SA's benchmark fabricator of complex vessels in modern materials

The Queensburgh and Bayhead fabrication workshops of Durban-based ND Engineering have recently been certified by the SAIW to ISO 3834: Part 2, Comprehensive quality requirements. *African Fusion* visits company and talks to Elvis Green, the managing director and Mark Ackerman, general manager.

Elvis Green, managing director; and Mark Ackerman, general manager of Durban-based ND Engineering.

ND Engineering, according to Ackerman has "fabricated more duplex stainless steel products than the rest of the South African market put together". "We started welding SAF 2205 steels back in the early 80s and we were the first South African company to extensively use 2507 super duplexes. We have long had an excellent relationship with overseas developers, such as Avesta Welding, who pioneered the welding research into these materials," he says.

The company's origin goes back to the late 60s, early 70s when three engineers started a consultancy. "Our fabrication business, however, began in 1975 when we began to maintain and manufacture digesters and other process equipment for the pulp and paper industry, in particular for Sappi Saiccor in Umkomaas," says Green. Nearly 40 years later, ND Engineering still runs a full time maintenance crew of over 25 people at the Saiccor cellulose fibre mill.

"Pulp digesters operate in very harsh environments, and although modern processes have moved away from the extremely harsh chemicals used in the past, a significant amount of materials development has been done to enable the vessels to resist chemical attack," continues Ackerman. "The insides of these vessels is subjected to: erosion at the bottom, due to the abrasive action of the fibrous product on the bottom-bend piping; pitting corrosion in the vapour space at the top of the vessels; and direct corrosive attack around the side walls where the black liquor is in prolonged contact. In addition, the vessels are subjected to cycling pressures and temperatures, from 10 bar at 200 °C down to ambient. And when the vessel is drained, a vacuum can also be drawn, which has been known to cause them to collapse," he adds.

During the late 70s and early 80s, ND Engineering fabricated digesters using 316 stainless steel: "We used to cold stretch the vessels to allow thinner wall thicknesses to be used," explains Green. "If you stress a stainless steel vessel to beyond its yield point, it work hardens the material, making it stiffer and stronger. This allows a thinner thickness material to be used for a given duty, saving on the material costs," he expands.

"But today, using standard duplex stainless steel grades, you can achieve double the yield strength of a 316 stainless steel without cold stretching. Consequently, duplex has been the preferred material for use since our early successes in the 80s," says Ackerman. Typically, a vessel made of 316 with a shell thickness of 32 mm could be reduced to 24 mm by cold stretching it. Using duplex stainless, however, reduces the shell thickness down to 18 mm. "And, along with the strength advantages, the erosion, corrosion and pitting resistance of duplex is far better than 316 stainless steel," Ackerman notes.

ND Engineering is still the preferred supplier of the paper mill digesters when the need arises. "In 2006 and 2007, we supplied and installed eleven 285 m^3 MgO digesters, with the twelfth of that

A view of ND Engineering's 250 m long by 25 m wide Queensburgh workshop with an under hook height of 5,0 m.

same batch being supplied and installed during 2010," says Green.

ND Engineering's growing status in South Africa's pulp and paper industry led to its acquisition in 1992 by the Finish fibre technology equipment specialist, Sunds Defibrator, then part of the Rauma group. "During this time, we went from a fairly small family run business to a fabricator of full cycle paper mill equipment: chippers; stacker/reclaimers; digesters; bleaching tanks; paper presses; bailing machines; and cutters. This is when we first started to operate according to international standards and to become more systematic about or approach to quality. We manufactured all of the bulky items for Sunds Defibrator that were too costly to bring into the country at that time. But the quality standards of the global group had to be met, so ISO 9000 and all of its associated documentation was incorporated into our daily routines," Green recalls.

In 1999, Sunds Defibrator changed its name to Valmet, which was owned by the Rauma Corporation. The brand was then unified under the Metso name and ND Engineering became Metso ND Engineering. In 2004, Elvis Green acquired 30% of the shares in Metso ND Engineering and then, in 2013, he bought the remaining shares, returning the company to 100% South African ownership.

"For three consecutive years we were one of the best performing manufacturing companies in the Metso group. And while there was a perception that the overseas group was responsible for bringing business into the company, Metso was responsible for less than 1% of ND's turnover. So it made sense to bring the company back into South African ownership," suggests Green.

ND Engineering operates two manufacturing facilities that are both SABS ISO 9001:2008 accredited. The Queensburgh Workshop houses the company's management, administration, engineering, quality assurance and the majority of its workshop employees. "Our workshop is 250 m long by 25 m wide, with an under hook height of 5,0 m. It is also the centre of our skills development and apprentice training and we have a well equipped training centre," says Ackerman.

"We are somewhat unique in that we employ our own core staff and seldom rely on labour brokers, which is unusual in the fabrication environment. We have many people with over 20 years of service and we are very proactive about retaining these skill, particularly since, in our niche areas of specialisation, people with these skills are rare. We have run apprenticeships on this site for over 30 years, regardless of incentives from government, and all of our top people have come up through our apprenticeships and engineering programmes," he adds.

Complex tar separator vessels for a Sasol processing plant in Secunda. These vessels involved duplex materials from 8,0 mm to 50 mm and, according to Green, "the most comprehensive welding procedures we have ever seen".

Green notes that "at any given time we are supporting between eight and 10 apprenticeships, and we have never had a break in this programme".

The Queensburgh premises also features a pickling and passivating bay. "All the stainless steel work delivered from our fabrication workshops arrives onsite with full material integrity restored and corrosive resistance intact," Ackerman proclaims. "We have done extensive research into this area over the years, using modern spray and environmentally friendly gels, for example, and we have developed an excellent reputation. So much so that we now offer pickling and passivating services to third parties. In one case, a client came to us asking why our vessels were outlasting a similar quality competitor product. While we found some small issues with surface finish, it's mostly about presenting a uniform passivation layer to the corrosive environment, which prevents initiation of corrosion and hence prolongs the useful life. This is another of our niche skills," he tells *African Fusion.*

For the tar separator vessels, ND Engineering did over 140 production test plates, and were the only tendering company to achieve 100% pass rate on all of these tests.

Three 285 m³ SAF 2205 Duplex MgO Digesters manufactured for Sappi Saiccor.

Two SO_2 converters for a nickel mine in Madagascar. Built on the quayside of ND Engineering's Bayhead workshop, these 500 t modular plants were shipped as completed units.

Due to limitations in the size of the equipment that can be fabricated in the Queensburgh facility, ND Engineering established a second workshop in the Bayhead area on a private quayside of the Durban harbour. The Bayhead workshop has a total area of 5 000 m², with an under roof facility of 50 × 30 m under a 12 m hook height.

"This workshop is equipped with a 100 t mobile crane to allow for the complete utilisation of the open area between the workshop and waters edge. The quayside facility has allowed us to tap into a global market for modular plants. Complete sections of plants can be manufactured, loaded onto ships and transported to site. This is a growing trend, particularly for remote sites, where clients are inclined to minimise the amount of work done on site and the total number of people on the site at any given time," Green explains.

Most notably, two SO_2 converters were recently completed at the Bayhead facility for a nickel mine in Madagascar. "At 500 t per piece, these were the biggest converters to be built anywhere in the world and we built them on the quayside of our Bayhead workshop and shipped them in one piece to Madagascar," reveals Ackerman. Each converter was 16 m in diameter and 27 m high. "The internals are also very complicated, consisting of 3 000 tube heat exchangers sitting in the centre of each vessel. The exchangers circulate SO_3 at 400 °C, which heats the incoming SO_2 to recover heat and improve the net energy efficiency. These converters are at the core of the mine's sulphuric acid plant," he adds.

The mine in Madagascar is less than 12 km from the coast, which made it feasible to load the converters onto a ship using its 2 × 800 t cranes and ship them to the nearest harbour. An SPMT (self propelled modular trailer) with an operator walking behind it with a remote was then used to transport the vessels to site.

"We also built three modular ammonium sulphate crystallisers for the Veolia water treatment plant on the same site, which was the world's largest modular plant for Veolia," adds Green.

Turning attention to welding and the company's ISO 3834 certification, Ackerman says that SANS/ISO 3834 is the ideal standard for welding fabricators and a requirement for all South African fabricators who design and construct pressure equipment to the ASME code. "This certification gives us an internationally recognised quality 'stamp' and, while other system focus on telling the client how wonderful the product is after it has been built, ISO 3834 is one of the few that focuses on the planning and process control philosophies on the way to making a product," he says.

"It also matches our processes well, as we have always had to follow this approach to succeed. Successful welding depends on controlling consumables, managing the issuing and receiving of materials, ensuring that welding procedures are thoroughly developed and tested, and that welders are properly trained, coded and informed," he says. "When I first saw this standard, I realised immediately that it was going to be useful.

"ISO 3834 also makes good business sense. From the first day of implementing a project, it requires that fabricators make sure they can make the product to the required standards. And by interrogating the fabrication process, numerous obstacles can be avoided. Every time we had a planning meeting, everyone was communicating and informed of the game plan. This process allows the whole organisation to pull in the same direction and for all involved to be made aware, upfront, of the dangers and difficulties.

"We are also supportive of the new Pressure Equipment Regulation (PER) and SANS 347. Along with ISO 3834, these allow us to compete on an equal footing with fabricators that try to be

Three ammonium sulphate crystallizers for the water treatment plant awaiting shipment to Madagascar.

competitive by cutting corners. These standards help balance the equation because they force everyone to meet the same safety and quality standards."

As an additional advantage of ISO 3834 certification, Ackerman says that some of the AIA inspection requirements can be averted if clients are using a 3834-certified fabricator. We need to educate our clients about these reduced requirements, but reputable AIAs and IPEs will confirm that they only need limited involvement when a fabricator with an ISO 3834 certificate is doing the work," he says.

Ackerman says that although all welding processes are employed at ND Engineering, MIG/MAG welding and flux-cored arc welding are generally preferred. "You will see some MMA and TIG welding specified on plans, particularly when access is difficult, but these are low productivity processes that we avoid, where possible. Also, on highly alloyed material, these processes leach out more of the alloying elements. We find that flux-cored wires often give us a better material composition match and a better surface finish to present to the corrosive environment," he explains.

"Welding is the worst catastrophic event that a pressure vessel is ever going to experience!" he exclaims, citing four core aspects to successful welds: the alloying composition; the microstructure; the surface finish; and the passivation layer. "If these four things are all successfully balanced in all of the welds, then you will have a quality vessel that will last," he adds.

"ISO 3834 goes a long way to helping avoid damaging the microstructure, ensuring that massive grain growth and brittle grain boundaries are not created, alloying constituents are not leached out, and that there are no rough surfaces on the welds that will preferentially corrode," Ackerman says.

From its core business in the pulp and paper industry, the ND Engineering of today benefits from the broadest range of clients. "We do acid plants, separator vessels, heat exchangers, duplex storage tanks, spherical pressure vessels and autoclaves. We have also begun to manufacture RDA valves for the sugar, industries," says Green. "Project work in South Africa's industries is very cyclical. By spreading our offering across several industry sectors, we have managed to maintain a steady inflow of work, which enables us keep our skilled core people," says Green.

The most current success involves the manufacture of complex tar separator vessels for a Sasol processing plant in Secunda. "These vessels involved duplex materials from 8,0 mm to 50 mm thick and the client had major reservations about a South African fabricator successfully welding this material in the thickness ranges required. Following intense involvement with Sasol, and using one of the most comprehensive welding procedures we have ever seen, we did over 140 production test plates, which included almost every welding scenario possible – and we were the only tendering company to achieve 100% pass rate on all of these test plates," Green reveals.

"Duplex is a fantastic material if you treat it right, but if you get it wrong, it can go horribly wrong," adds Ackerman, adding that ND Engineering was eventually contracted to manufacture 16 of these separators in SAF 2205 duplex material.

"We are a client focused company, committed to conducting our business in a manner that contributes to the success of the industries we serve. While perfection is rarely possible, we are determined to become the industry benchmark fabricator," Green concludes.

A third stage separator vessel for the recovery of catalysts in the petrochemical industry.

A 65 t horizontal acid cooler being airfreighted to New Caledonia.

A heat exchanger vessel under construction at ND Engineering's Queensburgh workshop.