EPOXY COATING APPLICATIONS IN THE SUGAR INDUSTRY

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Abstract

The maintenance costs of a sugar mill can be reduced by applying the correct coatings to corrosion-prone materials. Epoxy is one of many coatings available for application, and four specific epoxy coatings have been used extensively over the past four years in the sugar industry. The four epoxy coatings each have unique properties and areas of application, and examples of their use at Felixton are given.

Introduction

The economic climate in South Africa during the past decade has forced industry to focus its attention on reducing plant running costs. Maintenance, operational and technical departments have generally been made responsible for cost reduction.

In the sugar milling industry, corrosion and abrasion cost the company shareholders millions of rand each year. Sugar mills using diffusers had to contend with acetate extraction and ash in cane. Felixton mill was plagued with high acetate extraction (Beckett and Graham, 1989) and has one of the highest percentages of ash in cane. After six crushing seasons, certain steel components were so eroded and/or corroded that they had to be replaced or repaired. This prompted urgent trials of various products, including epoxy coatings, in an attempt to reduce the corrosion/erosion mechanism on the identified concern areas.

Epoxy coating consists of a pigmented resin solution and a catalyst. The two components are mixed immediately before use and the mixture has a limited 'pot life'. The pot life can vary from 20 minutes to 24 hours according to the nature of the components and the temperature of the curing mixture. The curing process is a chemical reaction between resin and catalyst which begins as soon as they are mixed. The reaction does not involve atmospheric oxygen and it is therefore possible to apply much thicker films than with conventional paints. Special grades of epoxy resins have been developed that exhibit outstanding resistance to water and chemical solutions. These coatings are widely used to protect steel and concrete surfaces.

Types of epoxy coatings used at various sugar mills

The four types that have been used extensively at Felixton are described by the manufacturer as brushable wear compound, steel trowel mix, high temperature wearing compound and blockseal.

Brushable wear compound is a liquid ceramic coating suitable for application by brush or paint roller. It provides protection against liquids and gases with a pH as low as 1,5 and can withstand continuous temperatures of 100°C. The alumina ceramic particles and fibres used in this epoxy composite provide excellent abrasion resistance from small to moderate size particles. Brushable wear compound gives good results as a coating for continuous and batch seed pan steam inlet chests, juice heat exchanger header doors, and boiler induced draught fan runners and casings (as discussed below). The product has also been used at Simunye, Umfolozi and Mount Edgecombe sugar mills.

Typical properties:	Compressive strength	82 MPa
	Tensile strength	34,5 MPa

Blockseal is a 100% leakproof, non-flammable, solvent free epoxy coating. The application of blockseal is by brush or roller. It dries to a shiny tile-like finish and can be used as a coating for steel, concrete or wood. Being solvent free it can be applied to the inside of vessels without any special safety precautions. When mixed with a suitable aggregate, this provides a non-slip floor coating. Blockseal renders excellent protection against attack by sugarcane juice, molasses, ash water, phosphoric acid and fluorine contaminated water. Due to its tile-like finish, the build-up of scale and contaminants is prevented. The coating has been tested and accepted for potable water storage vessels (Anon, 1987). Blockseal is presently being used at Felixton for juice heaters, walls surrounding the swirl tanks, floors and pumps. At Simunye it has been applied to floors.

Steel trowel mix is an epoxy resin filled with steel powder and is troweled on. Once it has cured it can be machined, drilled, tapped and filed similar to mild steel. Steel trowel mix can be used to rebuild worn pump shafts, volutes and valves, and the product has been used to restore surfaces that are exposed to cavitation. Badly corroded and deeply pitted areas have been restored using steel trowel mix as a filler instead of weld build-up.

Typical properties:	Tensile strength	42 MPa
	Compressive strength	110 MPa
	Hardening time	120 minutes

High temperature pneu-wear is a trowelable, wear resistant coating designed for repair of pneumatic conveying systems. It contains extremely hard-wearing alumina ceramic beads and fibres in a heat resistant epoxy resin matrix. Because of the small ceramic bead size (average 0,5 mm), it is most suitable as an abrasion-resistant liner against high velocity small particle and high temperature substances. Both the hardener and the resin of pneu-wear contain ceramic beads, which ensure a higher density ceramic in the final mix. Pneu-wear is capable of withstanding continuous temperatures in the 200-250°C range, and is most suitable for internal repairs to steam valves. Felixton and Mount Edgecombe mills have repaired steam valves in this manner and these are now in their third crushing season.

Surface Preparation

As with most coatings, including epoxy, proper surface preparation is vital for successful application. Grit blasting closely followed by the coating has been found to be the most efficient method of removing all contamination and creating the coarse textured surface required for maximum adhesion of the epoxy to the substrate.

Results of typical application of epoxy coatings at Felixton

Induced draft fan

Each of the three Babcock boilers at Felixton has an induced draft fan which is positioned between the wet flue gas scrubber and the flue gas stack. The boilers are fired on

bagasse and coal, which contains sulphur. The fan diameter and speed of rotation are approximately 3 000 mm and 640 rpm respectively, and the temperature of the flue gas entering the fan is approximately 80°C. One runner was due to be replaced during the 1990 crushing season but, before recommissioning the fan for the season, the runner was coated with brushable wear compound. The fan ran throughout the 1990 crushing season. During the 1990/91 off-crop the runner was touched up slightly in areas where the initial adhesion was not satisfactory, thereby preparing it for another season (see Figures 1 and 2).

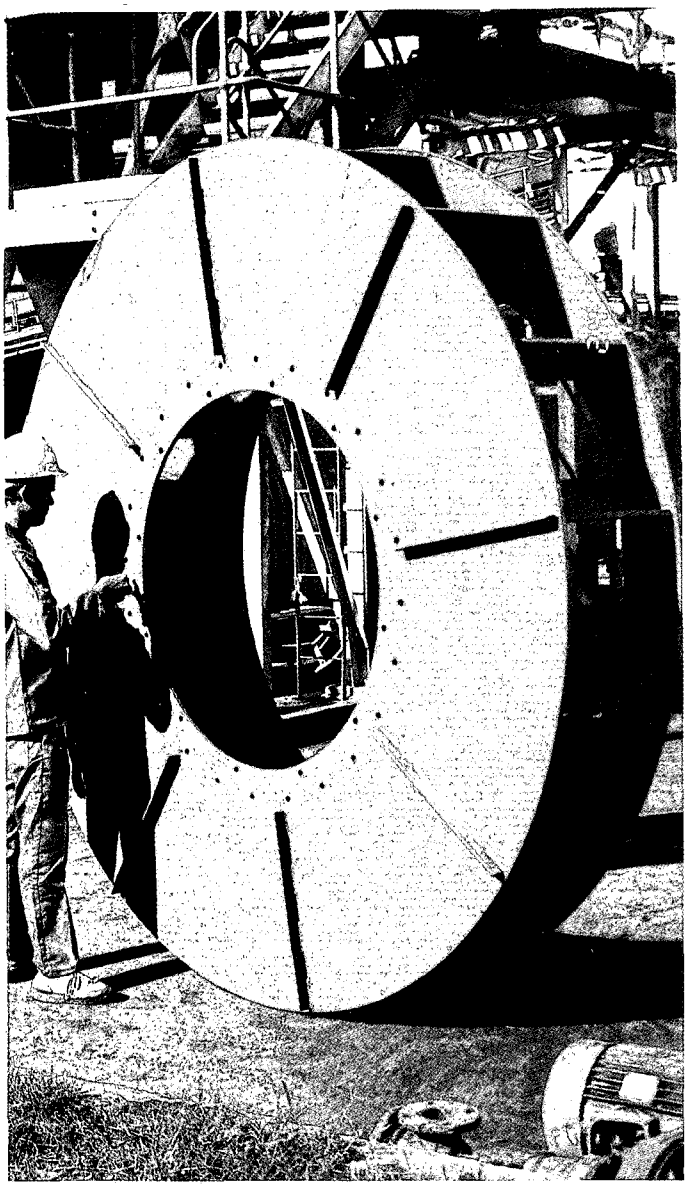

FIGURE 1 New induced draught fan runner coated with brushable wear compound.

Current opinion is that the fan runner need only be checked once a year and touched up if needed, and replacement of the runners in future will not be because of corrosion and erosion but due to metal fatigue. An added advantage of epoxy coating was the absence of fly ash accumulation on the blades due to their smooth finish, which in turn reduced vibration and power consumption.

Injection water pump casings

Brushable wear compound has been used successfully on the six injection water multi-stage pump casings at Felixton.

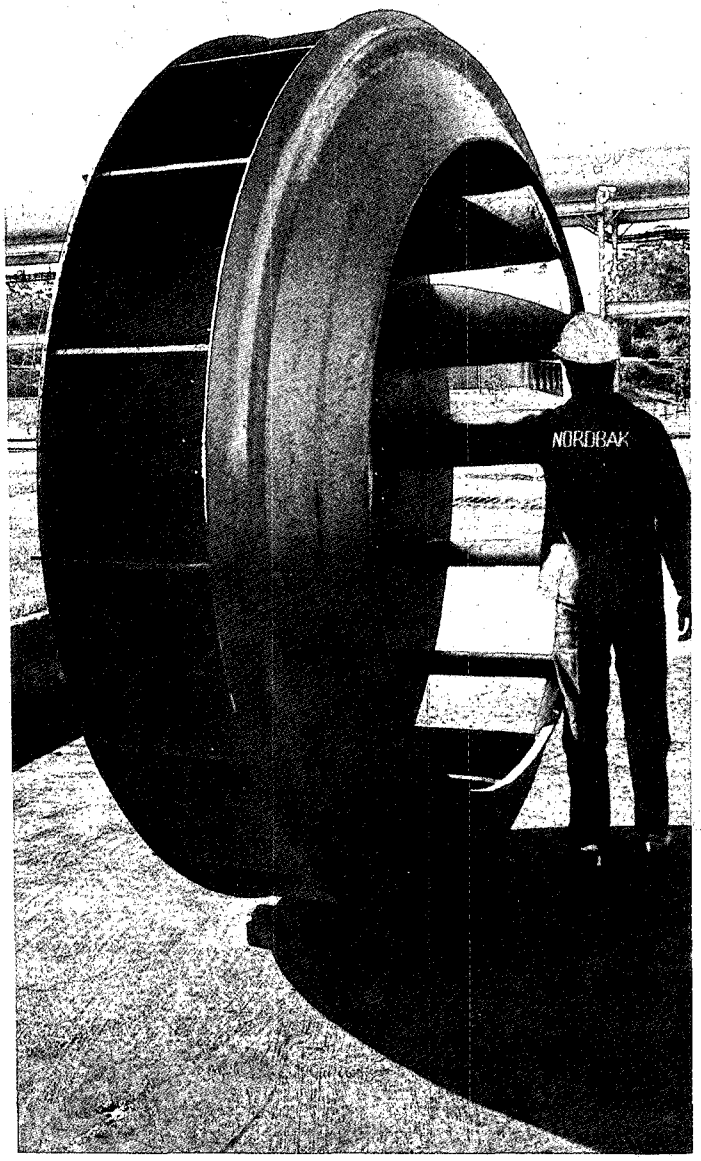

FIGURE 2 Fan blades of induced draught fan runner coated with brushable wear compound.

The product was applied to one pump in the 1987/88 off-crop, together with glass linings. The epoxy coatings compared well with the glass coatings with the additional advantages that repair of patches was possible, and could be done on site more economically. The casing's life has been extended considerably by both glass and epoxy coatings.

Continuous pan condensers

Steel trowel mix has been used on Felixton's continuous pan condenser internal walls as a filler epoxy, followed by brushable wear compound. A section of continuous pan condenser had to be replaced in the 1988/89 off-crop, when, after seven crushing seasons, the initial wall thickness of 12 mm was reduced to nothing. The condenser wall thickness has been monitored at specific nodal points during the 89/90 and 90/91 off-crops and no measurable loss of mild steel has been recorded. In Figure 3 the nodal matrix can be seen on the outside of the condenser. Figure 4 shows the smooth internal surface of the epoxy coating in the foreground and an external view of a continuous pan condenser in the background.

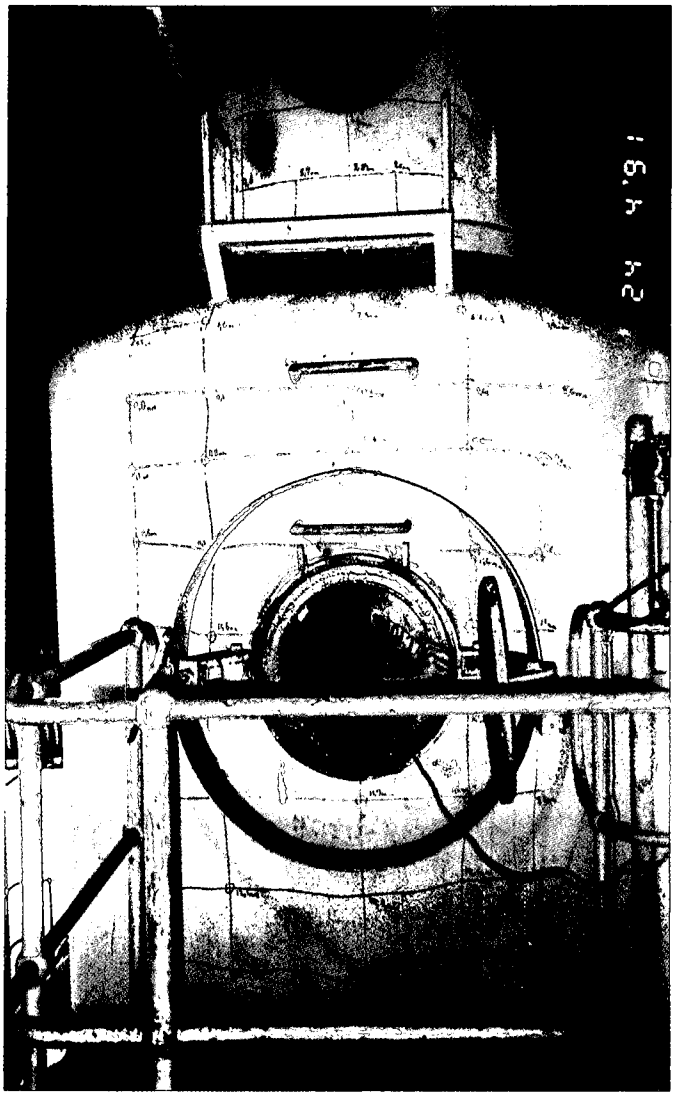

FIGURE 3 Continuous pan condenser exterior showing nodal matrix.

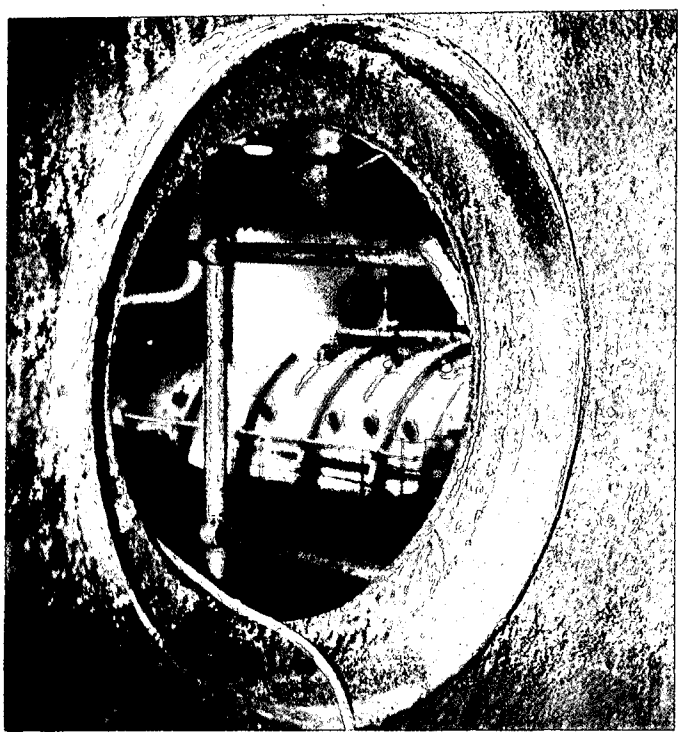

FIGURE 4 Epoxy coated internal surface of continuous pan condenser wall, with a continuous pan condenser visible through the manhole.

FIGURE 5 Batch pan steam chest inlet internal before epoxy coating.

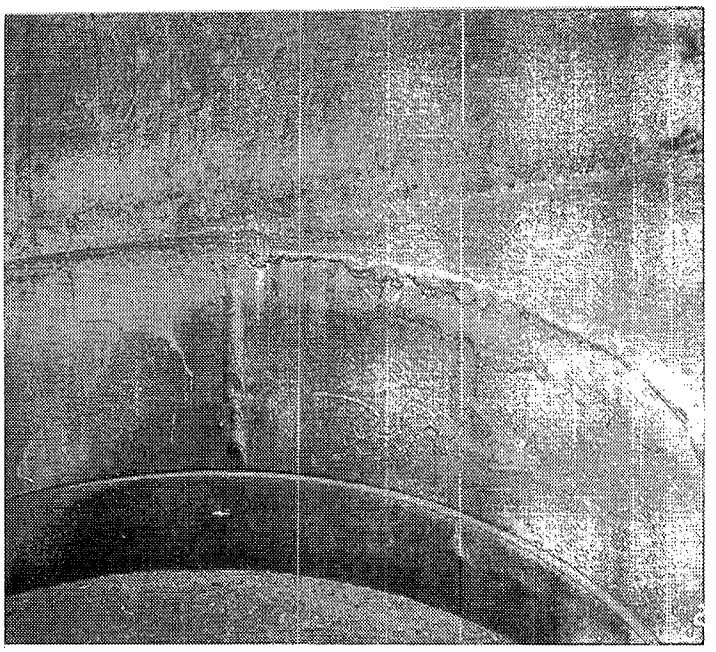

FIGURE 6 Batch pan steam chest inlet internal after epoxy coating.

Batch pan steam chest inlets

In the 1987 offcrop the batch pan steam inlet chests were found to have been severely attacked by corrosion/erosion. During the 1988/89 off-crop the steam chest inlet was epoxy coated using steel trowel mix as a filler, followed by high temperature pneu-wear. The rate of corrosion/erosion of an uncoated area was monitored during the 1989 crushing season and was found to be alarmingly high, whereas the epoxy coated area needed only to be patched in places of bad application. Figure 5 shows the batch pan surface before epoxy coating was applied, and Figure 6 shows the same area two crushing seasons after the application of the epoxy coating. The coating did not need repair after the 1990 crushing season.

Butterfly valve

A large (1 000 mm diameter) Danais butterfly valve is used for controlling the main steam flow leaving the 2nd evaporator. Vapour 2 at Felixton was found to be very cor-

rosive. The valve body and some components of the valve had been attacked by the organic acids in the steam. The corrosion was severe enough to warrant protection, and in the 1989/90 off-crop the corrosion cavities on the valve body and the retaining ring were filled with steel trowel mix and overlaid with a high temperature pneu-wear protective coating. The valve needed no further repairs during the 1990 crushing season and the 1990/91 off-crop.

Sugar dispatch floor

Raw sugar produced at Felixton is dispatched by rail. The sugar bin loading area has a concrete cast floor, which in three years of operations suffered severe attack from sugar spillage. The floor area was coated with blockseal in the 1989/90 off-crop and after one crushing season no repair was needed and no further concrete attack was evident.

Conclusion

Experience with four epoxy coatings used in various applications in the sugar industry has illustrated the potential of these products when used at the design stage and during plant maintenance, to reduce running costs and increase the life of the plant.

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