevant online user guide.



The first stage of a ProStage two-stage regulator adjusts the cylinder pressure down to a constant mid-pressure value. The second stage then regulates the pressure from that middle value to the pressure needed by the operator. This minimises working pressure variation due to falling cylinder pressures.

Stainless steel welding from Unique Welding

Unique Welding, through its national branch network, comprehensive product range, global partnerships and over 40 years of expertise, is able to assist fabricators to reduce welding costs, improve productivity and reduce weld safety risks in the stainless-steel industry.

Unique Welding supplies a flagship range of MMA, MIG, TIG and Plasma welding machines and equipment through its in-house brand, Thermamax, which has proven to be an affordable yet high-quality workhorse of industry. High reliability enables the company to offer three-year guarantees, supported by a network of service centres and after-sales support networks.

The Thermamax APOLLO MIG machines are fitted with gas selection charts that enable the welder to quickly and accurately select the right shielding gas for the common welding applications. With a powerful 500 A Synergic Pulse MIG machine in its Thermamax Range, no stainless steel job is too big to handle!

Besides an experienced welder, quality welding requires quality equipment, gas and consumables. Unique Welding has recently partnered with a new, proudly local, Level 2 B-BBEE producer of stainless-steel welding wire. This company has developed a comprehensive range of top-quality stainless-steel welding wires based on European technology, specifications and raw materials. Through this new partnership, Unique Welding is able to leverage international expertise, exceptional quality, support and knowledge to benefit our local market.

The new Thermamax Stainless Steel welding consumables come with an array of international certifications, including AWS, EN, ISO, and TUV. These consumables also have ABS and BV approvals, which are critical to many South African industries, including the shipping industry. This ensures that they are manufactured to produce a controlled weld metal ferrite content and designed to produce first class welds with reliable CVN impact toughness and lateral expansion at cryogenic temperatures. Despite the lower ferrite content, hot cracking resistance is good, even when welding thick-walled constructions.

Unique Welding has recently partnered with a new, proudly local, Level 2 B-BBEE producer of stainless-steel welding wire.

As a leader in the manufacturing, supply and distribution of industrial and specialty gas in the Southern African region, Air Products and Unique Welding supply a number of gases used for stainless steel applications.

The addition of helium or hydrogen to argon for the welding of austenitic stainless steels has been shown to increase production speeds by up to 30% over the more traditional 100% argon shielding gas. The high thermal conductivity of hydrogen also enhances the cleaning effect, as it is a reducing gas. Helium on the other hand is a preferred gas enhancer for ferritic stainless steels.

Carbon dioxide is added to the welding process as it is slightly oxidising, providing increased heat in the arc through disassociation. The available heat increases

Unique Welding supplies a complete range of products and services for stainless steel welding, including Thermamax MMA, MIG, TIG and Plasma welding machines; Thermamax Stainless Steel welding consumables; the full range of Air Products shielding gases and gas supply options, along with welding PPE such as Powered Air Purifying Respirators and pickling and passivating solutions.

Welding stainless steel pipes.

penetration, adding width to the weld and therefore improving side wall fusion.

Whilst technical performance is important, the gas supply solution is equally important. Unique Welding is able to supply shielding gases for applications from small to large, thus able to expand its supply arrangement as the customer's business grows. Supply ranges from single cylinder supply, to manifold packs, and on to Air Products' CryoEase mini bulk installations.

Taking a good weld to a great weld is as simple as finishing off the welding process effectively. Teaming up with German-based industry leader, Pelox, Unique Welding provides an array of pickling and passivating solutions for stainless steel welds. The stainless welding team is trained and ready to recommend the best solution to save both time and money, from manual application, to high-pressure spray solutions, to an entire pickling bath installation, which all leave flawlessly finished stainless steel weld beads.

Hexavalent chromium or Cr(VI) is one of the valence states (+6) of the element, chromium. It is usually produced by an industrial process. Cr(VI) is known to cause cancer. In addition, it targets the respiratory system, kidneys, liver, skin and eyes.

A major source of worker exposure to Cr(VI) occurs during hot-work such as welding on stainless steel and other alloy steels containing chromium and its compounds. Stainless steel fabricators may face future worker health claims, hence the need to protect workers with PAPR-type personal protection welding helmets (Powered Air Purifying Respirators).

The Thermamax TruFlo PAPR (Powered Air Purifying Respirators) comes with the TruVision WH02 auto-adjustable welding helmet with TruBlu colour technology.

The Thermamax TruFlo PAPR is widely accepted in the welding industry due to its European design and extended warranty. The system comes with the TruVision WH02 auto-adjustable welding helmet with TruBlu colour technology, an array of specialised filters for multiple welding environments, and a failproof warning system.

As the largest independent, black owned gas and welding distributor in South Africa, Unique Welding is at the forefront of welding technology, transforming the South African gas and welding industry with expertise, innovation and personal specialised services such as the end-to-end stainless steel offering outlined above.

www.uniquewelding.co.za

A simple guide to choosing stainless steel consumables

By John Du Plessis of Spesmet Technologies

The correct welding consumable grade must be used for each of the different austenitic stainless-steel grades. Matching consumables are available for most of the grades – 304, 309 and 316, for example – and these are either specified exactly according to the grade name, or the grade name for the consumable may carry a suffix such as -L, -H or -N. The L suffix means it is a low carbon alloy, an -N indicates it is nitrogen bearing and an -H indicates higher carbon content.

For shielded metal arc welding (SMAW) electrodes, there are different types of electrode coating, which are generally given a number suffix, 15, 16 and 17, depending on the coating type.

A Type 15 electrode coating has a lime-based coating and is intended for dc+ polarity only. The slag covering is not as thick as that found on the Type 16 and Type 17 coatings. The weld bead is normally convex in a horizontal fillet weld with excellent crack resistance. Type 15 stainless electrode coatings give the best all positional weldability, however the arc is harsher than the other types.

Type 16 electrode coatings are rutile-based and can be used with both dc and ac polarity. The weld bead in a horizontal fillet is almost flat. The arc is much softer than Type 15 electrodes, with good all positional welding capabilities.

The Type 17 electrode coatings have a silica-rutile composition. These can also be used with both dc and ac polarity. The additional silicon in the coating acts as a wetting agent, having the effect of increasing puddle fluidity. Type 17 electrodes produce a concave weld bead in a horizontal fillet weld, and are often used in the flat and horizontal welding positions. These electrodes have limited vertical welding capability. The arc is smooth and relatively soft when welding.

Welding consumables from different manufacturers, although having the same classification, are by no means equal. There are significant differences in the consistency from batch to batch, chemistry, ferrite number and impurity levels.

Customers are advised to carefully scrutinise products on offer, as some manufacturers either do not comply to the standards or produce products at the low end of the composition requirements, which creates increased risks in critical applications.

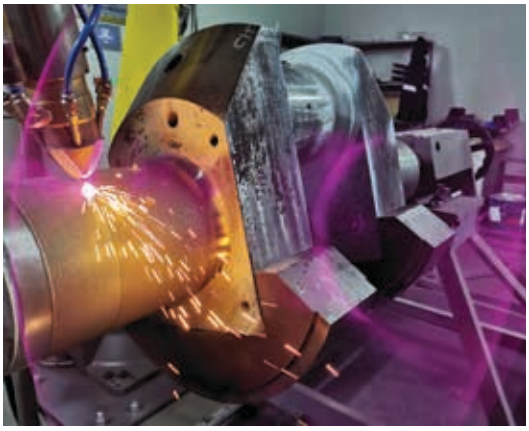
Laser cladding with ISO 3834 certification
the high integrity surfacing combination

African Fusion talks to newly appointed ISO 3834 Responsible Welding Coordinator, Pieter Venter (left), and laser cladding manager, Daan Lourens (right), about Thermaspray's addition of laser cladding services and the importance of consistent quality control.

Following a stellar career in South Africa's steel industry, Pieter Venter says he is excited to have joined South Africa's leader in surface engineering and high technology coatings. "I have long been interested in the principles and benefits of surface engineering and the total menu of technologies and equipment that Thermaspray, as the leader in this field, offers, dovetails perfectly with advancing my career," he tells *African Fusion*.

Venter, with BEng and BEng Hons degrees Metallurgy from the University of Pretoria, a Master in Materials and Welding Engineering from the University of the Witwatersrand, and an IIW International Welding Engineer Diploma, is extraordinarily well qualified for the position.

Laser cladding of a turbine rotor being done at Thermaspray's Olifantsfontein facility.



Thermaspray supplies major OEMs that require ISO 3834 certification.

"Considering fusion welding, irrespective of the welding process, there is a metallurgical bond between the parent- and filler metal used. Whether joining plates to fabricate a pressure vessel or hardfacing/cladding a shaft or valve seat to improve its wear/corrosion resistance and in-service life, there is a fundamental requirement to get the as-welded quality to the highest possible level," he continues.

Laser cladding (or laser metal deposition) involves a consumable powder that is melted using a laser light source. A thin layer of the parent metal is also melted by the laser which, with the powder, creates a fused metallurgical bond on the surface of the component. "So this process is inherently a fusion welding process for metallic materials, and therefore needs to meet the quality requirements of ISO 3834," Venter explains.

"With Thermaspray already being an ISO 3834-Part 2 certified organisation, certification fits perfectly into our quality management system to manage all work we do, with respect to relevant standards, customer requirements, welding procedure specifications, non-destructive testing requirements and much more. If it involves fusion welding, then ISO 3834 applies," he notes.

Describing his role within Thermaspray, Venter says that ISO 3834-2 management system certification requires the involvement and appointment of a responsible welding coordinator to assist management to ensure that the management system conforms to the requirements of ISO 3834-2, is capable of consistently achieving its stated policies and objectives and is effectively implemented. "As that welding coordinator, I now take responsibility for issues relating to fusion welding processes: reviewing and understanding customer and technical requirements, overseeing welding operations, carrying out welding procedure qualification tests, evaluating and approving weld test results and overseeing final production welding, inspection and testing and other related activities. In a nutshell, this support role is about making sure the needs of the customer are effectively and safely met in compliance with all Codes, Standards, and specifications and, at the end of the day, that the customer is happy with the results," he informs *African Fusion*. After all, Thermaspray believes that value for the customer is vested in excellent quality and service at the lowest total cost of ownership and within the best response time.

Laser cladding/laser metal deposition

As with all thermal spray, cladding and hardfacing processes, a key goal is to achieve a surface composition that fully meets the *in-situ* wear and/or corrosion property requirements without affecting the metallurgy of the supporting substrate. Sophisticated surface engineering is about reducing the heat input so as to deposit the thinnest dilution layer possible, so that the maximum possible percentage of powder constituents are available to protect the component surface. "Among the surface engineering techniques that form a metallurgical – and therefore impact resistant – bond between the substrate material and the overlay material, laser cladding is among the most flexible and sophisticated surfacing processes available," continues Lourens.

"Our core business focuses on both OEM and end-user customers, extending the wear and/or corrosion life of new OEM components, or refurbishing worn in-service plant components to OEM specification," he says. "Laser cladding is a complementary

process to thermal spray. With laser cladding, we can dimensionally restore worn components to OEM specification or use a tailored metal powder to extend the wear- and/or corrosion resistance of a working surface on a component, which ultimately saves the customer costs on maintenance or replacement," Lourens explains.

Laser cladding is used in various industries, such as power generation, pumps and casings, petrochemical, mining, automotive, turbomachinery and many more. "Our core business remains thermal spray, but the laser service has grown very quickly, and we continue to expand into new industries and with new applications," he adds.

"The process doesn't replace thermal spray, or any other surface engineering technology offered by Thermaspray, but supplements it with high levels of metallurgical flexibility with the availability of a wide range of powders for various, specific applications, exceptionally low heat-input, and dilution levels of only approximately 5%, which is up to three times lower than typically seen with PTA cladding," adds Venter.

"From a machining perspective, laser cladding offers near-net shape finishes, which can massively reduce post-weld machining times and ultimately costs. With some materials, the finished surface is very smooth when deposited. We can deposit to within about 0.1 mm (100 µm) of net shape on materials such as these, but for other materials, where the weld bead profiles are more pronounced, we can get to within 0.5 to 0.6 mm (500 to 600 µm) of the required machine-finished dimensions," says Lourens.

Thermaspray has chosen a diode laser for its laser cladding service. A six-axis robot and a two-axis tilt and turn manipulator give a total of eight manipulation axes for maximum flexibility. "With this system, we can achieve layer thicknesses of anywhere between 0.2 and 2.0 mm per pass." notes Lourens.

Another key advantage of using a highly automated and accurately controlled process such as laser cladding is repeatability: "We can very accurately control all input parameters, so once a procedure to deposit a layer of a specific material has been developed, subsequent layers will all be that exact same thickness and if we are working with several identical components, we can guarantee the layer thickness within a very precise range across all of these components," he adds.

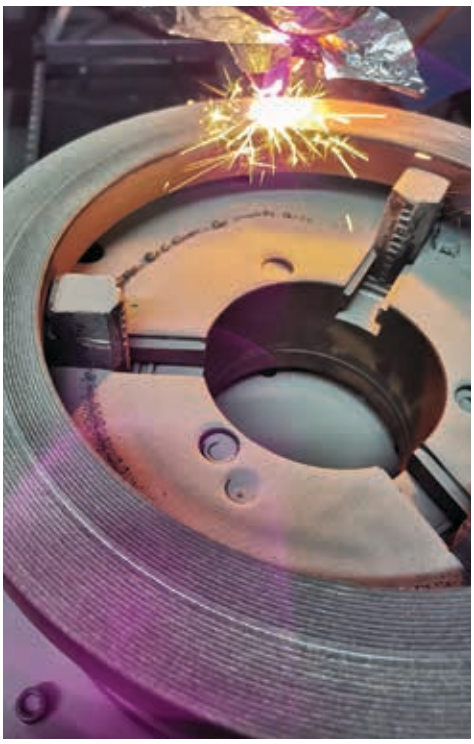
In terms of the powder deposition efficiency, 70 to 80% can typically be achieved. "The big advantage with powder-based filler materials, is that there are several global manufacturers that have spent many years developing a massive range of powder types for very specific applications, ranging from extreme abrasion resistance and impact resistance to corrosion protection or oxidation resistance. You would be hard-pressed to find an application for which there is not a readily available fit-for-purpose powder," Lourens assures.

The expanding capability and quality offering

Going back to the link between ISO 3834 and laser cladding, Lourens notes that Thermaspray has done thermal spray work for companies like Eskom, Sasol, Sulzer, Siemens and other OEMs for many years. "Many major OEMs and suppliers to the power generation and petrochemical industries require ISO 3834 certification as a tender condition for fusion-related work, and we wanted to expand our service offering to these companies.

"Our decision to adopt ISO 3834 certification went hand-in-hand with the addition of the laser cladding service to the Thermaspray portfolio. We brought Pieter Venter onboard, as his broad range of knowledge in metallurgy and experience with fusion welding further strengthens the foundation on which we have built our laser cladding service.

"The drive is to be able to approach any customer and confidently say we can offer a high integrity, high quality surface engineering service, through various technologies supported by all of the necessary knowledge, experience, certifications and support from the top professionals in the country and abroad," he says, adding: "We already practice strict quality control and assurance through our ISO 9001 certification, so the addition of an ISO 3834 system was a natural progression as our service offering grew."



Laser cladding offers high levels of metallurgical flexibility, exceptionally low heat-input and dilution levels as low as 5.0%.

Venter continues: "Thermaspray's offering is directly driven by customers' needs. We can assist customers to use their maintenance periods more effectively, delivering quick turnaround times of refurbishment projects in the pressure equipment inspection space, or supporting those customers wanting to improve competitiveness through reduced total cost of ownership of critical components. We can extend service life of components through refurbishment, which could otherwise not be considered with conventional arc welding processes because of inherent excessive dilution levels or distortion.

"The surface engineering processes that Thermaspray offers, especially now with the laser cladding service, lead to improved equipment performance in the support they give to maintenance improvement teams in their quest to improve mean-time between failure or repair of critical plant components," he concludes.

Böhler Welding's economic and ecological MIG/MAG process combinations

Böhler Welding's advanced copper-free welding wire, particularly when used with welding process control features such as RapiDeep and QuickPulse, offer the best possible combination of weld economy and protection of the environment. This article outlines why.

Uniting the best of two worlds, ECOspark™ copper-free welding wire is designed for outstanding efficiency in manual and automatic GMAW welding processes, as well as being more environmentally friendly for a healthier future world.

The ECOspark consumable portfolio represents the latest development of copper-free solid wire technology for joining non-alloyed and low alloyed steels. Benefits of using this Böhler Welding consumable include: the ultimate stable arc; perfect wire feedability; a wide tolerance window for welding parameter; and lower spatter levels, leading to less post weld grinding and cleaning.

User advantages include:

- No copper-plating on the wire surface, which reduces clogging of liners due to copper abrasion leading to less system downtime for cleaning wire guides.
- Safe arc ignition, which reduces initial spatter levels and gives better reliability and cleaner results for short seams and tack welds.
- Stable arc with large parameter box: Easy and quick parameter settings that deliver very low spatter levels and less finishing.
- Consistent wire feeding properties for trouble-free and productive welding at high welding currents.
- Very low formation of silica islands, again resulting in less finishing such as grinding and improved coating adhesion.
- Stable BS300 (S) spools that deliver reliable unwinding, easy handling and no spool deformation.

RapiDeep and QuickPulse

There are additional benefits to the excellent properties of ECOspark wires which become available when coupled with the advanced MIG/MAG welding process control features available on Böhler Welding equipment ranges such as Uranos and Terra welding power systems. Most notable among these are RapiDeep and QuickPulse.

Using ECOspark wires with either of these control features delivers high productivity welding with excellent bead shapes, smooth fusion with the base materials, no undercut and ideal penetration.

In high amperage butt-welding applications, the combination of ECOspark with Rapideep or QuickPulse also allows longer stick-out settings to be used which narrow the weld preparation angles, which further improves productivity.

Rapideep process control is an innovative welding feature that allows highly concentrated short arcs to be used, resulting in a consistent heat input reduction, higher precision, easier control, deeper penetration as well as reduced risk of undercut. Rapideep allows significant increases in welding speed, which, through higher productivity and lower arc-on time, has a direct impact on reducing total welding costs

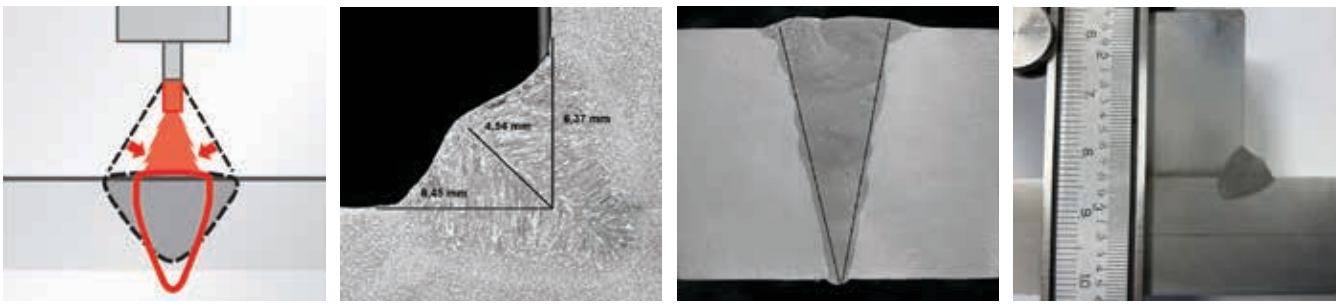
RapiDeep gives better penetration and smoother fusion with base material when operating at the same wire speed and travel speed as would be used in conventional MIG/MAG welding – and even at welding speed raised by 60%, higher penetration with very good bead shapes are still produced.

Böhler Welding's Uranos 4000 PME MIG/MAG welding system. Right: ECOspark, the latest copper-free solid wire.

QuickPulse is a pulsed MIG/MAG version that offers the same benefits as RapiDeep, but with the additional heat input reduction, high precision, deeper penetration and increases of welding speed associated with pulsed GMAW.

In South Africa, QuickPulse is an available option for Böhler Welding's premium Uranos 4000 PME welding system, while RapiDeep can be installed on Uranos and Terra equipment.

www.voestalpine.com/welding



Rapideep process control is an innovative welding feature that allows highly concentrated short arcs to be used, resulting in consistent heat input reduction, higher precision, easier control, deeper penetration as well as reduced risk of undercut.

Shutdown success – a delicate mix of planning, expertise and teamwork

Air Products' general manager for Operations, Dumisa Gina, and Area Production manager, Chris Schoeman, talk about a recent successful shutdown performed on air separation units used by Sasol in the midst of the COVID-19 pandemic.

Dumisa Gina, general manager for operations at Air Products.

Chris Schoeman, Area Production Manager at Air Products.

Conducting shutdowns while placing a strong focus on safety during the process has become an integral part of Air Products' service offering. Plant shutdowns involve critical work that needs to be performed at specific intervals to ensure optimal use of equipment, operational efficiency and, most importantly, to secure a safe working environment for Air Products staff and the employees of its customers.

As a market leader, Air Products is familiar with the planning and execution required for a successful shutdown. During COVID-19, however, an added responsibility has emerged to ensure safe work practices with another dimension: implementing infection control requirements in an already extremely complex and time sensitive environment.

Air Products recently completed a major shutdown at the Sasol Facility in Sasolburg and is extremely proud of achieving on-time, zero-incident and successful execution. In addition, the company reported zero COVID-19 infections despite having a team of more than 270 individuals involved.

This success at Sasol, part of one of the company's biggest maintenance shutdowns, is largely as a result of strategic planning and the quality of the local team's skills and expertise.

As customers are reliant on Air Products' gases to keep their operations going, it is important to ensure that they agree with the process and are constantly updated on the project status. According to general manager for Operations, Dumisa Gina, most of the Air Products' plants are directly linked to customer operations, and for that reason a process has been developed over years that mainly focuses on customers' operational imperatives.

"When we do a shutdown, communication with the customer is crucial and our team ensure that all parties agree on the timelines and have their planning in place to properly manage delivery during the shutdown period. In this situation the customer becomes the most critical player on our team," says Gina.

Area production manager, Chris Schoeman, explains that each shutdown is unique based on the size of the specific plant, the products manufactured and the challenges associated with each. However, the basic elements in the shutdown process, such as safety, planning, costs and quality remain the same and form the basis of any shutdown. "As long as these elements are all aligned, the project will succeed," he says.

This year, with the current COVID-19 pandemic, another important element was added – a contingency plan had to be developed to make provisions for COVID-19 infections. In effect, this meant that regular safety protocols as well as Air Products' and the customer's COVID-19 protocols had to be followed to create a safe working environment for all.

"Shutdown planning can take up to two years and a 20-day execution is conducted by experienced engineers and a maintenance team with the skills required to complete all the aspects of a shutdown. It is important for the management team to ensure that the execution plan is clearly understood and followed by all parties involved, within the set timeline and by following all the necessary safety protocols," says Schoeman.

"In essence, it is a collaboration of efforts and skills from the maintenance, operations and projects teams that ensure a successful shutdown. During a project of this nature, it is crucial that there is good communication, understanding and interaction between the teams to ensure each party's role is performed in accordance with the project plan," he adds.

"Although Air Products has highly experienced personnel, we often need more hands when it comes to specific skill sets and utilising the expertise of contractors definitely adds to the overall strength of a shutdown team. Having said that, it also requires a special focus, as they also need to understand the project at hand and have the same commitment as the rest of the other team members," continues Gina.

More importantly, contractors need to be familiar with all the general safety standards and protocols as well as the additional protocols that are needed to be maintained to prevent the spread of COVID-19 infections.

"I am really humbled by our Sasol project team. A shutdown is always a challenge, but everyone worked like true professionals and went the extra mile to adhere to the additional COVID-19 protocols," adds Schoeman.

Dumisa Gina concludes: "We have some very important new learnings from our last shutdown – using and having proven processes in place, we had a solid base to work from and were able to absorb additional challenges such as how to keep everyone safe during a pandemic."

www.airproducts.co.za

Air Products recently completed a major shutdown at the Sasol Facility in Sasolburg and is extremely proud of the on-time, zero-incident and 100% successful execution.

The use of simulators for welder training: a field study

Philipp Schlor, product manager for Virtual Welding at Fronius International, presents the argument for using modern virtual technology for welder training. Using field study data from the Fohnsdorf Training Centre in Austria, he reveals that using the Fronius Virtual Welding simulator gives student welders 23% more practice time and reduces material costs by €230 per student.

With no noise, no heat and no need for expensive consumables or materials, virtual welding provides a totally safe and sustainable framework for training prospective welders. As with a flight simulator, 3D glasses and outstanding graphics provide a realistic welding experience: the result being improved effectiveness, better skills levels and significantly reduced costs for welder training programmes.

A holistic training approach to theory and practice

With virtual welding, Fronius has developed a well-thought-out training approach that includes imparting theoretical knowledge of the MIG/MAG, TIG, and MMA processes, which also incorporates knowledge tests, with a ranking list motivating students to gauge their performance in relation to others.

The practical welding tasks in Fronius Virtual Welding lesson plans are based on the training offered by the International Institute of Welding (IIW). This means that they correspond to the international standard for training welders.

Ghost: the trainer always by your side

To master the manual skills required, the trainee practices first with a virtual teacher, also referred to as the Ghost. Step by step, the Ghost specifies exactly the right welding speed, distance and angle of the welding torch to the workpiece. Trainees therefore receive direct feedback from the Ghost. The degree of difficulty of the task gradually increases until welding is eventually being performed without the Ghost, in realistic simulation mode.

With Virtual Welding, the welding operations are recorded, and can subsequently be played back and analysed together with the real trainer.

Hannes Krempl, welding technology and transport trainer at the Fohnsdorf Training Centre in Austria, reports that using the Fronius Virtual Welding simulator gives student welders 23% more practice time and reduces material costs by €230 per student.

This combination of guided practical exercises and theoretical units allows the trainee to use the welding simulator to independently complete many of the training phases. In this way, trainees master the basic knowledge and the essential manual skills before working with a real welding system. Training equipment can therefore increase training effectiveness, while reducing costs.

Field study: Fohnsdorf Training Centre

The Fohnsdorf Training Centre, SZF for short, is one of the most modern and innovative facilities for professional training in Austria. The SZF has been using virtual welding in the metalworking sector since 2010, and 30% of practical welder training is now being carried out by means of simulation. As a result, this is a fixed component of the training content.

Research was conducted into what effects this has had on the effectiveness of the training by means of a field study. Data were analysed from 13 trainees over two weeks of training with 30% of the time being spent on virtual welding and 70% on real welding. Fillet welds on plate – done according to the EN ISO 135 P FW FM1 S PB ml fillet welder performance qualification test – and fillet welds on pipes – according to the 135 T FW FM1 S PB sl qualification test – were each welded in both the real and the virtual environment.

To determine the cost effectiveness of training using virtual welding, the metal, gas, welding wire and energy consumed by a total of 1 577 real weld seams were also analysed and compared with data from 1 733 virtual weld seams.

Improved training quality due to 23% more practice time

Using virtual welding, the SZF was able to increase the time actually spent welding by 23%. This means that more than three

times as many seams can be produced virtually than by spending the same amount of time in the welding booth. The main reason for this is that with virtual welding, there is no time-intensive preparation of test sheets, nor the need for cooling the metal sheets and cleaning the weld seams. A simulated weld seam only requires a click, leaving more time for mastering and practicing the required manual skills.

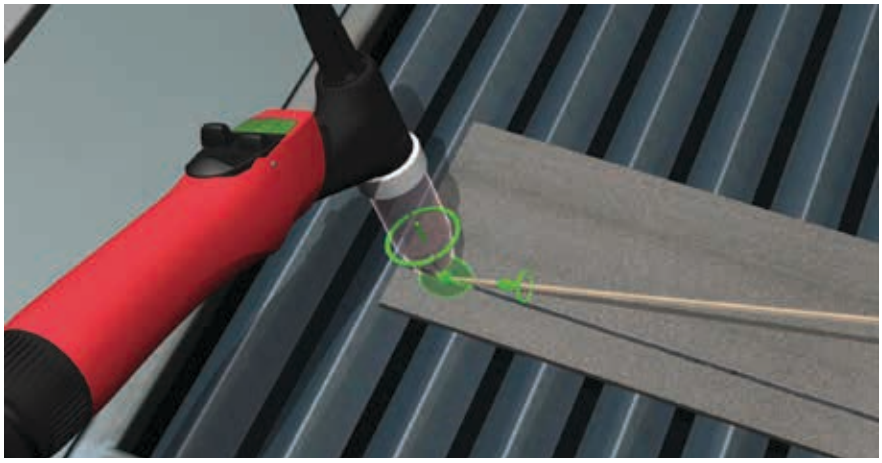
But it is not only the practice time that increases: "First of all, we see the use of Virtual Welding as an important contribution to improving training quality. The Ghost gives every student individual support and direct visual feedback – something a real trainer simply cannot achieve," says a convinced Hannes Krempl, a trainer in welding technology and transport at SZF.

As with a flight simulator, 3D glasses provide particularly high resolution and sharpness, as well as a wide field of vision, resulting in a realistic welding experience.

Cost saving: material costs reduced by €230

As well as improving the quality of the training, the welding simulator also increases the cost efficiency: by saving on consumables such as gas, wire and metal sheets, training becomes far less expensive. "The targeted use of virtual welding saves us, in total, around €230 per student in materials' costs – despite the increased arc time," calculates Krempl.

In addition, virtual training guarantees that the real portion of welder training will be significantly more effective, requiring far less time and fewer resources to get a welder ready to successfully complete the welder performance qualification test.



The Ghost is the virtual trainer that specifies the correct welding speed, the angle of the welding torch, and the torch to workpiece distance using visual guides (green in the image).

Virtual Welding is available in two versions: a StandUp terminal or a Mobile Case; and in more than 20 languages. Manual MIG/MAG, TIG and MMA can be mastered, along with robotic MIG/MAG processes.

Virtual welder training in a new compact size

Now available in South Africa from the Cosmo Group, Lincoln Electric's VRTEX® 360 Compact is a new, small, virtual reality welding simulator for mobile use in multiple environments.

The VRTEX® 360 Compact from Lincoln Electric provides a flexible, powerful, cutting-edge solution for cultivating welding talent quickly and resourcefully. Cost-effective and small, the system offers superior graphics for the most realistic and responsive weld puddle simulation available, along with convincing and accurate sound and movement. With the new VRTEX 360 Compact, virtual welder training can seamlessly transfer into real-world, hands-on welder training, including onsite locations.

In addition, as well as all of the welding processes embedded in previous version of the system, the new VRTEX Compact offers thermal oxyfuel cutting training options – all in a single virtual device. This enables students to also experience torch cutting in a virtual environment. Every aspect of thermal oxyfuel cutting in real-world cutting applications is included in the simulation, from setting up the torch to physically cutting plate.

As well as helping save time and costs, virtual welding offers new opportunities in performance-linked training. The VRTEX 360 Compact supports learning at different levels – from fundamental skills for beginners to advanced skills for professionals. Via the VRTEX® WeldometerTM, trainers and trainee welders themselves can accurately track skills development progress compared to real welding: per lesson, day and year.

Key advantages of adapting virtual welder training as part of a skills development programme include:

- Reduce training costs through savings on equipment, material, consumables and energy, while using a cost-efficient compact device.
- Reduce training time: Welder training and qualification success can be achieved in less time than on real welding machines.
- Increased certification rates, by up to 42%, can be achieved so that better skills are developed and more welders can be trained compared to traditional welding training on real machines.
- Tracking welding defects: Welding discontinuities appear when an improper welding technique is used. Via virtual bend tests and immediate results, trainee welders are given direct feedback about what caused the weld to pass or fail.
- Welder training becomes more eco-friendly: By minimising material waste, saving shielding gas, welding electrodes, weld coupons and weld fume generation, the welder training process becomes more environmentally friendly. Also, far less energy is consumed compared to using traditional welding processes.

The new VRTEX® Compact now also offers thermal oxyfuel cutting training options, enabling students to develop experience in torch cutting in a virtual environment.

The new VRTEX Compact is a perfect example of how to attract the next generation of welders.

"By using virtual welding equipment from Lincoln Electric in our own Cosmo Training Academy, and showcasing systems such as the new VRTEX® 360 Compact to our customers, colleges and welding schools, at Cosmo we are helping to engage and encourage more young welders to take up welding careers," says Petrus Pretorius, general manager of the Cosmo Group.

www.cosmogroupsa.co.za

IIW Statement on Lung Cancer and Welding

In 2018, IARC published Monograph 118, in which welding fumes were evaluated and reclassified as Group 1 – carcinogenic to humans. Based on this assessment, IARC revised its evaluation from 1990, when it classified welding fumes as 'possibly carcinogenic' to humans – Group 2B.

This assessment was based on epidemiological excess risks for lung cancer and was supported by publications on local and systemic inflammatory processes and the suppressive effect on the immune system caused by welding fumes.

The IIW statement on Lung Cancer and Welding

In 2003, IIW Commission VIII issued a statement on the excess risk of lung cancer in electric arc welders. In 2011, this statement was reconfirmed (Ref. Welding in the World, 55, 12-20, 2011). In this statement, the IIW recommended that, to eliminate the excess risk of lung cancer, welders and their managers must ensure that:

- Exposure to welding fumes is minimised, at least to national guidelines.
- There is no further exposure of welders to asbestos.
- Welders are encouraged and assisted not to smoke tobacco.

On the balance of evidence, the grade of risk excess has been confirmed. This assessment has also been corroborated in a meta-analysis published subsequently after the IARC monograph 118 (Honoryar et al. 2019). Again, the excess risk has been shown irrespective of the type of steel – mild steel or stainless steel– being welded.

In addition to lung cancer, IARC stated that there is also an excess risk for kidney cell cancer, as shown in several epidemiological studies. The evidence was rated 'limited' due to the fact that any confounding effect of solvents could not be ruled out.

IARC also classified ultraviolet radiation from arc welding as carcinogenic – sufficient evidence, Group 1 – based on an excess risk of uveal melanoma of welders found in some epidemiological studies.

Therefore, based on the current state of knowledge, IIW confirms its statement from 2011 and encourages all those responsible to reduce exposure to welding fume to a minimum.

IIW recommends that to eliminate the excess risk of lung cancer, welders and their managers must ensure that exposure to welding fume is minimised, at least to national guidelines.

www.iiwelding.org

ESAB Aristo with Robust Feed: the powerful multi-process option

ESAB's Aristo 500ix is a portable heavy industrial pulse power source with a robust and reliable mechanical design. Together with the Robust Feed U6 wire feeder, it is the perfect solution for demanding GMAW applications.

The Aristo 500ix has thick metal side panels with double bent sides and large feet that provide clearance and make the unit ideal for use in tough environments. The large side panels provide easy access for service and maintenance. Ergonomic handles that are clearly marked and safe for crane lifting provide easy transportation to or across sites. The unit comes fitted onto a sturdy cart featuring dedicated crane lifting points, a torch holder and large cable holders.

Key features include:

- Advanced pulse functionality for reduced heat input and minimum spatter.
- Up to 250 pre-programmed synergic lines (U82 Plus).
- Built in QSet™ intelligent welding system: a new quick way to obtain optimised welding parameters.
- Crater filling, adjustable burn back time and SCT (short circuit termination) options for defect-free weld termination.
- Durable and rugged due to its IP23 rating for outdoor and indoor use in rough environments.
- Compatible with Robust Feed U6 and Pulse wire feeders, which are rugged and portable feeder units with excellent feeding performance.
- MMA and gouging options are available from the wire feeders

ESAB's Aristo 500ix and Robust Feed U6 is a robust, reliable and portable industrial pulse power source and wire feed combination ideal for use for fabrication, construction and maintenance in welding workshops and onsite.

"These units are ideal for use in industrial and general fabrication; structural steel fabrication and erection; marine and offshore; transportation, trucks and rail; mobile equipment; tank and pressure vessel fabrication; power and chemical plant construction and maintenance, and much more," says ESAB South Africa's product manager for welding and automation products, Jannie Bronkhorst.

www.esab.co.za

Kemppi's new slogan: 'Designed for welders'

"Kemppi has been through many changes during the last few years. In order for our story to portray what Kemppi is today, we have reviewed our brand story and slogan. The new slogan 'Designed for welders' crystallises Kemppi's long-lasting commitment to deliver the best possible tools for welders, the heroes of our story," says Ville Vuori, CEO of Kemppi Oy.

"As a forerunner in arc welding, Kemppi has constantly shaped the welding market, he continues. "This has been our position for over seventy years and will continue to be so in the future. With welders at the centre.

"Today we are proud to release an updated brand that reflects our user-centric design approach, which has always been at the core of Kemppi. Our new slogan: 'Designed for welders' reflects our focus on welding product development: developing arc stability, advancing welding properties and improving the welding experience for individual welders.

"Our comprehensive design philosophy covers the entire welding ecosystem from welders' needs to advanced products and digital solutions, all aiming to deliver high performance and weld quality," he says.

"But it can never stopped there. We will continue to do our best to deliver products to inspire welders and elevate their professional status because of excellent user experiences: today and tomorrow," Vuori assures.

www.kemppi.com

Five million injury-free hours for DEKRA

NDT and inspection services specialist, DEKRA Industrial, recently reached a major milestone, achieving five million serious injury-free man hours of operational safety. This achievement is testament to the fact that as a 96-year old global safety stalwart, the company is leading by example. And many more safe hours are on the horizon.

"We really 'walk the talk' at DEKRA Industrial. Our primary purpose is to ensure the safety, health and wellbeing of all staff and that of our valued clients too. This achievement therefore reaffirms our commitment to the utmost safety across the board, on any project or contract that we undertake," says Brink-Kleinhans, DEKRA Industrial's Health, Safety and Environment (HSE) manager.

She continues: "For our current clients, this is also a reassurance that we are serious about their safety, and that of their staff and projects. To our future clients, it assures them that the systems we are implementing are practical and effective. In reaching five million serious injury-free hours, we can stand up and say that we have proved our ongoing commitment."

"A great part of our success is that the people we work with are proud to be part of the DEKRA Industrial family. This has a beneficial 'knock-on' effect in terms of their 'buy-in' to our safety culture, and that of our clients. We are open to discussion, collaboration and participation from everyone involved. Our next target is six million serious injury-free man hours, which we hope to reach by the end of this year. And I am confident that our collaborative, innovative ethos will help us get there," concludes Brink-Kleinhans.

www.dekrarsa.com

TIG welding for ultra-high purity (UHP) environments

Polysoude introduces some of its advanced Industry 4.0 welding solutions and the role of modern orbital TIG welding for dealing with requirements for maintaining ultra-pure clean rooms.

Workers and visitors in clean rooms have to wear protective coverings such masks, goggles, gloves, galoshes and laboratory coats or work suits.

Whenever high-quality joints are required, GTAW (Gas Tungsten Arc Welding) or TIG (Tungsten Inert Gas) welding, as it is commonly called, can offer an ideal solution.

But a wide range of products have to be manufactured under white-room or clean-room conditions. These products may be susceptible to microbes, as is the case with pharmaceutical ingredients; to contaminations, as seen in the field of micro-electronics; or to foreign objects, which have to be kept out of optical devices and precision mechanics.

In many cases, equipment for use inside clean rooms has to be produced and assembled under a controlled atmosphere as well. Tube networks, for example, are frequently used to supply clean room installations with ultra-pure gases and liquids, which serve to maintain inert atmospheres for etching, rinsing, diluting and injection purposes.

In order to minimise on site work, as many connections as possible for a tube network installation for a clean room supply are pre-fabricated. In the factory; standard components such as micro-fittings, tees, elbows and valves are welded together with matching tube segments. Here, the use of orbital TIG welding can provide significant advantages with complete weld cycles being carried out automatically, leading to consistent, high quality results.

To keep contamination inside a clean room as low as possible, any generation or emission of particles has to be avoided. Sending out an average stream of 100 000 particles per minute with at a size of less than 50 µm, the human body is considered to be one of the most significant particle generators in a clean environment, leading to workers and visitors in a clean room having to wear protective coverings such masks, goggles, gloves, galoshes and laboratory coats or work suits.

Polysoude closed chamber welding tools for use in the UHP industry.

Manufacturing processes can also be the origin of significant particle emissions. Each electric arc struck during a TIG welding procedure is accompanied by clouds of vaporising metal and streams of weld shielding and backing gas. Additionally, the released heat provokes turbulences between the inert gas and surrounding air, which entrains undesirable pollutants.

However, this can be avoided. Closed orbital welding heads were initially invented as fast and efficient tools for the numerous butt weld connections on aeroplane hydraulics. Ease of use, productivity and outstanding weld quality were the targets for the development and, ultimately, all of these were met in full.

Subsequently, the advantages of an arc burning inside a closed chamber were exploited for clean room purposes. Hot surfaces, turbulence, radiation, uncontrollable particle emission – the entire suite of inconveniences provoked by an open electric discharge – can be eliminated. Today, closed orbital TIG welding heads have become indispensable tools whenever tubes and accessories have to be welded together under clean room conditions.

In order to achieve the best possible benefits and the widest range of applications, the welding equipment should be developed and designed especially for specific clean room requirements. A smart welding station should be installed to supply and control the entire range of closed orbital welding heads for all of the important tube diameters.

Due to their very low weight, these heads can be moved by the operator without any hoisting equipment, which is important for minimising human effort and room infrastructure. The welding equipment should be kept independent from the power source, which can be housed outside the work area. If a liquid cooling circuit becomes necessary for larger tube diameters or improved productivity, this too can be independent of the welding power source and located away from the weld area.

Recent Industry 4.0 developments with respect to digitalisation, connectivity, communication and traceability can also be incorporated. This applies to both the data exchange between the different components of the equipment and the internal network of the factory.

Operators who works in a clean room environment have to face a lot of restrictions. Heavy work is forbidden, visual fields are obstructed by masks and their tactile senses are reduced by gloved hands. Professional welders need only manage the conditions of their equipment before starting a weld cycle. If working under a controlled atmosphere, this should be made as easy as possible. With a barcode scanner, which may be wired or wireless, the QR-code on a work suit can be scanned to identify the responsible operator. In the same way, the welding head, welding gas and workpiece can be identified. The required welding programme is then selected via a tablet, while any additional inputs can be added, even by an operator wearing gloves.

Preparing the weld is divided into two parts: fixing of the workpiece into the clamping unit of the welding head, and final positioning of the welding head with its motor, gear track, supply hose, etc.

One initiated, the real-time progress of the weld cycle can be watched on the tablet and recorded, while real time welding parameter values are displayed. This data is also transmitted to the connected network at the same time.

On completion of a weld and a visual inspection, the operator can immediately confirm the successful production of a joint that has been completed without compromising the cleanliness of the UHP environment.

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