**How to hardface: The ten-step approach**

At an afternoon seminar at SAIW on July 26, Alain Laurent, business developer of consumables for Saf-Fro and Oerlikon, presented the companies hardfacing offering and its ten-steps approach to achieving optimum surface layer characteristics.

Surfacing operations involve a harder or tougher material being applied to a less durable base metal, begins Laurent. “The objective is to extend the service life of equipment, avoid machine down-time and reduce production costs,” he says. Surfacing, hardfacing or cladding can be on new parts during production or on used parts to restore worn-down surfaces, with the aim to increase the wear, abrasion, erosion or corrosion resistance of contact surfaces.

“Selecting the proper hardfacing alloy, does not in itself always guarantee the desired result. Base metal interactions with the surface metal, the working environment, the welding process, the welding procedure and many other factors can be equally important to get the maximum benefits from a hardfacing operation,” he suggests.

Hardfacing processes are widely used in the cement, material handling, steel, sugar, railway, waste to energy, dredging and tunnelling industries, while many fabricators offer wear plate solutions for earthmoving and other plant equipment.

“All of the common welding processes can be applied for hardfacing and Oerlikon offers a wide range of consumables and solutions to meet the different applications needs,” Laurent says, adding, “to achieve cost-effective and optimal results. Oerlikon has identified 10 steps that need to be followed in order to choose the appropriate surface alloy, welding process and layering procedures.

**Step 1: Identify the base metal**

“We have to know the chemical composition of the base metal before choosing a consumable,” Laurent points out.

For new equipment this is easier, “but if we don’t know what the base material is, there are some tests that can help us to identify it.

“The majority of the base metal used for equipment is iron based and there are four broad categories: high carbon steel; low carbon steel; manganese steel; and cast iron,” he adds.

The first and easiest test is to see if the material is magnetic or not. If a magnet does not stick to the base material being hardfaced, then it is likely to be an austenitic stainless steel (3xxx series), manganese steel or a non-ferrous material such as copper, aluminium or tin. Low and high carbon steels and cast irons will be highly magnetic, as will ferritic stainless, while nickel-copper alloys such as Monels and some high-ferrite duplex stainless steels will be partially magnetic.

Laurent also cites the grinding spark test: white sparks for carbon steels, yellow for cast irons; the hammer test: if the surface marks, it’s a low carbon steel, if the hammer marks, it’s a high carbon steel; and the stick electrode welding test, which involves using a 3.2 mm basic electrode to weld a bead onto the surface. If the HAZ metal cannot be seen, the base metal is a hardenable low-alloy steel (>0.5% C), while if the deposit cracks or comes off, it is likely to be difficult-to-weld cast iron that can only be hardened on top of a ferro nickel buffer layer.

“The more information we can get, the better though,” he suggests, and there are more accurate ways of identifying the wear factors involved in an application, either from a site visit or from a detailed description of the equipment’s use,” says Laurent.

**Step 2: Identify the dominant factor of wear**

Laurent emphasises that information about the specifics of the application is vital for an appropriate hardfacing solution to be selected. Showing a diagram of how wear can occur, he says that abrasive wear is due to a gouging action of the particles with horizontal speed, while impact, which can cause denting, squashing or cracking, is due to the perpendicular impact speed. Mixed impact and abrasion is also common.

To overcome abrasion in the mining, earthmoving and materials handling context, for example, he suggests that the hardfacing process needs to be selected to suit the hardness of the specific ore being extracted or handled.

He notes several other mechanical factors with particular wear mechanisms: abrasive wear on the pressure rollers for the clinker crushing process in a cement plant; metal-to-metal friction wear on railway lines; and impact wear on crushing hammers, where the hardness, speed and weight of the impacting materials plays a vital role.

In addition, corrosion factors should be identified if using seawater or chemicals; and/or thermal factors, for furnace components and hot rolls in steel mills, for example.

“We have a lot of experience in the different hardfacing applications, though, so we can generally help to identify the wear factors involved in an application, either from a site visit or from a detailed description of the equipment’s use,” says Laurent.

**Step 3: Select the hardfacing alloy and process**

The better the match between the hardfacing alloy and the application, the longer the wear life of the coating is likely to be: “A first choice can be done by using ISO 17400 or the old DIN 8555 classifications, but the more information you can give us, the better,” he says. “Tests are sometimes necessary to validate the choice, because the carbon percentage in the alloy, while a good indicator of abrasion resistance, is not enough. Other parameters such as the microstructure and the type of carbides that will form must also be considered,“ he says, adding again, “the more information you give us, the better.”

Laurent displays a summary grid of consumables organised with increasing impact resistance on the y-axis and increasing abrasion resistance on the x-axis. Several types of consumables are represented: Citorail and Supradur MMA electrodes; Carbofil A350 and A600 GMAW wires; Fluxofil 56 and 66 for gas shielded FCAW; and for self-shielded FCAW, several Fluxodur consumables.

Cast iron, medium carbon steel alloys, martensitic stainless steel and manganese steel alloys are all represented. “And submerged arc wire, strip consumables and flux combinations as well as TIG or oxyfuel wires (Cilotel CT) are also available,” Laurent adds.

As an example application to show how to use the selection grid, he cites the clinker grind rolls on a crusher at a cement works, where Fluxodur S8 TC-0 or Fluxofil 66 would be chosen to cater for the high impact, high abrasion application on the pressure rolls.

On a friction application for the shafts of the grind rolls, however, a machineable Carbofil A350 or Supradur 400 might be more suitable.

“Where impact wear dominates, such as on crusher jaws, then manganese steels such as the Fluxodur AP-O.
and Supramangan consumables tend to work best,” Laurent says.

Temperature and corrosion resistance are taken into account as secondary criteria, and Oerlikon has developed a similar temperature versus corrosion grid to assist operators to choose appropriate consumables.

In terms of the welding process, Laurent says that each says that has its advantages and disadvantages. SMAW (shielded metal arc welding) is easy to implement both outdoors and onsite and a comprehensive range of consumables is available, covering every segment. “Some of our best sellers include Abracto 625, Supradur R 600 and Supramangan,” he notes. The only downside for SMAW is that the productivity is lower than other automatic or semi-automatic applications. But SMAW is that the productivity is lower than other automatic or semi-automatic applications. But

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For the flux-cored process, which offers deposition rates of up to 8.0 kg/h, both open arc (gasless) and gas-shielded wires are available in the Fluxodur and Fluxofil ranges respectively.

For higher deposition welding, all heat-affected zones adjacent to welds, for example, the preheating and interpass temperatures being used are not high enough.

Conclusions

Displaying his ten ticked steps, Laurent says that this approach offers the best possible assurance of achieving successful end results. And in making all of the choices required, Oerlikon and Saf Fro specialists, either directly or through its local distributors, are accessible and available to help fabricators to arrive at ideal hard-facing solutions.

The crack on the right in this hard top surface layer of Fluxodur 58, TIC-O has been stopped by a Supranox RS 307 buffer (bottom) layer.

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