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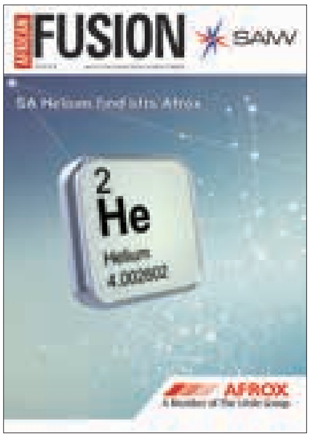

On May 4, 2016, The Linde Group; its African subsidiary, Afrox; and alternative energy company Renergen Limited – through its subsidiary TETRA 4 – signed an historic agreement for the commercialisation of the Free State Helium and Natural Gas field. *African Fusion* attends and talks to Nazmi Adams Afrox general manager of sales and marketing.

www.africanfusionmagazine.co.za

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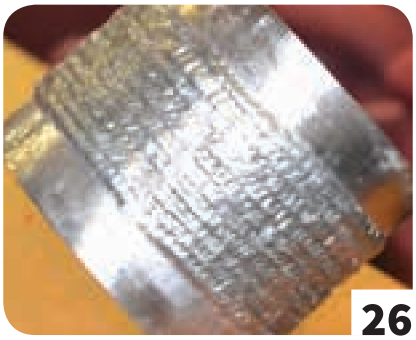

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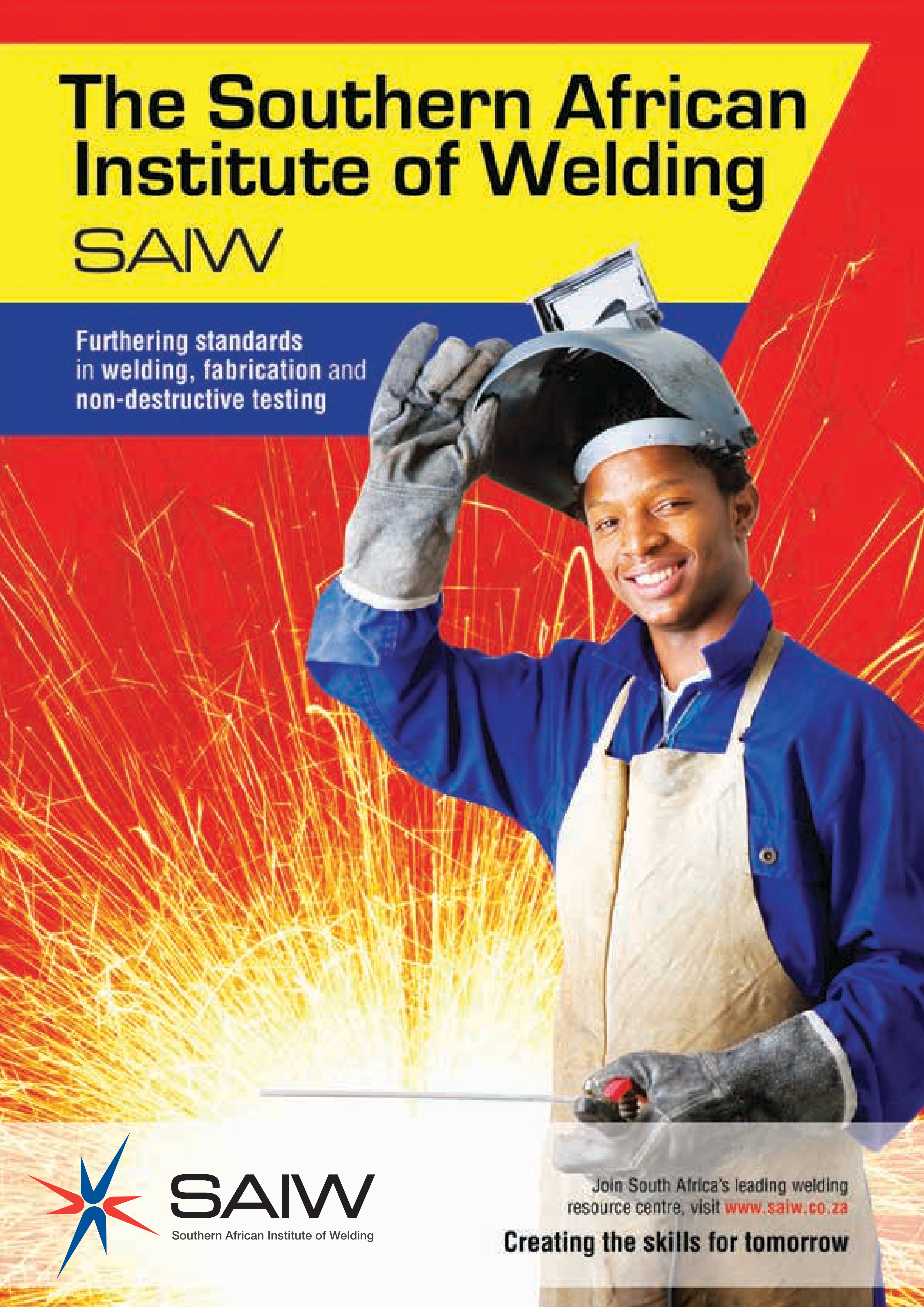
The Southern African Institute of Welding
SAIW
Furthering standards in welding, fabrication and non-destructive testing
SAIW
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Creating the skills for tomorrow

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I am pleased to report that the renovations to our City West headquarters have finally begun following a lot of deliberation and planning. The underpinning goal is to enhance customer service and the customer experience. We are developing an easily accessible customer service centre, based on a one-stop-shop model. The idea is that students, SAIW members and clients can go to the service centre on the ground floor near the entrance and all of their immediate needs can be met, as opposed to having to go from department to department within the SAIW building.

We are also strengthening the autonomy of SAIW Certification through this process. With its own area within the building, the independence and impartiality of the examination process are being secured, completely separating the awarding of qualifications and certifications from SAIW's daily training and industry support activities.

The reorganisation brings further benefits. First, the kitchen and canteen are being modernised in terms of the preparation equipment, the flow of people being served and the general environment. We have also managed to find room for more office and classroom space – to accommodate more students and enable us to expand staffing levels. In addition, we are improving the auditorium.

I have recently returned from an exciting trip to France and Belgium, where, as the South African representative of the IAB, I attended the IIW working group meeting developing the new guidelines for the International Welding Inspection Personnel (IWIP) training and qualification programme. I am pleased to report that this work in now complete. The revised syllabus will be presented at the IIW Annual Assembly in Melbourne in July for approval by IIW members and we expect it to be implemented shortly thereafter.

The changes make the qualification much more progressive. Previously, courses were designed to be more stand-alone, so that, on progressing, a student ended up having to repeat a lot of introductory content. The courses have now all been streamlined and repetition minimised. The new guidelines also address inspector responsibilities at each level with requirements detailed for the basic, standard and comprehensive levels of welding inspection personnel.

While in France, I was invited by Areva to visit its facilities in Chalon-sur-Saône. It was an eye opener to experience welding at its best in Europe and to see a facility that is manufacturing world-class products for nuclear applications at the highest levels of quality. We all know that fabrication for the nuclear industry involves additional controls and quality requirements but it was exciting to see how this is achieved in practice. I also visited the Alstom Transport manufacturing facility, which is busy fabricating the initial bogeys for the PRASA project.

With respect to our African expansion strategy I have visited Mozambique recently and we see training and development opportunities emerging there, as well as in Botswana, Kenya and Tanzania.

On behalf of SAIW and SAIW Certification, I would like to thank the outgoing board for its services and dedication and to welcome incoming board members elected at the AGM last month. The Institute of welding is built on industry's input and the value added through the participation of people from industry on the board. Without these people, SAIW would not be where it is today.

We continue to strive for excellence and continuous improvement in the welding industry and require sound industry direction and involvement in order to achieve these objectives.

Sean Blake

SAIW emerges as a self-sustaining

The SAIW held its 68th AGM on May 20, 2016 at the Institute's City West premises in Johannesburg. *African Fusion* summarises the 2015/2016 reports for SAIW and SAIW Certification, which were both presented by current SAIW president, Morris Maroga.

SAIW president Morris Maroga photographed with his wife, Lindeni.

"The past year has been a challenging one with much uncertainty in the economy and change in the Institute," begins Maroga, referring, most notably, to the appointment of Sean Blake as executive director following the retirement of Jim Guild.

Thanking his fellow SAIW governing board members – Andy Koursaris, Robin Williamson, Frikkie Buys, Dawie Olivier, Joseph Zinyana, Louis Breckenridge, Johan Pieterse, John Tarboton, Gert Joubert, Paul Bruwer, Tony Paterson and Tom Rice – Maroga says: "It is increasingly difficult for people to make time for involvement in organisations such as the Institute and we are very appreciative that these skilled people have been able to assist us with such eagerness and dedication."

Commenting on the report delivered during the meeting by financial advisor, Eric Berman, Maroga says that the Institute emerged with a significant operating surplus for the year. "Furthermore, we are encouraged that we are now a self-sustaining organisation with just 2.5% of Institute revenue derived from sponsorship."

SAISI remains a valuable sponsor and with their support, "we are able to offer practical welder training at our facility, which is a costly activity. We thank SAISI members for their continued support," he adds.

While membership remains a challenge, SAIW is continuing to attract new members, much of it driven by the ISO 3834 certification programme. "But we need to continue to be innovative in order to maintain and encourage membership as well as to provide tangible benefits," Maroga notes.

Annual highlights

The 2015 dinner, held in September last year at Emperors Palace was once again a great success. The SAIW Gold Medal was awarded to Hydra-Arc for the company's commitment to skills development and quality fabrication in South Africa and its innovation in the field of fabrication. Cornelis van Niekerk from the University of Pretoria won the Harvey Shacklock Gold Medal for the best technical paper; the Phil Santilhano Best Student Award went to Michael Godfrey; and the SAIW Presidents' Award for the best NDT student went to Alan Reid of DCD Heavy Engineering. "This year we look forward to another enjoyable annual dinner which will be held at Gold Reef City on the 23rd of September," Maroga notes.

The Young Welder of the Year competition remains a key event for SAIW. Jaco van Deventer, the winner of the SAIW Young Welder of the Year competition in 2015, competed in the WorldSkills 2015 competition that was held in Sao Paolo in August last year. "Jaco did South Africa proud by finishing the competition in 25th position, missing the medallion of excellence by a mere seven points. Jaco will again be representing South Africa at the 2016 Arc Cup International Welding Competition, which will be held in Beijing next month. Unlike WorldSkills, this competition is exclusively a welding competition with an associated welding conference, both endorsed by IIW."

WorldSkills 2017 takes place in Abu Dhabi in October next year. "We are going to have a different format to the competition this year as there will be enhanced local participation by WorldSkillsSA, Merseta and the Department of Higher Education. The WorldSkillsSA final competition is scheduled for January 2017 in Durban.

SAIW activities

Training: Training activity during 2015 continues to be encouraging with a 6.0% growth in total numbers of students trained. There has been a decline in numbers on the Inspectors and Competent Persons courses, however. "We continue to promote the IIW courses and to align our courses with the IIW requirements in order to improve international recognition of the qualifications that we offer.

"We are also promoting the International Welder (IW) scheme: by seeking further training organisations to adopt this programme and targeting its inclusion in the national curriculum for TVET colleges," Maroga adds.

The recapitalisation of the railway infrastructure and the requirements of EN 15085 are currently of significant importance and the Institute continues to be well positioned to make a significant contribution to capacity building in the railway sector through its related education and training programmes.

Material Testing Laboratory: Surekha Krishnan and Confidence Lekoane have worked tirelessly to complete the implementation of the Quality Management System in the Material Testing Laboratory in order to comply with the requirements for ISO 17025. The accreditation audit was undertaken in February 2016. "All outstanding non-conformances have now been closed out and we are awaiting finalisation of the process for issuing laboratory certification," he announces.

IIW: The next IIW Annual Assembly will be held during July in Melbourne, Australia.

ICNDT: The 19th World Conference on Non-Destructive Testing will be taking place in Munich in June. SAINT and SAIW will be sending a delegation with SAIW staff presenting four technical presentations at this conference. Harold Jansen continues to serve as the vice chairperson of the ICNDT Certification Executive Committee, further entrenching our position in the international NDT community.

AFNDT: Together with SAINT, SAIW planned a mini AFNDT conference in November last year along with an exhibition in Middelburg. Albeit small, the conference was a success with delegates from ICNDT, Kenya, Sudan, Cameroon, Ghana, Uganda and Algeria along with our South African industry participants.

organisation

Photographed at the 2015 SAIW dinner held in September last year at Emperors Palace are SAIW Gold Medal winners from Hydra-Arc: Ewan Huisamen; CEO, Jan Maswanganyi; and Riaan Kruger.

AFRA/IAEA: SAIW completed the training of nine fellows, four from Cameroon and five from Sudan. In addition, SAIW Executive Director attended a Scientific Forum at IAEA in Vienna last year where he provided an overview of training and certification in Africa.

Regional and African growth: "During 2015 we established a fully functioning branch in Durban. The facility has two classrooms for theory training along with a multi-purpose NDT laboratory. "This is a key development as we strive to expand our business. During 2015 we trained a total of 310 personnel in Durban, which represents a 60% increase on volumes compared to the previous year. "The SAIW Board of directors also believes that expansion into Africa is imperative to continue growth of the Institute and to support skills development on the continent," Maroga says.

SAIW Foundation: SAIW Foundation is now a fully functioning organisation with an operational board of directors. The first group of four students has completed the International Welder training programme and is now receiving workplace experience at a power station. "We are currently recruiting a further five students for the International Welder programme and two students for the Welding Technologist course," he reports.

Staff: Renier Mostert left the consultancy department early in 2015 to take responsibility for the ISO 3834 Company Certification scheme and Harold Jansen was appointed to the position of Systems and Quality manager in order to oversee the implementation of both operational and quality systems within the company. Mark Digby was appointed NDT Training manager; while George Walker and Elizabeth Shole were transferred from to Durban to run the new KZN facility. A replacement is being sought for the Technical Services Manager post, vacated by Alan Reid who has emigrated to Australia.

SAIW Certification

Maroga opened the SAIW Certification report by commending Herman Potgieter and his staff. "The SAIW Certification Governing Board is currently chaired by Gert Joubert who has been a member of the board for a number of years. The Board has the continued support of the SAQCC IPE/CP Scheme Committee, SAQCC NDT Scheme Committees as well as the Welding Fabricator Board. These are composed of dedicated and interested representatives for each certification programme," he reports.

From an income perspective, SAIW Certification's 2015 income from qualification and certification activities was up 4.0% over the previous year and, in spite of higher costs, the company reported a small operating surplus for the financial year.

SAIW Certification underwent a surveillance audit by SANAS in March 2016, which affirmed its accreditation and that SAIW Certification conforms to ISO 17024: 2012 and ISO 9712: 2012 for NDT. "Visual Testing (VT) and Eddy Current Test (ET) were both added to our scope of accreditation following this audit," Maroga says.

"SAIW Certification's registration of the SAQCC NDT Qualification and Certification scheme under Schedule 2 of the ICNDT Mutual Recognition Agreement is also a terrific achievement as it now puts our scheme on par with other international schemes," he continues.

During 2015, SAIW established a fully functioning branch in Durban with George Walker as manager. The facility has two classrooms for theory training along with a multi-purpose NDT laboratory.

SAIW's Material Testing Laboratory was audited in February 2016 for compliance with the requirements of ISO 17025. "All outstanding non-conformances have now been closed out and we are awaiting finalisation of the process for issuing laboratory certification," reports Maroga.

The ISO 3834 scheme continues to grow with 91 companies currently certified. SAIW Certification has also made progress with EN 15085 certification, the railway-vehicle welding standard. "In partnership with GSI-SLV, we are bringing this scheme to South Africa. Last year two companies were provisionally certified according to the requirements of this European railway standard," Maroga says.

During 2015 two appointments were made to the staff of SAIW Certification. Renier Mostert to the position of Manufacturer Certification Scheme coordinator and Elijah Banda to the position of Welding Technology Examiner. The company is also staffed by Jan Cowan, NDT Examiner and Iliske Joubert, who co-ordinates the company certification scheme and oversees quality systems for the company. Support functions are provided by SAIW.

"I thank all the SAIW Board members and staff for their contributions to the Institute. You all play a role in the success of the Institute and I commend you all for your loyalty and efforts this past year," Maroga concludes.

Transnet Engineering: the first CL 1-certified rail fabricator in Africa

African Fusion **visits Transnet Engineering's EN 15085-certified Durban facility and talks to welding engineers, Rodwell Baloyi (IWE) and Dhurusha Govender, along with Collin Moopanar, the executive manager of R&D mechanical.**

Transnet Engineering's executive manager of R&D, Collin Moopanar; welding engineer, Dhurusha Govender; and the company's internationally certified welding engineer, Rodwell Baloyi (IWE).

The contract between Bombardier Transportation South Africa and Transnet Freight Rail (TFR) for 240 Bombardier TRAXX Africa locomotives is part of the largest locomotive supply project in South Africa's history, with overall orders for 599 electric and 465 diesel locomotives from four different suppliers. TFR will use the 240 TRAXX Africa dual-voltage electric locomotives – valued at approximately R13-billion based on the original list price and exchange rates –for its general freight business.

As part of the localisation requirements, the fabrication of 480 bogies required by TFR for the locomotives has now begun at the Durban facilities of Transnet Engineering. Before doing so, however, EN 15085 certification for the manufacture of railway vehicles and components was required.

EN 15085 applies to the construction, manufacturing and testing of welded rail vehicles and their components. "This is the European railway engineering standard and, for Bombardier, as a European OEM, it is a non-negotiable quality standard," says Baloyi. "For us, therefore, all of the fabricated bogies that we are contracted to build are required to be welded in accordance with EN 15085," he adds.

The localisation of the railway industry cannot be achieved unless manufacturers of vehicles and components are successfully audited and certified to this code. As TE in Durban we are mandated to comply with EN 15085 for the 1064 project. We cannot comment about the certification requirements of other fabrication companies, except to confirm that it was required as a pre-condition that we are EN 15085 certified."

In addition, before a fabricator can be certified for manufacturing welded railway vehicles, it has to already be operating according to ISO 3834, quality requirements for fusion welding of metallic materials. "And the railway requirements are different again. EN 15085 is a different and more rigorous standard to any of those we have previously implemented," adds Govender.

Transnet Engineering's Durban facility has been accredited to ISO 3834 Part 2. Then, late last year, the facility became the first fabricator in the Southern Hemisphere to be certified to the highest level (Certification Level 1 or CL 1) of EN/ISO 15085-2. This certification level is essential for any new build, conversion or repair of railway vehicles or components, including: bogies and under frames; vehicle bodies; draw and buffing gear; supporting frames; wheel-set mountings, axle boxes, spring supports, shock absorbers and vibration dampers; brake equipment; supporting frames for heavy duty vehicles; welded bolsters; fuel tanks; and any safety critical welded component.

"Aligning to EN 15085 involves a mind-set shift, mainly due to personnel changes," reveals Baloyi. "While ISO 3834 does not specifically require a welding engineer as part of the fabrication team, for example, EN 15085 insists that all welding operations are under the direct control of an internationally certified welding engineer (IWE)," he adds. Baloyi and Govender are both qualified welding engineers, while Baloyi also holds the IWE qualification, as required.

"At any given time, vehicle OEMs such as Bombardier or CNR need to be

assured that there is a responsible welding engineer on site to take responsibility. So at least two welding engineers are needed so that the deputy can take charge when the responsible IWE is unavailable," he explains, adding, "This is a core principle in EN 15085. Certified people with international welding qualifications need to be employed in relevant positions of responsibility."

Transnet's Durban facility has CL 1 certification, the highest qualification level of ISO 15085. "Anyone wishing to manufacture components for bogies, cars or platforms, no matter how big the company, must have CL 1 certification as a minimum, because these are safety critical railway components.

"Sub-contracting is allowed, however. If a small company only make one component in relatively small quantities, for example, then a full time welding engineer is not mandatory, but a suitably qualified person needs to be allocated to take overall responsibility," says Govender.

In addition to the need for personnel taking overall responsibility, International welding specialists are required to take care of day-to-day production welding. With accreditation applying to five production bays spread across the Durban site, Transnet Engineering will require several Internationally accredited welding personnel to cater for full production welding. "We will also need to have foot soldiers, the Level 1 inspectors, who will be checking quality on a continuous basis on the shop floor. We are in the process of training 5 Level 1 visual testing (VT) inspectors to meet the immediate needs of the Bombardier bogie production stations," Baloyi adds.

While welding procedure specifications (WPSs) and Procedure Qualification Records (PQRs) are more or less developed as per the welding codes and ISO 3834, there are some differences. "For example, a butt weld PQR does not necessarily qualify fillet welds if there are a significant number of fillet welds during production," Govender reveals.

"Also, welders need to regularly produce work samples. In traditional welding codes such as ASME, once a welder is coded for a particular weld, he can proceed to the end of the job based on that coding. With EN 15085, the welder also has to produce production test pieces and he cannot be released for production-welding work until these test pieces have passes all of the testing requirements – and the client needs to inspect these results," she adds.

With respect to welders, Baloyi says the facility is drawing its skills from within Transnet, "absorbing people who are under utilised in our other businesses and training them up for the bogie fabrication work".

"Transnet artisans are mostly trained in the in-house School of Engineering (SoE) and we find our internal qualifications are well suited to our needs – but it would also be a plus if we could get welders with international welder (IW) qualifications," Baloyi says, adding that the EN 15085 qualification requirements are specified according to ISO 9606 personnel qualifications.

Govender continues: "We do not see a skills shortage in our area and we do not believe that it is so difficult to develop high-end skills in South Africa. We have proved that we can get our welders up to the international railway standards.

Adds Baloyi: "At the starting point of achieving quality welding results, is removing the obstacles to producing good welds. We look carefully at access and welding positions, for example. This is part and parcel of European experience and built into the EN 15085 code. Manipulation needs to be integrated into the production process so that critical butt and fillet welds can be performed in the flat (PA) position, for example. We make use of accurate jigging systems and positioners to make this possible," he says.

On the use of robots, he says that the flexibility offered by a manual welder still outweighs the production advantages of full automation, which is usually not practical. "We are benchmarking ourselves against the production principles used by Bombardier in Europe, and with the same levels of jigging and manipulation, the actual in-situ performance of our welders comfortably matches those of the Europeans," Baloyi assures.

Says Moopanar: "we are required to make 480 bogies in the contract period. These will be sold internally to our locomotive assembly facility next door."

Looking further afield, he adds: "EN 15085 certification has opened up export opportunities to manufacture anything in rail. All overseas OEMs – Bombardier, GE as well as CSR and CNR for example – are looking for CL 1-certified fabricators to enable them to meet their localisation commitments. Instead of manufacturing overseas and shipping into Africa, we can now manufacture for the local and export markets, particularly for Africa, where we see significant opportunities," concludes Moopanar.

1. Manipulation needs to be integrated into the production process so that critical butt and fillet welds can be performed in the flat (PA) position. "We make use of accurate jigging systems and positioners to make this possible," says Baloyi. 2. A bogie frame component being manipulated into position for welding. 3. With respect to welders, Baloyi says the facility is drawing its skills from within Transnet, "absorbing people who are under utilised in our other businesses and training them up for the bogie fabrication work". 4. The near completed prototype bogie undergoing final assembly.

Latest ISO 3834 certifications

SAIW Certification general manager Herman Potgieter says he continues to be pleased with the ever-increasing numbers of companies, big and small, that are being ISO 3834 certified. "I cannot stress enough how important this certification is," says Potgieter. "It's the basic stamp of quality in the welding fabrication business and it is a considerable boost to one's business potential."

He once again stressed that this certification is for companies of all sizes. "Large or small, this is your stamp of quality. It gives your potential customers the confidence to move ahead with you, in the knowledge that you are producing excellent work."

AWT: ISO 3834 Part 2, Comprehensive quality requirements

Established in 1987, Applied Welding Technology (AWT) is a specialist in weld repair of machined components and in applying hardfacing layers such as Stellite. The company also operates a complete machine shop so that it can provide a full service from beginning of welding, through heat treatment to the end of machining.

AWT's premises are completely serviced by overhead cranes ranging from 5.0 to 10 t and the company is capable of welding and machining a wide variety of metals including basic carbon steels, low alloy steels, stainless steels and aluminium. All of its employees are certified in their specific fields of welding and machining.

Applied Welding Technology prides itself on the quality of the work it produces and specialises in producing and supplying the certification necessary for demanding clients such as Eskom and Sasol. AWT has Eskom Level 1 welding approval, TüV Rheinland ISO 9001 approval and now ISO 3834 Part 2 certification.

AWT currently has a B-BBEE Level 5 rating.

ILVA: ISO 3834 Part 2, Comprehensive quality requirements

ILVA is one of the leading manufacturers in the South African pressure vessel industry. Products are built to customer specific requirements, as well as industry norms, while still adhering to the highest international standards. ILVA has the ability to design, manufacture, test and deliver virtually all types of pressure and storage vessels for use throughout Africa and abroad.

ILVA vessels can be found in virtually every mine, power station, brewery, petrochemical and industrial plant throughout southern Africa and its air and nitrogen receivers can be found in garages and small to medium workshops across the country.

ILVA currently holds a Level 4 B-BBEE certificate.

SPE: ISO 3834 Part 2, Comprehensive quality requirements

Stainless Precision Engineering (SPE) caters to, amongst others, the metal fabrication requirements of the local and overseas power generation industries. The company can undertake complex medium to high volume fabrication projects from conception to completion.

Facilities include: CNC laser cutting machines to accurately produce highly complex flat form parts at exceptional levels of precision; flexible punching facilities that obviate the need for expensive dies and stamping presses; and substantial tooling capabilities, including a 220 t press to enable SPE to bend stainless steel, mild steel and aluminium in almost every combination requested.

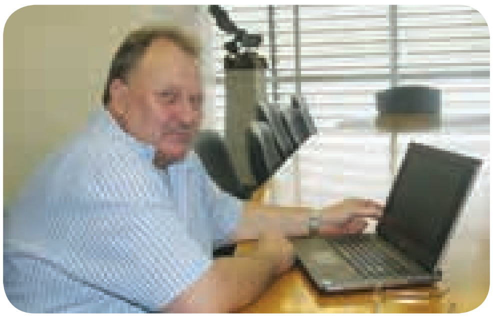
Full fabrication services are available from SPE's jobbing shop, which is fitted with a comprehensive range of state-of-the-art welding and fabrication machinery. Material competencies include: carbon, low-alloy and high carbon steels (>0.25% C); ferritic, martensitic, precipitation hardened and austenitic stainless steels; and aluminium alloys.

Top: AWT is a specialist in weld repair of machined components and in applying hardfacing layers such as Stellite.

Centre: ILVA has the ability to design, manufacture, test and deliver virtually all types of pressure and storage vessels.

Right: SPE caters to, amongst others, the metal fabrication requirements of local and overseas power generation industries.

YWoY now to be called SAIW Youth Welding Challenge



SAIW's Etienne Nell has been appointed by WorldSkills SA as the South African National Expert. He will coordinate the new processes for the regional Worldskills SA competitions, the national SAIW Youth Welding Challenge and the 2016 Worldskills welding competition in Dubai.

The biennial SAIW-hosted Young Welder of the Year (YWoY) competition for welding industry youth will, in future, be known as the SAIW Youth Welding Challenge. This is a result of an overhauling by WorldSkills South Africa of its welding competition from which the winner gets sent to the International WorldSkills event.

One of the advantages of the new system is that the first stages of the competition will take the form of a countrywide series of regional competitions organised by the Technical Vocational Education and Training Colleges (TVETS) and the Further Education Training Colleges (FETS).

From these regional competitions about 20 of the best performing young welders will participate in the SAIW Youth Welding Challenge over five days at the SAIW premises. The top three candidates then qualify for the WorldSkills SA national competition and the winner of that will represents South Africa in the welding section of the international WorldSkills competition.

This year the regional competitions will be starting in April and the SAIW Youth Welding Challenge will be held from 21-25 November. The WorldSkills SA competition will take place at the ICC in Durban from 16-18 January 2017 and the WorldSkills International competition is in Abu Dhabi from 14-19 October 2017.

The SAIW's Etienne Nell, appointed by WorldSkills SA as the South African National Expert and who has been the coordinator of the Young Welder of the Year competition since its inception, has been given the task of coordinating the entire new process.

"I am pleased with the changes," says Nell. "Because of the increased emphasis on regional skills development in the new competition structure, more young welders will have the opportunity to demonstrate their skills, which is excellent for the welding industry as a whole in South Africa."

He adds that the new format also widens the net and will attract significantly more young welders to the competition. "This will inevitably increase the chances of South Africa performing better at the International WorldSkills competition," Nell says.

All stages of the competition will continue to test the welders in the three categories of carbon steel, stainless steel and aluminium with the welding projects all based on the WorldSkills 2015 Sao Paolo project structure. The three winners of the SAIW Youth Welding Challenge and the winner and runner-up of the local WorldSkills SA competition will win sponsored cash prizes. The competition will remain a biennial event.

www.worldskillssa.dhet.gov.za

Houdremont Lecture: IIW International Conference 2016

The 2016 Houdremont lecture, which will be delivered at the start of IIW International conference in Melbourne, will be delivered by Dr Stuart Cannon, a research leader in naval architecture.

Cannon holds a leadership position in the Maritime Division of Australia's Defence, Science and Technology (DST) Group. He is responsible for research programmes in platform systems analysis and performance; advanced materials and fabrication methods; and naval power and energy. In addition, Cannon is responsible for all surface platform research in support of the Royal Australian Navy's (RAN) surface fleet as well as future surface ship acquisitions.

Cannon is a trained naval architect who specialises in surface warship performance. He has a bachelor's degree in Nautical Studies from Plymouth University, a master's degree in offshore structures from Cranfield Institute of Technology in the UK, and a doctorate in Naval Architecture from Brunel University in London. His research ranges from the behaviour of ships in a seaway to determining the residual strength of a ship structure following weapons damage.

During his employment at DSTO he has been involved in a variety of structural investigations on the current fleet and has advised the Defence Materiel Organisation (DMO) on projects such as the Armidale Class Patrol Boats, the Air Warfare Destroyer and the amphibious ships. He received a Chief of Defence Force Commendation for his work investigating the circumstances that lead to the loss of HMAS Sydney.

Cannon is a Fellow of the Royal Institution of Naval Architects, a Fellow of Engineers Australia and a Chartered Professional Engineer. He is a member of Lloyds Register of Shipping Technical Committee and a member of the International Ship and Offshore Structures Congress Naval Vessel Design committee.

He is an Adjunct Professor in the National Centre for Maritime Engineering and Hydrodynamics at the Australian Maritime College – University of Tasmania. In 2014 he was awarded the Vice Chancellor's Award for outstanding contributions by adjunct and honorary position holders.

Dr Stuart Cannon, research leader at the Defence Science and Technology Organisation, was awarded the 2014 Vice-Chancellor's Award for Outstanding Contributions by Adjunct and Clinical Title Holders.

With the theme, *'From concept to decommissioning: the total life cycle of welded components'*, the 69th IIW International Conference will be held in Melbourne July 10 to 15, 2016.

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SA's first onshore helium and

On May 4, 2016, The Linde Group, its African subsidiary Afrox and alternative energy company Renergen Limited – through its subsidiary TETRA 4 – signed an historic agreement for the commercialisation of the Free State Helium and Natural Gas field. *African Fusion* attends and talks to Nazmi Adams (left) Afrox general manager of sales and marketing.

Eons ago, an asteroid about 15 to 20 km across slammed into the Earth in what is now Vredefort, in the Free State province of South Africa. This, the largest verified impact of its kind in the history of our planet, formed a crater 300 km in diameter.

Today, partial concentric rings of rocks can still be seen on satellite images, with the oldest being the Witwatersrand rocks, which form an interrupted arc of outcrops, the most famous being the Johannesburg group where gold was discovered in 1886. Had it not been for the Vredefort impact, gold may never have been discovered on the Witwatersrand and our economy and industry would have been considerably different today.

In Virginia near Welkom, about 160 km from the impact centre, now the site of the Vredefort Dome World Heritage Centre, a 187 000 hectare natural gas/helium field has been discovered with proven reserves of 25-billion cubic feet of natural gas and helium. The helium present today was created by the natural radioactive decay of heavy radioactive elements (thorium and uranium) formed as a direct result of the Vredefort impact event. This radiogenic helium is trapped with natural gas in concentrations averaging 4.0% by volume.

This field is the first and only onshore and natural gas resource in South Africa with commercially viable percentages of helium.

Under the agreement signed on May 4, TETRA 4 has contracted the helium under an offtake agreement with the Linde Group – via its global helium business – and assigned the distribution rights for these substantial reserves. JSE listed Afrox, a member of The Linde Group, will operate the plant and market the helium locally.

"The discovery and commercialisation of the Free State onshore helium source is great news for industry, healthcare and the South African economy as a whole," said Afrox managing director, Schalk Venter. "The signing of this agreement marks an historic moment in bolstering South Africa's self-sufficiency in terms of helium production."

Helium, although the second most abundant gas in the universe, is relatively scarce on earth and tends to be found trapped with natural gas in relatively low concentrations, typically up to 1.0% by volume of the gas released. The Free State Helium and Natural Gas field, however, enjoys much higher concentrations.

Linde's high-tech extraction technology will be used to separate helium from natural gas through a single system based on patented processing plant technology, which purifies, compresses, liquefies and stores the helium ready for distribution to customers. The helium plant will be designed and delivered by Linde Engineering and is expected to commence operations in 2018/19.

Linde helium plants reduce energy consumption and cut CO_2 emissions compared to traditional helium from natural gas extraction processes and incorporate the latest in engineering technology advances. The plant will be of modular design and will be precision manufactured in Europe before being shipped to the Free State for fast and efficient construction.

Nick Haines, head of The Linde Group's Global Source Development, Global Helium & Rare Gases, said: "Linde has worked diligently to commercialise this unique helium resource together with TETRA 4 and looks forward to receiving helium upon commencement of plant operations."

Utilising the latest in land preservation techniques, TETRA 4 has drilled wells to tap the gas source dome, while ensuring minimal visual and environmental impact on the gas field's landscape. The wells and wellheads are being interconnected underground via an intricate network of pipes. These pipes will feed directly into the Linde-

Photographed at the signing of a commercialisation agreement for the Free State Helium and Natural Gas field are, from left: Alexander Brandl, senior process engineer, Linde; Renergen CEO, Stefano Marani; Schalk Venter, Afrox CEO; Nick Haines, head of The Linde Group's global helium source development; and Nick Mitchell, COO and executive director, Renergen.

natural gas field

Helium is one of the most important noble gases and is used in a variety of industrial applications. As a result, global demand is rising by around 5.0% per year.

***Above:** Utilising the latest in land preservation techniques, TETRA 4 has drilled wells to tap the gas source dome, while ensuring minimal visual and environmental impact on the gas field's landscape.*

engineered, Afrox-run helium processing plant.

As part of TETRA 4's commitment to social regeneration, the company has created a number of bursaries for local students in the Virginia/Welkom area and has refitted the local Stilte Primary School with classrooms, furniture, a solar borehole pump, and upgraded the children's play area. TETRA 4 also plans to supply the local operations of Mega-Bus with compressed natural gas, (CNG) as 'green' fuel for its local bus services.

Renergen chief executive officer, Stefano Marani, said: "Today is indeed an important milestone as we embark on the beneficiation of this important helium deposit for the benefit of all our stakeholders."

The helium market and welding

According to Afrox's Nazmi Adams, helium is an inert gas that can be used as a replacement for argon in shielding gas mixtures for welding applications. "Helium tends to be used in more complex mixtures, where a better quality weld is preferred," he says. "For aluminium welding, for example, we offer the Alushield® brand; an argon-helium mixture where the helium is added to give higher arc energy. The helium combats the high thermal conductivity associated with aluminium alloys, increasing penetration and reducing the need for preheating," he explains, adding that the same principles apply to the welding of copper, for which the argon-helium Coppashield® gas mix is recommended.

These mixtures are best for automated welding processes where faster welding speeds and lower defect rates can significantly reduce fabrication costs.

Helium is also use in steel and stainless steel shielding gas mixtures, such as Stainshield Heavy and Stainshield TIG Plus, where smaller quantities of helium are added to better meet fusion and bead surface quality requirements and to increase welding speeds, especially for thicker materials. "These gas mixtures are used for high-value items where the quality is paramount," Adams tells *African Fusion*.

"A local source of helium, which will be more competitive simply because it is not having to be imported, will make the use of helium more attractive to a wider range of fabricators," he continues. "It will allow our local industry to move up the fabrication technology ladder in terms of added value and weld quality," he says.

Currently, Adams believes, the welding market is dominated by repair and maintenance activity. "We are very competent at finding ways to fix things that get broken. If you look at the costs of fabricating simple structures, the material costs dominate. This limits the value the industry can add through technology.

"In the European fabrication market, however, high-value components are being manufactured where the costs of the components are significantly higher than the cost of the material used. The value added during the manufacture of a Rolls-Royce engine, for example, far outweighs the R/kg cost of the material used."

Adams believes the local helium source will create value-adding advantages for local fabricators. "South Africa is striving towards better beneficiation of local natural resources. With our helium plant, we are taking gas out of the ground, purifying it to process the higher value helium 'impurity', and then using it to create even higher value three- and four-part shielding gas mixtures for local fabricators," Adams argues. "Compare the cost/kg of helium and the cost/kg of coal. Helium gives a much higher process return ratio. Then by using the helium in three and four part gas mixtures, we create an even higher value shielding gas product," he says.

In addition, helium gas can help to better process local steel, chromium (in stainless steel) platinum and titanium resources. "If readily available and competitively priced helium makes it more competitive for a fabricator to use more exotic materials to make higher value fabrications, then we will have generated an additional value multiplier," he suggests.

The Virginia gas field is predicted to have a helium capacity of 650 000 m^3 p/a. "We also suspect more helium-rich natural gas fields will be found as geologists continue to map the resource patterns around the Vredefort Dome," Adams concludes.

The alform welding system

the world's first system for high-strength welded structures

M Fiedler, R Rauch, R Schnitzer, W Ernst, G Simader, J Wagner voestalpine Böhler Welding and voestalpine Stahl, Austria

This paper, delivered at the 2015 IIW International Conference in Helsinki, Finland last year, describes the alform® welding system, a new approach to base material and welding consumable development that aims to optimise the combination for fabricated structures in high-strength and ultra-high-strength material grades. Customer-focused advantages are listed and examples of successfully implemented alform® welding systems are illustrated.

Filler metals and base materials are usually developed separately and offered independently from each other. Base material producer, voestalpine Stahl and welding consumable producer, voestalpine Böhler Welding, have now adopted a different approach. Within a group project, the two companies have developed an entire series of base-material/filler-metal combination for high-strength and ultra-high-strength weld joints with yield strengths ranging between 700 and 1 100 MPa.

This series is being marketed as the alform® welding system. The essential advantages of this fine-tuned solution are the extended welding range for high-strength and ultra-high-strength weld joints as well as lower cold-cracking sensitivity in weld seams and optimised seam properties. The filler metals supplied in the system include stick electrodes, solid wires, metal-cored wires and submerged arc wire/flux combinations. Special emphasis during the development is placed on well-adjusted microstructure while taking into account the dilution of the base material and the resulting property profiles.

The alform® welding system

The selection of a proper combination of filler metals and base materials is usually done by the customer, who, therefore, carries the risk that the combination may not meet the specified and required properties for the application. Sub-optimum weld seam properties often result. (Figure 1).

Figure 1: Conventional weld design. Filler metals and base materials are usually developed separately and offered independently from each other.

This situation is rooted in the different development objectives and design limitations of base material and filler metal manufacturers.

The manufacturer of the base material is bound by normative specifications and the production equipment (Figure 2). This results in varying production routes, especially in the high-strength range of steel grades, such as QT, DIC, DIC+A, etc, which influence weldability to a substantial degree. Characterisation of the weldability of the base materials primarily focuses on the properties in the heat-affected zone (HAZ) and the achievement of properties similar to the required specifications of the base material. Evaluation of the hardening and softening behaviour and the toughness properties is of primary importance (Figure 3). At voestalpine, these evaluations are achieved via welding experiments at the processing centre and by conducting of welding-procedure qualification tests. The filler metals used are usually standard types that often yield sub-optimum property profiles of the weld seam due to dilution with the base material.

Figure 2: Restrictions in alloy design of the base material manufacturer are bound by production routes, such as QT, DIC, DIC+A, etc.

Figure 3: Characterisation of the base material weldability primarily focuses on the properties in the heat-affected zone (HAZ) – cold-cracking resistance, hardening, softening and toughness.

As mentioned above, material grades originated by various production routes are characterised by different welding behaviours. Examples of cold-cracking sensitivity in several steel grades available on the market with yield strengths between 700 and 1 100 MPa are shown in Figure 4. Special attention is drawn to the low carbon content of voestalpine steel grades alform 700 through to alform 960 x-treme. The carbon content of conventional quenched and tempered steels is generally much higher.

According to a classification by Graville, lower carbon content leads to lower sensitivity to cold cracking. Higher resistance to cold cracking in steel grades with low carbon content is achieved through reduced HAZ hardening, as shown in Figure 5. In comparison to traditional quenched materials, high-strength steel grades made by voestalpine do not show

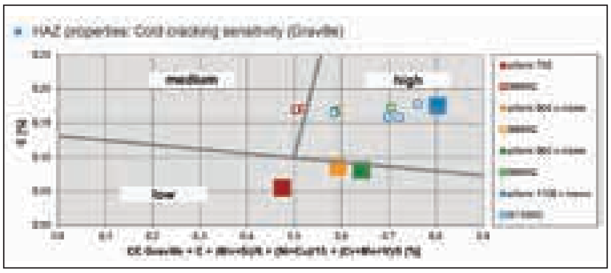

Figure 4: Sensitivity to cold cracking during welding of steels as a function of carbon content and carbon equivalent (Graville [4]).

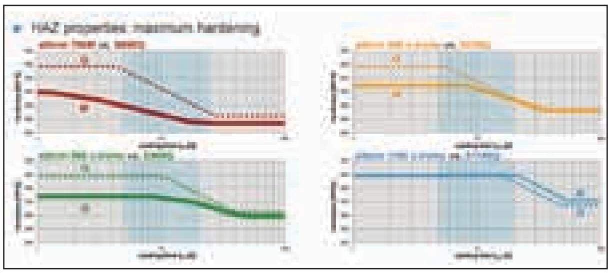

Figure 5: Maximum hardness in the coarse grain HAZ of single pass welded joints.

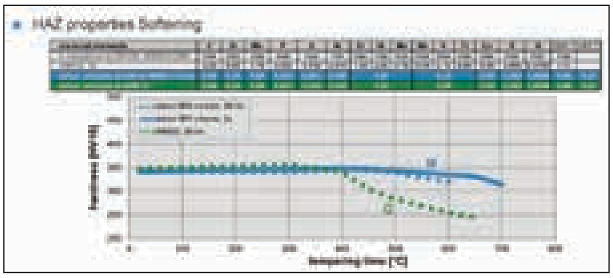

Figure 6: Softening in the tempering zone of HAZ (SCHAZ) of ultra-high-strength base material steels produced using different methods.

any significant temper softening (see Figure 6) in the HAZ. These steel grades are an optimum compromise between the QT and DIC base material production routes [2],[3].

The welding range (in terms of the cooling time between the 800 and 500 °C temperature window, $t_{8/5}$) is limited by applying the results obtained from the thermal welding simulator and the property profiles of the real weld seams created during welding procedure qualification tests. This guarantees that the mechanical/technological properties of the joints meet the specified values of the base material (Figure 7).

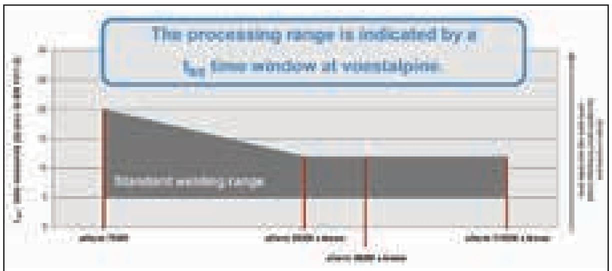

Figure 7: The $t_{8/5}$/heat-input range when welding using standard welding consumables of 'similar' composition.

In many cases the properties are limited by the standard filler materials used rather than the base material itself. This fact can be explained by the development objectives of the filler-metal manufacturers. Filler metals are classified in accordance with standards (such as EN 12534 and EN ISO 18276) that specify guaranteed values (chemical composition, mechanical/technological properties), which are solely based on the pure and undiluted weld metal for a single welding parameter combination (only one $t_{8/5}$ time) (Figures 8 to 10). A $t_{8/5}$ window is usually not taken into account. Properties of the diluted weld metal within practical joints, however, cannot be determined from these results (Figure 11).

Figure 8: Restrictions in alloy design by filler material manufacturer relate to the standards, which are solely based on the pure and undiluted weld metal for a single welding parameter combination.

Figure 9: Normative requirement for determining the chemical composition of welding consumables.

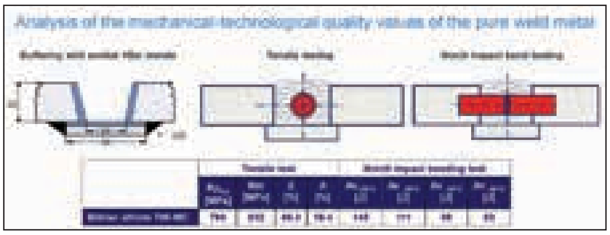

Figure 10: Normative specification for determining the mechanical properties of the weld metal.

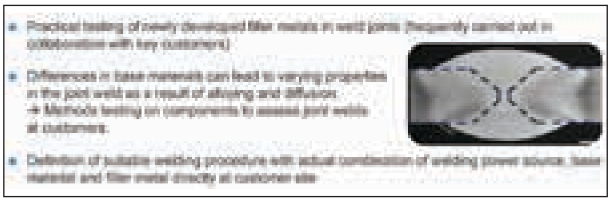

Figure 11: Diluted weld-metal in real welds.

Figure 12: Some of the problems experienced by fabricators in the design of welding procedure qualification tests.

Therefore customers are faced with the following scenario (Figure 12). Differently designed steels and filler metals are employed that do not share the same property profiles and this results in varying properties in weld seams.

As mentioned above, properties of the weld metal cannot be estimated because of dilution between the filler metal and the base material. The extent of dilution depends heavily on

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the shape of the bead and the joint build-up sequence for the seam. These in turn are determined by welding parameter selection.

Consequentially, the properties of joint weld metal for specific welding parameters must often be directly tested via extensive welding procedure qualification tests by the customer. Determination of a suitable welding procedure, along with the respective combination of welding current source, base material and filler metal, results in significant additional expenses.

The selection of optimised welding parameters is always challenging because prescribed $t_{8/5}$ cooling times can only be regarded as reference values for heat input and can be achieved using a variety of different parameter combinations. In designing weld seams, the bead shape and layer sequence must be taken into account along with the $t_{8/5}$ time because all of these factors determine welding properties. The approximate $t_{8/5}$ cooling time can be calculated according to EN 1011-2 or measured with thermocouples.

The calculated $t_{8/5}$ cooling time according to EN 1011-2, however, is also only a reference value because of the large number of variables that cannot be conclusively determined (Figure 13).

In addition, experience has shown that converting prescribed $t_{8/5}$ times into welding parameters is problematic because the displays on welding machines merely indicate mean values, which in the case of the short or pulsed current arc are too low (by 30 to 60%) when compared with the effective values at the torch.

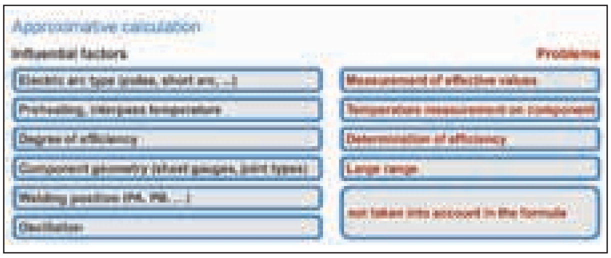


Figure 13: Sources of error in the calculation of the cooling time $t_{8/5}$ according to EN 1011-2.

The interpass temperature also has a substantial influence on the seam properties in thin-walled weld joints with two-dimensional heat flow. According to Figure 14, for example, an increase in the interpass temperature from 20 °C to 100 °C would lead to an inadmissible prolongation of the $t_{8/5}$ cooling time by 50% (from 20 seconds to 30 seconds). The loss in weld seam strength caused by these conditions can only be avoided by reducing heat input.

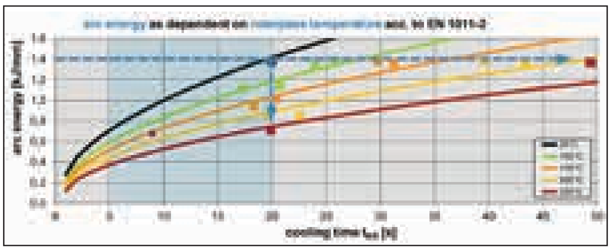


Figure 14: The influence of the interpass-temperature on the $t_{8/5}$ cooling time.

Welding-position-dependent oscillations, which cannot be taken into account by the calculation, have a similar effect in prolonging the $t_{8/5}$ cooling time. The most efficient method of ascertaining the property-determining $t_{8/5}$ cooling time is measurement by means of a thermocouple dipped into the weld pool at the component. This method is especially recommended for sheet thicknesses thinner than 10 mm (in the range of two-dimensional heat conduction).

As shown in Figure 15, the weld metal softens significantly at prolonged $t_{8/5}$ times. The dissolving effect caused by dilution of the base material, therefore, often results in a very narrow processing window for similar standard filler materials.

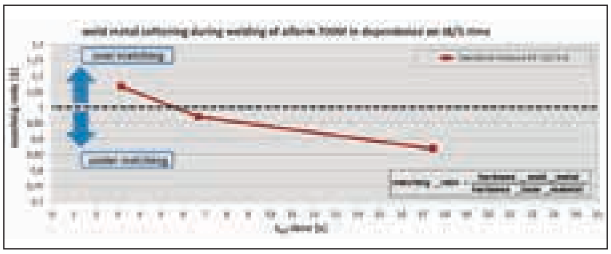


Figure 15: Softening of the weld metal in real welds with increasing $t_{8/5}$ cooling time is due to decreasing alloy content with increasing dilution of low-alloyed base material.

The weak points and difficulties in weld seam design discussed above have been eliminated through a collaboration between base metal producer, voestalpine, and its affiliate, voestalpine Böhler Welding. The two companies have developed an entire series of base-material/filler-metal combinations for high-strength and ultra-high-strength weld joints with yield strengths ranging between 700 and 1 100 MPa.

This series is marketed as the alform® welding system (Figure 16). The essential advantages of this fine-tuned solution are the extended welding range for high-strength and ultra-high-strength weld joints, low cold-cracking resistance in the weld seams and optimised mechanical properties. The filler metals supplied in the system include stick electrodes, solid wires, metal flux cored wires and wire/powder combinations.

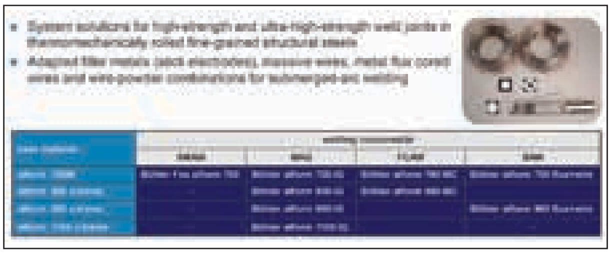


Figure 16: Base metal and welding consumable combinations that make up the alform welding system.

The dilution between the base material and the filler material is taken into consideration in the alloy design of the filler metals. Therefore, a decrease in the carbon equivalent values of the diluted weld metal below the respective values of the base material is overcome. This leads to an increase in weld metal strength at prolonged $t_{8/5}$ times, as shown in Figure 17.

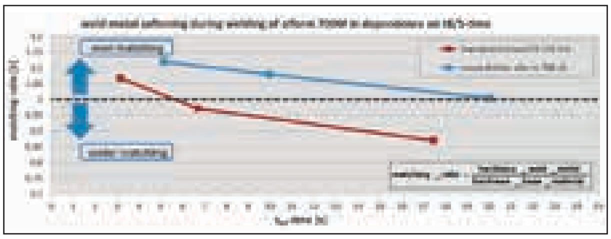
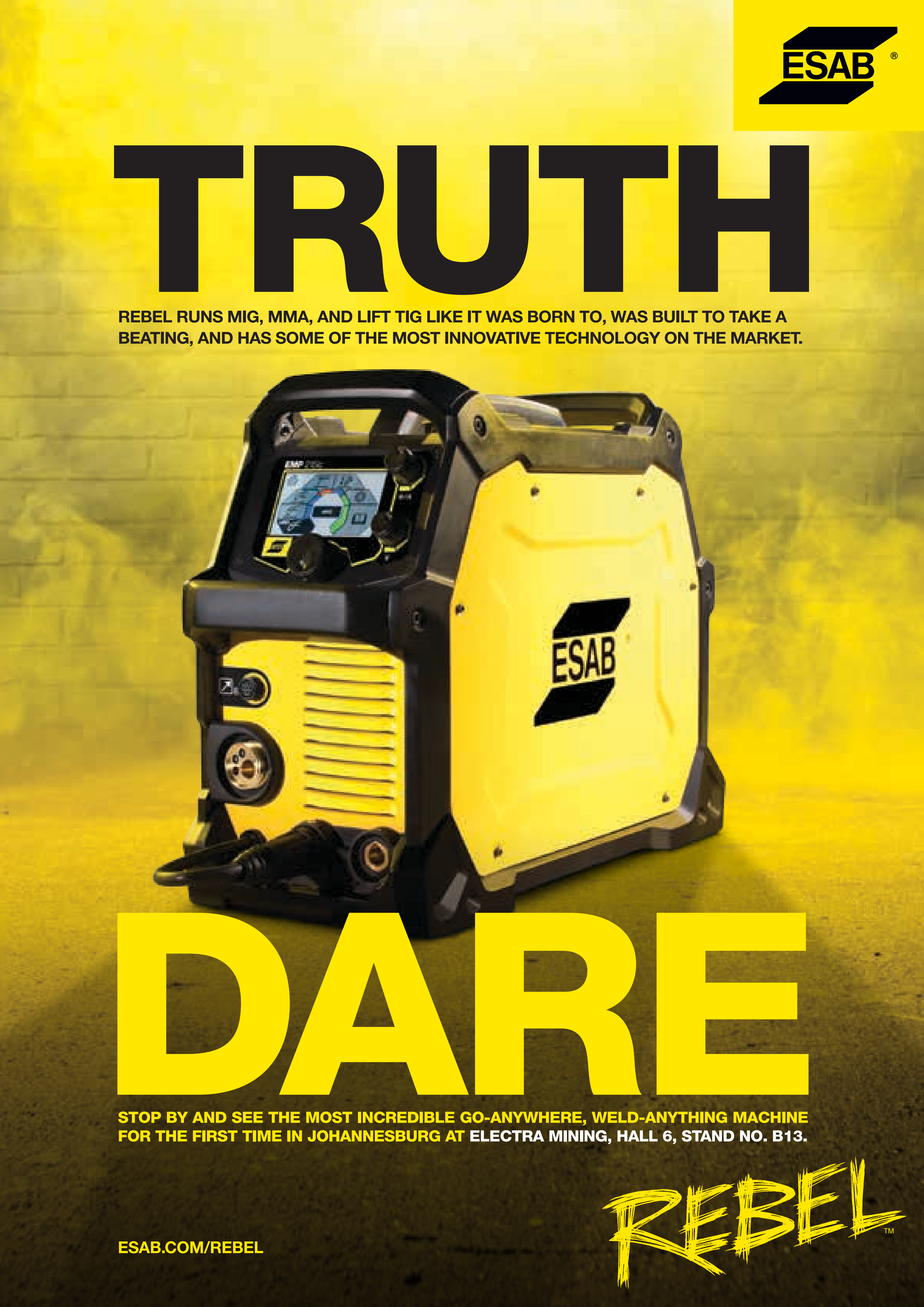


Figure 17: Softening of the weld metal in real welds using the newly developed alform system welding consumables.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The extended welding range has been verified by a wide variety of welding method tests for both X and V seams. Figure 18 provides an overview of the investigated combinations of filler, base materials and seam shapes.

Figure 18: Available system solutions, secured by welding procedure qualification tests according to EN 15614-1.

Welding parameters that have an influence on properties, such as heat input, layer buildup and interpass temperature, were also intentionally varied and taken into account.

Furthermore, the strength of optimised system V-joints meets the required strength values of the base material up to a $t_{8/5}$ time of 20 seconds and higher, e.g. alform welding system 960, Figure 19. The charpy-V-notch toughness values are at high levels, both in the weld metal and the heat-affected zone, even at a testing temperature of -40 °C, and are substantially higher than the guaranteed value (Figure 20).

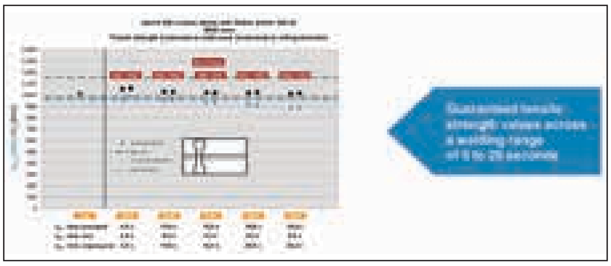

Figure 19: Strength properties transverse to V-seam welds prepared with the alform 960 welding system.

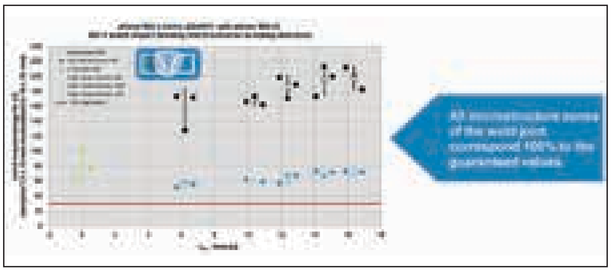

Figure 20: Toughness properties of the weld metal and the HAZ transverse to V-seam welds prepared with the alform 960 welding system.

The system solution also features a balanced hardness (strength) profile across the seam without any significant softening and hardening zones (Figure 21).

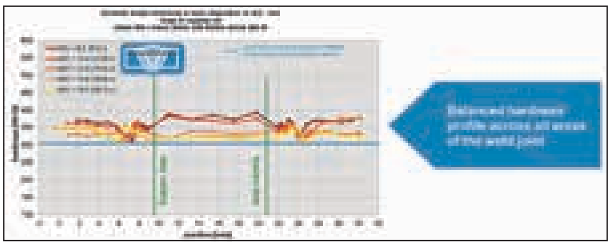

Figure 21: Hardness tracks across a V-seam weld prepared with the alform 960 welding system.

The possible extension of the welding range (up to 70%) with the alform welding system for weld joints ranging in yield strength between 700 and 1100 MPa is shown in Figure 22.

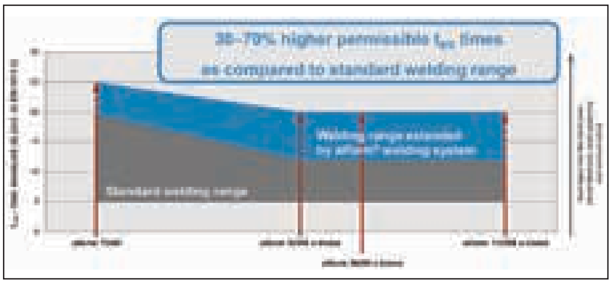

Figure 22: The expanded $t_{8/5}$ heat-input range for welding, made possible by using alform welding system combinations.

Summary and conclusion

As a result of optimising base material and welding consumable combinations, customers benefit from unique advantages, particularly with respect to efficiency and reliability. Aspects such as easier system implementation of existing welding solutions and higher parameter windows in terms of $t_{8/5}$ cooling times lead to higher efficiencies for fabrication customers.

Reliability is assured through proven system solutions, well-matched material partners as well as high quality requirements.

In Figure 23 a successfully implemented alform welding systems is shown. In this case the crane as well as the basic frame was welded with the alform welding systems. Higher weights may lifted and the lower machine weight offers better performance in rough terrain.

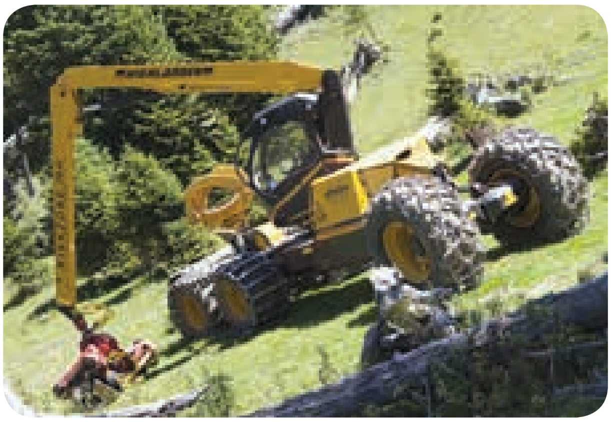

Figure 23: Example of well-implemented alform welding system to manufacture a lighter weight crane with a greater lifting capacity.

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High-strength materials – challenges and applications

Yaoyong YI; Kai WANG; Shida ZHENG; Jianglong YI; and Lei XU

This paper, delivered at the IIW International Conference in Helsinki, Finland in July last year, studies the narrow gap gas metal arc welding (GMAW) of S890QL steel.

During this research, S890QL steel was successfully welded using narrow gap gas metal arc welding (GMAW) with a novel automatic welding system. Results show that the mechanical properties of the welded joint fulfil the EU standard. In multi-pass welding, the mechanical properties of the foregoing welded joint are better than those of the subsequently welded joint. The reason for this is due to the thermal cycling effect of multi-pass welding process and the finer microstructure obtained.

Introduction

Manufacturing and operating costs are known to be reduced by using high-strength, finer-structured steels [1]. Welding of these steels needs to focus on the prevention of cold crack formation and meeting the mechanical properties requirements of welded joints [2] [3].

Narrow gap welding is an economical and efficient welding technique. It can produce welded joints with good mechanical properties because of the application of a multiple layer technique. In this study S890QL steel were welded using narrow gap GMAW process with a novel automatic welding system.

Materials, welding technique and sample preparation

The base material used is a high-strength fine microstructure S890QL steel plate, with a thickness of 40 mm, supplied by Dillinger Hütte. The filler material is 1.0 mm solid wire supplied by Thyssen. The chemical compositions and the mechanical properties of the base and filler materials are listed in Table 1 and Table 2, respectively. The shielding gas used is 90% argon + 10% CO_2.

The experiments were performed using a novel automatic welding system with arc sensors [4][5]. A wire speed of 9.0 m/min was used with a pre-heat and inter-pass temperature controlled to 170 °C in this experiment. The welding speed, weld current and voltage, heat input and the measured cooling time from 800 °C to 500 °C are listed in Table 3.

The sample size used had dimensions of 500×200×40 mm with an I-groove width of 10 to 13 mm. Specimens for mechanical testing were sampled from the weld joints according to DIN EN 288-3. Specimens were machined according to DIN EN 10002 and meet the DIN 50125 standard. Charpy-V impact tests were done at -40 °C, -20 °C and 20 °C according to DIN EN 875 and DIN EN 10045-1.

The hardness on the upper surface (2.0 mm under the surface), the middle and the lower (2 mm from the bottom) cross section of welded joint were measured according to DIN EN 1043-1.

Results

Tensile test results of the weld joints and weld metal

In order to test the mechanical properties of the weld joints, two round samples were machined from the weld metal with grooves of 10, 11, 12 and 13 mm, respectively, according to DIN 50125–B10×50. Experimental results are listed in Table 4. The yield strength and tensile strength of the weld joint reduced slightly, but the elongation enhanced somewhat following the increase in heat input. All tensile specimens were broken in the HAZ close to the base metal.

In order to test the mechanical properties of the weld metals, two round samples were machined from the welded joints with grooves of 10 and 12 mm, respectively, according to DIN 50125–B6×30. The results are listed in Table 5. The yield strength and the elongation of the weld metal are slightly better, but tensile strength is somewhat worse in the upper region of the welded joints, when compared to that in the lower region.

Charpy-V test results

The Charpy-V test results for the weld metal with a groove width of 12 mm are shown in Figure 1. The toughness at the lower region of the weld metal is better than that of the upper.

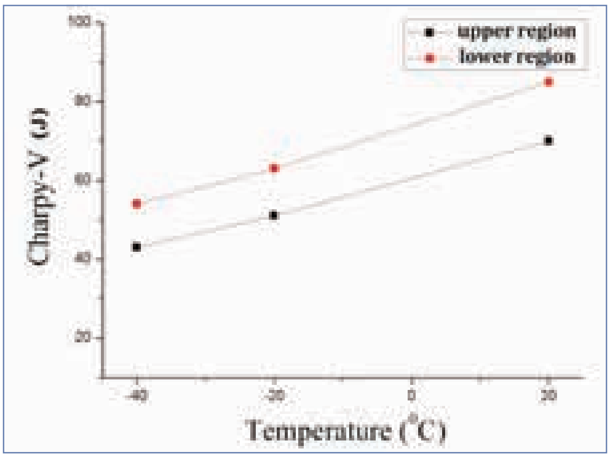

Figure 1: Charpy-V toughness results at the centre of the weld metal.

	C	Si	Mn	P	S	Mo	Ni	Cr	Al	V	Nb	B
S890QL	0.165	0.302	0.87	0.010	0.0017	0.48	0.97	0.46	0.074	0.05	0.011	0.0016
UNION X90	0.09	0.79	1.88	0.008	0.013	0.57	2.27	0.36	-	-	-	-

Table 1: Chemical compositions of the base metal and welding wire (mass%).

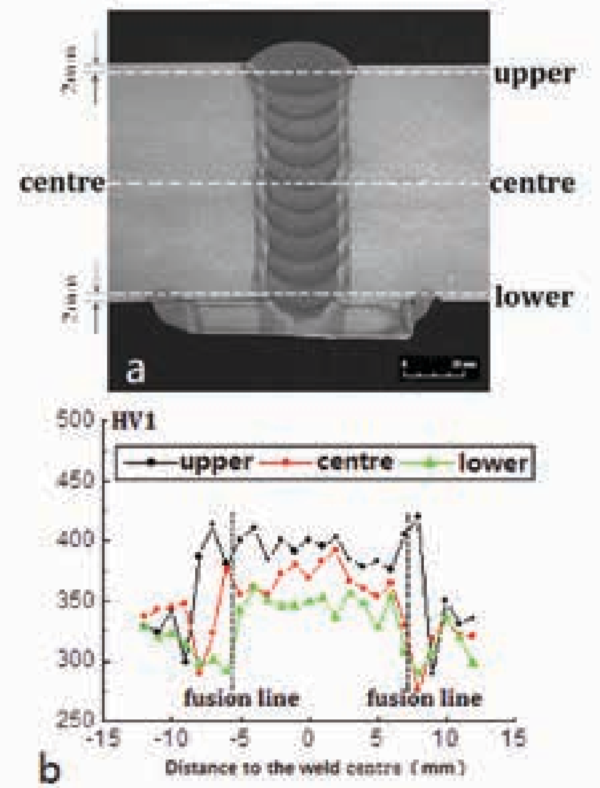

Figure 2: Macrostructure and hardness distribution of the weld joint.

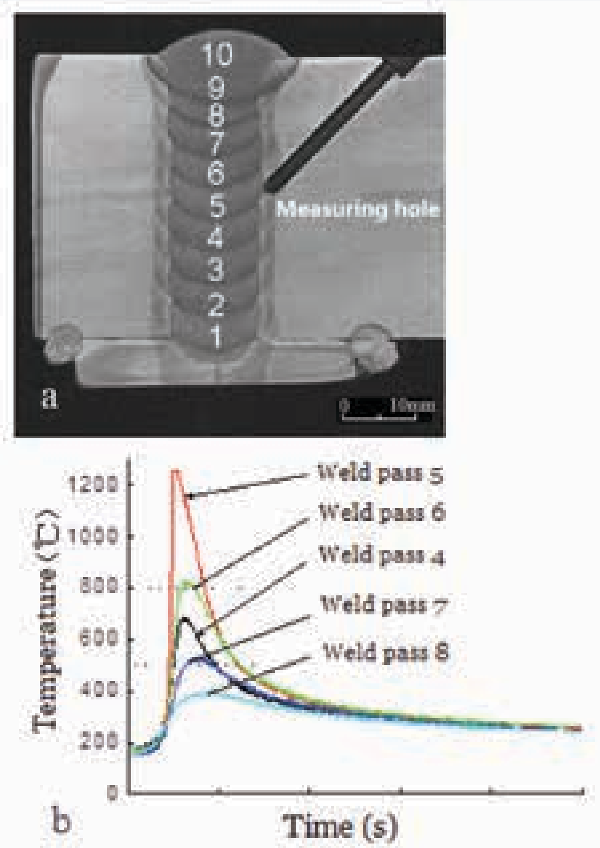

Figure 3: The heating cycles measured at Weld pass 5 during welding.

The Charpy-V test results of the weld metal at the centre and in the HAZ with groove width of 11 mm at -40 °C were measured at 56 J and 86 J, respectively, while at -20°C, values of 64 J and 97 J were recorded.

The toughness in the HAZ is better than that of the weld metal. Three specimens from the weld joint with a groove width of 10 mm were also tested at -40 °C. These three Charpy-V test results are 32 J, 33 J and 34 J, respectively. The average value is more than 30 J. The toughness result from the weld performed at the lowest heat input can still meet the requirement for the Dillimax 890QL steel and DIN EN 10137-2.

	Impact toughness A_{kv} (joules)		Strength (MPA) and elongation (%)		
	-20 °C	-40 °C	Yield: σ_s	Tensile: σ_b	Elongation: σ_5
S890QL		40	942	988	15.0
UNION X 90	90	50	890	950	15.0

Table 2: Mechanical properties of the base metal and welding wire.

Groove width (mm)	Speed: v (cm/min)	Current: I (A)	Voltage: U (V)	Heat input: Q (kJ/cm)	Cooling time: $t_{8/5}$ (s)
10	21	220	25.8	16.2	7.3/13.1*
11	19	213	26.1	17.6	7.8/13.6*
12	17	213	25.9	19.4	8.7/15.3*
13	16	217	25.7	20.9	10.1/15.5*

Table 3: Welding parameters (indicates min/max measured values).*

Groove width (mm)	Yield strength σ_s (MPa)	Tensile Strength σ_b (MPa)	Elongation A (%)
10	934.0	979.1	19.5
11	931.6	977.7	20.7
12	928.1	975.3	17.8
13	925.5	972.1	20.7

Table 4: Tensile test results of the weld joint.

Groove width (mm)	Sample region	Yield strength σ_s (MPa)	Tensile Strength σ_b (MPa)	Elongation A (%)
10	Upper	875.7	1090.2	19.5
11	Lower	981.5	1055.6	20.7
12	Upper	971.6	1120.5	17.8
13	Lower	1001.0	1060.2	20.7

Table 5: Tensile test results of the weld metal.

The hardness distribution at the welded joint

Figure 2 shows the macrostructure and hardness distribution of the welded joint. The hardness of the weld metal is higher than that of HAZ and the lowest hardness is located in the HAZ, as shown in Figure 2b.

Discussion

The mechanical properties of the weld joint meet the

EN 10025 S890QL steel

The European structural steel specification EN 10025 includes a range of high strength quenched and tempered steel grades within Section 6 and the designation S890QL gives the composition and mechanical requirements for the steel grade with a minimum yield strength of 890 MPa.

While this steel is over three times the strength of a basic S275 structural steel, it is relatively easy to weld and fabricate and is becoming increasingly popular with engineers and designers looking to exploit its strength-to-weight ratio.

S890 steel is used in applications such as cranes, aerial platforms, load handling equipment, bridges, and special containers.

DIN EN 10137-2 standard. But the mechanical properties in the lower region of the joint are better than those in the upper region. The fracture zones are located in the HAZ close to the base metal for all the tensile specimens of the welded joints. In order to understand these results, the heat cycling temperature created by welding was measured and the microstructure of the welded joint was analysed.

Figure 3 shows the test piece with a temperature-measuring hole (Figure 3a) and the heat cycling effects by welding (Figure 3b). The microstructure of Weld pass 5 has been affected by the interpass heating of Weld passes 6 and 7 (Figure 3b). The highest temperature recorded at the same position after completing Weld pass 6 and Weld pass 7 is more than 800 °C and 500 °C, respectively.

The microstructure of each weld pass is refined, not only by the heat treatment effect of the following weld pass, but also by succeeding weld passes. Therefore, the microstructure of the lower region of the weld metal will be finer and better in toughness than that of the upper region. Similarly, the preceding and succeeding weld passes will affect the microstructure of the nearby HAZ and, therefore, the mechanical properties of the weld joint will be affected. For example, the microstructure of the HAZ near Weld pass 5 is affected by Weld passes 4, 6, 7 and 8.

According to the ASTM standard, the grain size of the base metal is class 13. But the grain size of the HAZ and the weld metal is harder to classify, because the grains are too tiny. The microstructure of the last weld pass shows as dendritic, since there are no succeeding weld passes.

The toughness of the welded joint in the lower region is better than that in the upper region owing to the heating effect provided by cyclical welding.

Conclusions

High strength fine microstructure S890QL steel was successfully welded using narrow gap GMAW, using a novel automatic welding system, with groove widths of between 10 and 13 mm. The heat input was maintained at no more than 21 kJ/cm, while the working temperature was 170 °C.

Results show that the mechanical properties of the weld joint fulfil the EU standard. The mechanical properties of the joints in the lower region are better than those in the upper region due to the thermal cycling effect provided by subsequent weld passes on previous passes.

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Self-shielded flux-cored wires

The on-site alternative to stick-electrodes

African Fusion **talks to Renttech's Johan Bester about self-shielded flux-cored wires, which can be an ideal substitute for shielded metal arc/stick electrode welding for on-site construction projects.**

Self-shielded flux-cored welding or self-shielded gas metal arc welding (FCAW-S) was invented in the mid-1950s by Lincoln Electric as a way of mechanising and increasing the welding speed of the manual stick electrode welding process (SMAW). This also made it possible to weld outdoors without the necessity for gas as a shielding medium, but still using the same equipment as used for GMAW (MIG/MAG) welding.

These wires and the associated process were already perceived as potential substitutes for SMAW. "In addition, FCAW-S was seen as a way of taking the benefits of MIG/MAG outdoors," Bester tells *African Fusion*.

When argon gas became more readily available in the 1970s, the argon+CO_2 mixed shielding gases emerged for GMAW, offering spectacular weldability in comparison to using 100% CO_2, which was prone to excessive spatter. But this did not help to make the GMAW process suitable for use outdoors in windy conditions.

While GMAW-S should have become the ideal outdoor solution, more than 60 years later SMAW still predominates for outdoor construction in South Africa.

"Today, while the self-shielded process has gained popularity in certain niches, little is generally known in industry about how far the self-shielded flux-cored wires have come in the past few decades, or the variety that is now available. We show people the process on a daily basis, most of whom have never seen it before – and they are amazed at the ease of use and weld quality that this process offers," Bester says.

Bester believes that stick welding can be a challenging process. "To my mind, TIG welding requires the most skill from an operator, but stick welding is not far behind. Also, stick welding, due to the limited length of the electrode, involves a lot of stops and starts that can create potential defects if a welder applies incorrect technique. From a single electrode, you can deposit between 100 mm and 200 mm of a weld bead. This results in up to ten stop starts per metre when using the SMAW process," he says.

Left: Lincoln's Innershield self-shielded flux-cored wires in use on a pipeline project. "FCAW-S is the 'tool in the box' that has great potential, particularly for on-site structural steel construction, mining, ship building, pipeline and tank projects," says Johan Bester of Renttech.

"The FCAW-S process requires less skill and 600 mm to 1.0 m weld lengths can comfortably be completed with welders only needing to stop for repositioning. I have seen skilled welders who can weld for up to 3.0 m in this manner. The risk of weld flaws due to stops and starts thereby reduces, and quality welds are easily achievable, " Bester argues.

An additional benefit is gained when considering electrode efficiency. SMAW has an electrode efficiency of between 55 and 65%. This means that at least 35% of the weight of every electrode ends up in the stub or as spatter, slag or smoke. FCAW-S has an 85% electrode efficiency, so you get 20 to 30% more weld metal from the wire consumable as compared to electrodes," Bester estimates.

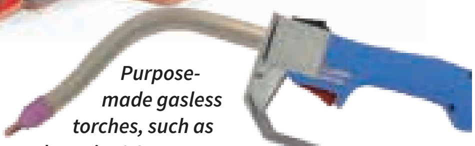
From a productivity point of view, non-welding activities such as grinding each stop-start, changing electrodes, and removing slag reduces the operational efficiency of the welder for SMAW to between 15 and 35%, depending on how much handling is needed. This means that the welder can spend up to 85% of his day on activities other than actually welding. The operational efficiency for semi-automated processes, such as FCAW-S, can be significantly better, between 35 and 50%, similar to those achievable with gas-shielded processes such as GMAW; but with the added benefit of being able to achieve this increase in productivity in an outdoor environment.

With respect to materials handling, Bester notes that the self-shielded process offers a significant advantage due to its positional capability. This allows the welder to weld the part as it lies or where it stands, without having to manipulate the part or move it to an enclosed workshop to suit the welding process.

As material handling can constitute up to 45% of welding costs, this single factor has a tremendous impact on the cost of production or repair. "With FCAW-S, the flux offers a 'dam-wall' effect, where the fast-freezing flux holds the molten metal in place while it solidifies. The resulting slag also helps to shape the weld bead and protect the weld from atmospheric contamination. Another benefit of the fast-freezing slag is that higher currents can be used for out-of-position welding, which produces "great fusion and penetration" at significantly higher deposition rates compared to SMAW.

"With the gasless process, an out-of-position joint can be deposited at 1.9 kg/h and at as high as 2.4 kg/h by a more skilled welder. With a 3.2 mm stick electrode, the current might have to be reduced to 70 A to complete an out-of-position weld, which would reduce the

Lincoln Electric manufactures a complete portfolio of Innershield electrodes.



Purpose-made gasless torches, such as the TBi MOG 50, are also now available with Euro gun- ends.

Suitcase wire feeders are portable and fully enclosed to protect the wire from dust and damage caused when moving the feeder around.

deposition rate to below 1,2 kg/h," he explains.

Responding to myth that self-shielded wires are associated with poor toughness, Bester says that this is not the case: "One has to select the correct wire for the application, as there are various products available, catering for different grades of materials. A common mistake is still made in this regard, where a wire is selected which is not suited for a specific task, resulting in poor toughness and weld failure. With SMAW one can run into the same predicament when selecting an E6013 electrode when your application dictates the use of an E7018-1 low hydrogen electrode," he says.

"One of the pitfalls of FCAW-S wire selection, however, is that some classifications have weld thickness limitations. Users, therefore, must make 100% certain that they choose the correct classification based on both the grade of material and the weld thickness. These limitations are, however, clearly identified by responsible manufacturers such as Lincoln Electric on the product information sheets and marketing materials.

In debunking the poor toughness myth, Bester cites the new Innershield NR233 wire (AWS E71T-8) from Lincoln Electric, which meets the AWS D1.8 seismic code for construction used in countries on earthquake fault lines – such as California, Japan, New Zealand and Malaysia. The -29 °C Charpy toughness results for this wire are in the 34 to 54 J range. Other benefits include: unlimited weld thickness and ease of welding. "This wire is also an easy switch to make for SMAW welders, due to the similar welding techniques that are required," Bester adds.

"Self-shielded wire is a great alternative to SMAW with benefits including: better deposition rates, positional capabilities, operational efficiencies, outdoor weldability, welder appeal, and lastly, no shielding gas is required. This is a massive benefit in remote areas, which do not have gas readily available. For piping and tanks there are also various stainless steel TIG rods available as gasless derivatives."

Describing the equipment requirements for self-shielded welding, he advises on the types of power sources: "The process needs a CV (constant voltage) power source with a built-in feeder or a loose wire feeder. However, unlike GMAW, which runs on dc-positive polarity, almost all gasless wires run on dc-negative polarity." The polarity on the machine, therefore, has to be able to be changed. Renttech SA offers various solutions via its Uniarc and Lincoln Electric brands, including 220 V single phase, 380 V and 525 V three phase as well engine drives in both petrol or diesel configurations – and for TIG welding using gasless welding rods, CC (constant current) power sources are also available.He adds that specially designed 'suitcase' wire feeders are also a very good idea for welding up, over or inside structures. These feeders are robustly built and are fully enclosed to protect the wire from dust and damage to the spool caused by moving the feeder around in confined spaces.

"Purpose-made gasless torches are also now available with Euro gun-ends. US equipment manufacturers used to offer torches that were designed to fit US wire feeders," he explains. "However, customers who had European welding power sources had to use a traditional GMAW torch with the shroud removed. These torches got damaged very quickly and were usually destroyed during the course of the project. Today, purpose-built self-shielded torches, such as the TBi MOG 50 are designed specifically for gasless wires and these are now available with the Euro gun-end as a standard – and these torches accommodate self-shielded wire sizes from 2.0 mm down to 1.2 mm in diameter," Bester informs *African Fusion*.

"FCAW-S is the 'tool in the box' that has great potential, particularly for on-site structural steel construction, mining, ship building, pipeline and tank projects. On a water pipe project in Zambia, for example, our customer has had phenomenal success using the shielded STT process for root runs followed by Innershield NR211 capping runs. The end result was a project finished well before schedule and an extremely satisfied customer," he says.

"Self-shielded wires are easy to use and it is easy for welders to adapt to this welding process. Although it is not the answer to all outdoor or SMAW applications, it's well worth investigating for your next project. Our team at Renttech SA will gladly assist and demonstrate the advantages of this great process," Bester concludes.

Cobalt-based cladding: a local success story

In this article, Wiehan Zylstra (right), technical manager of Welding Alloys South Africa (WASA), presents a case study on the use of Welding Alloys' cobalt-based cladding material, STELLOY 6-G, which was welded out of position using Fronius' TPS synergic pulsed-GMAW equipment.

"I am going to share a break-through application with you today, which involved collaboration between the petrochemical client, Sasol; piping contractor, Petrochemical Piping Services; equipment OEM, Fronius and its local distributor BED; and Welding Alloys South Africa, WASA," Zylstra begins.

As with all application related-successes, the story starts with the client need. "Sasol have a requirement for a cobalt-based alloy for high-temperature erosion resistance – and erosion involves the combination of corrosion and abrasion, so both wear and corrosion resistance were needed," he explains, adding that a cobalt-based rather than nickel-based alloy had to be used because of the need for hot corrosion and sulphidation resistance from the clad layer.

Cladding had to be applied in-situ and out of position, while time constraints drove the client towards exploring higher deposition rate welding processes. "The welding was previously applied using SMAW or stick electrode welding with some manual TIG welding using consumable rods. Both these processes have productivity issues, so an additional requirement was specified for a procedure to be developed that reduced welding time," Zylstra says.

Summarising the need, he says that suitable cobalt consumables with good out-of-position weldability were required, along with a process and associated equipment to enable higher productivity.

A history of cobalt-based alloys

After playing the Beach Boys song, Kokomo, Zylstra says that Elwood Haynes developed the basic metallurgy of cobalt-chromium (Co-Cr) alloys in the early 1900s – in a town near Kokomo, Indiana, USA. "And now that you have heard that song, you won't forget where Haynes came from."

Haynes contributed significantly to our knowledge of martensitic stainless steels and, in 1905, he designed a motorcar and founded the Haynes Automobile Company.

Turning attention back to the cobalt alloys Haynes invented, Zylstra says that he derived the name for his alloy from the Latin word 'stella', because of its 'star-like lustre'. Haynes formed the Haynes Stellite Company and registered the trade name 'Stellite'. His company became Union Carbide in 1920 and Deloro Stellite in 1922. "Haynes' cobalt-chromium alloys for weld overlay cladding have been known for over 100 years and many different brand names have emerged," Zylstra informs us, adding that the 'Stellite' trade name is still owned by Deloro Stellite today.

Moving onto the history of the Welding Alloys Group, he says that the company was started in 1966 in Fowlmere, a town near Cambridge in the UK. Originally, WA was a hardfacing business founded by Jan Stekly to solve abrasive wear problems. Today, the company has 10 factories producing flux-cored wires, one of which is here in Roodepoort, where hardfacing flux-cored wires are produced – "98% of which are chrome-carbide (CrC) consumables".

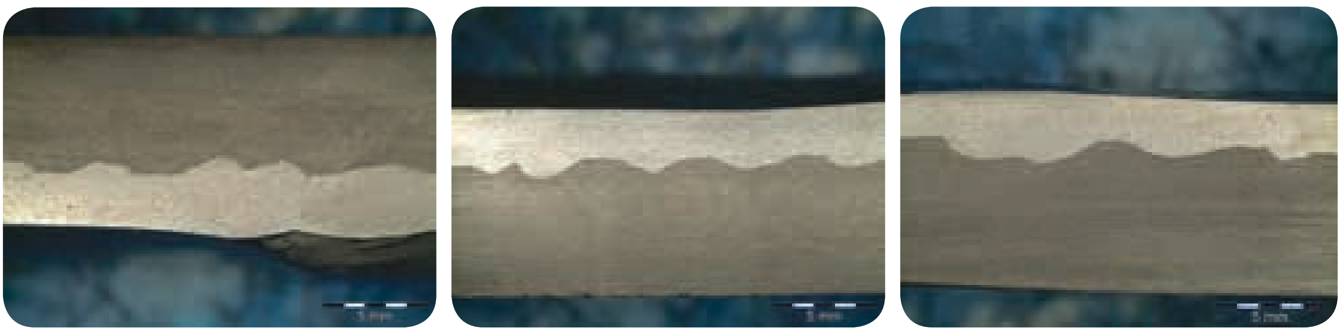
As well as wire production, the business still has production units all over the world. "In South Africa, for example, 52 t/a of our own wires are used to make CrC overlay plate for a range of materials handling applications for mining equipment such as crushers," Zylstra reveals.

Welding Alloys also produces a comprehensive range of stainless steel and nickel-based alloys and its cobalt-based consumable range is marketed under the STELLOY trade name.

Metallurgy of cobalt-based alloys

The Stellite alloys are, essentially, cobalt chromium alloys containing 50 to 60% cobalt, hence the term 'cobalt-based'. Cobalt has a face-centred cubic (FCC) crystal structure, which makes it ductile like austenitic stainless steel. "But this structure is somewhat unstable. If exposed to mechanical stress or high temperature, the FCC crystal structure transforms to a hexagonal close packed (HCP) structure, which has less ductility, higher yield stress, a high work hardening rate, good fatigue properties and higher toughness," Zylstra explains.

The chromium in the alloy gives it its corrosion resistance. As with stainless steel, the chromium forms a passivation



Micrographs of the STELLOY-clad layer for three different welding positions: left, from the overhead position; centre, from the 3:00 vertical up position; and right, from the downhand position.

layer on the alloy's surface, which forms a barrier to further corrosion. Chromium is also a solid solution strengthener. "One of the fundamentals of metallurgy is that, because of the different atoms in the crystal structure of a solid solution, structures with higher internal stresses are formed, which are more rigid and, macroscopically, stronger," he explains.

Common grades of the Stellite alloy include: Stellite 1 with 32% Cr, 2.5% carbon (C) and 13% tungsten (W); Stellite 6, which has 27% Cr, 1.0% C and 5.0% W; Stellite 12 with 30% Cr, 1.8% C and 9.0% W; and the very low carbon Stellite 21 with 27% Cr, 0.2% C and 5% Mo, which is often used as a buttering layer. All of these grades (and most others) also contain nickel, iron, silicon and manganese.

"Tungsten and molybdenum are solid solutions strengtheners, while tungsten is also a carbide former. It is the CrCs, however, that are the fundamental hardening constituents. They impart the hardness and wear resistance to the Stellite range of alloys," Zylstra points out.

Showing typical microstructures of deposits, for Stellite 1; Stellite 6 and Stellite 12, Zylstra says: "Note the volume fraction and dispersion of carbides. What you are looking at is the black CrC dispersed around the grain boundaries of the solid solution phase. Clearly, the volume fraction of carbides is highest in the Stellite 1 alloy, which has 2,5% carbon, followed by Stellite 12 with 1.8% and Stellite 6, which only has 1.0% C. This explains why the Stellite 6 alloy is the only machineable cobalt-based alloy in the range," he says.

In a second series of micrographs, the dispersion of carbides is shown for three different welding processes: GTAW; Oxy-acetylene; and SMAW. "From a dispersion perspective, the TIG process is the best of these three, because the carbides are finer and more evenly distributed around smaller grains.

"This indicates that the welding process choice directly influences the end quality of the clad layer. While the size and distribution of carbides depends on the alloy chemistry of the grade, the cooling rate and heat input associated with welding processes also have important roles to play.

The welding solution

Welding Alloys manufactures metal-cored cobalt-based alloy wires for both the GMAW and automated GTAW welding processes. "In term of Stellite 6, we have three or four different variants, with STELLOY 6-G being the wire best-suited to the requirements of Sasol's applications," notes Zylstra.

The GMAW process was chosen as it can be welded with heat inputs as low or lower than the GTAW process, but it also offers much better productivity. "WA manufactures both 1.2 mm and 1.6 mm metal cored wires in this grade, which offer excellent weldability and a weld bead that looks almost exactly the same as that from the solid wire GMAW process," he notes.

Being metal-cored, however, the wires are not as ideal for all-positional welding as a flux-cored wire would be, because flux, particularly fast freezing flux, helps to make out of position welding much easier. Metal-cored wires have less than 4.0 % mineral contents – calcite, rutile, feldspar and fluorspar, for example – which are fluxing agents and slag formers.

Hence the partnership with Fronius and BED.

Fronius' Transpuls Synergic technology is microprocessor controlled and digitally regulated pulsed, synergic GMAW system. The system is pre-programming with welding parameters for various alloy types, including Stellite alloys, based on years of application experience. "Synergic MIG/MAG welding is a variant of pulsed MIG/MAG, where unit current pulses detach and transfer a single droplet of weld metal of around the same diameter as that of the wire," Zylstra explains. The deposition rate/wire feed speed can then be varied proportionally, both upwards and downwards, by altering the pulsing frequency.

"Fronius has more than 156 000 synergic programmes for different material grades, wire size and shielding gas combinations," Zylstra continues, before listing three essential characteristics of synergic welding: pulse parameters are selected automatically; pulse frequency and duration is directly related to wire feed rate; and the electronic control of parameters ensures uniform penetration and weld bead profile.

"Once the consumable grade, diameter and shielding gas has been selected, a single 'one-knob control' is used to 'synergically' adjust the wire feed rate and pulsed current frequency," he explains. "This allows the average current and the associated heat input to be reduced below the spray transition current of the wire without having to resort to dip transfer mode. This makes the process ideal for out of position welding at higher deposition rates and with much lower spatter levels," he adds.

Fronius' Transpuls (TPS) inverter and the VR4000 wire feeder – along with the Job-master torch with its integral remote control and weld data display – are pre-programmed to enable out of position, in-situ welding of the all common cobalt-based alloys.

In addition the job-master torch with its integral remote control and weld data display makes the system ideal for in-situ welding – the welder does not have to stop welding and go to the power source to fine-tune the welding parameters.

"Digital arc length control is also applied to maintain the arc length, even with changes in the stick-out length. This further reduced spatter and improves weldability," Zylstra adds.

Showing a set of etched samples from the procedure qualification records (PQRs), Zylstra highlights the successful results of the collaboration: Overhead, vertical-up and downhand weld samples all show excellent fusion, penetration and surface quality. "A total of 54 samples were sent in for metallurgical evaluation and all passed with flying colours," he says.

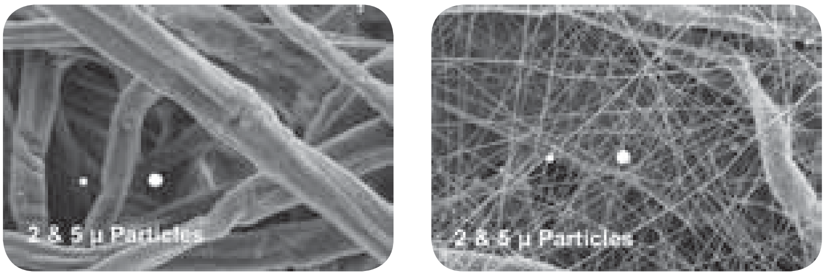
"So it is possible! By choosing a suitable metal-cored wire consumable with good weldability and coupling it to a digitally controlled inverter with advanced synergic technology – along with a skilled welder – out of position in-situ cladding with cobalt-based alloys can be achieved at significantly higher production rates," he concludes.

Welding fume extraction

At an SAIW evening meeting earlier this year, Jacques Cato (left) talked about welding fume, filtration technology and the solutions available from Donaldson Filtration Solutions in South Africa. *African Fusion* attends and reports.

"The fume given off by welding and hot cutting processes is a varying mixture of airborne gases and very fine particles, which, if inhaled in sufficient quantities, will cause ill health," says Cato, while displaying a slide on the facts about welding fume.

The gases present in welding fume include nitrous oxide (NOx), carbon dioxide (CO_2), carbon monoxide (CO), inert shielding gases such as argon and helium, and ozone (O_3), which is produced by the high temperatures associated with welding arc plasmas. "The visible welding fume is mainly particles of metal, metal oxide and/or flux, if it is being used, but it is not only the visible fume that is dangerous," he points out. "The exact level of risk from the fume will depend on three factors, how toxic the fume is; the concentration of fume; and how long the welder breathes it in," he adds.



Ultra-Web nanofibres (right) are 0.2 to 0.3 mm in diameter, which enables sub-micron particles to be captured on the surface. Cellulose media blends (left) are made from fibres in the 10 to 20 µm range, which makes this impossible.

Cartridges can be used in any of Donaldson's filtration solutions, from portable fume extraction systems to its Torit dust collectors.

Displaying a diagram of the amount of fume produced by different welding and cutting processes, he points out that the submerged arc welding process generates the least fume, while arc-air gouging generates the most. The SMAW (MMA) and flux-cored welding processes (FCAW) are on the high generation side, closely followed by the solid wire GMAW (MIG/MAG) processes.

From a size perspective, Cato notes that fine sand with particles larger than 0.1 mm (100 µm) cannot get through a person's natural filtration systems and into the lungs. This particle size is said to be at the limit of inhalability. "The finer the particle, the more damaging it can be to the lungs," he says, pointing out that smoke and fume fit into the ultrafine particle size range of 0.1 µm or less and are therefore dangerous.

"A typical welder can inhale around 500 mg/min of welding fume in this size range," Cato warns. "Even if we assume a duty cycle of 30%, 150 mg/min of fume can be entering that welders lungs if no filtration or fume extraction system is being used."

To prevent this, global standards such as BGW (Belgische Grenswaarde) and MAC (Nederland) set maximum fume concentrations in an enclosed area in the vicinity of any person to 5.0 mg/m^3 and 3.5 mg/m^3 respectively.

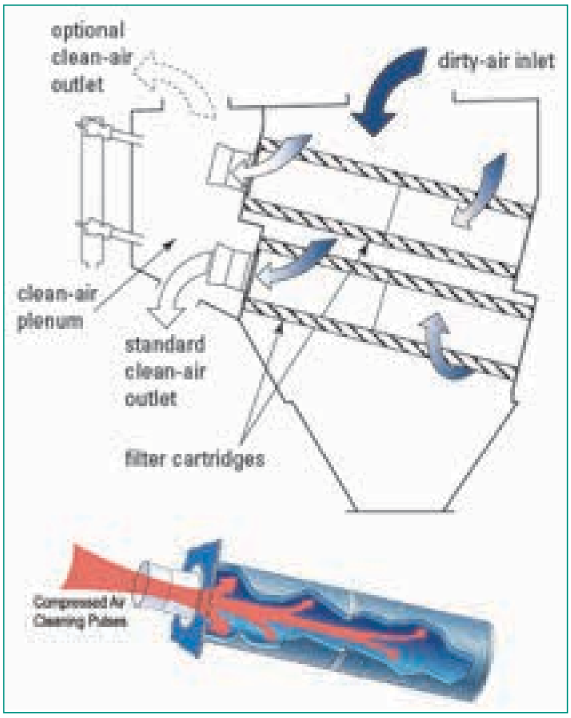
Pointing towards the South Africa SABS Health and Safety standards for welding and thermal cutting processes, Cato notes that different welding fume constituents are allocated different threshold limit values (TLVs) and threshold weighted averages (TWAs) in the standard. The thresholds for aluminium and iron, for example are set at 5.0 mg/m^3, while more dangerous constituents, such as mercury and silver are set significantly lower (0.01 to 0.1 mg/m^3).

The specific illnesses linked to welding fume? "Pneumonia and lung Infections are at the top of the list. Health and Safety statistics from the UK report 40 to 50 hospitalisations per year for occupation-related pneumonia, of which two to three are fatal," Cato says.

Occupational asthma is strongly associated with the fumes from stainless steel welding, which contain chromium oxide (CrO_3) and Nickel Oxide (Ni_2O_3). "Both of these constituents are known to cause asthma. Welding fume is also classified as 'possibly carcinogenic' to humans, although the system of classifying substances does not consider the by-products of a process, which means that welding fume is not currently assigned a hazard classification," he says.

Other known conditions are metal

and **filtration**



The cartridges are arranged inside the collector at an angle so that the dirty air passes through the filter media on the outside of the cartridge and into the cartridge's core.

Donaldson's collector units can be combined in various configurations to make up larger units with air volumes ranging from 2 500 m³/hr to 200 000 m³/hr.

fume fever, which presents as flu-like symptoms after welding but does not usually have any lasting ill effects – "and this condition cannot be prevented by drinking milk before welding," Cato says, debunking a common myth.

Dryness, irritation and 'tickling' of the throat and lungs; coughing or a tight chest are common. "Ozone is a particular cause of this, particularly when TIG welding stainless steels and aluminium. High exposures to nitrous oxides, generated during most arc welding operations, can also cause this health effect.

Extreme exposure to ozone can also cause pulmonary oedema (fluid on the lungs). "Temporary reduced lung function is relatively common. It affects the ease at which you can breathe out (peak flow). It tend to get worse through the working week but gradually improve shortly after exposure is reduced – following a weekend, for example."

Filtration technology

Donaldson's Ultra-Web® nanofibre technology is at the core of its filtration technology. Nanofibres are scientifically proven to give an advantage with respect to filtration efficiency and pressure drop reduction, which relates directly to energy efficiency. "Ultra-Web patented nanofibres are made using an electro spinning process that produces a very fine, continuous fibre of between 0.2 and 0.3 µm in diameter," Cato reveals.

Using nanofibre, a permanent web-like net is formed with very fine interfibre spaces. Traditional cellulose or cellulose/synthetic media blends are made from fibres in the 10 to 20 µm range, which makes it impossible to create a net with sub-micron spaces. These media, therefore, rely on the use of larger spaces and thicker volumes to trap particles inside the medium.

In contrast, the use of Ultra-Web nanofibre enables sub-micron particles to be captured on the surface. This promotes much better pulse cleaning and it significantly reduces the operating pressure drop across the filter media. "The nano-net result is cleaner air, longer filter life, better energy efficiency and greater cost savings," Cato explains.

Ultra-Web nanofibre is used by Donaldson in its cartridge filter units, which, according to Cato, are the modern alternative to bag filters. "Cartridges offer a smaller foot print, higher filtration efficiencies – 99.997% at 0.5 µm – and lower emissions in the clean air – 5.0 mg/m³ or less. In addition, they are cheaper than bag filters, operate at lower pressure and consume less energy," he reveals.

Cartridges can be used in any of Donaldson's filtration solutions, from portable fume extraction systems to its Torit dust collectors. A typical dust collector draws the fume in from the top of the collector. The cartridges are arranged inside the collector at an angle so that the dirty air passes through the filter media on the outside of the cartridge and into the cartridge's core. The clean air then flows up the incline to the outlet of the collector.

Periodically, a reverse pulse of compressed air is sent through the cartridge cores, which shakes the dust off the outside surface of the cartridge. The dust falls into a collecting bin below, for disposal when full. This process keeps the cartridges from clogging and the system's operating pressure low.

"The use of cartridges in dust collectors offers very easy maintenance. Cartridges can be removed and replaced by one technician without the need for any tools. We have also adopted a modular approach, which enables collector units to be combined in various configurations to make up larger units with air volumes ranging from 2 500 m³/hr to 200 000 m³/hr," Cato says.

For welding applications, Cato lifts out the Donaldson Environmental Control Booth or ECB workstation. 'The ECB is specially designed to remove fine airborne dust from multiple sources without interfering with workers' movements or visibility. The booth comes complete with lighting, sound-proofing, built-in fume extraction and dust collection. It requires no ductwork, can easily be moved around the shop floor and re-circulates the cleaned air for reduced energy costs.

"We at Donaldson offer solutions for every conceivable dust or fume extraction application, and our experience and range ensures that the sub-micron particles and dangerous constituents in weld fume are efficiently collected before they can reach a welder's breathing zone," Cato concludes.

Cost-effective shielding gas choices

Sean Young, Air Products' welding specialist, spends much of his time advising customers on how their choice of gas mix can have a profound impact on long-term cost-effectiveness.

The variety of welding procedures and their requisite shielding gases makes welding a complex and intricate process. In this highly specialised field, so critical to many manufacturing processes, it is important to know that you are getting the best advice.

Air Products' welding specialist, Sean Young, is well placed to offer such advice. With a broad knowledge of welding gases and their applicability to specific welding procedures, Young spends much of his time advising customers on how their choice of gas mix can have a profound impact, not only on the weld quality, but also on long-term cost-effectiveness.

"Sometimes it can take a bit of convincing that the cheapest option is not always the most cost-effective. But for a customer who is looking to make sensible long-term decisions, choosing the best gas mix for a specific procedure can save money and increase efficiencies in the long run," says Young.

"As an active gas, carbon dioxide used to be the gas of choice and, while it can be effective for a faster and deeper weld, because it is quick freezing, it tends to cause spatter. Using a mixture of active and inert gases, such as our Magmix 3 can reduce post-weld activity – leading to a better weld for the long-term."

Choosing a gas mix depends entirely on the type and thickness of the metal to be welded. Air Products supplies argon for TIG (tungsten inert gas) welding of aluminium, copper, mild steel and stainless steel, and an argon/helium mix for thicker aluminium or copper.

For MAG (metal active gas) welding of mild steel, three-part gas mixes are recommended. Air Products' most sought-after gas mixes for MAG welding are its premium brands: Coogar-Plus, Magmix 3 and Coogar 84/82.

"When it comes to MAG welding of stainless steel, specific gas mixes come into the picture. For example, an argon/carbon dioxide mix is recommended for the welding 3CR12 stainless steel. Pure carbon dioxide is not recommended as carbon precipitation can cause cracking," Young explains. For MIG welding of aluminium, argon is recommended, and a mix of argon and helium for thicker aluminium. Flux core welding of stainless steel and mild steel requires a filler material, which in turn determines the specific welding gas choice.

"While Magmix 3 for general purpose and Coogar 84/89 for structural materials are our most popular brands, the choice of welding gas or gas mixes depends on customer requirements, metal properties, and in certain cases, precise specifications. Mechanical construction, pressure vessels, and civil construction such as bridges, and the use of critical components, for example, all require a specific welding procedure, which determines the welding gas type," says Young.

In the current economic climate, the trend for large manufacturing organisations is to consolidate work areas, which makes for more economical gas usage. However, it is sometimes a challenge to forecast gas volumes and to calculate the most cost-effective long-term usage. To this end, Young makes use of a customised welding cost calculator, an Air Products innovation, which assists the customer in making the right choice and to plan ahead.

"At Air Products we are passionate about providing a service which goes far beyond the supply of product. We provide a close analysis of specific requirements and match those with recommendations on the correct welding procedure, shielding gases and filler material. And our customers know that we are always available if they have queries on technical issues."

Air Products South Africa – having long been at the forefront of welding gases and technologies in this country – has invested substantially in welding skills training and development. For example, the company has been closely involved with the South African Institute of Welding (SAIW)'s Young Welder of the Year competition since its inception in 2004.

With service delivery at the core of its operations, Air Products supplies all its customers, with the full spectrum of welding gases throughout South Africa. "From small packaged gas supply mode (cylinder) to CryoEase and Bulk delivery, Air Products prides itself on high service levels and turnaround. Furthermore, as the market is constantly changing, we ensure that we keep ahead of trends by constantly looking at innovative ways of delivering the most operationally efficient and cost-effective welding solutions," Young concludes.

www.airproducts.co.za

Air Products' gas supply solutions

Cylinders: For small and medium-sized users, cylinders can be supplied in a full range of sizes, pressures and gas purities for a wide range of gases and gas mixtures.

Manifolded cylinder packs: Manifolds connect together two or more cylinders to provide greater storage capacity and security of supply. Manifolded packs of different gases can also be connected via the company's Dynamic Gas Mixer to enable two or three part gas mixtures to be distributed across a site.

CryoEase®: CryoEase is a cost-effective, reliable and convenient microbulk supply solution. Specially designed tank trucks with integrated controls and flexible storage tanks provide pure gases, cryogenic liquids or gas mixtures via a blender installed on site. Even if using as few as ten cylinders a month of the same gas mixture, CryoEase microbulk tanks could offer a cost effective alternative.

Bulk storage tanks: Bulk deliveries by truck of high-purity gases such as argon offer a reliable and cost effective solution for customers with high demand. Coupled with gas mixing solutions and cylinder manifolds, a variety of gas mixtures can be piped through the site.

Repair and maintenance focus at NAMPO

In trying times Afrox acknowledges that farmers are more cost conscious, and to this end the theme of Afrox's display at the 2016 NAMPO Harvest Day exhibition was 'Total Solutions Partner'. Afrox demonstrated complete solutions focusing on in-house fabrication, repair and maintenance, as well as hardfacing for all farming-related welding applications, aimed at assisting famers reduce their costs in the light of the current economic conditions and the severe drought crisis gripping South Africa.

Afrox's do-it-yourself approach to this year's exhibition is not only an acknowledgement of the support Afrox has received from the agricultural industry over the last 89 years, but also a gesture of assistance, with an emphasis on fabrication and products that can be used for repairing implements as opposed to the more costly replacement option.

"We want to show famers how to repair equipment themselves so that there is no need to outsource or unnecessarily replace existing machinery," says Johann Pieterse, Afrox manufacturing industries business manager. "Experts from our manufacturing division were on hand to physically demonstrate some of these applications," he adds.

"It's all about hands-on practical advice this year," comments Pieterse. "For example, with our trailer build demonstration, we gave a detailed explanation and a practical display of how to build your own trailer, and we provided particulars on the basic products required for this project," he says.

Among Afrox's leading brands for the sector are: Vitemax, the premium electrode for mild steel applications; Handigas, with a range of LPG products for the agricultural sector; and the Miller range of welding machines including the XPS 450 and the MigMatic 380, both recommended for maintenance, repair and fabrication.

Another sought-after DIY product is the light and robust PortaPak® welding and cutting set that allows work to be performed at remote locations and in elevated areas. The Porta range of gas cylinders offers farmers the option of acquiring a cylinder without paying any rental fees. This range consists of the PortaPak oxygen and acetylene cylinders as well as the Portashield® shielding gas for MIG welding and PortaTIG® for TIG welding.

At Nampo, Afrox focused on repair and maintenance during the trying drought and economic conditions facing SA's agriculture sector.

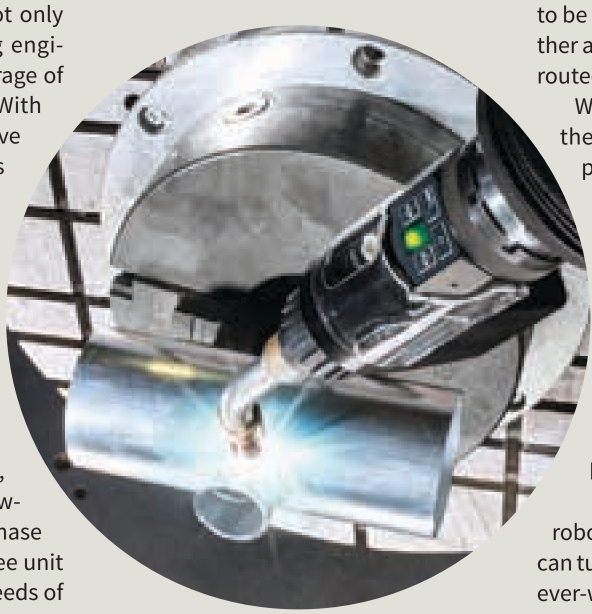
www.afrox.co.za

The world's most compact push-pull welding torch

Fronius has launched the world's most compact push-pull robot welding torch: the Robacta Drive TPS/i. Thanks to its compact design and refined engineering, the component accessibility and TCP precision of the welding torch has been improved significantly. What's more, the dynamics of the drive unit has been increased to 33 m/s² – ten-times that of its predecessor generation. A consistent, modular structure not only eases the workload of servicing engineers, but also simplifies the storage of spares and replacement parts. With all these benefits the Robacta Drive TPS/i allows more welding tasks to be economically performed with robots.

Available in either gas-cooled or water-cooled versions, the welding torch has an exceptionally small interference profile and its reduced weight means it can be fitted to robots with load capacities as low as 3.0 kg. Yet despite its small size, the lightweight torch packs a powerful punch thanks to its three-phase stepper motor: a maintenance-free unit capable of smooth wire travel speeds of up to 25 m/min. The speed is kept constant by an integrated, highly accurate rotary position encoder, while two driven feed rollers transfer the speed to the wire electrode. In the event of a change in the overall system, the TCP accuracy of 0.5 mm is guaranteed.

To deliver an even more cost-effective solution, Fronius engineers have adopted a consistently modular approach to the new welding torch's structure, meaning that the hosepack and drive unit of the Robacta Drive TPS/i are connected via a standardised connection with a union nut. As the connection to the power source is also established through a Fronius System Connector (FSC) housing, all the necessary media, signal lines and hosepacks can be exchanged rapidly. This modularity also allows the drive unit to be used with robot types featuring either an external hosepack or a hosepack routed inside the robot arm.



Well thought-out details such as the easy way of setting the contact pressure using a tool-free adjusting screw and instructions on the display all help to deliver higher levels of availability. Just as impressive is the ergonomic user interface, which boasts a dot-matrix display and pre-assigned buttons for the wire feed and gas test as well as an unassigned function key that can be programmed as desired.

The Robacta Drive TPS/i universal robot welding torch ensures that users can turn to robot-assisted welding for an ever-wider range of applications.

New all-in-one multi-process inverter

Renttech South Africa is pleased to introduce a welding solution to their customers which 'ticks all the boxes' when it comes to operational and energy efficiency.

The Uniarc Multiarc 350 Compact multi-process inverter is a robust, lightweight unit that offers customers an easy transition between multiple welding processes, bringing new levels of versatility to the end-user, as well as cost-saving advantages.

The Uniarc Multiarc 350 Compact multi-process inverter from Renttech is a robust, lightweight unit that offers customers an easy transition between multiple welding processes.

"The Multiarc 350 represents highly efficient inverter technology, which draws 30% less current than traditional rectifiers," says Johan Bester, welding product manager at Renttech South Africa. "The multi-process capability essentially allows for one machine to do the work of two or three machines, providing further operational efficiencies and cost benefits."

Another significant benefit is that the unit is generator-compatible, while meeting all mining safety specifications. The dual voltage of 380 and 525 V enables flexibility on a mining operation, be it workshop or plant, without the risk of damage to PC boards.

"Being generator-compatible makes the unit suitable for customers who have been forced to install generators in their workshops to ensure continuity in their production process. Traditionally machines that did not have this safety feature would have encountered damaged PC boards and components from typically older generators that did not supply consistent power to the machines," explains Bester.

"The inverter benefit also applies to generators as its current draw is less on a generator, making for better fuel efficiency; and, depending on the size of the generator, the ability to run more machines off the same generator."

The Multiarc 350 offers easy transition between MIG, TIG and FCAW welding processes and is recommended for carbon steel, alloy steel and stainless steel applications. Added advantages include a built-in wire feeder with a dual drive system and quick polarity change when welding gasless flux-cored wires.

"Multi-process machines are becoming increasingly sought-after because many welding jobs combine two or more processes in the same joint, for example TIG for the root and fill, followed by gas assisted flux-cored wires for capping," notes Bester.

Inverters also produce more refined arc characteristics, according to Bester, which has a direct impact on weld quality. In addition, the Multiarc 350 weighs approximately half of its rectifier counterparts, which significantly enhances the mobility of the unit.

"This is a huge advantage, in that the unit can be moved from workshop to site, and so the job is not limited to one area, such as a production line.

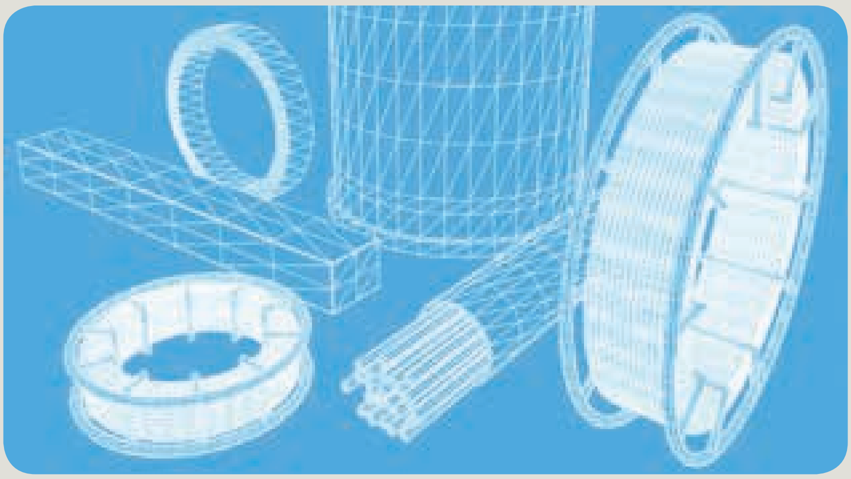
"Renttech SA can also offer customers product expertise and full service backup on this unit," Bester concludes.

www.renttechsa.co.za

New welding app launched at Tube 2016

An innovative welding app was launched on the Sandvik stand at Tube 2016, specifically designed to meet welding professionals' requirements when planning and performing welding projects. The app, Sandvik Welding, is available and free to download for phones and tablets from the App Store for Apple and Google Play for android devices.

Built with ease of navigation, the app brings extensive information to hand for welding engineers, welders, specifiers, project engineers and owner operators. Brimming with useful technical data it allows users to plan which material grades to choose for which jobs, make ferrite number calculations, determine the level of heat input for a specific grade, select filler material and get help.



There is full information on welding parameters; gas-shielding mixtures, maximum interpass temperatures and post-weld heat treatments. All calculations and recommendations are designed to help operators and planners ensure good weld metallurgy is being achieved in the weldment, while maintaining optimum material properties.

"We believe the new Sandvik Welding app to be the most comprehensive available today, providing welding engineers with a vast amount of informative data and practical functions – created to meet customers' welding needs in a handy form right to their phone or tablet," explains Clemente Tallarico, Sandvik's global product manager for welding.

www.smt.sandvik.com

Orbitalum agency for South Africa appointed

Complete solutions for high-end requirements in tube and pipe welding preparation for a range of industries are now available locally from Dowson & Dobson (D&D) Industrial, a division of Actum Industrial.

D&D Industrial has been appointed as the exclusive South African distributor for Orbitalum Tools, a global leader in orbital tube, pipe preparation and orbital welding technology for industrial piping systems, prefabrication and maintenance.

Orbitalum Tools is part of the ITW Welding Group, a global leader in welding products with brands including: Miller Electric and Hobart on the welding machine side; TIG torches and accessories from Weld-Craft; welding consumables and gas equipment from Hobart and Elga; and automated welding equipment from Jetline.

Actum Industrial was awarded the agency via Orbital Cutting & Welding of Dubai, which represents both EH Wachs and Orbitalum. The company is looking to make inroads into the South Africa market. Kumar Sundaram, head of Orbital Cutting and Welding for the Middle East and Africa, recently visited South Africa to conclude the agreement.

Applications for Orbitalum equipment, under the brand name Orbimat, range from process plants processing ultra-pure media for industries such as semiconductors, electronics, pharmaceuticals and biotechnology, the chemical, food and beverage industries, aviation and aerospace technology and shipbuilding, through to the energy sector – power plants, refineries and the oil, gas and petrochemical industry – and utilities – water and gas supply, heating, air conditioning and cooling and sprinkler systems.

"The Orbimat range of welding equipment is ideal for the South African market," says Actum Group director, Greg Barron, adding: "Representing the latest technology, it is also user-friendly and low on maintenance, which are critical factors in a low-skills environment such as Africa.

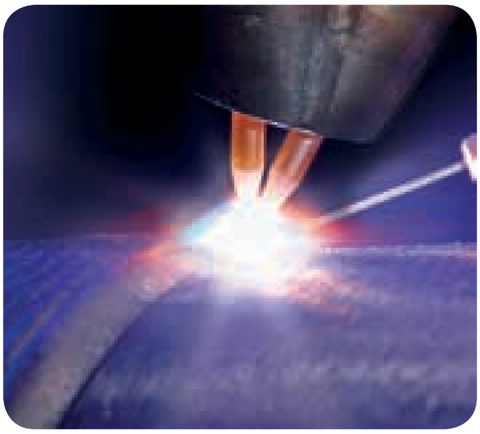
"We will be targeting the agricultural and food and beverage sectors in particular, which represent an exciting new market for Actum Industrial. This is in line with our strategy to continually diversify with new reputable brands into different sectors," Barron notes.

Actum Industrial encompasses industrial products, instrumentation, pneumatics and professional tooling. Together with Actum Electronics, it forms part of the larger Actum Group. "We have gradually evolved from being a component supplier to being able to offer integrated solutions," Barron concludes.

www.actum.co.za

The Orbimat 165 orbital welding system from Orbitalum is now available in South Africa from Actum Industrial.

Polysoude TIG^{er} technology on show



TIG^{er} technology involves the juxtaposition of two TIG arcs, organised, controlled and combined to act as a single arc, with the addition of wire heated by a third power source.

At the Stainless Steel World Conference & Exhibition in November 2015 in Maastricht, The Netherlands, Polysoude's latest TIG-based weld overlay cladding technology was on show.

The event presents the newest and most relevant innovations in the field of corrosion resistant alloys (CRAs), together with sharing knowledge and good practice. Polysoude, invited by Netherlands-based publishing company KCI, took part in the event as an exhibitor and delivered a technical presentation by Kees Meurs on the company's new TIG^{er} process – TIG electrically reinforced – a process designed particularly for tubing with corrosion resistant alloys.

The principles and numerous technical and economic advantages of the TIG^{er} welding solution were emphasised during the conference. From quality perspective, the quality of the deposit, the low dilution rate and the tight control of the cladding thickness are all crucial requirements for companies striving towards zero-defect weld cladding.

When calculating the profitability of a project, productivity gains are achieved due to high deposition rate; the absence of the need for post cladding machining; and the repeatability of operations derived from successful automation. These are all acutely advantageous economic aspects.

TIG^{er} technology is a variant of hot-wire TIG welding. The basic principle involves the juxtaposition of two TIG arcs, organised, controlled and combined to act as one single arc with a calorific value equal to the sum of two power sources, but with characteristics that are unusual for such intensities.

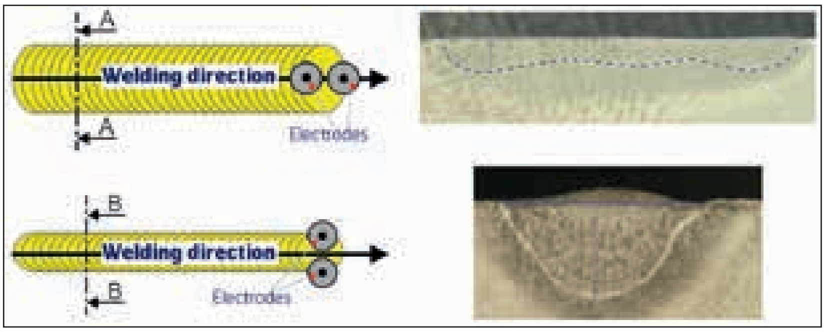
The addition of a preheated wire, which uses a third power source for Joule heating, enables special profiles of the weld pool to be achieved. This also significantly improves the efficiency of the process.

Depending on the requirements, it is possible to optimise the thickness of the layers to within a range of 1.5 and 3.5 mm. This flexibility enables the quantity of weld metal to be adjusted to strict requirements and thus allows significant savings with respect to the costs of filler materials, which are generally noble alloys.

Optimised welding speeds in the order of 70 to 90 cm/min can be achieved with deposition rates of between 2.5 and 6.0 kg/h, about three times faster than that from hot-wire TIG technology.

Control over dilution in the order of 12% for the first layer and 1.5 to 2.0% for subsequent layers is achievable. TIG^{er} technology is calculated to reduce operating costs per kilogram of weld metal deposited by between 20 to 50%.

Following recent industrial successes, Polysoude has reaffirmed its ambition to advance the welding and cladding fields by designing innovative, competitive solutions that draw on in-depth studies of its customers' specific needs and technological expertise.



An asymmetrical shape of the arc column, molten weld pool and fusion zone can be achieved by changing the relative positions of the electrodes.

Ideal applications include horizontal cladding of internal and external tubes and pipes.

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