Corrosion Problems in a Bagasse-Based Paper Mill

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Corrosion, in general terms refers to deterioration caused when a metal reacts with its environment. Corrosion manifests itself as a problem in increased downtime and maintenance costs. In the past, paper mills considered corrosion as an operating expense replacing equipment/machinery when necessary. Changes in paper making technology, economics and ecological restrictions have all combined together to alter the thinking of present day Management of Pulp and Paper industry.

Tamil Nadu Newsprint and Papers Limited(TNPL) have, for the first time in India embarked upon a new venture manufacturing newsprint and writing paper using bagasse as its principle raw material. The corrosion problems of the mill, which has adopted a new technology and process in using bagasse are unique and concerted efforts to avoid/solve them have already started.

Bagasse Depithing :

Bagasse by nature is an abrasive material. This is further accentuated by the presence of sand, grit and other foreign material. It is therefore, expected that when bagasse with sand goes through the feeding, conveying and depithing operations, rapid wear-out of depither hammers, screen brakets, screw conveyors etc takes place. Further, when pith is separated from bagasse in the depithing operation and fed to boiler for burning, the sand causes rapid wear-out of conveying equipment, baffleplates, fans etc. At pith storage yard, all base structures of belt conveyors needed cement encasing with an epoxy coating in order to avoid corrosion effects of pith.

Bagasse Handling and Storage

Wet bulk storage is a normal practice employed for storing large quantities of depithed bagasse. The wet piling method adopted in TNPL mill consists of storing depithed bagasse on two huge slabs of special construction measuring 90 M × 540 M, using a self propelled boom-stacker. The central channel between the two slabs and the side channel located around the perimeter of the slabs, collect the effluent drained from the piles, for recirculation again to slurry the incoming bagasse in the mixing cyclone of the stacker.

During the storage period, the residual sugars present in the bagasse are converted to alcohols by fermentation which are further oxidised to aldehydes and then to acids. As a result, the pH of the effluent draining from the piles, drops to about four. This highly corrosive liquor together with the enormous load factors involved in wet bulk storing of bagasse, calls for specialised construction of the storage slabs. A typical cross section view of the bagasse storage slab of TNPL is shown in fig. 1. The surface of the slab has a uniform 3% slope to aid easy draining of the

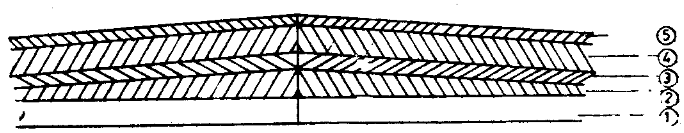

FIG 1. CROSS SECTION OF BAGASSE STORAGE SLAB

1 GRAVEL SOLING 150mm thk
2 1st LAYER WBM 100mm thk
3 2nd LAYER WBM 100mm thk
4 BLACK TOPPING (ASPHALTIC CONCRETE WITH 20mm & DOWN GRADE METAL) 40mm thk
SEAL COAT 10mm thk (6mm STONE WITH TAR)

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effluent. Factors like heat, radiation due to sunlight, condition of soil etc were taken into consideration in designing the slab. TNPL project site had a hard gravel surface which gave considerable economy in the construction of the bagasse slab.

The surface of the bagasse slab is subjected to—

i) Erosion due to movement of heavy equipment like front-end-loaders and dozers used for reclaiming and piling operations. Frequent accelerations, application of brakes of these equipment leave the marks of the tyres on the surface of the slabs causing severe erosion.

ii) Erosion due to pumping of slurry from a receiving pit or dropping it from a boom stacker.

iii) Corrosion due to acidic condition of bagasse in the pile. In TNPL, the erosion of slab was observed at the edges where stagnation of low pH effluent takes place during piling operations due to jamming (with bagasse fiber) of drainage holes located in the side walls. Movements of front-end loaders on the stagnated water caused rapid erosion of the slab. The slabs are repaired during every off season. Erosion of the slabs due to dropping of bagasse slurry from Boom stacker (from an elevation of about 20 metres) was not noticed so far.

Though it is good to have a 2" protected layer of bagasse on thn slabs where the heavy vehicles move, it is found impracticable as the tyres of loaders and dozers were skidding, making it difficult to operate. Many Mills have reported more maintenance on channcals as compared to slabs. The central channel is of RCC construction with a surface coating of coal tar epoxy paint. No corrosion was observed in the channel so far. The side channels of the bagasse slabs are constructed of stone masonary. After two seasons of operation, the pointing material (cement mortar) used for the stone masonary was found corroded at few places. This is mainly due to stagnation of effluent in the channel. Front–end–loaders and wheel dozers are not affected by corrosion as both are tyre (rubber) driven. Dozers of crawler (chain driven) type are known to have affected by corrosion on bagasse slabs. The under carriages are exposed to acid attack so that track parts (links and shoes), sprokets, front idlers and track rollers will have to be changed every other season.

BAGASSE RECLAIMING OPERATIONS :

In the reclaiming operations in TNPL, bagasse from the top of the pile is pushed down by the dozers and the crumbled material is collected by front–end–loaders and fed to mobile reclaim hoppers. The hoppers in turn meter bagasse to belt conveyors running along the length of the storage slabs for feeding to pulp mill feed conveyor. No corrosion problems were experienced in the reclaim operations in TNPL. Pneumatic transportation of bagasse or pumping to pulp mill in a slurry form involves expensive piping and is exposed to combined effects of erosion and corrosion.

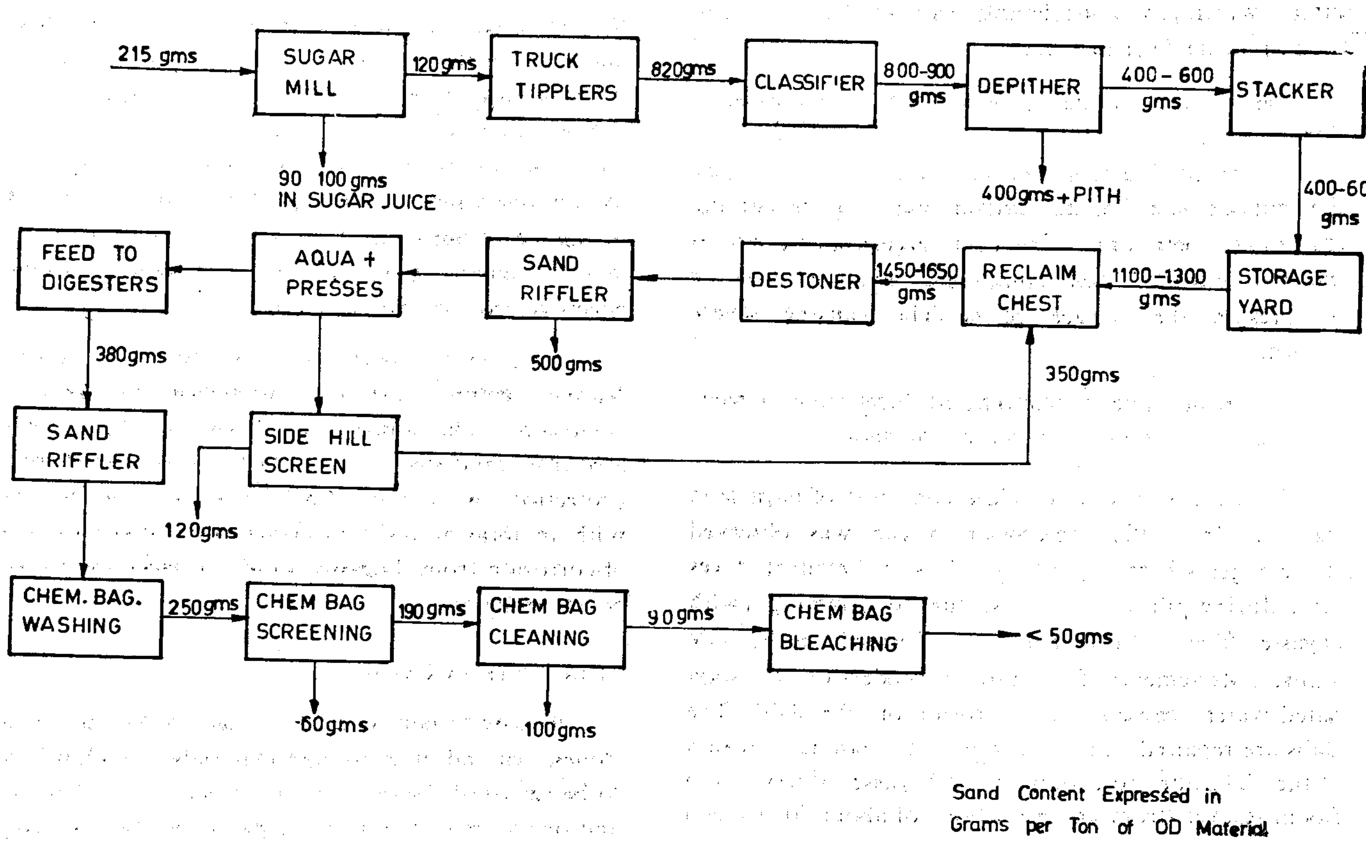
The mobile reclaim hoppers used for reclaiming bagasse features special construction to take care of corrosion. The hopper and chasis assembly are fabricated from mild steel plate, shot–blasted before surface protection is applied. All inner surfaces are coated with an abrasion resistant epoxy resin to combat effects of corrosion from bagasse. outer surfaces are protected by epoxy paint.

FIBRE PREPARATION :

Bagasse reclaimed from storage slabs contains sand, stones, grit and other foreign materials which will have to be removed before further processing. The design and operation of the fibre preparation plant is extremely critical as it directly reflects on the performance of the various equipment operating down stream of the plant. In the fibre preparation plant TNPL, bagasse reclaimed from storage slab is taken to reclaim chest through stone catch tanks to trap heavy stones. The bagasse is slurried and pumped to a destoner and a sand riffler for removing smaller stones and sand. It is then taken to aqua–separators and raw bagasse presses for increasing the consistency and fed to refiners and chemical digesters.

The abrasiveness of bagasse due to presence of sand (Fig.2) and its aciduous nature posed severe erosion and corrosion problems in the plant. Wear out of pump impellers, press spindles failure of welding joints in the piping were common due to severe erosion/corrosion. The snub pulleys, return idlers (mild steel) of belt conveyors often corroded due to contact of metal with low pH water carried over by bagasse. Proper materials selection is of paramount importance to combat corrosion. The piping and other equipment like chest agitators, pump impellers, screw conveyors, press

SAND CONTENT AT VARIOUS STAGES OF BAGASSE HANDLING AND PULPING



FIG—2

spindles, baskets etc., are of SS 304/ SS 316 construction. Rubber lined pulleys and idlers for belt conveyors result in longer service. All the chests are lined with acid resistant tiles. The tiles in the reclaim chest were breaking due to failure of the pointing material caused by severe erosion/corrosion. Instead of acid resistant tiles, granite stones were used in stone catch tanks and the performance is encouraging.

To reduce carry over of sand with fiber, a pilot sand riffler was developed and introduced. The performance of the various equipment after the introduction of the riffler have vastly improved as seen in Table. 1 Further improvements as projected is expected to be achieved when a few modifications in the design of the sand riffler are taken up.

Continuous Digester :

Corrosion is not a serious problem with continuous digester as it is with batch digester because continuous digesters are not subjected to frequent temperature cycles, further there is no exposure of the metal to air. The corrosion problems that do occur with continuous digesters are mainly at the welds on the vessel shell. The cracking that occurs in welds is a form of stress corrosion cracking (SCC) and known as 'caustic embrittlement' or 'caustic cracking'. SCC is caused by the action of tensile stress during exposure to a specific corrosive environment. The tensile stress in case of digesters is provided primarily by residual stresses left in the welds after fabrication. Kraft cooking liquor provides the corrosive environment. Thermal gradients and operating pressures also contribute to tensile stresses. Crack prevention is achieved by weld overlay (Stainless steel or high alloy). Anodic protection is another useful technique for both crack and corrosion prevention in digester.

Digesters are less susceptible to stress corrosion cracking when the shell has low tensile stress.

TABLE : 1 EFFECT OF INTRODUCTION OF SAND RIFFLER ON VARIOUS EQUIPMENT

S. No.	EQUIPMENT	EQUIPMENT LIFE BEFORE INTRODUCTION OF SAND RIFFLER	EQUIPMENT LIFE AFTER INTRODUCTION OF SAND RIFFLER	PROJECTED LIFE AFTER MODIFICATION OF EXISTING SAND RIFFLER
01	Raw bagasse press spindles in fibre preparation plant'	10–15 days	50–60 days	80–100 days
02	Plug screw feeder spindles of continuous digesters	200–250 Hrs	500–700 Hrs	800–1000 Hrs
03	Pulg screw feeder wear bars	200–250 Hrs	500–700 Hrs	800–1000 Hrs
04	Refiner segments	100–150 Hrs	200–300 Hrs	500–600 Hrs

Erosion/corrosion is again a severe problem in bagasse continuous digesters feeding system. The plug screw feeder spindles and its wear bars rapidly wear out due to presence of sand in the bagasse. They are replaced or rebuilt before using again. Reduction of sand in the bagasse fed to the digesters greatly reduced equipment wear out as seen in table—1.

Erosion in blow lines mainly occur at the bends which are reinforced with additional blow line boxes.

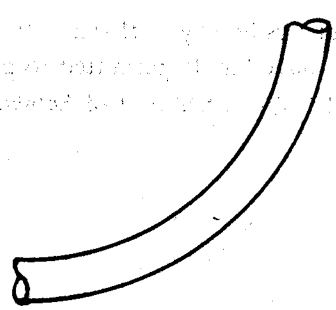
Washing, Screening & Cleainng :

Carry over of sand with the pulp created problems of erosion in washers, screens and cleaners. Sand accumulation occurs in washer vats, repulper troughs, feed headers causing frequent damages to the wire clothes and deck wires. Screen doors and centricleaners bodies developed frequent cracks due to erosion. Replacing SS centricleaners with polyurethene cleaners is contemplated to combat erosion.

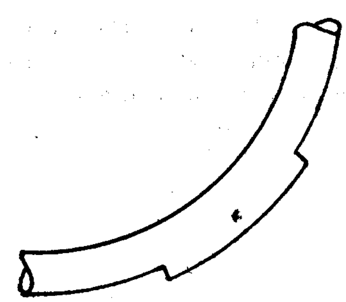
Bleaching :

Bleach plant process liquors are basically oxidising in nature and hence are corrosive to metals. Chlorine hypo-chlorite, peroxide, chlorine dioxide, oxygen, which are the most common oxidising agents used for bleaching of pulp, will also degrade stainless steel. Residual oxidants like chlorine, ClO_2 are primary causes for corrosion in bleach plants. Recycling of filtrates further accentuates corrosion problems. It leads to low pH in all acidic washing stages.

Vacuum filters used in bleach plant installations are more affected because there are more parts exposed to the corrosive material and in addition passage of air through the filter increases oxidation and corrosion. SS 316/317 are conventional bleach plant alloys. Metals are chosen for moving equipments such as washers etc., whereas non metals like fibre reinforced plastic, PVC etc., are used for piping. Vapour phase



BLGW LINE



STRENGTHED BLOW LINE

chlorination of non wetted parts such as spray pipes and metal vats above stock level is a major problem in chlorination stages. The attack is caused by excess chlorination. Chlorine from filterate forms small droplets of condensation which is highly corrosive. The problem was experienced in chlorine washer spray pipes. The spray pipes were given FRP coating. Better chlorine control, lining of whole Vat with non metallic coating will help reduce corrosion.

Proper materials selection also plays a vital role in selection of the control valves. For example, the butterfly type control used for the chlorine tower launder dilution flow control in the chemical bagasse pulping line went out of order within 2 years of operation. The control valve disc (Hastelloy C) and seating (Neoprene) were completely corroded. The disc and seatings were changed to SS 316 with an anticorrosive weld coating using Eutectrode 6800 and valve was put back in service. Similarly the Pulp flow and chlorine flow control valves in chlorination stage, (type : ball valve, material SS 316) failed within a year due to corrosion. They were replaced with diaphragm valves (glass lined).

Hypo chlorite bleaching is usually carried out in alkaline medium with consequences of corrosion. Stainless steels are much less subjected to pitting or crevice corrosion. Hypo chlorite washers are made of SS 316 to resist crevice attack.

Refining:

In the thermo mechanical refiners (pressurised) used for production of mechanical pulp from bagasse, wear out of refiner segments, refiner inlet impeller, casing wear ring occured due to erosion. Corrosion of the segments due to cavitation was also noticed. The blow lines and blow valve bodies were subjected to severe erosion. The 8" refiner blow valve (Ball valve) developed holes in the body (SS 316). The valve body was reconditioned with strain trode D electrode with hard facing done with chrom corb N 6006. The body again failed within a month of its operation. After hard facing with Eutectrode 6800, the performance of the valve improved. The blow lines were strengthened by providing blow line boxes at the bends.

Peroxide Bleaching

Peroxide in presence of alkali is used for bleaching mechanical pulps without any consequences of corrosion.

Paper Machine

The use of bagasse pulp, especially mechanical bagasse pulp together with the carry over of sand with the pulp have created erosion problems in the paper machine rolls. The calender rolls were found to be affected most. When using bagasse furnish, the calender rolls required conditioning once in three months as against normal expected life of six months. The stainless steel 316 piping of the wet end system showed signs of erosion at bends, elbows, welding joints etc. The frequency of doctor blade changing at granite roll has come down remarkably from once in a month to once in six months after improving the sand removal techniques in Pulp Mill.

Conclusions :

Erosion corrosion and corrosion due to low pH are the two principle types of corrosion experienced in bagasse based paper mill. While the abrasiveness of bagasse accentuated by presence of sand causes erosion/corrosion, the acidulous nature af bagasse is responsible for low pH corrosion. Selection of proper materials of construction, system design to eliminate sand as much as possible from bagasse fibre assume greater importance in combating the corrosion problems. With the background of experience and knowledge gained in operating the mill, it is hoped to come out successfully in our endeavours to combat the corrosion problems.

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