Hardfacing solutions and the sugar industry

In support of South Africa’s sugar industry, which grows and processes some 2,5-million tons of sugar every season and contributes R6-7-billion to the South African economy, Afrox is rolling out a comprehensive service and product offering for the hardfacing of washboards, cane knives, shredder hammers and mill rolls. *African Fusion* talks to Bonisile Isaac, the company’s product manager for hardfacing electrodes.

The South African sugar industry consists of approximately 30 000 registered cane growers and 14 currently operational sugar mills spread across three provinces, KZN, Mpumalanga and the Eastern Cape. Approximately 50% of local production, of which 80% originates in KZN, is exported.

“Afrox, through its Special Consumables Factory (SCF), and its extensive regional representation and technical expertise, has been a dominant player in the hardfacing of sugar mill components in South Africa throughout its history,” says Isaac. “Recently, we have been particularly successful at Illovo’s Sezela Sugar Mill, where, together with Lionel Peters, the customer manager and Raj Naidoo, our regional manager for the Pietermaritzburg area, we have developed a comprehensive process offering for the hardfacing of wear components. We have developed specific electrodes, consumables, and optimised welding processes and procedures to save the mill both money and, more importantly, to improve uptime,” he adds.

“I started out in the welding consumables factory in Brits and then went on to be Afrox’s process development specialist for the sugar industry. So, on the hardfacing side, I am familiar with the whole supply chain, from electrode development, through process R&D and all the way to successful application,” Isaac reveals.

He explains that hardfacing is about increasing the wear resistance of machine components. “In the sugar industry, we put layers of wear resistant materials onto the exposed parts of components to increase their wear life: wash boards; cane cutting knives; hammers; and mill rolls. By optimising hardfacing procedures, the life of these wear parts can be extended, and the operational efficiency of the whole can be improved, which reduces costs and increases production,” he says, before going on to list some other reasons for investing in comprehensive hardfacing solutions:

- Plant downtime can be reduced.
- Reconditioning components instead of replacing them saves on direct costs and on labour costs due to fewer replacements.
- Expensive alloy steel parts can be replaced with cheaper mild or low-carbon steel parts, hardfaced with a minimum amount of wear-resistant alloy around the area of wear.
- Reduced plant dependence on replacement new parts, with associated lead times and inventory requirements, can result in considerable savings.
At the starting point of sugar cane processing are the washboards and the cutting knives. Trucks come in from the growers and offload the cane onto spiller tables that feed the cane into the preparation section. Through the process of cutting and crushing, via large rotating cane knives and shredders on washboards – large, curved metal plates – the sucrose cells of the plant are exposed in order to wash out the sugar juice. “The raw cane comes with a lot of sand and stones, so impact, abrasive and erosive wear are all problems,” says Isaac.

“We have developed special electrodes for the washboards as well as a procedure where you superimpose crossed layers of Duracor 59 self-shielded wire. The wire is best deposited using longitudinal stringer beads, with each adjacent bead deposited using a slight overlap. But only the most exposed areas need to be repaired, so some mills, like Sezela for example, prefer to use electrodes for the washboards. Here, we recommended Cobalarc 9, Cobalarc 1 or CR 70.”

Duracor 59 self-shielded wire, and the Cobalarc and CR70 electrodes are all chromium-based alloys that increase wear resistance because of the very hard chromium-carbide (CrCO3) precipitates that become embedded in the surface layers. “We also add manganese for impact resistance and molybdenum, a ferrite former, which increases the work hardenability of these alloys,” Isaac explains.

On the process side, Isaac says that the most important factor affecting the quality of hardfacing is dilution. “Too much dilution of the hardfacing alloy with the base steel raises the stresses at the interface, which can cause cracking,” he explains.

Turning his attention to the cane knives, Isaac relates that the hardfacing needs to be done so that ‘choking’ is prevented, which is when the knives bend and plastically deform. Choking prevents the cane from passing through the knives, which causes clogging and, potentially, a shut down.

“Knives operate under severe conditions. Wear is caused due to a combination of conditions such as impact due to stones; severe abrasion because of sand or ash; and heavy erosion due to the high cutting velocities involved. The worn portion of the knife is cut away at the end of its operating cycle and a new one is welded on. Then the back edges of the knives are sharpened, while the other edges are left to sharpen themselves through the wear processes,” Isaac tells MechTech.

The knife hardfacing process involves both a build-up of the steel substrate, typically using Afrox LH 7018-1 or 78 MR electrodes, followed by a hardfacing layer using mostly Duracor 59, a self-shielded flux-cored wire. “Self-shielded flux-cored welding offers excellent speeds and efficiency.

All of the knives from a rotator are removed and placed onto a turntable. Then one welder welds the first side of each knife before beginning to weld the other side. This helps us to keep the dilution down because the knives are cooler when the second edge is welded,” he explains.

“This process has also been used to significantly improve the hardfacing process on the hammers,” he continues. Isaac points towards the shape of a typical hammer and reveals that the formation of a lip with an undercut is of paramount importance to the system’s effective operation. The presence of this lip ensures reliable feeding into the shredder, efficient shredding and the elimination of choking. “You are trying to pass 150 ton/hour of cane through these hammers, so if the lips do not form, then you will end up with a lot of cane stuck on the washboard,” he warns.
“So when hardfacing, we only put a single layer on top to allow the lip to wear, and we then build up the side edges.”

The hammers operate continuously and are replaced or reversed either every week or second week, depending on the wear life obtained. This is affected by many factors, but mostly by the amount of sand or soil processed with the cane, which in turn depends on the rainfall during harvest time.

“To cut out downtime, you need to match the hardfacing rate with the actual wear rate. Hammers need to be ready at the right time and they must last for the full week or two-week expected life.”

Hardfacing on the hammers is a cornerstone of the welding optimisation process at Sezela mill. “At Sezela, a single welder does both the build-up and the hardfacing layers on the shredder hammers. Two wire feeders are permanently connected to one Miller GMAW welding machine: the first with Afrox TM-44 self-shielded flux-cored wire for the build-up welding, and a second with the Duracor 59 hardfacing wire. The hammer components are again all arranged onto a turntable to allow the welder to process all of them at once.”

This process, when compared to an equivalent welding process using a major competitor consumable, has resulted in total savings, per kilogram of weld metal deposited on the hammers, of 56%, “and this is now being achieved at each of five hammer welding stations at Sezela,” says Isaac.

Johan Jansen van Rensburg, factory manager of Sezela Illovo Sugar says: “We have been using Afrox products – machines, consumables and gases – for 10 to 15 years, and although we have tried other brands, we have never achieved better results.

Afrox solutions offer us good process efficiency, better turn-around times and we find them to be more cost effective.” He also adds: “My department always receives good back up, repair services and technical support from Afrox, particularly during shut-downs.”

Another Afrox niche sugar hard-facing application, called mill roll roughening, takes place at the opposite end of the mill after the shredded cane leaves the diffuser. “The bagasse comes out of the diffuser wet, and is then squeezed dry by a number of large three-roll drying mills – sets of expensive mill rolls about 1,2 m in diameter, 3,5 m long and costing about R1-million per roll,” Isaac tells African Fusion.

Because this is a continuous process, the mill rolls cannot be allowed to slip, which would cause a build-up of cane in the diffuser, so they are roughened using the MMA process. “We roughen these rolls using a continuous arcing process, while the mill is running. And this is a wet and hot environment, so the properties of our CR70 electrode, which has been specially developed for this task, are critical,” reveals Isaac.

First among these are the electrodes’ strike and restrike capabilities. “The wet roll is moving all the time, which makes it important that the arc-on time is as high as possible, and the mill judges the electrode based on the amount of slip they get,” he adds. “Also, the roughness of a newly welded roll must last for at least two weeks, because welders can’t be in that environment for a long time.”

CR 70 is a chromium-based electrode which forms an austenitic matrix of chromium carbides with high resistance to wear and good impact resistance. The electrode has hardness of about 59 HRc and it can withstand temperatures of up to 400°C. “Our Afrox CR 70 has proved to be the most cost effective roughening technique yet developed for this application, ensuring excellent traction and throughputs.

“Our comprehensive offering and product range, supported by our R&D, process development and technical support teams, have proved that they can cut costs and improve productivity at sugar mills.

“At Afrox, we aim to ensure that mills receive fair value by supplying relevant products that are specially tailored to the industry and to the specific application requirements at each mill,” Isaac concludes.