AFRICAN FUSION

NOVEMBER 2023 Journal of the Southern African Institute of Welding

SAIW

Commercial Banking

Make Nedbank Manufacturing your next big move.

If you are looking for an industry leader who understands the sector, then partner with a bank that sees the bigger picture. We have designed a bespoke offering that will support your manufacturing business needs, and our dedicated team has the knowledge and expertise to help your business grow.

So, why not partner with Nedbank Manufacturing?

Think bigger.
Think Nedbank Commercial Banking.

For more information about our bespoke offering, scan the QR code or e-mail manufacturing@nedbank.co.za.

see money differently


NEDBANK

COSMO TRAINING ACADEMY

COSMO TRAINING ACADEMY
449 Pretoria Road, Silverton, Pretoria
info@cosmotraining.co.za · 012 846 3388
www.cosmotraining.co.za

WELDER COURSES

BASIC WELDER

COURSE FOCUS:

Teaching the learner the basics needed to work with welding equipment

The different welding processes and positions
The up skilling and learning of new welding techniques

This is a practical course, and the modules will be completed in a fully equipped workshop.

GROUP SIZE: 6-12 learners
PRICE: R8999 incl. VAT

On completion of the course you will receive a certificate.

PRACTICAL WELDER

Practical welder training can be booked on a week-by-week basis, either at COSMO Training Academy or in-house.

Practical welder training is tailored to Accommodate any welding skill level, from beginner to experienced.

Training is thus designed to meet the needs of the individual considering the entry skill level and the desired end result. The pace of progress is determined through practical assessments and so the duration will vary from one person to the next.

PRICE ON REQUEST
Contact us today for your Welding skills need!

ENQUIRE ABOUT AVAILABLE DATES IN 2024

CROWN PUBLICATIONS

Published three times a year and mailed out together with *MechChem Africa* by:

Crown Publications (Pty) Ltd

Crown House
Cnr Theunis and Sovereign Streets
Bedford Gardens 2007
PO Box 140
Bedfordview 2008

Tel: (011) 622 4770
Fax: (011) 615 6108

Editor: Peter Middleton
E-mail: peterm@crown.co.za

Advertising: Peter Middleton
E-mail: peterm@crown.co.za

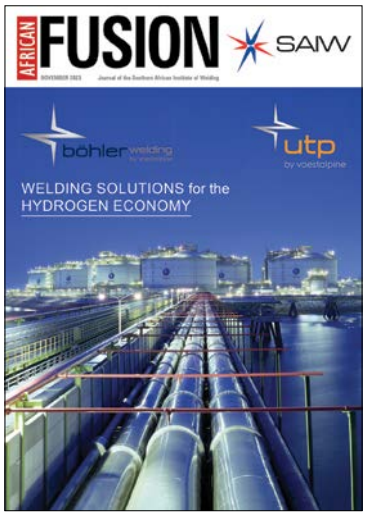
Publisher: Karen Grant

Deputy publisher: Wilhelm du Plessis

Production & layout: Darryl James

Circulation: Brenda Grossmann

Printed by: Tandym Print, Cape



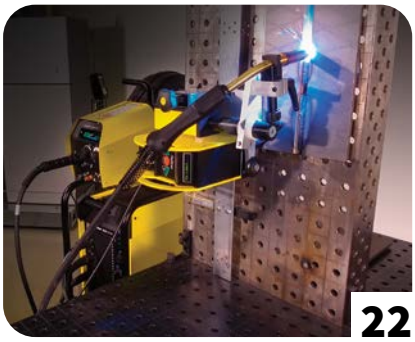
Nicola Faraone, an International Welding Engineer for voestalpine Böhler Welding with a focus on welding consumables for the power and process industries, introduces the company's recently developed welding solutions for hydrogen storage and transportation.

www.africanfusionmagazine.co.za

November 2023

FEATURES

REGULARS



An impressive eye for detail. Creative. Passionate. Wildlife Photographer. Mother.

I am an International Welder.

We think of welding as a 'dirty' job, of loud factories and workshops, of noise, heat and risk. After all, it's merely a tradesman's job, right? Think again, being a **qualified International Welder** is a highly skilled career and your expert welding skills are one of the most internationally sought after, highly paid and essential trades.

Being an **International Welder** isn't just a trade, it's a craft, an art and a science and you'll be able to work in over 60 countries and do a lot more than simply fuse metals together. You'll be **building a better world, a better life** for you and **the generations to come.**

SAIW

Southern African Institute of Welding

Contact SAIW on (011)298 2100 or visit www.saiw.co.za

SAIW and SAIW Certification

SAIW Board

President: Joseph Zinyana – New Age Engineering Solutions
Michel Basson – Sassda
Anthony Boy – CEA
Muzi Manzi – AFSA
Morris Maroga – Eskom
John Tarboton – SAIW
Dawie Olivier – OSG
Charles Dednam – SAISI
Johann Pieterse – AFROX
Carel van Aswegen – Steinmüller
Knox Msebenzi – NIASA
Kevin Xaba – ESAB
Charles Dlamini – Eskom

SAIW Certification Board

Chairperson: G Buitenbos – Steinmüller
D Olivier – SAQCC CP
G McGarrie – Steinmüller
H Potgieter – SAIW Certification
J Tarboton – SAIW
N Venter – Aveng Group
P Bruwer – SAQCC IPE
P Pistorius – University of Pretoria

SAIW and SAIW Certification representatives

Executive director
J Tarboton
Tel: (011) 298 2101
john.tarboton@saiw.co.za

SAIW Certification CEO
Herman Potgieter
Tel: (011) 298 2149
herman.potgieter@saiw.co.za

Training and technology manager
Mark Digby
Tel: (011) 298 2169
mark.digby@saiw.co.za

Executive secretary
Dimitra Kreouzi
Tel: (011) 298 2102 (Direct)
dimitra.kreouzi@saiw.co.za

Finance and administration manager
Michelle Warmback
Tel: (011) 298 2125
michelle.warmback@saiw.co.za

It was a real joy to be able to host our SAIW Awards and Gala Dinner this year. It has been four years since we last gathered for this celebration of success. Congratulations to all those worthy award winners and thanks to all who participated, attended and contributed to making the night memorable. Special thanks also to our sponsors, ESAB and Lincoln Electric.

I hope this dinner will be remembered as a turning point for the SAIW and for the welding industry. We have come through a tough few years but we are now back on the move and stronger. I am particularly pleased with our performance in NDT, for example, which turned a corner in 2022 and is now significantly stronger than it was prior to the Covid pandemic.

We are also replenishing our cash reserves. As a nonprofit company, we need to hold cash reserves for at least nine months, but to ensure SAIW's long-term sustainability we have tended to hold more than that. The reserves have been falling over the past years, but we started to build back in 2022, and, in 2024, will be re-establishing reserves at the preferred level.

Our recovery is complete, and we are more ready than ever to face future challenges.

I would like to draw your attention to our new SAIW Course Prospectus 2024, which we have completely revised to better communicate our offering, with career pathways to help people to make better choices. On the NDT side, for example, there is an excellent introduction by Mark Digby that highlights the importance of taking NDT courses in a preferred order to increase the chances of success. A student may choose to do the NDT methods in any order, but it is best to start with the more concrete ones. Mark suggests starting with Liquid Penetrant Testing (PT), followed by Magnetic Testing (MT) and then Visual Testing (VT), before attempting to do Radiographic (RT), Ultrasonic (UT) and the more advanced methods.

We have also revamped and streamlined our Competent Persons for Pressure Vessels (CP-PV) course. This used to be a six-week course consisting of a foundation week, a core week, and then a four week course on process plant inspection. But this syllabus was originally designed to meet the petrochemical industry's needs, so the industry-led subcommittee set up to oversee the course has changed the syllabus by taking out some of the content that is not needed for general pressure vessel work. So, we now have a new three-week CP-PV syllabus: two weeks and three days of coursework followed by two days of exams, which makes the course much less time intensive and less expensive.

Next year, we will also be trialling an efficient and cost-effective approach to IIW International Welder (IW) programmes. We have found in the past that welding students are reluctant to use virtual welding machines, but we hope a new approach, based on virtual reality computer gaming from a company called Dig in Vision, will change that.

The system uses cloud-based software, a high-end gaming computer, a virtual reality headset and a simple 'torch'. This allows a whole virtual reality welding environment to be created with the job set up inside it. To incentivise its use, we are offering students a 30% discount if they are willing to use this system for 50% of the training time. The model is already proving successful, more resource efficient and cost effective. In addition, the IIW, through the Canadian Welding Bureau, is busy incorporating all the IW course theory.

We are looking forward to an exciting New Year. I invite you all to share it with us.

John Tarboton

SAIW 2023 Awards and Gala Dinner celebrates excellence and industry growth

After a Covid-19 induced four-year hiatus, on 23 October 2023 the Southern African Institute of Welding (SAIW) announced the winners of its prestigious annual awards at a gala dinner in Fourways, Johannesburg sponsored by Lincoln Electric and ESAB.

The 2023 SAIW Awards and Gala Dinner was dedicated to recognising and celebrating remarkable achievements, innovations and contributions within the welding and fabrication sectors, marking a significant milestone in the industry's pursuit of excellence and sustainability.

Opening the event, the SAIW President, Joseph Zinyana reminded guests that the SAIW Gala Dinner had not graced our calendars since 2020, a period marked by the global challenges and disruptions brought about by the Covid-19 pandemic. "Our absence from such gatherings for the past few years reminds us of the resilience and strength of our industry, as well as our commitment to safety and well-being," he said.

"Tonight, we have the distinct pleasure of recognising and honouring those individuals and organisations who have demonstrated exceptional dedication and made significant contributions to both the Institute and the welding industry over the past year. Your unwavering commitment and exceptional efforts have not only sustained us during these challenging times but have propelled us forward," said Zinyana.

The 2023 SAIW Awards and Gala Dinner.

SAIW Executive Director John Tarboton unpacked the theme of the awards evening – 'Unity Through Fusion' – explaining that this reflected the new consolidation of the SAIW and SAIW Certification into a single entity. "We've taken the initiative and established distinct sub-brands and logos for the SAIW, representing our diverse service offerings: Technical Services, Education & Training, and Qualification & Certification. These logos are poised to carve out unique brand identities for our services," he said.

Tarboton added: "Through our unwavering commitment to long-term sustainability, we've created a highly effective turnaround strategy at the SAIW, driven by a comprehensive approach and integrated marketing plan. This success has been achieved amidst challenging times and two restructuring exercises and stems from a united, motivated workforce with shared values."

The SAIW Awards and Gala Dinner also serves as a hub for networking and collaboration, bringing together industry professionals, leaders, and experts in one location, fostering valuable connections and potential collaborations.

A diverse range of awards was presented at the Gala with the additional good news that each student recipient will receive a R60 000 bursary. Awards and winners were:

- The President's Award for NDT Level 1: Sunithi Barends.
- The President's Award for NDT Level 2: Kurt Du Plooy.
- The Phil Santilhano Award for the best Welding Coordinator and Inspector Level 1 student: Tsiliso Litali.
- The Phil Santilhano Award for best Welding Coordinator and Inspector Level 2 Student: Willem Rossouw.
- The Best Welding Co-Ordinator Award: Chandri Swanepoel from Ratamang Civil Projects and Fabrication.
- Best International Institute of Weld-

Sunithi Barends was awarded the SAIW President's Award for NDT Level 1. She is flanked on her left by SAIW executive director, John Tarboton and on her right by Joseph Zinyana, SAIW President.

Tsiliso Litali was awarded the Phil Santilhano Memorial Award for Best Level 1 Welding Inspector and Coordinator Student.

Chandri Swanepoel won the SAIW Best Welding Co-ordinator Award.

ND Engineering won the Best IIW ISO 3834 Company Award.

Honorary Life Membership of the SAIW was granted to Tony Paterson, (left photo) while Makakane Morris Maroga became a Fellow of The SAIW (right photo).

ing (IIW) Manufacturing Certification Scheme ISO 3834 Company Award: ND Engineering.

- Honorary Life Membership of the SAIW: Professor Tony Paterson.
- Fellow of The SAIW Award: Makakane Morris Maroga.
- SAIW Gold Medal 2023: Columbus Stainless.

Sunithi Barends, winner of the SAIW President's Award for NDT Level 1, expressed her pride in the achievement, saying: "I am incredibly proud to win the President's Award for NDT. This recognition will propel my career as an NDT technician, allowing me to become an NDT Level 3 and Inspection Specialist.

"I am honoured and proud to have won the Presidential Prize and been chosen out of all the brilliant students. I am particularly grateful to my colleagues in my current Sasol Inspection Learnership at SAIW who have contributed so much to me winning this award."

Sunithi Barends' prize of a R60 000 bursary from the SAIW will cover her SAIW NDT Level 3 Basic course and UT2 and VT2 modules. "This award and recognition will increase the momentum of my career path as an inspector and NDT technician, as well as my pursuit of becoming an NDT Level Three and Inspection Specialist," said Barends.

Tsiliso Litali was awarded the Phil Santilhano Memorial Award for Best Level 1 Welding Inspector and Coordinator Student. Adding to his triumph is the development of an innovative non-destructive testing (NDT) technique. In Tsiliso Litali's words: "This innovative approach is designed to enhance the detection and characterisation of defects in welded structures, a vital element in ensuring the structural integrity of various projects."

He explained: "'My work has been instrumental in minimising the risk of structural failures, a crucial aspect of overall health and safety. Additionally, the application of these technologies has the added benefit of saving both time and resources, expediting project completion to a remarkable degree."

Chandri Swanepoel won the SAIW Best Welding Co-ordinator Award. Swanepoel said she has had to overcome gender biases in a traditionally male dominated sector. "This has given me a unique perspective on the significance of diversity and inclusion in the workplace and reinforced my commitment to breaking barriers and empowering other women to pursue careers in male-dominated fields," she said.

The overall SAIW Gold Medal award was given to Columbus Stainless for their groundbreaking work in the invention and development of 3CR12 stainless steel, a proudly South African innovation that has revolutionised the stainless steel industry and offers remarkable toughness and weldability, even in thick gauges.

On the company certification side, ND Engineering won the Best IIW ISO 3834 Company Award. The company's owner and MD, Elvis Green, said: "While there is not one singular project that stands out as the crowning achievement, it's the cumulative success of numerous projects and the comprehensive application of ISO 3834 principles that paved the way for this recognition. The decision to integrate ISO 3834 into our operations marked a transformative moment, as it deepened our understanding of welding," he said.

Looking ahead, John Tarboton expressed confidence in the SAIW's upward trajectory and called for continued commitment and dedication from industry professionals. He extended gratitude to the dedicated volunteers who have served the industry selflessly and thanked the entire SAIW team for their unwavering commitment.

www.saiw.co.za

Advancing SA's welding capability for the Power industry

Steinmüller Africa's Senior Welding Engineer, Friedrich Schwim, talks to *African Fusion* about a current flagship welding development, the HP Heaters for Tutuka and Duvha, which have been locally designed in-house by the engineering team and are currently being manufactured out of the company's Pretoria West fabrication facilities.

For over five decades, Steinmüller Africa has been providing comprehensive solutions for steam generating and processing plants in every phase of their life cycles. "Design, maintenance and repair of steam generating plants are core business for us, and this includes manufacturing replacement pressure components at our local facilities in Pretoria West, before installing them on site," begins Friedrich Schwim, Steinmüller Africa's Senior Welding Engineer.

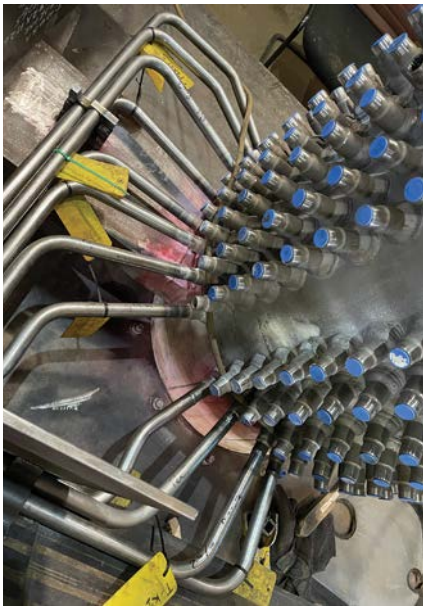
"While we continue to be very active on the maintenance side of steam generation, one of our current flagship projects is at our Pretoria West Workshop on the fabrication side, where we are busy manufacturing replacement HP Heaters for Eskom's Tutuka and Duvha Power Stations," he says.

These heaters are a crucial part of power generation boilers. They take the bled steam from the turbine – which is still at a relatively high temperature and pressure (above 250 °C and 100 bar) – and use it to preheat the boiler feed water. This relieves the pressure on the boiler, reduces the energy and the amount of fuel required to evaporate the feedwater, and therefore increases the efficiency and reliability of energy generation plant.

"We are currently in the fabrication stage of this project, which involves manufacturing a total of 14 HP heaters, which each of which contains some 54 t of mostly imported steel," Schwim continues. Several different variations have been custom designed by Steinmüller's South Africa's engineering team to meet the requirements of the client's specifications.

"This is flagship work because it is designed and manufactured in South Africa, by South African engineers. Only the raw materials are being imported: 16Mo3, which is a specified pressure vessel grade chrome-molybdenum steel alloy for use at high pressures and temperatures and 15NiCuMo (15NiCuMoNb5-4-6) for use on the steam headers, for example," he says.

Describing the complicated structure of these heaters, Schwim says they are effectively heat exchangers with shells 12 to 14 m long and 2.0 m in diameter. Inside, the vessels are packed with tube bundles that carry steam from the low-pressure turbines back to the condenser. Headers on either side of the vessel transfer this steam into the tubes and out on the other side. In the opposite direction, boiler feed water is being pumped through the heater shell, heating up as it passes through.



Machined solid round bars called nipples are first welded onto the header pipe. Each nipple must then be drilled to the right inside diameter so a connecting tube can be welded on, to distribute the steam into the heater.

The headers themselves, he says, are manufactured from forged 15NiCuMoNb5-4-6 (WB36) material. These are critical components that are manufactured locally In Steinmüller's Pretoria West workshop. "For each connecting steam tube, we first must weld a machined solid round bar, called a nipple, onto the header pipe. Each nipple must then be drilled to the right inside diameter so connecting tubes can be welded on, in order to distribute the steam into the heater," Schwim explains.

Most of the header work has already been completed, with the majority of the nipple welding being done using an Oerlikon submerged-arc nipple welding machine that was originally installed for manufacturing headers for the Medupi and Kusile power stations.

"With an OD of just 30 mm, though, submerged arc welding is not always ideal. So, in collaboration with eNtsa at the Nelson Mandela University (NMU), we used friction welding to do the nipple welding for four of the 28 headers – with great success. This is a world-first and has the potential to become a preferred technique for us in the future," Schwim informs *African Fusion*.

eNtsa, along with Eskom, pioneered friction welding as part of an integrity testing technique – called WeldCore – for high-

One of Steinmüller's flagship projects on the fabrication side is the manufacture of replacement HP Heaters for Eskom's Tutuka and Duvha Power Stations.

pressure boiler systems subject to cyclic creep. The process involves removing a core test sample from the shell of a pressure component for cyclic testing and remaining component life assessment. The shell is then repaired using a friction welding technique called friction taper hydro-pillar processing (FTHPP), which fully restores the high-pressure integrity of the system.

Weldcore is not only approved by Eskom, it also has unconditional global acceptance for application on high-integrity plant and equipment designed in accordance with ASME's Boiler and Pressure Vessel Code (BPVC). "This SA-developed expertise in friction welding and FTHPP was used to develop a new friction-welding technique for welding nipples onto headers, which really does look promising in terms of weld integrity," says Schwim, adding that Steinmüller has also done some successful trials using its explosive welding capability, which may also play a role in future header work.

Once the headers are complete, the ends of the steam-tube heater bundles need to be connected to the header nipples. "Here, where possible, we use orbital welding. We have two orbital systems, the first is an AMI system, but it is quite big so we could not use it for the small-bore heater tubes welded to the nipples on this project. It is used, however, for normal tube to tube welding, which is just 25 mm OD with a wall thickness of 2.9 mm. So, we bought a new TIG-based orbital welding system with feed wire and the smallest heads from Polysoude for welding tube-bundle ends to header nipples.

"We had to recruit and train a team of local welders to complete the joints where the orbital heads would not fit and to speed up production. At one point there were six tube bundles on the floor that needed to be welded and each heater has around 900 of these welds. There are not many people who can weld in the cramped space around these tubes so, as with all new projects, we started with a higher-than-expected repair rate. But we are now down to below 2%, which is excellent, particularly on difficult welds like these," Schwim points out.

On the quality side, he says that Eskom requires 100% radiographic testing on every weld on each system, which is factored into the daily routine of the fabrication process. "We have also implemented a new cloud-based production system for this project, a tracking and traceability system called WeldEx. It is a local solution that helps us to record and track progress on a project in real time, with welding supervisors updating the system as specified by the workshop. This system is in the process of being implemented across the entire company to track progress daily on all sites. Steinmüller welds an excess of 100 000 units per year, so tracking each weld is critical to us" he says.

A view of the cramped internal space inside an HP heater.

"We have also added fitting, cutting and prepping operations to the WeldEx system. These can now be tracked to monitor productivity on the production side and not just the welding side of things. This helps to give a complete and up-to-date picture of how production is going, and it assists in compiling the records we need for our ISO 3834 and ISO 9001 quality management systems," he adds.

Retaining skills, according to Schwim, is a key challenge for Steinmüller as for the whole of the South African welding industry. "It has been 30-years or so since we last built these particular HP heaters, so the whole team is new. The design was done by new and relatively young engineers. Then we have had to develop people from scratch to have the expertise and experience to deliver the flawless welding results that are required," he points out.

"We all went through a massive learning curve on this project, but after a few difficulties, things have come together and we now have a good system running. We would like to keep that going, though, with ongoing work to help us to retain the skills we have developed," Schwim says.

"We have now manufactured and tested all 28 of the headers required for this project, with 24 of them being welded using our Oerlikon system and a further four being done using friction welding. To date, two fully completed HP heaters have been delivered to Duvha and are waiting to be installed, while a further two for Tutuka are complete and in storage at the workshop, ready to be delivered and installed by Steinmüller.

"We continue to fabricate and assemble the remaining units, all of which will be completed in the new year," says Friedrich Schwim. "We believe we are well placed to do more of this work, which, if not done perfectly, can prove to be very costly for inexperienced fabricators," he concludes.

steinmullerafrica.com

Steinmüller had to recruit and train a team of local welders to complete the joints where the orbital heads would not fit, and to speed up production.

SAIW Gold Medal Award: Columbus Stainless

In recognition of its role in the invention and development of 3CR12 stainless steel, Columbus Stainless has been awarded the SAIW Gold Medal Award.

Columbus Stainless receives the SAIW Gold medal award at the SAIW Gala Awards Dinner.

Columbus Stainless, a pioneering name in the world of stainless steel, has been honoured with the prestigious 2023 SAIW Gold Medal Award for its exceptional contributions to the field. This recognition is testament to its groundbreaking work in the invention and development of 3CR12 stainless steel, a proudly South African material that has revolutionised the stainless steel industry and, notably, offers remarkable toughness and weldability, even in thick gauges.

Columbus Stainless's invention of 3CR12 stainless steel marked a significant milestone in the industry. This achievement was born out of a vision to address the limitations of existing ferritic stainless steels, especially in applications that demanded superior weldability, toughness and resilience.

Columbus Stainless embarked on a remarkable journey of innovation, spanning several decades, to create and evolve 3CR12 stainless steel, a proudly South African invention that now features in international specifications as ASTM S41003 and EN 1.4003. Here is a glimpse into their innovation timeline:

- Conceptualisation and Birth (1976-1977): The foundation for a low-chromium ferritic stainless steel with exceptional weldability was laid by the visionary pioneers of 3CR12. A pivotal moment arrived when an off-spec 409 heat was produced, leading to the discovery of a tough, fine-grained dual-phase ferrite-martensite heat-affected zone when welded.
- Plant Production and Breakthrough (1978-1980): In 1978, Columbus Stainless achieved a significant breakthrough with the production of the first plant heat, which ultimately led to the launch of internal grade 41211 in 1980. This variant exhibited unparalleled weldability, even in thicker sections, and showcased remarkable HAZ toughness and low ductile to brittle transition temperature (DBTT).
- Continuous Refinement and Innovation (1988-1990s): Columbus Stainless persisted in refining the chemistry of 3CR12, culminating in the development of Grade 41214 chemistry. This innovative step involved the removal of nickel and titanium while maintaining austenite potential, enabling cost-effective production and positioning 3CR12 as a bridge between mild steel and alloyed stainless steel.
- Advancements in weldability and sensitisation prevention (2000s): Collaborative research efforts with institutions such as the University of Pretoria led to an in-depth understanding of sensitisation modes post-welding. The creation of 'bullet-proof' 3CR12Ti (41313) with high austenite potential and Ti-stabilisation showcased an unparalleled level of weldability and resistance to sensitisation.
- Recent Innovations (Past 10 Years): The introduction of 3CR12HP400, a higher yield strength variant, opened new design possibilities for thinner sections while maintaining outstanding weldability.

3CR12 is now widely used for coal wagons because no corrosion allowance is necessary and much thinner 3CR12 plate can be used, giving a lighter wagon with increased payload and a much longer life.

Legacy and impact

The contributions of Columbus Stainless have extended far beyond the boundaries of the metallurgical world, impacting diverse industries, including sugar, mining, and construction. The development of 3CR12 stainless steel has empowered these sectors with a transformative material that embodies toughness, weldability, and corrosion resistance.

"With deep appreciation for their incredible journey from conceptualisation to revolutionary development, we wholeheartedly endorse Columbus Stainless as the deserving recipient of the SAIW's Gold Medal Award. Their unyielding commitment to innovation, excellence, and the advancement of metallurgical science has not only elevated their status within the industry but has also positively impacted countless sectors that rely on the capabilities of 3CR12 stainless steel," said John Tarboton at the SAIW Gala Awards Dinner.

"Columbus Stainless' invention and development of 3CR12 stainless steel epitomises the spirit of ingenuity, dedication and advancement that the SAIW's Gold Medal Award seeks to honour," he added.

Breakthroughs of this magnitude are infrequent and are invaluable in providing more cost-effective materials for a wide range of applications. The innovation exhibited by Columbus Stainless is particularly noteworthy considering the challenging circumstances of that era, marked by embargoes and sanctions that necessitated the development of their unique solutions.

The legacy of Columbus Stainless and the impact of 3CR12 stainless steel on multiple industries are undeniable. This remarkable material bridges gaps and brings new possibilities to engineering and construction. It is a testament to the power of innovation in the metallurgical world, and Columbus Stainless is certainly deserving of this recognition.

www.columbus.co.za

The vital role of the welding engineer

Tony Paterson, who was recently granted Honorary Life Membership of the SAIW, expressed his thoughts on the boundary spanning role played by welding engineers and called for South African welding engineers to aspire to higher levels of ongoing professionalism.

Tony Paterson.

Where common or complementary interests are involved governed by different groups whose understanding and analyses are derived from different theoretical backgrounds, as in the case of welded fabrication, the Welding Engineer is well positioned to play a boundary spanning role. Competent Welding Engineers are well suited to providing specialist boundary spanning inputs, passing on the 'why' on understanding, rather than only the 'how.'

These welding related inputs fall into three areas: technical, economic and quality inputs.

On the technical side, welding engineers are exposed to structural engineering design. While structural engineers develop solutions to yield the desired end product, their design models tend to assume that materials, including the weld metal, are homogenous and isotropic. The limiting stress capacity – to which a risk-based uncertainty factor is applied – is taken as the yield stress for static loading. Failure is, therefore, stress or, sometimes, strain/deflection related.

Where cyclic or fatigue loading is dominant, capacity is life related, this governed by the Youngs modulus of the base material together with the weld geometry. Failure is given at a load repeat limit. Outside of the aero-space sector, a single set of straight-line graphs representing stress vs the log of the number of repeated load applications has been developed that relates directly to welded or bolted geometry.

For steels there exists a load-cycle level below which failure will not occur – the endurance limit. Whist the fatigue curves differ for each material group, an acceptably good approximation of this limit can be determined by dividing the allowable stress for a given number of load repeats by the Youngs Modulus of the steel. The fatigue curves are independent of the alloy or steel grade as the welds will fail first.

From a metallurgy point of view, on a scale some 10 000 to 100 000 times smaller, models consider materials to be heterogenous and anisotropic. The important weld HAZ area is an example. Material strength is taken as the ultimate tensile strength. Fatigue is governed by crack initiation at a position of stress concentration, rate of crack development and final failure and fracture mechanics can be used to determine residual life.

Weld or material geometry and imperfections, as well as the impacts of stress concentrations, are understood. The impact of weld HAZ grain growth management through pre and, sometimes, controlled post weld heat soaking is understood. Metallurgists are aware of material manufacturing defects, composition and shape tolerances and, also, the effects of global sourcing. As materials have become stronger, structures lighter and more prone to deflection, welds have become more highly stressed. Thus, failure is more likely. The effect of transport to site may be significant.

The Welding Engineer, positioned at the interface of the welding discipline, is able to speak to different centres of influence in the different ways that reflect the relevant input. Life extension applications, where base materials have changed, and failure analysis offer ongoing challenges to the discipline. The effects of bacteria and corrosion related to the weld area are of ongoing interest, particularly in the food, beverage and pharmaceutical arenas.

Turning to economics, the economic effects of time and consumables require data and consideration. Analysis by a welding engineer should assist in welder and consumables selection and support, and in profitability. In addition, decisions regarding appropriate technology for the type and scale of project, together with the jobbing versus production line environment will benefit from informed input to the financial department.

As noted above, life extension is a new relevant challenge to the sector, while risk assessment and mitigation in terms of process and materials selection are also important economic inputs.

Finally, quality, and by this I mean fitness for purpose as distinct from a quality system, is of vital importance. Where welding is considered, valuable input can be given at the conceptual level, at the practical design level in terms of buildability and weldability, and at the fabrication level in terms of the stress regimes of specific welds. Generally, only 5 to 10% of welds are significantly stressed and designers can identify these. This information can assist in the allocation of welders and the focus of attention of supervision and inspection personnel. The Welding Engineer should also be able to assess quality risks and may, from time to time, recommend joining alternatives such as bolting on site.

To achieve this level of input, it is not sufficient for the Welding Engineer to be only technically trained. This represents the science of the discipline. He or she also needs to build up a sufficient degree of ongoing and appropriate practical experience to become recognised as competent, which can be achieved by pursuing CIWE (certified international welding engineer) status, for example.

Experience demonstrates the practical art of engineering, while anchored by the theory. This is generally true of all professions. The PrEng is seen as Part 3 of an engineering degree. Documented experience and a formal test of competence after some three or four years of specific and varied experience leads to this professional recognition of engineering competence. But, in practice, this recognition is time limited and requires a career commitment to keeping up to date with both theory and practice.

Perhaps an interest group can be formed to pursue recognition of the ongoing professional competence of South African welding engineers, so they too can aspire to the levels of professionalism seen in Europe.

Welding solutions for the transportation and storage of hydrogen

Nicola Faraone, an International Welding Engineer for voestalpine Böhler Welding with a focus on welding consumables for the power and process industries, introduces the company's recently developed welding solutions for hydrogen storage and transportation.

In a world where energy consumption is projected to grow, there is an urgent need to reduce CO_2 emissions drastically, as renewable energies take over to meet energy targets. Wind and solar energy have been shown to be reliable options for producing CO_2- free energy. The main drawback of these is that wind and sunshine are not constantly available. This in turn causes issues during peak times when demand on the grid is high. There is also a risk of wasting energy when production exceeds demand.

Hydrogen offers options for stabilising energy production for renewables. The gas is well known as a fuel and a feedstock, but it is also projected to become the most popular energy carrier in an integrated cycle connected to the energy produced from renewable sources.

We will therefore need pipelines and tankers for hydrogen transportation, as well as tanks for storage. Hydrogen can be transported and stored in gaseous or liquid state, bringing different challenges for the choice of materials used. voestalpine Böhler Welding is developing and proving a suitable range of welding consumables to meet the fabrication requirements of this future challenge.

Pipelines and tankers for hydrogen transportation, as well as tanks for storage will be needed to meet the fabrication requirements of the future hydrogen challenge.

Hydrogen production

Hydrogen is the most abundant element and the smallest molecule in the universe. It can be utilised as a fuel in tur- bines or in fuel cells, and is a fundamental feedstock for the petrochemical and urea industries. The main technologies to produce hydrogen include: Methane reforming; coal gasification; and the electrolysis of water.

Depending on the production technology and source, the hydrogen produced is labelled using different colours. Grey hydrogen is not climate-neutral, since coal and natural gas are used as the raw materials for production, which results in significant CO_2 emissions. Blue hydrogen is a more CO_2-neutral way of producing grey hydrogen, because the CO_2 generated during production is separately captured and permanently stored; while green hydrogen is produced from renewable energy using electrolysis, so is 100% CO_2-neutral with respect to the fuel used and the process. Of these, green hydrogen is the one pushing the development of renewable energy use and electrolysers, while blue hydrogen is considered to be an important part of the transition to 100% green hydrogen.

Arc welding processes for the hydrogen transportation and storage components

The main welded components for hydrogen transportation and storage are pipelines, storage tanks, carriers, trailers, vessels, etc. These components are generally well-known, with the welding processes involved being the same as those we already see used in industries such as Oil & Gas and petrochemicals.

In particular, the following processes are mainly used:

- GTAW, mainly for root passes and filling passes for low thickness components.
- GMAW for filling passes.
- SMAW, most notably, for the pipelines.
- FCAW for high productivity and out-of-position welding.

Base Material type	Product name	EN ISO Classification	Welding Process
Alloy 800/800H/800HT	UTP 2133 Mn	3581-A, EZ 21 33 B 4 2	SMAW
Alloy 800/800H/800HT	UTP A 2133 Mn	14343-A, WZ 21 33 Mn Nb	GTAW
Alloy 800/800H/800HT	UTP A 2133 Mn	14343-A, GZ 21 33 Mn Nb	GMAW
Alloy HK, HP, HP Nb, HP MA	UTP 2535 Nb	3581-A, EZ 25 35 Nb B 6 2	SMAW
Alloy HK, HP, HP Nb, HP MA	UTP A 2535 Nb	14343-A, WZ 25 35 Zr	GTAW
Alloy HK, HP, HP Nb, HP MA	UTP A 2535 Nb	14343-A, GZ 25 35 Zr	GMAW
Alloy 35/45, 35/45 MA	UTP 3545 Nb	3581-A, EZ 35 45 Nb B 6 2	SMAW
Alloy 35/45, 35/45 MA	UTP A 3545 Nb	18274, S Ni Z (NiCr36Fe15Nb0.8)	GTAW
Alloy 35/45, 35/45 MA	UTP A 3545 Nb	18274, S Ni Z (NiCr36Fe15Nb0.8)	GMAW

Table 1: voestalpine Böhler Welding has a full portfolio for the welding of reformers tubes.

Green hydrogen is pushing the development of renewable energy use and electrolysers.

- SAW for heavy-walled vessels for CGH2 (compressed gas hydrogen) storage and for the manufacturing of longitudinal seams of welded pipe.

In the welding industry – apart from some small additions to the shielding gases for GTAW and GMAW processes and in the rutile and cellulosic flux covered electrodes – hydrogen is rarely used. The reason is that hydrogen is often detrimental to weld joints, creating serious defects, most notably, cracks.

Hydrogen can enter a weld pool through the residual humidity in the coverings of electrodes or fluxes, but there are also potential risks – especially in the O&G industry – associated with the presence of hydrogen in process streams. Sulphide stress corrosion cracking (SSCC) and high temperature hydrogen attack (HTHA), for example, are known causes of failures in the Oil & Gas industry.

Defects caused by the hydrogen in the weld joints include worm holes, porosity, fish eyes, hydrogen-assisted cold cracking (HACC), hydrogen-assisted cracking (HAC), and hydrogen induced cracking (HIC). These are all undesirable phenomena associated with residual quantities of hydrogen present in the weld metal. The future challenge for construction in the hydrogen industry is to guarantee safe service conditions in 100 % hydrogen environments, including some potential residual detrimental elements, such as the electrolytes. In particular, the main task for the materials and welding engineers will be the assessment of the potential for hydrogen embrittlement on steels being used.

Hydrogen molecules can attack the surface of the steel by absorption, separate into atomic hydrogen by dissociation, and migrate as hydrogen atoms into the steel. There, the hydrogen atoms may react with metallic materials resulting in specific issues:

1. Hydrogen embrittlement: the absorption of the hydrogen atoms into the steel with the direct consequence of reducing the ductility and toughness of the steel. In general, the susceptibility to hydrogen embrittlement increases as the material strength increases.
2. Property changes at low temperatures: tensile properties of austenitic stainless steels increase at sub-zero temperatures, while elongation and impact properties reduce.

The role of the ammonia in the hydrogen economy and related welding challenges

Hydrogen is an important feedstock in the fertiliser industry and hydrogen used for ammonia production is often defined as green ammonia (GNH_3). Green ammonia can play an important role in the hydrogen industry, not only as a feedstock for the chemical industry, but also as the energy carrier for hydrogen transportation.

Material	Gaseous hydrogen	Liquid hydrogen	Comment
Carbon steel	Acceptable	Not acceptable	Not suitable for cryogenic service
Austenitic SS	Acceptable	Acceptable	Suitable for cryogenic service
Nickel Alloys	Not acceptable	Acceptable	High risk of hydrogen Embrittlement
Aluminium Alloys	Acceptable	Acceptable	/

Table 2: Material compatibility for compressed gas hydrogen and liquid hydrogen applications.

In green ammonia projects, the core welded components, in addition to the ones for the process equipment for the production of ammonium carbamate – $[NH_4^+][H_2NCO_2^-]$ – are the pressure vessels used to store the H_2 produced by electrolysis and renewable energy (wind or solar).

The big challenge for the materials and welding engineers is to guarantee safe compressed gas hydrogen storage at high pressure (up to 200 bar). Moreover, in order to reduce the wall thicknesses for the vessels and to increase the operating pressure, high strength steels may be selected, with a higher potential risk of hydrogen embrittlement compared to common steels.

Hydrogen forms explosive mixtures at concentrations of 4 to 74% and the use of ammonia as an intermediate energy vector reduces this potential risk. After transportation, the ammonia can be transformed back into H_2 before use, or it can be used directly as feedstock as well as fuel in turbines to produce CO_2-free electricity.

Welding engineers also need to find optimal solutions for ammonia storage tanks and carriers, while considering the potential risks of stress corrosion cracking related to condensed ammonia in the anhydrous state. For this reason, materials with ultimate tensile strengths of a maximum of 485 MPa (70KSi) are often selected and need to be carefully welded with appropriately developed filler materials in order to control tensile and hardness properties in the weld joint.

Constant load testing on Böhler Welding filler materials

The susceptibility of welded components such as pipes and tanks to hydrogen embrittlement can be assessed using different tests. These include, amongst others: Constant load tests in accordance with ISO 16573 Part 1; Slow strain tests in accordance with ISO

Product name	AWS	EN ISO Classification	Welding Process
BÖHLER FOX EV 60	A5.5, E8018-C3H4R	2560-A, E 46 6 1Ni B 42 H5	SMAW
Diamondspark Ni1 RC SR	A5.29, E81T1-Ni1M-JH4	17632-A, T 50 6 1Ni P M21 1 H5	FCAW
Union S 3 Si - UV 418 TT	A5.17, F7A8-EH12K	14171-A, S 46 6 FB S3Si	SAW

Table 3: Welding processes and voestalpine Böhler Welding consumables selected for constant load testing.

voestalpine Böhler Welding has a strong heritage in the production of stainless steel filler materials for critical applications at cryogenic temperatures.

Property	Requirement in acc. to EN 10028 for P355 NL1 steel
R_{p02}	> 355 MPa
R_m	> 490 MPa
A	> 22 %
Impact energy (transverse)	> 27 J @ -40 °C

Table 4: Constant load test requirements for P355 NL1 carbon steel.

pH_2 @ 80 °C [bar]	Electrolyte NaCl [g/l]	Sample exposure	Fracture	Hydrogen content [ppm]
SMAW Böhler FOX EV 60				
100	0	Gaseous	NO	0.09
100	200	Gaseous	NO	0.17
100	200	Electrolyte	NO	0.12
FCAW Diamondspark Ni1 RC SR				
100	0	Gaseous	NO	0.10
100	200	Gaseous	NO	0.09
100	200	Electrolyte	NO	0.09
SAW Union S3Si (wire) and UV 418 TT (flux)				
100	0	Gaseous	NO	0.16
100	200	Gaseous	NO	0.19
100	200	Electrolyte	NO	0.11

Table 5: Constant load test results. Testing conditions: Hydrogen pressure: 100 bar; Temperature: 80 °C; Load: at yield strength of the material; Testing time: four-weeks per specimen; dry: no electrolyte; and wet: 200 g/l NaCl electrolyte.

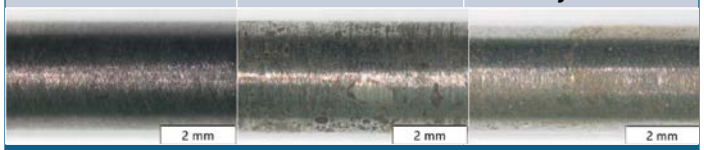
SMAW Böhler FOX EV 60		
Gaseous	Gaseous 200 NaCl	Electrolyte 200 NaCl
		
FCAW Diamondspark Ni1 RC SR		
Gaseous	Gaseous 200 NaCl	Electrolyte 200 NaCl
		
SAW Union S3Si (wire) and UV 418 TT (flux)		
Gaseous	Gaseous 200 NaCl	Electrolyte 200 NaCl
		

Table 6: Samples surface condition after testing.

16573 Part 2; as wells as Fracture mechanics tests; Small punch tests; Permeation tests; and Dynamic tests.

In order to verify the hydrogen embrittlement resistance of filler materials developed for the construction of pressure vessels for gas hydrogen storage, voestalpine Böhler Welding performs constant load test on a selection of welding products.

The constant load test is performed under 100 % hydrogen, which makes it more representative of the operating condition than other tests designed to demonstrate HIC (hydrogen-induced cracking) resistance in H2S service (EN 10229 or NACE TM 02/84). A selection of filler materials for the main processes used in pressure vessel and pipeline construction have been tested in order to verify the resistance to hydrogen embrittlement. The constant load test enables estimates of the maximum diffusible hydrogen content to be determined at which a material does not fail due to hydrogen embrittlement under a constant load.

The GTAW (TIG) process was not included in this testing campaign since it is used mainly for root pass/tack welding under high dilution conditions that do not represent all-weld-metal for the constant load test. In addition, FCAW has been preferred to GMAW because of the better usability, especially for out-of-position welding.

The mechanical properties of the selected filler materials, following usual post-weld heat treatment, match the requirements of the carbon steel that is permitted for selection for this application (P355 NL1, for example. See Table 4). The higher the temperature and the pressure, the tougher the testing condition.

No fractures on any of the all-weld metal specimens were observed under dry or wet conditions. The results confirm the low tendency to hydrogen embrittlement under the H2-gas environment of these Böhler Welding products.

Böhler welding filler materials for liquid hydrogen applications

Similar to natural gas, gaseous hydrogen can be liquefied by cooling at cryogenic temperature. For hydrogen, the liquefaction temperature is -253 °C. In its liquid state, hydrogen can be stored and transported in tanks that require a lower volume compared to the gaseous state. This is a very important property when the hydrogen cannot be transported using pipelines (overseas, for example).

The metallic materials for the liquid hydrogen tank manufacturing must be carefully selected, considering the operating temperature of below -253 °C. A typical choice for this application is stainless steel, due to its good toughness properties given by an austenitic structure at sub-zero temperatures.

voestalpine Böhler Welding has a strong heritage in the production of stainless steel filler materials and, in particular, for critical applications at cryogenic temperatures. A comprehensive portfolio of controlled-ferrite products is available and we are able to guarantee the requested impact properties for liquefied natural gas applications.

In the ASME BPV Code, Section VIII Div.1, part UHA-51 defines the rules for impact testing heat affected zones and base metals, depending on the MDMT (minimum design metal temperatures) for pressure vessels constructed from high alloy steels. The typical requirement for the weld metal is 0.38 mm of lateral expansion at -196 °C.

Also available and well established in the market is a welding consumables portfolio that guarantees outstanding properties at cryogenic temperatures even lower than -196 °C, under the product names Böhler ASN 5 and Thermanit 18/17 E Mn.

When the minimum design metal temperature (MDMT) is colder

Welding Process	Consumable Type	Product name
SMAW	308L	Böhler FOX EAS 2 LF
FCAW	308L	FOXcore 308L T1 LF
GTAW	308L	Thermanit JE 308L Cryo
SAW	308L	Thermanit JE 308L Cryo - Marathon 431
SMAW	316L	Böhler FOX EAS 4 LF
FCAW	316L	FOXcore 316L T1 LF
GTAW	316L	Thermanit GE 316L Cryo
SAW	316L	Thermanit GE 316L Cryo - Marathon 431
GMAW	316LSi	Thermanit GE 316L Si Cryo

Table 7: voestalpine Böhler Welding stainless steel filler materials for critical applications at cryogenic temperatures.

Product name	AWS	EN ISO Classification	Welding Process
BÖHLER FOX ASN 5	A5.4, E317L-15 (mod.)	3581-A, E 18 16 5 N L B 2 2	SMAW
Thermanit 18/17 E Mn	A5.9, ER317L(mod.)	14343-A, Z 18 16 5 N L	GTAW
Thermanit 18/17 E Mn	A5.9, ER317L(mod.)	14343-A, Z 18 16 5 N L	GMAW
Thermanit 18/17 E Mn - Marathon 104	A5.9, ER317L(mod.)	14343-A, Z 18 16 5 N L	SAW

Table 7: Böhler ASN 5 and Thermanit 18/17 E Mn consumables.

Process	d [mm]	Gas	KV @ -196°C [J]			L.E. @-196°C [mm]			KV @ -269°C [J]			L.E. @-269°C [mm]		
GTAW	1.6	Ar	93	81	86	1.06	0.98	1.07	88	82	81	1.03	0.87	0.89
GTAW	2.4	Ar	78	85	84	0.91	1.06	1.06	79	92	80	0.76	1.03	0.91
Process	**d [mm]**	**Gas**	**KV @ -196°C [J]**						**KV @ -269°C [J]**					
GMAW	1.2	M12	69		74		84		80		79		84	
GMAW	1.2	M13	82		84		82		82		83		83	
GMAW	1.2	M22	45		42		50		44		46		45	

Table 8: Impact toughness results for the wire Thermanit 18/17 E Mn welded using GTAW and GMAW processes.

than –196 °C (-320 °F), as for liquid hydrogen applications where the MDMT is below -253 °C, UHA-51 sets further rules for permissible welding processes (SMAW, FCAW, GMAW, SAW, PAW and GTAW) and for toughness testing – for both PQR qualifications and filler materials pre-use testing. Specific requirements for the ferrite content and impact properties – such as 0.53 mm of lateral expansion at -196 °C, for example – are defined when type 308L and 316L filler metals are welded using GTAW, GMAW and FCAW process, and voestalpine Bohler Welding is further improving this portfolio in order to meet these ASME requirements.

Conclusions

Thanks to multi-purpose use as a fuel, feedstock and energy carrier, hydrogen will play a primary role in the reduction of our carbon footprint, and new investments in hydrogen terminals, pipelines and carriers will be necessary to support this economy.

voestalpine Böhler Welding is actively working to support its partners on this path to the reduction of emissions, investing in new product developments and testing in order to be one step ahead in this emerging market.

www.voestalpine.com/welding

Novel metal deposition-based additive manufacturing for aluminium alloys

Angshuman Kapil, Vatsalya Sharma and Abhay Sharma of KU Leuven University in Belgium, along with Jan De Pauw of the Belgian 3D printing startup company, ValCUN BV, introduce molten metal deposition (MMD), a disruptive additive manufacturing process for aluminium and some initial research into single droplet deposition.

Aluminium (Al) alloys have significant applications in many sectors, including but not limited to the automotive, aerospace, and aircraft industries. Although additive manufacturing (AM) of Al alloys has gained significant interest in the industry and academia, its full-scale implementation is currently restricted due to issues such as porosity, low mechanical properties, large solidification shrinkage, etc. This study highlights a new molten metal deposition-based AM technique developed by 'ValCUN' that not only alleviates these issues but also provides a pathway for fast and affordable Al 3D printing.

The novel disruptive technique reduces capital investment and operating costs by foregoing the use of lasers and improves safety and sustainability by employing safe-to-handle wire feedstock (even in recycled conditions) instead of powders. The process uses continuous extrusion of molten metal at an adaptive resolution to deliver high build rates that enable the production of medium-sized and complex 3D-printed Al metal components such as manifolds, heat exchangers, and lightweight parts for robots.

To better understand the process, it is crucial to explain the post-deposition behaviour of individual droplets. For this purpose, a parametric study is conducted to understand the influence of the initial conditions of molten Al droplets on the post-impingement (with the heated metal substrate) behaviour and final shape. During experimentation, the temperature and size of the droplet before detachment is captured. Post-deposition droplet behaviour and shape are then utilised to fine-tune the process parameters for more accurate AM of Al parts with complex shapes and features.

1. Introduction

Over the past two decades, metal additive manufacturing (AM) has made significant progress owing to the availability of cost-effective industrial lasers, high-performance computing software and hardware, and the availability of a wide array of metal feedstock in powder or wire form [1]. Metal AM, with the ability to fabricate parts with intricate geometries, is increasingly finding acceptance for applications in many critical fields, including medical implants and aerospace [1,2].

Although metal AM parts have attained fully certified production readiness for specific applications, it is necessary to have a comprehensive and fundamental understanding of the process involved, the feedstock, its structure, and properties, in order to fabricate reliable, defect-free and structurally sound metal AM parts.

The exponential rise in the research interest in metal AM is evident from the increasing number of comprehensive reviews available in the literature [1,3-11]. While many metal AM technologies exist, the fusion-based AM technologies – powder bed fusion (PBF) and directed energy deposition (DED), using high-energy-density beams, including lasers, electron beams or electric arcs as the heat source – have garnered increased industry and academic interest. The wider acceptance of PBF and DED technologies for metal AM compared to the indirect and solid-state metal AM technologies – binder jetting, fused filament fabrication [12], cold spray AM [13], and ultrasonic AM [14] – is because of the ability of PBF and DED technologies to fabricate components with significantly superior performance owing to their inherent complicated thermal history [15].

In the area of metal AM, the most investigated material class after steels and titanium alloys are aluminium (Al) alloys [16,17]. Al alloys find widespread application in the automotive, aerospace, and rail transportation industry owing to their favourable properties, including low density, high thermal conductivity, good mechanical properties and corrosion resistance, wide availability, and lower costs [18].

Despite multiple advantages, the growth of Al alloy AM has been relatively slow compared to other metallic alloys [19], owing to the numerous technical challenges associated with the currently employed techniques. To date, the laser-based PBF process remains the most widely investigated technique for Al alloy AM, followed by the arc-based DED process [18]. Laser wavelength is an issue for Al alloy AM due to the high reflectivity of Al alloys [19]. Moreover, the laser-metal powder interaction, which involves a combination of mechanical, thermal, physical, metallurgical, and hydrodynamic phenomena, makes process control difficult.

Al parts fabricated using PBF are subject to numerous defects, including porosity, hot cracking, poor surface finish, anisotropy, vapour plumes, spatter, and solute losses [20, 21]. Arc-based DED is a suitable option for Al alloy AM due to the unconstrained build volumes, and the ability to use feedstock in the form of a wire that not only alleviates the cost but also reduces health and safety concerns [22].

However, there are certain critical issues when arc-based DED is employed for Al alloy AM. Firstly, the Al parts fabricated using arc-based DED have a significant presence of pores that lead to severe degradation of the mechanical properties [23]. Secondly, due to the high thermal conductivity of Al alloy, only a small portion of the arc energy is absorbed by the molten pool and the wire, leading to low thermal efficiencies and consequently lower deposition rates [24].

Use of the above-mentioned processes for generalised Al alloy AM is further limited due to issues such as the propensity of Al alloys to form adherent oxides, the relatively wide solidification range, and the relatively poor flowability of Al metal powders [19].

Over the past few years, research on Al alloy AM has been directed towards the development of alternative novel and efficient AM processes that can increase product quality, minimise defects and reduce the overall cost. This paper focuses on a novel molten metal deposition (MMD) based AM process for 3D printing of Al alloys.

2. MMD-based AM of Al alloys: the process

The novel, innovative and proprietary metal 3D printing process developed by 'ValCUN' is disruptive to all existing metal 3D printers and has been named molten metal deposition (MMD). Like the commonly seen polymer fused deposition modelling (FDM) technology, the process uses Al filler wire instead of polymer, providing

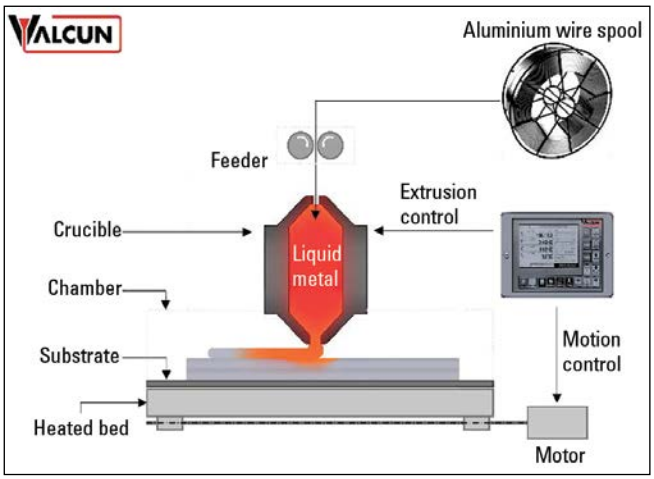


Figure 1: Schematic diagram representing the working principle of the MMD technique for Al alloy AM.

a pathway for fast and affordable Al 3D printing.

Figure 1 schematically describes the working principle of the developed MMD technique. The Al wire is fed and melted to a liquid state in the crucible through resistive heating. Liquid aluminium is then extruded through the nozzle. The temperature of the nozzle is controllable, which directly affects the temperature of the extruded Al. The extruded Al detaches from the nozzle due to gravity and surface tension forces, travels towards the substrate, and fuses with the previous layer to build up the part.

Note that the temperature of the substrate is also controllable. ValCUN's in-house developed software generates both the toolpath and the print parameters. Once the desired part is deposited, the parts are detached from the quick-release substrate.

The developed proprietary technique for direct 3D printing of Al alloys is fast, simple, sustainable, and deployable. It allows direct, on-demand manufacturing of Al parts. Automatable pre- and post-processing allows for a reduction in lead times and simultaneously ensures the availability of parts.

The novel technique reduces capital investment and operating costs by foregoing the use of lasers and improves safety and sustainability by employing safe-to-handle wire and granular feedstock instead of powders, which can be toxic. The process is energy efficient (up to 80% savings) and has a lower environmental impact, providing a greener AM solution by reducing waste and material usage and reducing the use of toxic chemicals.

3. Experimental materials and methods

In this study, the single droplets of Al are deposited on Al substrates. ER4043 welding wire with a diameter of 1.2 mm was chosen as the filler wire and AlMgSi1 plates (50×50×2 mm) were used as the substrate. The chemical composition of the wire is provided in Table 1, obtained from the product certificate provided by the supplier.

Mn	Si	Fe	Cu	Mg	Al
<0.10	4.5-5.5	<0.40	<0.10	<0.10	Balance

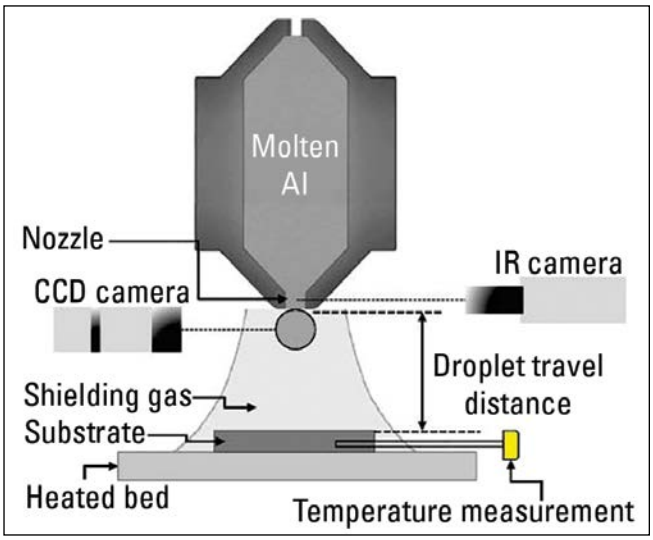
Table 1: Chemical composition of the filler wire (wt%).

Figure 2 schematically depicts the experimental setup. For the deposition, three nozzle temperatures (NT) of 750, 850, 950 °C were used with three substrate temperatures (ST) of 400, 450, 500 °C. Three droplet travel distances (H), ie, the distance from the nozzle to substrate of 20, 25 and 30 mm were considered. This experimental matrix is presented in Table 2. A total of 21 experiments (7 parameter sets with 3 repetitions at each set) were conducted to understand the influence on the deposited droplet attributes.

Argon gas with a flow rate of 2.0 l/min was used to shield the droplet and the substrate from atmospheric influence. The mass flow rate of the molten Al was kept constant at 500 mm/min. The nozzle temperature was measured using an infrared (IR) camera with a lens having a focal length (f) of 25 mm.

The droplet temperature lies within ±10 °C of the nozzle temperature, and hence the nozzle temperature is considered to be the initial droplet temperature.

An optical camera was employed to monitor the droplet formation and pinch-off. Figure 3 shows the state of the droplet just before pinch-off, along with the nozzle and droplet temperature measurements for experimental condition 4 provided in Table 2 and the substrate temperature was measured using a Type K thermocouple.



Experimental setup.

Exp no	N_T (°C)	S_T (°C)	H (mm)	Repetitions
1	850	450	20	3
2	850	450	25	3
3	850	450	30	3
4	750	450	25	3
5	950	450	25	3
6	850	400	25	3
7	850	500	25	3

Table 2: Experimental conditions matrix.

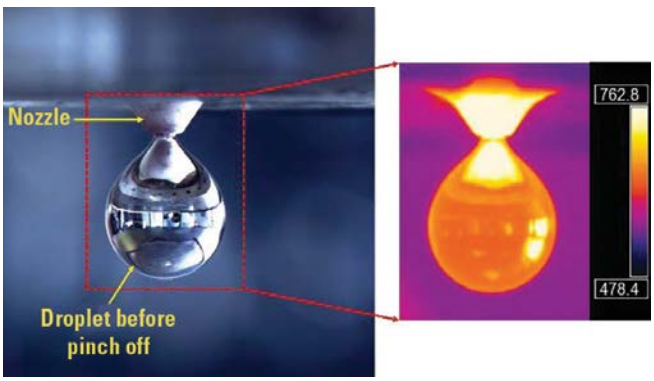


Figure 3: Representative image showing the droplet just before pinching off along with the nozzle and droplet temperature measurements for condition 4 in Table 2.

4. Results and discussion

Prior to the actual experiments, a few pilot experiments with varying substrate temperatures (nozzle temperature 850 °C and droplet

travel distance 25 mm) were conducted. It was observed that the droplet did not stick to the substrate when the substrate was kept at temperatures ranging from room temperature to 300 °C. At 350 °C substrate temperature, the droplet stuck to the substrate.

This behaviour could be attributed to the process type. The MMD process, unlike arc-DED, does not heat the substrate via the presence of high-temperature arc as in arc-DED. Even though the impinging droplet is at a high temperature (≥750 °C) in this case, it is not enough to cause fusion with the substrate.

Figure 4 depicts the droplet state for the substrate at 350 °C and 300 °C, respectively. The initial temperature of the impinging droplet and the substrate temperature are crucial for its proper adhesion to the substrate. For the droplet to remain sufficiently warm till its contact with the substrate, the droplet heat content is crucial.

To avoid shrinkage stresses, the substrate must be rigid enough. In addition, the substrate's thermal properties (thermal conductivity and heat capacity) significantly affect the droplet morphology.

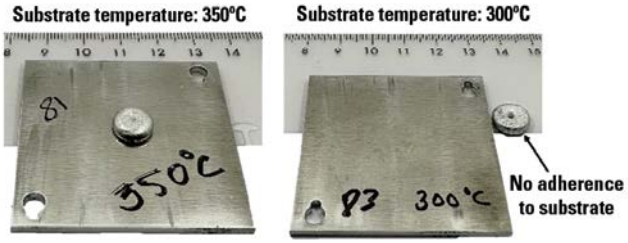


Figure 4: Droplet behaviour at different substrate temperatures.

Figure 5 shows an overall image of a droplet deposited with the following parameters: nozzle temperature, 850 °C; substrate temperature, 500 °C; and droplet travel distance, 25 mm. Due to the lower surface tension of Al (both substrate and droplet), the droplet takes a flattened shape with a small contact angle.

However, the contact surface is large, leading to faster cooling. The high thermal conductivity of the Al substrate also assists the higher cooling rate. Table 3 shows the droplet attributes – average width and height – for all the experimental conditions).

Note that the measurements provided in Table 3 are conducted using vernier callipers and hence represent approximate values only. More accurate measurements of droplet attributes will be conducted from micrographs of the droplet cross-section. It can be observed from Table 3 that the process parameters have more influence on the droplet width, whereas the droplet height remains nearly the same for all the experimental conditions.

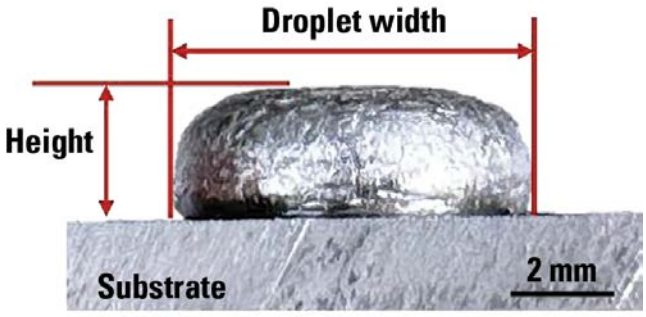


Figure 5: Attributes of a droplet with the following parameters: nozzle temperature, 850 °C; substrate temperature, 500 °C; and droplet travel distance 25 mm.

Figure 6 provides the cross-sectional view of the droplet presented in Figure 5 and micrographs of the interface at various locations. The droplet is free from cracks or porosity, common issues when PBF and arc-DED processes are employed for Al 3D printing.

Exp No	Droplet width (mm)	Droplet height (mm)
1	9.2 ± 0.2	3.1 ± 0.1
2	9.8 ± 0.5	2.9 ± 0.2
3	9.9 ± 0.3	2.7 ± 0.1
4	9.3 ± 0.2	3.1 ± 0.0
5	10.3 ± 0.2	2.7 ± 0.1
6	9.5 ± 0.2	2.9 ± 0.1
7	9.7 ± 0.0	3.0 ± 0.1

Table 3 Droplet attributes for different experimental conditions based on three droplets per experimental condition.

A lack of fusion is observed along the edge of the droplet (location marked a and e in Figure 6). The interface at the centre of the droplet (marked c in Figure 6) is free from any lack of fusion defect. On both sides of the centre (marked b and d in Figure 6), the interface has regions of good bonding as well as regions where a lack of fusion can be seen.

The interface state relates to the droplet's impact on the substrate, its subsequent spread outwards, heat transfer, and solidification behaviour. The droplet first contacts the substrate at the centre and then spreads outwards, leading to good bonding at the centre. Evaluation of the droplet cross-sections for all the other experimental conditions listed in Table 2 will provide a detailed understanding of the droplet bonding with the substrate.

For AM, ie, droplet-on-demand applications, the common practice is to deposit multiple droplets on top of one another. Thus, the bonding quality of the first droplet with the substrate can be optimised based on the requirement, to facilitate the easy removal of the deposited part from the substrate, for example.

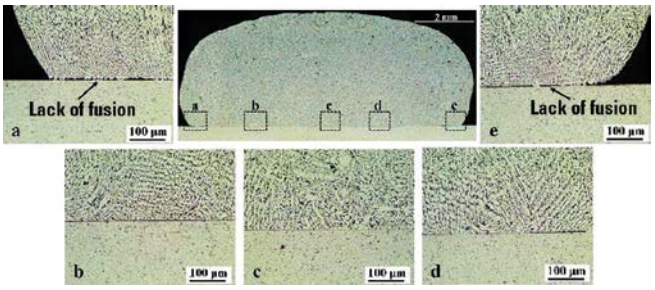


Figure 6: Cross-section view along with micrographs of the droplet-substrate interface.

5. Conclusions and future directions

The proprietary MMD technique developed by 'ValCUN' provides a suitable alternative for direct on-demand Al 3D printing. The technique has a first-of-its-kind ability to print overhang and bridging structures without support structures.

The technique also provides the unique ability to switch from continuous metal printing to individual droplet deposition. The experiments conducted in this study to investigate the individual droplet deposition for droplet-on-demand applications provide insight into the droplet morphology.

For adhesion of the droplet, the substrate must be heated to a certain temperature – 350 °C in this study – even though the initial droplet temperature is around 750 °C. The deposited Al droplet takes a flattened shape owing to the high surface tension. The droplet-substrate interface has regions of good bonding (centre of the droplet) as well as regions where a lack of fusion is observed (edges of the droplet).

The early results presented in this study are very promising. Future work will focus on correlating the droplet morphology for

a wider range of input process parameters. The authors' previous computational fluid dynamics-based multiphase simulation model (for arc-based DED process) will be modified for the MMD process considered in this study [25].

The developed model will provide a route for parametric optimisation, process design, and reverse engineering. Additional techniques like process monitoring through sensor fusion and error and anomaly detection automation need to be developed. The mechanical properties of the printed parts must be quantified. The effect of post-processing steps (heat treatment, surface treatments, and machining) on the deposited part needs to be analysed.

Since Al is prone to rapid oxidation, a detailed study on the effect of surface oxides (on the droplet) needs to be conducted. There are wide-ranging opportunities for topology optimisation and the development of unique print features and infill strategies focusing on real-world applications.

The process also provides flexibility for new alloy designs (in-situ alloying) and the development of exotic microstructures. Finally, machine learning models can be developed for process parameter prediction.

Acknowledgments

Support for this work comes from the project 'Towards the Next Generation Fast and Energy Efficient Arc-Resistance Hybrid Additive Manufacturing (ARHAM) (3E210589)' under the programme 'Postdoctorale Onderzoekers' funded by 'Fonds Wetenschappelijk Onderzoek (FWO)'. The authors also acknowledge the support provided by 'ValCUN' for providing experimental support.

[The original paper and the full list of references can be accessed via the online version of this paper on www.crown.co.za/african-fusion-magazine]

References

1 T. DebRoy, H.L. Wei, J.S. Zuback, T. Mukherjee, J.W. Elmer, J.O. Milewski, A.M. Besse, A. Wilson-Heid, A. De, W.Zhang: Additive manufacturing of metallic components–process, structure and properties, Progress in Materials Science 92 (2018) 112-224.

[2] J.O. Milewski, Additive manufacturing metal, the art of the possible, Springer International Publishing, 2017, pp. 7-33.

[3] D. Herzog, V. Seyda, E. Wycisk, C. Emmelmann, Additive manufacturing of metals, Acta Materialia 117 (2016) 371-392.

[4] A. Vafadar, F. Guzzomi, A. Rassau, K. Hayward, Advances in metal additive manufacturing: a review of common processes, industrial applications, and current challenges, Applied Sciences 11(3) (2021) 1213.

[5] Y. Zhang, L. Wu, X. Guo, S. Kane, Y. Deng, Y. Jung, J.H.Lee, J. Zhang, Additive manufacturing of metallic materials: a review, Journal of Materials Engineering and Performance 27 (2018) 1-13.

[6] M. Yakout, M.A. Elbestawi, S.C. Veldhuis, A review of metal additive manufacturing technologies, Solid State Phenomena 278 (2018) 1-14.

[7] D.G. Ahn, Directed energy deposition (DED) process: state of the art. International Journal of Precision Engineering and Manufacturing-Green Technology 8 (2021) 703-742.

[8] D. Svetlizky, M. Das, B. Zheng, A.L. Vyatskikh, S. Bose, A.Bandyopadhyay, J.M. Schoenung, E. J. Lavernia, N. Eliaz, Directed energy deposition (DED) additive manufacturing: Physical characteristics, defects, challenges and applications, Materials Today 49 (2021) 271-295.

[9] Z. Liu, D. Zhao, P. Wang, M. Yan, C. Yang, Z. Chen, J. Lu,Z. Lu, Additive manufacturing of metals: Microstructure evolution and multistage control, Journal of Materials Science & Technology 100 (2022) 224-236.

[10] E.M. Sefene, Y.M. Hailu, A.A. Tsegaw, Metal hybrid additive manufacturing: state-of-the-art. Progress in Additive Manufacturing 7(4) (2022) 737-749.

[11] J.P.M. Pragana, R.F. Sampaio, I.M.F. Bragança, C.M.A. Silva, P.A.F. Martins, Hybrid metal additive manufacturing: A state–of–the–art review, Advances in Industrial and Manufacturing Engineering 2 (2021) 100032.

[12] J. Gonzalez-Gutierrez, S. Cano, S. Schuschnigg, C. Kukla, J. Sapkota, C. Holzer, Additive manufacturing of metallic and ceramic components by the material extrusion of highly-filled polymers: A review and future perspectives, Materials 11(5) (2018) 840.

[13] S. Yin, P. Cavaliere, B. Aldwell, R. Jenkins, H. Liao, W. Li, R. Lupoi, Cold spray additive manufacturing and repair: Fundamentals and applications, Additive manufacturing 21 (2018) 628-650.

[14] R.R. Dehoff, S.S. Babu, Characterization of interfacial microstructures in 3003 aluminium alloy blocks fabricated by ultrasonic additive manufacturing, Acta Materialia 58(13) (2010) 4305-4315.

[15] G. Vastola, G. Zhang, Q.X. Pei, Y.W. Zhang, Modelling and control of remelting in high-energy beam additive manufacturing, Additive Manufacturing 7 (2015) 57-63.

[16] D. Zhang, S. Sun, D. Qiu, M.A. Gibson, M.S. Dargusch, M. Brandt, M. Qian, M. Easton, Metal alloys for fusion-based additive manufacturing, Advanced Engineering Materials 20(5) (2018) 1700952.

[17] I.M. Kusoglu, B. Gökce, S. Barcikowski, Research trends in laser powder bed fusion of Al alloys within the last decade, Additive Manufacturing 36 (2020) 101489.

[18] P. He, Z. Wei, Y. Wang, M. Jiang, C. Ma, X. Chen, X. Lai, A novel droplet+ arc additive manufacturing for aluminium alloy: Method, microstructure and mechanical properties, Additive Manufacturing 61 (2023) 103356.

[19] A.I. Mertens, J. Delahaye, J. Lecomte-Beckers, 213 ©2023 IIW 2023 Organisers. ISBN: 978-981-18-7859-6.All rights reserved. Proc. of the 76th IIW Annual Assembly and Intl. Conf. on Welding and Joining (IIW 2023) 16–21 July 2023, Singapore. Edited by ZhouWei and John Pang Fusion-based additive manufacturing for processing aluminium alloys: State-of-the-art and challenges, Advanced Engineering Materials 19(8) (2017) 1700003.

[20] C. Galy, E. Le Guen, E. Lacoste, C. Arvieu, Main defects observed in aluminium alloy parts produced by SLM: From causes to consequences, Additive Manufacturing 22 (2018) 165-175.

[21] P.A. Rometsch, Y. Zhu, X. Wu, A. Huang, Review of high-strength aluminium alloys for additive manufacturing by laser powder bed fusion, Materials & Design (2022) 110779.

[22] C.R. Cunningham, J.M. Flynn, A. Shokrani, V. Dhokia, S.T. Newman, Invited review article: Strategies and processes for high quality wire arc additive manufacturing, Additive Manufacturing 22 (2018) 672-686.

[23] C. Zhang, M. Gao, X. Zeng, Workpiece vibration augmented wire arc additive manufacturing of high strength aluminium alloy, Journal of Materials Processing Technology 271 (2019) 85-92.

[24] G.M. Choi, D.G. Kim, B. Im, H.J. Chae, Reflectance Characteristics of Al Alloys Containing Si, Mg, Cu, and Lanthanide (Nd, Sm, Gd) for 3D Printing, Metals and Materials International 25 (2019) 946-955.

[25] A. Kapil, N. Kayarthaya, V. Sharma, A. Sharma, Capturing droplet flight and impingement behaviour in plasma–MIG process for metal droplet-on-demand applications, Journal of Materials Processing Technology (2023) 117955. 214 ©2023 IIW 2023 Organisers. ISBN: 978-981-18-7859-6.All rights reserved.

Renttech invests in premium Kemppi brand

As a significant next step in its transition from being a rental and equipment supplier to the construction industry to a total welding solutions provider for the whole of the welding industry across Southern Africa, Renttech has invested in the premium welding equipment brand, Kemppi. *African Fusion* talks to Johan Bester about the reasons for the move.

Since the Bidvest acquisition in 2016, Renttech has been on a transformation path. Previously well known for its rental offering and its robust range of associated equipment for use on construction sites, turnkey projects and routine plant maintenance work, since the Bidvest acquisition Renttech has developed a comprehensive product range well suited to high-end fabrication.

"While we continue to offer rental services for onsite and shutdown work, we have been steadily strengthening our position in the use of advanced welding processes to improve the cost and quality drivers for South African fabricators," says Johan Bester, welding product manager for Renttech.

"To further foster this goal, we have now invested in one of the best premium welding equipment brands in the world. We are now the sole distributor for Kemppi in South Africa, having just taken over the Kemppi agency. To support the latest high-end Kemppi products, we feel a bit of Renttech muscle is needed behind the brand to get the local exposure it deserves," Bester tells *African Fusion*.

"We are sure that the Kemppi product range will help the local fabrication industry to address modern and complex welding challenges and quality demands. The company has embedded decades of collected knowledge and technical ability, welding process management and welding arc optimisation routines into its welding machines and made this easily accessible to welders using advanced welding software," Bester points out.

Kemppi's X5 Fastmig provides easy and accurate process control through a range of user support features such as Weld Assist, Auto Cable Calibration, Memory Channels, Digital WPS, USB Backup & Restore, and the Personalised Screensaver feature.

Kemppi AX Robotic Welding Systems are specifically designed for MIG/MAG welding. Complete arc welding automation packages for MIG/MAG welding enable significant savings in time and quality benefits.

Kemppi's global guiding principle is to continuously enhance the usability and reliability of its products, with local experts as highly skilled partners sharing the company's expertise with local welders and fabricators. "This closely matches what we at Renttech have been working towards, and we believe South Africa is ready and in need of high-end solutions, especially if these make it easier for welders to achieve the first-time quality we need to raise productivity levels," says Bester.

He notes that Kemppi recently completed another innovation phase with the release of a new high-end range of welding machines for all common welding processes. "On the new advanced products, the user interfaces are among the best we've ever seen – compared to high-end competitors from anywhere in the world." he says.

Using embedded software called Weld Assist, for example, he says that settings

Kemppi's Master 315 offers multi-process welding from cellulosic MMA to pulsed SMAW, all from a new user interface, which has been carefully put together with welders in mind.

WeldEye is a universal solution for managing welding production – including welding procedures, welder and inspector qualifications, documentation, reporting, and administration.

for even complex arc welding processes such as pulsed MIG/MAG welding have been made particularly easy. "If using the Kemppi Master M 358 for pulsed MAG welding, for example, Weld Assist asks the welder to choose the base material being welded, the gas being used, the wire thickness, the welding position, and the travel direction. The software comes back with all the machine parameter options, which can then be selected for use or adjusted if necessary. This takes the guesswork out of setting up a welding machine prior to welding," he explains.

From a process control point of view, he describes the WiseRoot function embedded into these advanced machines for open-root/backing-free weld preparations. "Traditionally, for water pipes or pressure vessels, for example, this would have to be done using the MMA or TIG processes. But WiseRoot enables this critical weld to be accomplished using the semi-automatic MAG process with solid wires," he notes.

WiseRoot is a modified short-arc process that uses precise real-time voltage monitoring to control short-arc current levels for right-time filler metal droplet release. This results in a stable, smooth, spatter-free and efficient arc that delivers excellent weld-root quality – even if using CO_2 gas.

MAG welding with Kemppi's WiseRoot is significantly faster than stick (MMA) or TIG welding options for root welding, while producing welds of equally high-quality at the very least. "Welding of fixed pipes in any position is possible and, most importantly, WiseRoot is easy to learn and it significantly reduces lack-of-penetration risks and potential weld failures," Bester notes.

WisePenetration is another innovation unique to Kemppi. "Normally in CV MIG/MAG welding, the power to the weld pool will change when the welder changes the stand-off distance between the joint and welding torch. This can affect penetration, result in a lack of fusion, change the weld profile or raise spatter levels.

"WisePenetration prevents the current from dropping down by actively adjusting the wire feed speed. This maintains power levels into the arc at preferred levels and reduces the risks of welding defects. "It also allows the weld preparation volume to be decreased, so fewer passes will be needed to fill the joint, heat input can be reduced, and production rates increased," Bester explains.

"Across all welding processes, Kemppi has put a lot of effort into controlling the welding arc, by embedding digital arc monitoring and real-time control, for example, which can rapidly react to events in the arc to prevent occurrences such as spatter. Also designed into these advanced machines is software to enable fabricators and welders to easily access the best welding programs and parameters needed to produce better quality welds more productively and economically.

"In every machine it has produced, Kemppi has chased speed and positional capability. It is striving to substitute manual and time consuming processes such as MMA and TIG with more productive semi-automatic processes such as MIG/MAG. And, in our opinion, Kemppi is doing an excellent job of this," Bester tells *African Fusion*.

The whole platform, he says, has migrated to this philosophy, from stick welding all the way to advanced synergic MIG welding processes for robotic and automated systems. Even on the TIG welding platforms, Kemppi has included features that make the welder's life so much easier, particularly when he or she is faced with technically difficult welds," he adds.

When asked to pick out the key features that make the new Kemppi range stand out, Bester highlights two key areas: the highly sophisticated arc-process control that enhances every aspect of welding performance; and the user interface, which has been carefully put together with welders in mind. "The user interface has been developed to interact with welders and to make their lives much easier. These two features really do set Kemppi apart from other manufacturers, in my opinion," Bester responds.

And the value proposition? "At the end of the day, it is all about the quality required from the welded product. There are certain welds that are very difficult to do well using traditional welding processes. We are seeing more and more of these with very demanding welding, engineering and fabrication requirements.

"Improvement in productivity and repair rates also come into play, which can quickly justify the additional expense of a premium welding solution. So yes, top of the range Kemppi equipment does come at an increased cost compared to conventional welding solutions but compared to other high-end advanced processing machines in the welding space, it is actually quite affordable," Johan Bester concludes.

www.renttech.co.za

Stainless steel sector fights for the right to supply local parastatal projects

The use of local stainless steel is crucial to driving demand and the subsequent beneficiation but work still needs to be done to cement the correct specifications of South African stainless steel components in key strategic projects.

Sassda Executive Director Michel Basson.

The Southern African Stainless Steel Development Association (Sassda), together with the local demand-creating structures of the Steel Master Plan (SMP), have identified a set of local construction projects that can positively impact the local conversion of stainless steel.

Sassda Executive Director Michel Basson states; "We firmly believe that increased local conversion of stainless steel is not just essential; it's a game-changer for our industry and the national economy. These projects are our industry's stepping stones to fostering local demand and boosting the stainless steel sector".

Eskom transmission towers

Based on the need for local components in government projects, a key focus of the SMP Local Demand structures has been on applying strong pressure on Eskom to engage more openly regarding the supply of transmission towers. The criteria for allowing local industry to participate in the supply of these items and/or their components and have firm targets for local content is still debated.

However, in the interim Sassda has seen an opportunity to submit a change in the material specifications to allow for the use of South African 3CR12 stainless steel, which is widely used across the globe in corrosive applications as a cost-effective alternative. This submission by Sassda and its key members is based on Lifecycle Costing principles and was received favourably by the committee, but it still needs to be accepted by Eskom.

Bailey bridges

Another government project with good potential for the use of stainless steel is the proposed construction of Bailey Bridges in rural areas. These are used in emergencies or as temporary structures for planned events. They are particularly useful in rural areas in the event of natural disasters such as floods.

"During the consultation process with government departments, we once again used the opportunity to submit that 3CR12 stainless steel should be used in corrosive environments to ensure the optimum lifespan of the installations. The submission was received in a positive light and will be taken forward," reports Basson.

Hollowware

Sassda's research also shows that more than 10 000 tons of finished holloware products: pots, pans, and cutlery, for example, are imported to South Africa annually. This is in stark contrast to the early 2000s when the local hollowware sector efficiently met 80% of domestic demand. By 2008, this figure plummeted to less than 50% and today it stands at a mere 10%.

Basson reports: "The Steel Master Plan still sees value in resurrecting the industry and, as such, Sassda has started to research and update the information on local demand and local capacity. By determining and potentially addressing the gap, a sizable local demand can be created for stainless steel holloware products in South Africa with job creation attached to this growth."

Automotive sector

While investigations are ongoing to ensure the use of maximum volumes of stainless steel in the local manufacturing of vehicles, there might also be room for creating more capacity for stainless steel products. Basson explains: "A major challenge hindering cost-effective production in the hollowware and cutlery industry is the demand for highly efficient automated processes. Fortunately, we see an opportunity for collaboration with the automotive industry, which boasts advanced technology and automation capabilities that can help us overcome this hurdle and revitalize our sector."

Notably, certain legacy companies in the automotive sector possess large presses that were historically dedicated to automotive production. However, as the automotive industry diversifies in response to emerging trends such as electric vehicles, these presses are sometimes idle. "Together with NAAMSA, we're exploring opportunities to leverage this spare capacity to produce semi-finished holloware components. This strategic alliance aims to empower the hollowware industry by providing access to advanced technology and diversifying production capabilities," says Basson.

Beer kegs sector

There has also been a commitment from the formal brewing industry in South Africa for the procurement and use of locally made beer kegs within the context of competitive pricing and quality. A local standard for beer kegs has been accepted by the Department of Labour. This standard is based on the German equivalent and stipulates stainless steel as a suitable material for the application. The stainless steel grade generally used in the food and beverage industry, including beer kegs, is Grade 304.

A Western Cape based component manufacturer, Fabrinox, was identified by Sassda and the PtSA as a potential pilot producer. It is exciting to note that the required technology will be locally developed, built and tested.Basson reports that the grouping of stakeholders is currently conducting a technology audit and capacity overview. and is also discussing the ownership and future use of the IP to be developed during the project. This process aims to create world-leading technology and is committing to a continuous development process of the project lifecycle.

Looking ahead Basson says: "Overall, the potential for stainless steel in these projects is immense. Resurrecting and building these strategic stainless steel industries can lead to substantial demand and create accompanying job opportunities and economic growth."

The Southern Africa Stainless Steel Development Association (Sassda), is one of the most active stainless steel industry associations in the world and has, since 1964, been involved in increasing the awareness and use of stainless steel in Southern Africa. The organisation provides a platform for Sassda members to collectively promote the sustainable growth and development of the industry with the main emphasis on stainless steel converted within the South African economy.

sassda.co.za

ESAB Railtrac welding solution for tank terminal project

Jannie Bronkhorst, product manager for welding and automation equipment at ESAB South Africa, talks about the ESAB Railtrac B42V tractor system, selected by South Africa's tank farm service provider, Trotech, for the construction of a new state-of-the-art Tank Terminal in KZN.

ESAB's Railtrac B42V welding system is able to manipulate a torch in terms of travel speeds; weaving speeds and widths; and hold times and positions on either side of the weld preparation.

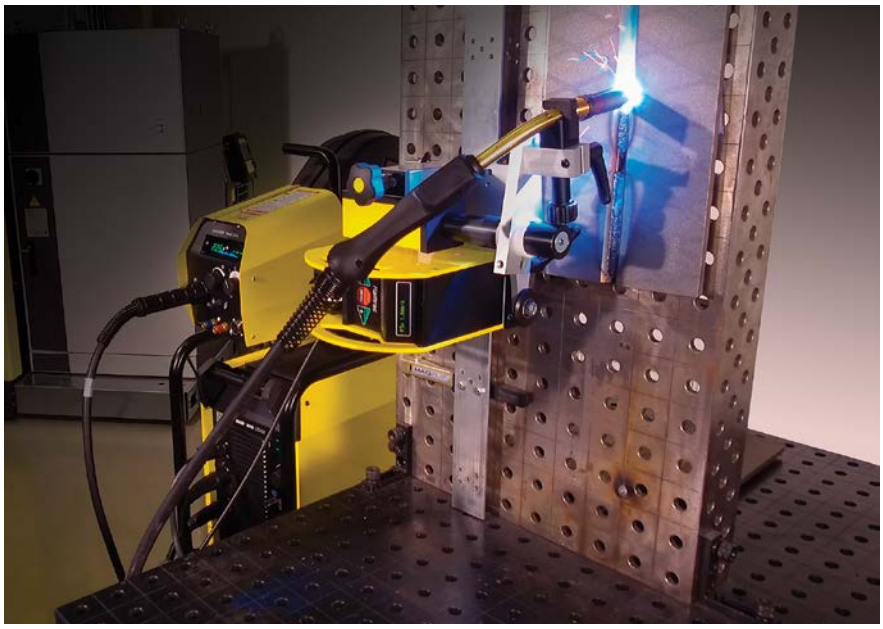
ESAB has secured an order for the supply and support of mechanised equipment, welding machines and consumables for the construction of a new Tank Terminal in KZN. "The new terminal is currently under construction using an ESAB solution: our ESAB Railtrac B42V welding tractor along with welding power sources, wire feeders and ESAB consumables," Jannie Bronkhorst tells *African Fusion*.

Trotech is a recognised South African tank manufacturer with the full suite of engineering, design, quality control and inspection capabilities and a local construction company that can build tanks that conform to the global API standards. "The project involves construction of eighteen large multi-purpose and chemical tanks. Each 16 m in diameter and 22 m high.

Mechanisation for improved quality and reduced costs

These large tanks, according to Bronkhorst, were previously fabricated onsite using traditional manual welding techniques and a 'bottom-up' technique. The bottom section of the tank wall, called the first strake, was manually tack welded to form a cylinder and then the vertical and horizontal seams were welded, all using SMAW/stick welding electrodes. Then the next strake would be added, tacked and welded, from the bottom up, followed by subsequent strakes. Once at the required height, walkways, a reinforcing ring and the roof would be added.

Tanks for this project will also be manufactured onsite, but Trotech has selected a far more modern, safe and cost efficient construction technique. "At the start of contract negotiations, we invited Trotech to our new ESAB facility located at Tunney Ridge business Park in Johannesburg, where we set mock-up plates for the vertical and horizontal seams with different plate thicknesses. ESAB demonstrated how the use of our mechanised Railtrac system together with fluxed cored wire successfully produces sound quality weld seams says Bronkhorst.



ESAB's mechanised Railtrac B42V-based solution uses Fabricator EM 500i power sources and Fabricator Feed 364 wire feeders, and the vertical and horizontal seams are being welded with OK Tubrod 15.15 E71T-1 H4R flux-cored welding wire.

Railtrac, he continues, is a mechanised bug-and-band type welding tractor system. "A magnetised track is aligned to the weld seam. The tractor carrying and manipulating the welding torch gets attached to the rack, and a torch suitable for flux-cored arc welding (FCAW) is clamped into a holding bracket and aligned. The Railtrac system is then able to manipulate the torch in terms of travel speeds; weaving speeds and widths; and hold times and positions on either side of the weld preparation.

"During the demonstration, ESAB produced quality and sound welds, which at the end of the day will save tremendous amounts of time and costs due to the high quality and consistency that comes with mechanisation," Bronkhorst tells *African Fusion*.

Further highlighting the productivity advantages of mechanisation using ESAB's Railtrac system, Bronkhorst points out that there is a lot less stopping and starting – resulting in fewer arc starts and arc stops compared to the SMAW process and, in turn, reducing repair rates. The welding speed is faster, which reduces the heat input into the plate, so distortion on the tank is reduced. "FCAW also delivers better and more consistent weld metal quality than the SMAW process can," he says, adding, that "these advantages sealed the deal."

Railtrac itself offers flexibility and practical control, however: "Welders have a pendant enabling them to keep the weld on

When using Railtrac, there is a lot less stopping and starting, resulting in fewer arc starts and arc stops compared to the SMAW process. Repair rates reduce and welding speed is faster, which reduces the heat input into the plate, so distortion also reduces.

Railtrac also offers flexibility and practical control. Welders have a pendant enabling them to keep the weld on the seam, to increase or decrease the speed and to accommodate onsite variations.

the seam, to increase or decrease the speed and to accommodate onsite variations. This is why we call it mechanised welding and not automated welding. The process offers a good compromise between the flexibility offered by a manual welder and a key problem with fully automated systems that cannot deal with fit-up variations," he points out.

Trotech purchased 32 mechanised Railtrac B42V units from ESAB, complete with Fabricator EM 500i power sources and Fabricator Feed 364 wire feeders. In addition, the manual tack welding is being done using ESAB's OK 55 7018-1 low hydrogen welding electrode, while the vertical and horizontal seams are being welded with OK Tubrod 15.15 E71T-1 H4R flux-cored welding wire, which is designed specifically for out of position welding. "This wire has fast freezing, designed to support weld metal when welding out of position joints," Bronkhorst adds.

Emphasising the simplicity of the system he says, "Welders still need to line up and tack the joints for each strake. Then they position and align the Railtrac magnetised track along the next weld seam. Once lined up, they attach the tractor, align the torch and start the welding process. The operator then monitors the system as it welds, making occasional adjustments where necessary."

He continues: "Because we are using a flux-cored wire, we can use a standard CV (constant voltage) process, which enables us to use a wide welding parameter set depending on the position and the plate thickness," he informs *African Fusion*.

Jack up tank construction

To further raise safety and productivity in the project, Trotech chose to use the alternative 'jack-up' method of construction. "This technique is sometimes called the 'top-down' method, because the top and thinnest strake section is welded first, while still at ground level. The bottom, and thickest, section is welded last.

"A temporary support structure is first created around the tank's foundations and floor. The strake for the top section is assembled and tacked together at ground level. The vertical seams between the plates of this strake are then welded using the Railtrac system and the flux-cored welding process. The horizontal seams are also completed to make a cylindrical section.

Thereafter, the whole ring and roof are jacked up to allow another ring of strakes to be inserted below, tacked into place and welded in the same way, Bronkhorst explains. "Because all the welding takes place much closer to ground level and inside the temporary support structure, safety issues are easier to manage, wind becomes less of a problem and quality improves," he says.

To increase import capacity, more tank farms will be required, since the investment cost of these is significantly less than that required to upgrade refineries to meet the new fuel standards. This bodes well for investments in modern tank farm fabrication equipment and techniques.

"Using the ESAB Railtrac B42V mechanised solution, we at ESAB have developed a total welding solution for the mechanised manufacture of tanks, with component parts that can be configured to maximise productivity and minimise complications in this harsh environments," Jannie Bronkhorst concludes.

esabsa.co.za

ESAB's Railtrac B42V welding tractor

Some key features include:

- 42 Vac powered from the power source or battery driven using a standard Makita®18 V system.
- Possible to program a specific welding length with auto return to start position.
- Stepper motors for drive and weaving functions have extremely high precision and a wide speed range.
- The remote is programmable for weave patterns and travel speeds and is capable of controlling voltage and wire feed speed in up to five standard programs.
- Unit can be programmed to run directly from the controls on the Railtrac machine, should the remote control be lost, damaged or not preferred.

Welding machine verification services from ArcStrike

ArcStrike has partnered with Koomi Consulting to invest in a Calibrator Pro 600 portable load bank for calibration, validation and consistency testing of welding machines.

ArcStrike's new Calibrator Pro 600 portable load bank for calibration, validation or consistency testing of welding machines according to the new and international EN IEC60974-14: 2018 Standard.

"Our new Calibrator Pro 600 portable load bank enables us to perform welding machine verification testing according to the new and international EN IEC60974-14: 2018 Standard, which supersedes the old EN 50504 verification standard referenced in ISO 3834 (via ISO 17662)," begins Sean Blake, the technical director of ArcStrike.

In the past, he says, it was typical industry practice simply to measure the welding current and voltage values during welding and compare them to the welding machine settings and meter readings. "This is difficult to do while welding since a live arc produces unstable and inconsistent readings. Values are constantly changing and getting all the necessary readings at the same instant becomes a challenge," he says.

"The welding machine verification requirement has now been split into three different options: calibration, validation and consistency testing as described in IEC 60974-14, which makes the requirements for new and old welding machines much clearer," notes Blake.

Calibration, he explains, is for modern welding machines that can measure and display actual welding current (A), voltage (V), and/or wire feed speed (m/minute) while welding. Here, the welding machine display values will be calibrated against a set of real reference values measured during the calibration tests.

As per the requirements of EN IEC 60974-14:2018, five sets of parameters need to be collected, typically at 20%, 40%, 60%, 80% and 100% of the welding machines output range. Alternatively, though, five sets of different values can be chosen across the normal operating range used when welding with the machine.

Validation is for welding machines where absolute values for the welding parameters can be set on the welding machine setting panel. In this case, the current (A), voltage (V) and/or wire feed speed (m/minute) settings are validated against the measurements taken during the test.

The third option, consistency testing, is for older welding machines where the parameters are set via non-specific dialled increments or units. The consistency test ensures that five discrete positions on the adjustment dials will be accurate and consistently deliver known current, voltage and/or wire-feed rate levels from one test to the next.

Welding machine verification incorporating calibration, validation and consistency testing of welding machines according to EN IEC 60974-14:2018 ensures that all welding machine settings can be effectively used to control the welding process and to ensure weld quality requirements are met, the welding process is repeatable, and that welding procedure specifications (WPSs) can be accurately implemented. "In terms of frequency, the new standard requires that all welding machines be verified at least once a year, and following any changes or repairs to the machine," Blake adds.

In addition, the requirements are that the test be conducted under a steady electrical load. At the very least, this means that if welding while taking measurements, the welding arc-length must be kept constant. The standard does make provision for welding machine calibration of a TIG power source by creating a stable welding condition with a mechanically held torch.

"Our new Calibrator Pro 600 portable welding load bank enables us to mimic the electrical characteristics of any welding arc, so that more accurate measurements can be recorded quickly and easily," he explains. The welding machine cables are connected to the calibrator, which creates typical welding load conditions when current passes through. Actual current and voltage readings are automatically recorded and displayed. While this is happening the welding machine values, meter readings or dial positions can also be noted. Wire feed speed, which is an important control parameter for GMAW, FCAW and SAW welding processes, can also be measured and recorded using a tachometer-based system.

Multiple load resistors are built into the Calibrator Pro 600, with resistive loads being selected using the front panel switches. Five main load switches can be operated independently, with a sixth fine-step switch giving more precise adjustments of load. This enables over 150 different welding load values to be accurately tested, which allows all MIG/MAG, TIG and MMA power sources – GMAW, FCAW, GTAW, SMAW machines –with welding power ratings of up to 600 A to be tested at or very close to real operating conditions.

"For instance, on a MIG/MAG welding machine required to weld at 300 A, the load can be adjusted to deliver 29 V, while if TIG welding, it might need to be adjusted to give 22 V, and for MMA, 32 V might more accurately match the real welding parameters," Blake explains.

Calibrator Pro instrument panels use precise, high stability electronics and accuracy levels exceed the highest requirements of IEC60974-14, which allows verification testing to precision grades, where needed.

This makes the system ideal for meeting the needs of all ISO 3834-certified fabricators, along with the demanding precision needs of the nuclear, power, and petrochemical industries.

ArcStrike offers a range of technical and consulting services to improve weld quality and productivity, including welding machine verification.

www.arcstrike.co.za

TROJAN
600 SERIES

★ GENERATOR
★ WELDER
★ COMPRESSOR

DESIGNED & MANUFACTURED BY

STAR WELD WELDING PRODUCTS

EMAIL: sales@starweld.co.za

STARWELD AFRICA DISTRIBUTOR

WOLFRAM MINING SUPPLIES CC

EMAIL: sales@wolfram.co.za

MADE IN SOUTH AFRICA

Pulse welding with Fronius TransSteel Pulse

African Fusion talks to Edric van der Walt of Fronius South Africa about the addition of the pulse function to the TransSteel series. Not only does the pulsed arc allow faster welding speeds on thicker materials, but rework is reduced – by up to 70%– since the pulsed arc causes less welding spatter.

The TransSteel range of Fronius power sources was introduced to meet the need for rugged and reliable welding equipment for structural-steel fabricators. To produce quality welds, reliability is essential and, on any construction site, tough tools are needed for ongoing reliability.

Robust and reliable TransSteel welding machines have long been characterised by their intelligent design and exceptional ease-of-use. Digitally controlled and primed with expert knowledge, TransSteel welding systems are continuously being optimised to deliver better and better arc stability and weld quality, with guaranteed system performance.

While TransSteel machines have multiprocessor capabilities, the most used processes for structural steel welding are semi-automatic wire-based gas-metal arc welding (GMAW) and flux-cored arc welding (FCAW). For these, a vast range of possible steels, alloys and material grades, thicknesses, and welding positions is involved in structural steel welding and, for each, different welding parameters must be applied. In addition, lightweight structures are frequently made from aluminium, while stainless steel must often be used where corrosion resistance is required. Both require totally different welding parameters and arc characteristics.

For ease of use, therefore, Fronius' new TransSteel power sources are pre-programmed with 168 different parameter sets, including settings for:

- Mild and low alloy steels, which can be welded with solid or metal-cored wires; or rutile, basic or self-shielded flux-core wires.
- Stainless steels and CrNi alloys.
- Aluminium and AlMg and AlSi aluminium alloys.
- Welding wires with diameters from 0.8 to 1.6 mm.
- Gas shielding using any one of eight different gas mixtures.

Fronius is adding the pulse function to the existing TransSteel series, making welding even easier.

Pulse welding helps the welder to produce neat seam rippling or to minimise distortion, such as during tacking.

In addition, integrated Fronius know-how for the GMAW/FCAW processes is embedded into these machines. Steel Transfer Technology, for example, is a knowledge package that has been specially put together for the steel market. The idea is that it perfectly tailors the welding characteristics to suit the precise needs of the welding arc for that application. This technology delivers precision ignition with perfect burn-off behaviour, depending on the fill requirements of the job: Option include:

- **Steel** is the universal set of characteristics for quick and easy 'normal' welding of steel.
- **Steel root** is the characteristic specifically developed for root pass welding. It is characterised by particularly strong gap-bridging ability, in other words, the ability to fill wide gaps.
- **Steel dynamic** is a characteristic with a forceful and concentrated arc, resulting in high welding speeds and deep penetration.

Pulse mode added

When GMAW welding, the mode of metal transfer between the filler wire and the weld pool changes depending on the welding current level, the material being transferred and the wire thickness. These different metal transfer modes include dip-transfer or short arc transfer mode, typically for low current welding of thinner plate; open arc or spray transfer for high current levels on thicker plate; and intermediate or globular transfer for welding at intermediate current levels, when welding in the overhead or vertical up positions, for example.

In addition, by using pulsed welding current, it is also possible to achieve open arc metal transfer at a precise rate of one droplet per pulse. So, by incorporating pulse mode into the new range of Fronius TransSteel welding machines it becomes possible to avoid completely the intermediate current levels associated with globular

With the intuitive operating concept, the welder can start up the TransSteel immediately and without any prior knowledge of the device.

metal transfer, which is difficult to control and prone to spatter. This is a particular problem when welding out of position.

The resulting reduction in spatter and defect repair by adopting pulse mode in the intermediate current range, leads to up to 70% reductions in rework. Also, compared to the standard intermediate arc, the pulsed arc allows welding speeds of up to 30% higher to be achieved, particularly for aluminium and stainless applications.

Most notably for TransSteel power sources, the welder is not required to have any previous knowledge of transfer modes or which parameters to select before welding. The intuitive operating concept of the system allows the welder to select the best set of parameters for each welding job by making three simple choices: the material, the wire diameter and the shielding gas.

The current and the voltage settings can then be adjusted to suit the needs of the job, and the key arc welding characteristics and metal transfer modes will automatically be selected to give best possible results. If required, however, all the welding parameters can be set on the front panel.

To satisfy individual welder preferences, a set of adjustments has also been made available for making small corrections to arc characteristics. These include arc length correction, arc force dynamic and pulse correction.

Arc length correction enables the welder to choose a shorter arc with reduced welding voltage; a neutral arc with an average arc voltage; or a longer arc with above average welding voltage. The arc-force dynamic is used to influence the short-circuiting dynamic at the instant of droplet transfer during short-arc welding. Options include a hard and stable arc at the one end, a soft low spatter arc at the other and a neutral short-circuit dynamic inbetween.

To correct the pulse energy during pulsed metal transfer welding, there is also an adjustment for influencing the droplet detachment force between lower, neutral and higher, which also influences the arc stiffness.

Other key TransSteel innovations include:

- **Automatic documentation:** A simple option for collecting and documenting real welding data is incorporated via a USB thumb drive, which can be connected to the rear of the power source to store all important data – including time and device-related data, along with the welding parameters used such as current, voltage and wire speed.
- **Spot/tack mode:** Spot mode enables welders to place welding spots at regular intervals. With complete flexibility over the pause time between the intervals, this spot function is ideal for tacking joints prior to welding.
- **Stitch mode:** Stitch welding not only produces a rippled seam appearance, but the low level of heat input also reduces material distortion when working with light gauge sheet.
- **SynchroPulse** is an option recommended for welding aluminium alloys when a rippled seam appearance is preferred. This effect is achieved by modifying the welding power between two operating points at a frequency of up to 5.0 Hz. The changing current levels between high and low current also assist when welding in the vertical up position.
- **Pulse Controlled Spray** is a mode designed for minimal spatter and deep penetration.
- **The hose pack connector** is integrated directly onto the motor plate in the wire feeder. This enables the welding wire to be guided all the way from the feeder to the contact tip of the welding torch, resulting in highly stable wire feeding and less wear on the consumable parts.

The TransSteel 3000 compact Pulse is a multiprocess device that masters MIG/MAG, TIG, and electrode welding to the same high degree.

TransSteel 4000 and 5000 Pulse have a separate wire feeder and are therefore particularly suitable for intensive welding applications.

Fronius has added the pulse function to three models. The TransSteel 3000 compact Pulse, which is also a multiprocess device that masters MMAW, GTAW and GMAW/FCAW welding processes to the same high degree. This compact unit is ideal for a wide range of welding tasks, on a construction site, in the workshop, or for repair work.

For regular welding tasks or in small series production, the pulse function on the TransSteel 4000 Pulse and TransSteel 5000 Pulse brings more options and speed benefits. In contrast to the Compact version, these higher-power units have separate wire feeders.

Fronius' TransSteel welding machines are the embodiment of a wealth of technological know-how collected since Fronius began producing its first welding transformers in the 1950s. This know-how is all now incorporated and available in the new Fronius TransSteel 3000 Compact, the TransSteel Pulse 4000 and the Fronius TransSteel Pulse 5000 welding power sources.

www.fronius.com

Cosmo Training Academy: now stronger than ever

African Fusion talks to Cosmo Academy's new trainer and facilitator, Rozanne Herion, who is introducing international welder training with code tests to the Academy's offering, giving local fabricators access to welders with international qualifications and successful candidates access to the international welding workplace.

Rozanne Heroin (right) receives the JouYster Solidarity award for the Best Trades Person of the Year, 2023.

Rozanne Herion joined Cosmo as the Academy's in-house welder facilitator in March 2023, having spent several years honing the ideal skills set for the challenge.

"After completing my matric, I went on to do a diploma in metallurgy at the Vaal University in Vanderbijlpark. I was on a bursary, though, which got cancelled due to a recession in South Africa, so I had to abandon my studies just seven credits short of a diploma," Herion tells *African Fusion*.

"From there I started working for a local laboratory that provided destructive weld testing services for coding welders. Weld test specimens were sent to the laboratory to make sure they conformed to the specifications required. We did a range of mechanical tests, we looked at the macros and then compiled a test report. This experience gave me my first taste of what welding was about.

"I then approached ArcelorMittal, which was still called Iskor back then, to get onto its engineering training programme, which was set up to help people to finish their qualifications. Unfortunately, applications were closed when I applied, but the training manager invited me to switch to a trade instead. I asked him what trades were available and I chose welding, because of my metallurgical background and my experience with weld samples in the laboratory.

"So I started as an apprentice and immediately fell in love with welding. I did a full apprenticeship at ArcellorMittal and qualified as a Red Seal welder back in 2013," she says.

On qualifying, Rozanne Herion went to work for company called Azam, which was responsible for the maintenance work for mining company, Samancor. "We were doing the fabrication and weld maintenance work for them, on the structural side and for the ladles for their foundries, for example. We also did a lot of work for Afrisam, where we built the large cement silos, along with installation jobs for BHP Billiton and Multotec.

"I started out as a welder and was then placed in a quality control role, which involved overseeing a small group of welders, inspecting their work, and offering advice. I began training welders to help them pass their code-tests when the inspectors came in," Herion relates, adding that she was coded in flux-cored welding as well as MIG/MAG processes.

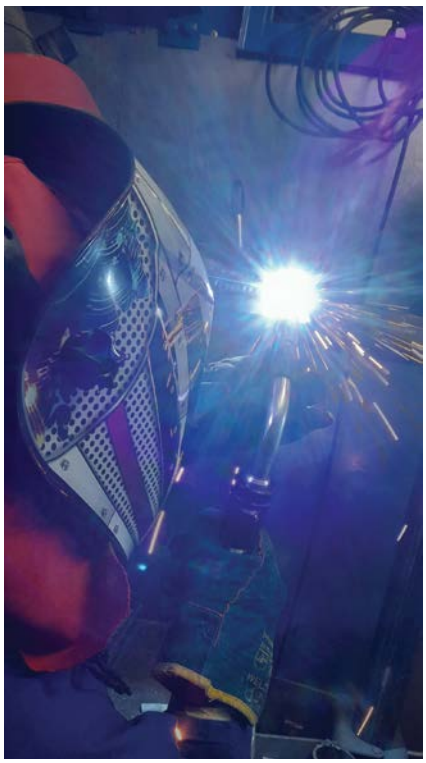
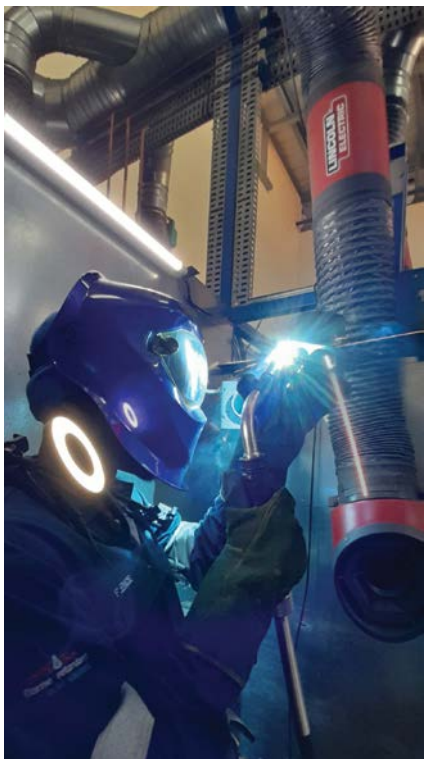
While at Azam, Rozanne Herion was contacted by global training giant, City and Guilds, which was developing a welder training course in Johannesburg. "They wanted me to help them develop training material for their welding training course. They already had the theory in place, but they needed someone to develop the practical side of the training. It was there that I really began to shift over to the training side. They persuaded me to join them permanently, so I moved to Johannesburg and started a practical training course that included all the common processes: MMA/stick welding, MIG, Mag and Flux-cored welding as well as TIG or Argon-arc welding," she says.

"Through them, I completed the SAQA Facilitator and Assessor qualifications, South African requirements from the ETDP SETA, which is mandated in South Africa to promote and facilitate Education, Training and Development in the areas of education, training and skills development.

"City and Guilds was bought by the MSC Artisan Academy, who do the full suite of South African learnerships and apprenticeships. On the welding side, I began to deliver the SAQA Welder training programme, but I was also part of the board of people chosen to develop the toolkits for QCTO Boiler making, Welding and Electricians artisan programmes," she says.

After being retrenched in 2018, Herion joined a TVET college in Boksburg and continued to deliver welder training, initially based on the SAQA requirements but soon transitioning over to the new QCTO-based curriculum. "I was also part of the team delivering the old NATED N2 to N6 engineering courses. And I still do the online welding courses for them," she says.

The second group of six Air Products-sponsored Cosmo apprentices – three women and three men – began training in August and now have IIW International Welder Diplomas as coded and certified Fillet MIG Welders. From left: Tebogo Kgomo, Dolph Mashele, Samson Ngobeni, Calvin Lekoakoe, Mitchell Moekwa, and Fortunia Selolo.

Three Cosmo apprentices demonstrating their skills in down hand (left), vertical up (centre) and overhead welding (right).

Due to Covid, Herion was again retrenched, so she joined a school that worked with people with learning disabilities. "I was in the welding workshop teaching these kids to weld. It involved a lot of creativity, because they had to build things that could be sold at the end of the year to make money for the school. So we made braais, chairs and tables, based on their own design ideas. I was teaching them how to bring ideas from their heads onto paper and then to translate that into actual products," she tells *African Fusion*.

"From there, I went to work at the Olifantsfontein Trade Centre, assessing candidates coming for their Trade Tests. During that time I started doing my Moderator course, which I completed earlier this year. It was while working at Olifantsfontein that I first met people from Cosmo, who came to show us the training equipment and welding machines they had on offer.

"We began to collaborate when Olifantsfontein had a big group from a Seta coming to us for trade test training. We could not accommodate the entire group, so I went to Cosmo and met Emma, Head of Training, and Eduan, former facilitator, to try and see how they could assist us. That is how we first met and shortly afterwards, they persuaded me to join them," she adds. She also completed her diploma in Project Management in 2023.

In 2023, Rozanne Herion was nominated for the South African Trade Union, Solidarity Best Trades Person of the Year competition. Out of more than 1 000 nominations across all trades spanning South Africa, she was the first welding artisan and the first female artisan to reach the top five. She then won the competition, further raising the profile of women and welding in South Africa.

Exceptionally well qualified for welder training, Rozanne Herion says the job is her passion. "I absolutely love what I do" she exclaims.

International qualifications for local youngsters

On the welding side, the Cosmo Training Academy is an SAIW-accredited Authorised Training Body (ANB) for the delivery of the IIW's International Welder (IW) training courses. Rozanne Herion was invited to join Cosmo off the back of an Air Products-sponsored project to give local talent from rural communities this international welding qualification.

"These are guys and girls are from previously disadvantaged rural areas that do not have many employment options. Cosmo goes into these areas to find potential students that are willing to be evaluated. Of the first group of 20 students we evaluated, we found six that met all our criteria for success, three men and three women. Air Products Funded these young welders, including all the training costs and PPE, tools, travel and daily provisions for the duration of the course. They have now completed a seven week IIW training course and were all successfully Code tested in July and awarded IIW Fillet Welder diplomas in MAG Welding of Carbon Steels," Herion informs *African Fusion*.

These students are now available to work in the local fabrication industry. "We keep their CVs at Cosmo Academy and we get a lot of clients who call asking us to recommend skilled welders that we know well," she says, adding that a second group of six – also including three women – began training in August and completed it in the first week of October."

For the rest of this year, the Cosmo Academy is fully booked with other training courses: companies that need young welders to be coded for a particular process, and a steady stream of students who come to Cosmo for Red Seal Trade Test preparation. "We are still waiting to see, but we believe Air Products wants to try to take more groups of welders though the IIW programme next year," notes Herion.

"Cosmo is a very people-oriented company. I really like the way they get involved with their staff and customers. A big thing underpinning our growth is word of mouth communication about our services. When people buy machines from Cosmo, we train them on the machine so they know how to use it properly. As a result, we then get people calling for training on their own machines, which leads to code and qualifications' related enquiries.

"We have developed excellent community connection as well. Cosmo and the local community are very supportive of each other," Rozanne Herion concludes.

cosmogroupsa.co.za

TransSteel Pulse

Controlled welding
in the area around the
intermediate arc

The pulse function of the TransSteel 3000C Pulse, 4000 Pulse and 5000 Pulse permits faster welding speeds for thicker materials. The pulsed arc also reduces the amount of reworking required, as less welding spatter is generated.

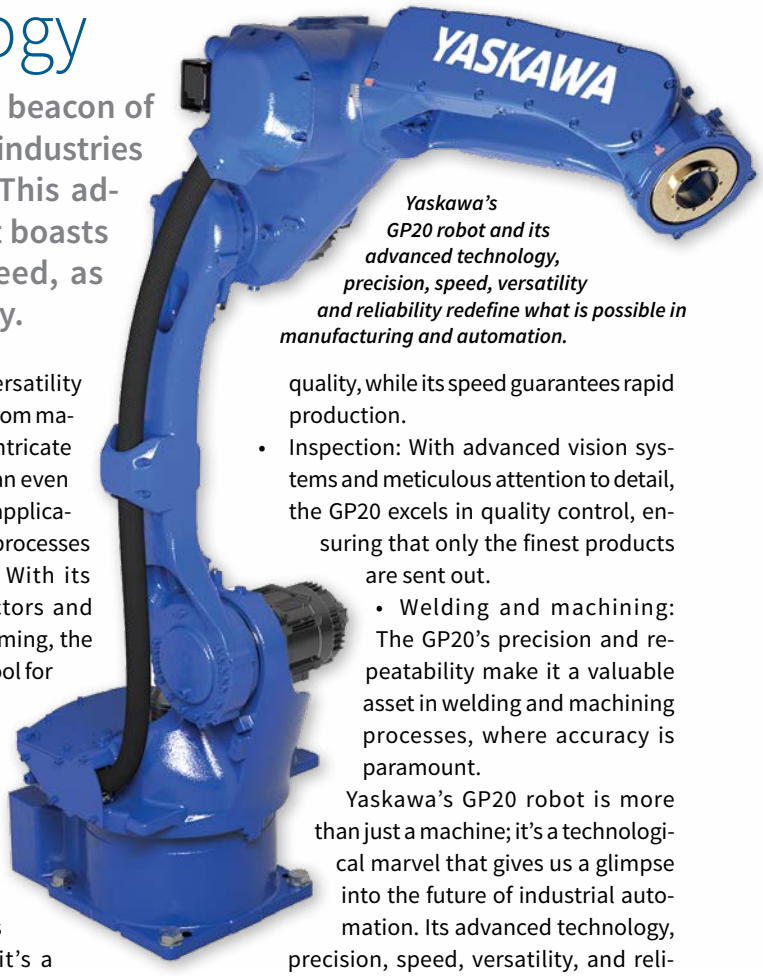
For further information visit:
www.fronius.com/transsteel

70% less reworking

30% faster welding

Motoman GP20: the embodiment of cutting edge technology

Yaskawa's Motoman GP20 robot stands as a beacon of innovation and precision, redefining the way industries approach manufacturing and automation. This advanced robot is more than just a machine; it boasts cutting-edge technology, precision and speed, as well as unparalleled versatility and reliability.



Yaskawa's GP20 robot and its advanced technology, precision, speed, versatility and reliability redefine what is possible in manufacturing and automation.

At the heart of the GP20 lies an intricate puzzle of advanced technology, a testament to Yaskawa's commitment to pushing the boundaries of industrial automation. "The GP20 isn't just a robot; it's the embodiment of cutting-edge technology, forging the path forward in industrial automation," says John Mostert, Sales Manager at Yaskawa Southern Africa. With its state-of-the-art sensors, precision control systems, and intuitive programming capabilities, the GP20 offers a glimpse into the future of manufacturing. Its adaptive learning algorithms ensure that it continually optimises its performance, making it an invaluable asset for industries seeking to stay ahead in the automation game.

Redefining productivity

In the manufacturing world, precision and speed are the parameters of success. The GP20 doesn't just demonstrate this, it exemplifies it. With meticulous accuracy, it executes tasks with a level of precision that minimises errors and maximises efficiency. But precision alone isn't enough in today's fast-paced industrial environments. The GP20 matches precision with speed, delivering lightning-fast cycle times without compromising accuracy. "From material handling to inspection, welding and machining, the GP20 shines in a range of applications across the manufacturing and automation sectors," says Mostert.

Adapting to needs

Manufacturing and automation needs are diverse, and the GP20 meets and exceeds expectations. Its versatility knows no bounds. From material handling to intricate assembly tasks, it can even transition between applications, streamlining processes across industries. With its modular end-effectors and adaptable programming, the GP20 is a versatile tool for any task at hand.

Built to last

The rigors of industrial environments demand unwavering reliability. The GP20 is not just a robot; it's a dependable component that is able to operate in challenging conditions. Its robust construction and meticulous quality control ensure it can endure hazardous production environments. It delivers consistent performance, minimising downtime and maximising productivity.

Applications where GP20 Shines

The GP20's value shines in a range of applications across the manufacturing and automation sectors:

- Material handling: Whether it's moving heavy payloads or managing delicate materials with care, the GP20's precision and capability make it a go-to choice for material handling tasks.
- Assembly: In the world of intricate assembly, the GP20's precision ensures perfect fits and enhanced product quality, while its speed guarantees rapid production.
- Inspection: With advanced vision systems and meticulous attention to detail, the GP20 excels in quality control, ensuring that only the finest products are sent out.
- Welding and machining: The GP20's precision and repeatability make it a valuable asset in welding and machining processes, where accuracy is paramount.

Yaskawa's GP20 robot is more than just a machine; it's a technological marvel that gives us a glimpse into the future of industrial automation. Its advanced technology, precision, speed, versatility, and reliability redefine what's possible in manufacturing and automation.

As industries evolve, the GP20 paves the way, offering the tools needed to thrive in an ever-more complex landscape. Choose the GP20, and choose a future where automation knows no limits.

www.yaskawa.za.com

Yaskawa's Motoman GP20 specifications	
Controlled axes	6
Max. payload [kg]	20
Repeatability [mm]	±0.02
Max. working range R [mm]	1802
Temperature [°C]	0 to +45
Humidity [%]	20 - 80
Weight [kg]	250
Average power draw [kVA]	2.0

Starweld introduces home-grown Trojan 600 multipack

Steve Hutchinson, marketing manager for South Africa's inverter-based, microprocessor-driven welding machine manufacturer, Starweld, talks about the company's new Trojan 600 engine-driven generator/welder/compressor combination, which has been locally designed to better meet the on-site needs of mining houses across Africa.

The Trojan Twin 600 Air welding multipack combines a Perkins genset with two Orion 600s, a compressor for arc-air gouging, two 380 V, 3-phase and two 220 V, single phase auxiliary outputs.

Robert Case and Steve Hutchinson first met 25 years ago when they were both involved in the manufacture and marketing of the South African-designed Modweld range of welding inverters. In 2011 they met up again, and founded Starweld, a company established to locally manufacture a high-end range of microprocessor-driven welding inverters. "We soon began to focus on the 'yellow metal' industry where welding equipment is used for manufacturing and refurbishing mining and earth moving equipment. This equipment has to be very durable, as it is typically used for heavy-duty MIG/MAG welding and arc air gouging," Steve Hutchinson tells *African Fusion*.

The multi-process Orion 600 welding machine rapidly became the flagship machine of the Starweld range. It competes favourably with international brands dominating this market segment in South Africa. In its favour is that it goes to market at a significantly lower price than its international competitors, while spare parts such as the main PC board are readily available and at a much lower price.

A key advantage of the Orion 600 was brought to light when Sandton Plant, the largest hirer of yellow metal equipment to the country's mining industry, appointed DG Power Services to conduct an independent survey to monitor the machine's electrical usage: against the market leader's heavier transformer-based machines. "The results were astounding. An overall saving of 40% was achieved when using the Orion 600. This resulted in Sandton Plant replacing all 15 of the company's transformer based welding machines with Starweld Orion 600s," notes Hutchinson, adding that these machines are used for heavy duty 1.2 mm MIG/MAG welding and arc-air gouging of earth moving buckets and tippers.

The Trojan 600 engine driven multipack

The findings from the Sandton Plant survey led Starweld to begin looking at adding an engine driven generator/welder/compressor combination to its range. "Once again this market was dominated by the same two international brands, and this made it difficult for newcomers to break in. The imported products, however, were sold at premium prices and spare parts were also expensive with lengthy delivery times," says Hutchinson.

Starweld quickly learnt that, in Africa, there was a resistance to moving away from these tried and tested machines. For this reason they decided to design an engine-driven machine, utilising the internationally recognised Perkins engine range, where spare parts would be readily available across the continent.

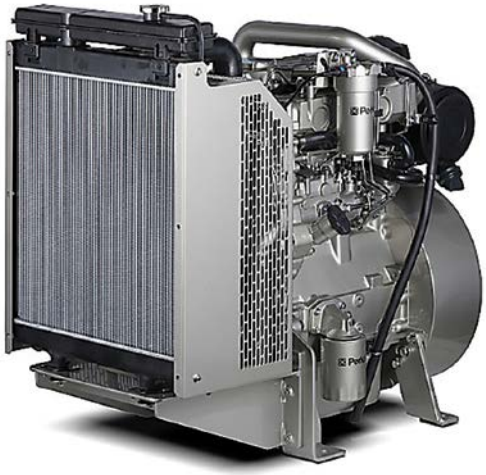
Manufacturers of these engine driven welding machines have always opted for using 'chopper technology' and wired the welding units directly into the generator's alternator. This enables them to get high welding current outputs, and it saves on space within the generator's housing. The downside though is that the welding unit is part of the machine's alternator and cannot be removed for servicing, or replacement.

Based on the fact that the inverter-driven Orion 600 had already shown itself to be economical on electrical usage, tests were conducted on running twin Orion 600s off a single Perkins 60 kVA genset. "Once again, the result beggared belief. It was found that two Starweld Orion 600s and a compressor can be run simultaneously. This was a world first," suggests Hutchinson.

"In addition, if not wanting to arc air gouge while welding, a third MIG/MAG

Starweld's modular 'plug-and-play' system enables faceless Orion 600 welding units to be mounted on a shelf directly above the alternator.

All the welding controls and the digital displays are placed on the front panel of the multipack, with plug-in connections to the power sources made via power cables and harnesses.



Above: Using a single Perkins 60 kVA genset, two Starweld Orion 600s and a compressor can be run simultaneously.

Left: A robust Italian piston-type Nu Air twin head compressor with a cast iron crank and high strength steel valve rods was selected for use in the Trojan 600.

welder inverter could be plugged into the auxiliary power outlet, and all three units could then weld simultaneously. And, if the client wished to do only stick/MMA welding, two additional inverters could be plugged into the auxiliary power outlets, bringing the total number of stick welding operators using the same generator up to four," he informs *African Fusion*.

The plug-and-play concept

The next challenge was to incorporate these findings into designing and building a generator/welder/compressor multipack. "The high performing Orion 600 is extremely compact; it only weighs 45 kg. So Starweld set about designing a modular 'plug-and-play' system, where removable faceless, welding units would be mounted on a shelf directly above the alternator. The welding controls and the digital displays were then placed on the front panel of the multipack, with plug-in connections to the power sources made via power cables and harnesses. "This became a further game changer, as a replacement power source could be installed with ease, and the operator could be welding again within an hour," Hutchinson points out.

For arc air gouging, hydrovane-styled air compressors are used by both of the existing brands in the market. This saves on space and produces the large volumes of air needed for arc air gouging. However, the design has not proved to be robust in arduous African conditions and, unless serviced regularly and properly, expensive breakdowns result.

For an alternative option in its Trojan 600 multipack, Starweld decided to approach Warne's Compressors, a company that has been involved in the local compressor market for over 70 years. A robust Italian piston-type Nu Air twin head compressor with a cast iron crank and high strength steel valve rods was selected. This was directly coupled to a 7.5 HP electric motor, and produced a continuous 30 cfm of compressed air. Warne's further reduced the air reservoir down to 50 litres. Once again, the compressor, like the welding power sources, is powered off the alternator's output, meaning that it can be easily removed for repairs.

Starweld's engine driven Trojan 600 welding multipacks are now available in a number of different combinations, including:

- The Twin Air 600 with two Orion 600s, a compressor, two 380 V and two 220 V auxiliary outputs.
- The Single Air 600 with a compressor, two 380 V and two 220 V auxiliary outputs.
- And the generator with a Single Orion 600 without a compressor but with the two 380 V and two 220 V auxiliary outputs.

Soon to be introduced is the Starweld Trojan 400 range, with a similar set of multipack options.

Starweld's Africa agent: Wolfram Mining Supplies

"Wolfram Mining Supplies, which was established in 1990, has been appointed to market our Starweld Range of welding equipment into Africa," continues Hutchinson.

"Wolfram has a firm footprint across all the SADC countries. Core to the company's mission is to 'simplify technical support' for its customers. Having previously been associated with several international welding brands, Wolfram understands the welding market, and has now chosen to partner with Starweld, and to exclusively market its products.

"The decision was based on the quality, performance and product support that Starweld provides," Steve Hutchinson concludes.

www.starweld.co.za

Model	Engine & alternator	Compressor	No of Orion 600s	3-phase aux	Single phase aux	Dimensions (l, w, h: mm)	Mass (kg)
Trojan Twin 600 Air	Perkins 1103A-33TG2	60 kVA	2	60 kVA, 400 V, 50 Hz	7.5 kVA, 32 A, 230 V, 50 Hz	2 000×900 ×1 215	1230
Trojan 600 Air	Perkins 1103A-33TG1	40 kVA	1	40 kVA, 400 V, 50 Hz	7.5 kVA, 32 A, 230 V, 50 Hz	1 720×850 ×1 150	1080
Trojan 600	Perkins 1103A-33TG1	40 kVA	1	40 kVA, 400 V, 50 Hz	7.5 kVA, 32 A, 230 V, 50 Hz	1 720×850 ×1 150	1050

Table 1: Key specification of the Starweld range of Trojan Multipack engine-driven generator/welder/compressor combinations.

CONSISTENT QUALITY RELIABLE DELIVERY

BHI

BELL HEAVY INDUSTRIES

BHI is a specialist division of Bell Equipment focused on project engineering and contract manufacturing for diverse industries.

Contact bhi@bellequipment.com to explore the possibilities and benefits.

www.bhi.bellequipment.com

Competition grows in specialty gases market

Competition in the calibration gases market is heating up with leading specialty gases supplier Afrox awarded ISO 17025:2017 accreditation by the South African National Accreditation System (SANAS). Afrox's laboratory and technicians are now officially recognised by the Government of South Africa as competent to provide specialty gas mixtures to exacting tolerances and standards.

The ISO 17025:2017 accreditation of Afrox means medical laboratories, environmental, construction, power suppliers, automotive, materials and chemicals industries, among others, now have a wider choice of suppliers. Regulations mandate that all companies can only use accredited standards of calibration gases to calibrate their emissions detection instruments, confirms Afrox Senior Director of PGP and Healthcare, Marius Kruger.

"This accreditation will allow Afrox to penetrate new markets and offer superior products and services than currently available in South Africa," says Kruger. "It is also an excellent development for many companies that competition in the calibration gases space is opening up and providing more choice of the highest of standards."

In real terms, ISO 17025:2017 enables Afrox to demonstrate that its laboratory operates competently and generates valid, reliable and certified results of calibration gas mixtures, enabling the industrial and medical gases company to ensure customer confidence both nationally and across sub-Saharan Africa.

Afrox has invested more than R20-million in an automated gravimetric filling plant and upgraded its analytical capabilities to enable more stringent analytical criteria for its range of HiQ Life Science gases and calibration mixtures. These gases are analysed for accuracy of composition, harmful impurities such as sulphur dioxide, nitric oxide and volatile organic compounds.

The leading gases company also invested an additional R5-million to upgrade laboratory equipment required to analyse and certify mixtures to industry requirements.

"These forward-looking investments and the high calibre of our laboratory technicians and equipment give us a real edge in many markets and show Afrox's ongoing commitment to existing and new customer requirements," Kruger adds.

"As a result of the upgrade of the analytical capabilities, Afrox is now able to analyse a far wider range of substances with concentrations as low as one part per million and, in some instances even as low as parts per billion," says Danie Kriel, Afrox Head of Sales Management PGP Compressed. "A Certificate of Calibration is provided for each mixture, which provides details on the analysis results, adding additional certainty that the mixture will not be harmful to life in its required application."

Afrox has been awarded ISO 17025:2017 accreditation by the South African National Accreditation System (SANAS) and is now officially recognised as competent to provide specialty gas mixtures to exacting tolerances and standards.

Kriel adds: "ISO 17025:2017 accreditation will enhance customer confidence and satisfaction with our products since our accreditation scope is larger than that generally offered in the market. Additionally, our calibration measurement capability and accuracy is far better as a result of the steps Afrox has taken in recent times."

SANAS confirmed that, "Following the SANAS Approval Committee meeting on 18 October 2023, accreditation has been granted in accordance with ISO/IEC 17025:2017 to, African Oxygen (Pty) Ltd, Afrox Analytical Services, Accreditation No: CAL 099-15-00."

www.afrox.co

Disability Centre gets a boost from Steinmüller

Through donations and upgrades, Steinmüller Africa recently assisted the Sinqobile Disability Centre, a nonprofit organisation in the Vosman area of eMalahleni, to ensure the centre could help disabled members of the community more efficiently.

The company donated appliances, including a fridge, a gas hob and an electric stove. Along with these was the donation of gardening equipment, kitchen utensils, tables and chairs. The centre was also provided with the full refurbishment of its plumbing and electricity systems, including the installation of a solar geyser. To help with the administrative operation of the centre, a laptop and printer were also donated, along with a variety of games to keep centre members entertained. For the purpose of making and mending clothes for those who will be serviced by Sinqobile, two new sewing machines have been supplied.

The Sinqobile Disability Centre not only helps disabled community members, but is also involved in feeding and housing locally disadvantaged people. Its founder, Hilda Simelane, is an active member of the community who strives to improve the lives of those around her.

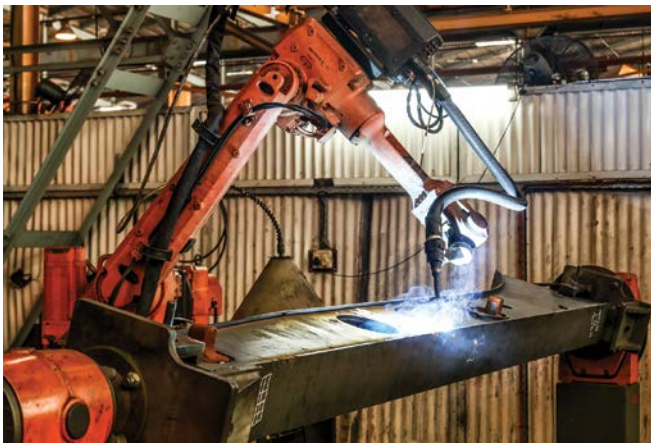
"Community building stories such as that of Sinqobile Disability Centre inspire and motivate us to participate in initiatives that improve the lives of those living in the communities in which we operate," says Steinmüller Africa's Corporate Communications Specialist, Mpho Muvhango.

www.steinmuller.bilfinger.com

Steinmüller Africa is assisting the Sinqobile Disability Centre, a nonprofit organisation in the Vosman area of eMalahleni.

Bell launches new Bell Heavy Industries division

Bell Equipment has opened a new 45 000 m² undercover local manufacturing facility in Richards Bay that complies with the ISO 9001:2015 Quality Management System.



BHI is well equipped with specialist machines including both horizontal and vertical CNC machining centres and advanced automated welding stations.

With almost seventy years of demonstrated expertise in complex engineering, heavy fabrication, and machining for its own range of material handling equipment, Bell Equipment is now offering these specialist services to all industries in the country through its newly formed division, Bell Heavy Industries (BHI).

Bell Equipment's Group Business Development Director, Stephen Jones emphasises the current scarcity of local companies providing these vital services. "South Africa has seen a huge reduction in engineering companies, and, in response, we have strategically positioned our South African manufacturing facility to fill this void by providing project engineering and contract manufacturing through BHI.

"The growth of Bell as a well-established mining, earthmoving, and agriculture equipment manufacturer, both domestically and in terms of exports around the world, is testament to the skills available and the quality of products we make in Richards Bay. We're confident in our ability to expand into other industries and believe this will benefit not only the manufacturing sector but the whole country."

Bell has also received accolades for its demonstrated performance from organisations such as the South African Capital Equipment Export Council (SACEEC), the Mining Equipment Manufacturers of South Africa (MEMSA), and the Department of Trade and Industry, which hosts the South African Premier Business Awards together with Proudly South African and Brand South Africa.

The 45 000 m² undercover manufacturing area in Richards Bay complies with the ISO 9001:2015 Quality Management System. It is well equipped with specialist machines, including both horizontal and vertical CNC (computerised numerical control) machining centres, 5-axis boring machines, laser cutters, high-definition oxyfuel and plasma cutters, bending brakes, and advanced welding technology.

A blasting plant, phosphating tanks, sealed spray booth, galvanising bath, and automated powder coating installation are also available to take care of surface treatments.

The Richards Bay Bell team of over 800 machinists, welders and assemblers is among the best in the country, thanks to the company's own training centre.

The Richard's Bay Bell team of over 800 machinists, welders and assemblers is among the best in the country thanks to the company's own training centre, which plays a crucial role in internally developing world-class skills from the surrounding community. "This is complemented by our highly skilled team of welding, quality, and industrial engineers, along with onsite calibration facilities, equipment to perform material checks, and several highly specialised co-ordinate measuring machines.

"Together with our strong focus on process development, BHI can guarantee consistent quality to customers. BHI can also tap into a wealth of group resources – notably a team of over 100 South African design engineers – enhancing its suitability for local manufacturing across diverse industries," adds Jones.

Bell Equipment's manufacturing operation, which is 55% black-owned and 24% black women-owned, contributes to B-BBEE scores and creates localisation opportunities for potential customers. "Over the years we have established a global supply chain with access to world-class suppliers. Procurement staff are well skilled in international logistics and our strategic sourcing department has strong commodity expertise, which ensures stringent input cost control.

"We have always maintained that manufacturing has massive transformation potential for the South African economy and employment, so we are optimistic about this new division and will be actively engaging with those looking for the expertise we now offer outside of our traditional market segment," Stephen Jones concludes.

www.bellequipment.com


Railtrac:
for unique, flexible and
multi-purpose welding and cutting.
ESAB
ESAB / esab.com
salesjhb@esabsa.co.za
salesdbn@esabsa.co.za
salespe@esabsa.co.za
salescpt@esabsa.co.za
VICTOR
STOODY
THERMAL DYNAMICS
ARCAIR
ewac
AN ESAB BRAND
TBi Industries
TWECO
TURBOTORCH
GASARC
ece DruVa
EXATON

Perfect alignment of welding machines, consumables and technologies combined with our renowned application and process know-how provide the best solution for your requirements: A true and proven connection between people, products and technologies. The result is what we promise: Full Welding Solutions for Lasting Connections.

Scan for more information

voestalpine Böhler Welding
www.voestalpine.com/welding

voestalpine
ONE STEP AHEAD.