Corrosion management at Andhra Pradesh paper mills limited

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SUMMARY

Corrosion is one of the major factors for equipment failure in Chemical industry. On account of premature failure of equipment due to corrosion, industries in our Country are losing Crores of Rupees every year. Paper Industry in particular, using corrosive gases and chemicals in bulk quantities has to putforth continued efforts to combat corrosion by improving the process technology, by adoption of superior metallurgy and by utilisation of synthetic polymers for the fabrication of piping and equipment etc.

The paper deals with various types of corrosion that commonly occur in different stages of pulp and paper manufacture viz , pulping, bleaching, recovery of chemicals, stock preparation and in the paper machines in general and specific corrosion problems encountered in APPM in particular along with the preventive/remedial measures that may be successfully adopted.

INTRODUCTION :

Corrosion can be termed as surface chemical action especially on metals, due to contact with moisture, air or chemicals. The corrosion products under ordinary conditions of exposure comprise mainly oxides, carbonates and sulphides. In pulp and paper industry equipments, piping and ductings are subjected to corrosion due to various process chemicals, high temperature and humidity prevailing in the environment.

TYPES OF CORROSION :

Various types of corrosion phenomenon that generally occur may be broadly classified as follows :

I) INTER-GRANULAR CORROSION :

Selective attack on the grain boundaries of the metal or closely adjecent material without appreciable attack on the grain themselves is caused by this type of corrosion. It will destroy mechanical properties of the metal till the depth to which it has progressed.

II) GALVANIC CORROSION :

It occurs every time when two dissmilar metals are in electrical contact, while exposed to conductive solution. It can be recognised by increased surface attack electrically close to the junction of the two metals.

III) EROSION :

It Occurs whenever high velocity fluid movement occurs, causing turbulance and impingement. Usually occurs on impellers of pumps, agitators, and piping bends and elbows, Slurries with hard particles aggravate thss type of corrosion.

IV) PITTING CORROSION ·

Pitting is probably the most prevalent type of corrosion oberved in Pulp and Paper Mills. By definition pitting Is corrosion confined to a small area as

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compared to a whole surface. However, the pits may be small or large, few or numerous, smooth or rough, empty or filled with corrosion products.

The primary cause of pitting is due to the formation of an electrolytic cell. In this cell an emf is developed which is large enough to initiate the anodic-cathodic corrosion reaction, Ion concentration pitting can be minimised by careful design and fabrication to elminate crevices, by polishing the exposed surface of equipment and by passivating the components involved.

V) STRESS CORROSION :

Stress corrosion is caused by welding, thermal treatment or externally applied stress on metals. The resultant cracks follow inter-granular or trans-granular pathways within the metallic structure. This type of corrosion often shows branched cracking. Good strees relieving will greately prevent this type of corrosion.

CAUSES OF CORROSION :

Corrosion is caused due to microbiological action or by chemical action.

I) MICROBIOLOGICAL :

Corrosion can occur from direct biological accretions. It starts because of the metabolism of bacteria at the point where they are present and active.

Where microbiological corrosion is concerned it is generally more desirable to treat with an effective biological agent. Use of chemical agents of proven ability decreases the probability of existing bacteria to gradually develop resistance.

II) CHEMICAL

Chemical slimes are caused by deposits of an organic or inorganic nature such as pitch, fatty acids, resins, esters and their salts along with organic metallic compounds. These substances are present in mill supply water or in furnish They may also be the result of Compounds added to the stock for other purposes.

Generally the acidic pH range of Paper Mill systems increases the occurance of corrosion. Low pH systems coupled with high temperature, high dissolved solid fibers, organic and inorganic matter and varied water characterstics all combine to prevent formation of protective film necessary to good corrosion protection.

A chemical corrosion inhibitor added in small concentrations to water will effectively decrease or even prevent the reaction of a metal with its environment. Many inhibitor formulations can be used for corrosion control in water systems but most have only limited use in Pulp and Paper Mill systems for various reasons.

Various corrosion problems are experienced in almost all the sections of Paper Industry. A brief review of some of the problems associated with corrosion with suggested remedial actioned to overcome the same are presented.

DIGESTERS :

It is an established fact that liquors in Kraft cooking have a strong corrosive effect on the digesters. Various Sulphur compounds like Na_2S_2, $Na_2S_2O_3$ and Na_2SO_3 present in the cooking liquor besides the principal sulphur compound viz Na_2S are the main culprits for the corrosion. It is reported that sulphate compounds considerably accelerate the corrosion. Traditionally Kraft digesters are constructed with carbon steel and the corrosion is due to anodic dissolution of ferrous ions of the digester internal surface. However, the higher concentration of poly sulphides in the liquor rather inhibits corrosion by passivation. Direct steaming, oxidised black liquor and even excessive amount of black liquor is reported to have increased corrosion. This can be explained by the phenomenon that the necessary electric micro current required for passivation is greatly reduced by the above factors.

At APPM it has been observed that the wall thickness of the bottom cone portion of the digesters started decreasing progressively more towards the bottom discharge opening. This can be due to outflow of cooked material at high velosity causing erosion of metal surface besides scraping effect on the protective film that is generally formed.

At APPM the decrease in thickness of bottom cones was observed to be relatively faster and with in a span of 10 years operation, 20 mm thickness had been reduced to 8 mm predominently to a height of 400 mm from the bottom flange. When noticed low thickness, the worn out portion was builtup with layers of weld

deposits using special low temperature electrodes, besides providing additional plates on the external surface to keep tha digester in operation

A systamatic programme was evolved there after to monitor bottom cone wall thickness regularly with the help of ultrasonic thickness tester and planned for the replacement of the conical portion with new pre-fabricated cones. The cones are also provided with wear resistant welding deposits at the bottom most portion where erosion- corrosion is maximum.

BROWN STOCK WASHING :

The fumes/vapours escape from the washer which cause corrosion of piping and fittings, equipments, steel structures, purlins of roof and even the reinforcement of concrete structures. Periodical painting of all piping, and equipments with rubber and chloro-rubber paints reduce the extent of damage. Further, APPM is planning to provide well designed hoods on washers and lay systamatically conducted vent systems.

BLEACH PLANT :

Probably no other area in Pulp and Paper Industry is subjected to as severe corrosion as Bleaching Plant. In the chlorination stage the environment consist of acidic and strongly oxidising chlorine eompounds which cause drastic corrosion,

The vacuum drum filter of chlorination stage is fabricated with SS 316. At APPM severe pitting and erosion/corrosion in the chlorine washer was observed. The grooves of the supporting strips of spirally wound under wire have also been found badly corroded due to galvanic action. Consequently the under wire had gone deeper in the supporting strips causing physical damage to the filter cloth due to the supporting strips protruding into the same. The drainage pipes which were of 316L construction were also effected by pitting corrosion and developed holes. The pipes were replaced with new ones, of SS 317 of imported origin and the strips were rebuilt. Finally the washer was replaced after 15 years of service.

However, it is always advisible to keep the minimum residual chlorine in the chlorination stage to minimise the corrosion. At subsequent stages of Alkali extraction and Hypo Bleaching, SS 304 equipment were found to be adequate to withstand the corrosion.

FRP Hoods connected With PVC/FRP ducting and PVC exhaust fans were found quite effective in exhausting the corrosive vapours from the bleach washers.

Fibre glass reinforced plastics (FRP) and PVC pipes and fittings are found to be quite suitable for handling corrosive pulp slurries, liquids and back water but sufficient precautions are to be taken to avoid damage due to hammering while pumping and also vacuum stress that develop during power outages on this comparatively fragile lines providing supports and adequate thickness of piping, besides providing vents at appropriate locations

It is always desirable that all MS Structures in the Bleach plant are to be coated with FRP or Chloro rubber paints. The concrete towers and chests are lined with Acid/Alkali resistant naturally occuring tiles using appropriate bonding materials. The chlorine back water is lead by a hume pipe lines with acid resistant resins to mix and get nutralised with back water from other stages. Even the roof, supporting columns should be painted with chloro rubber paints periodically to avoid any damage to the reinforcement.

EVAPORATORS :

Sulphur compounds present in the black liquor give rise to pitting corrosion on the tubes of evaporators. At APPM, at the natural circulation evaporators with MS tubes have been discontinued and Falling Film Free Flow Evaporators are under operation. This unit not only operate at very high steam economy but also has less chances of corrosion as the plates are made of SS.

RECOVERY BOILER :

Corrosion in Recovery boiler is mainly due to high sulphidity. Liquid smelt is corrosive and the action starts at low temperature even. Generally the hearth portion and upto the level of secondary air ports the tubes are provided with studs and protective coat of plastic chrome ore so that corrosive molten smelt does not come in contact directly.

The corrosion at the upper portion of the furnace is proportional to the amounts of hydrogen sulphide in the flue gas. However, the rate of corrosion decreases with the increase of oxygen and water vapour and excess oxygen is suppressed to form Fe_3O_4 which sets up high resistance to corrosion on the tube wall.

ECONOMISER :

Due to high water film heat transfer co-efficient the metal temperature of the tube is only few degrees above water temperature. If this is less than acid due point of the gas the acids would condense on the tubes causing corrosion. Hence at APPM, the feed water temperature is maintained at 135 °C to avoid such damage to tubes.

The outlet ductings from Cyclone Evaporator to Electro Static Precipitators, and to ID fan is periodically replaced as they are subject to corrosion due to deposits.

ELECTRO STATIC PRECIPITATORS :

To minimise corrosion at Electro Static Presipitators the inlet flue gas temperatures are maintained around 165 °C at APPM.

CAUSTICIZING :

MS Slaker shells are being initially gunnitied/ provided with thin concrete lining to avoid erosion corrosion.

Erosion is more experienced in over flow lines of causticized liquors and more predominently observed in the sludge pumping lines. In these areas C.I. pipe lines proved to have less wearout then MS lines.

The plug valves in this section are observed to have developed pitting on their plugs and wear resistant alloy plugs proved to perform better in service.

HYPO PREPARATION PLANT :

APPM has opted for FRP Hypo reactors which are giving satisfactory and trouble free performance. However, the erosion caused due to abresive fine silica present in the milk of lime, the resin coating on the inner walls makes it necessary to repair/replace the sectors. The concrete clarifier lined with acid resistant natural tiles proved to resist thermal corrosion due to hypo solution. However, it has been experienced that any cracks crevices, holes occuring in the bonding material had caused severe corrosion to the reinforcement rods of the clarifier endangering the stability of the structure. FRP lining provided in the MS Secondary Clarifier provide good protection but the resin coat inside need timely renewal to avoid damage to the fibre glass etc.

PAPER MACHINE :

The conventional fourdriner type paper machine wet end operates at acidic pH with the back water pH maintained at 4—5 which give scope for chemical as well as biological corrosion.

The steel structures of the wet end get corroded necessitating frequent replacement. At APPM the machine beams are clad with SS 304 which is more effective resistent to corrosion.

Suction Press Rolls are subject to alternate bending loads. Due to this loading the inner surface is subjected to more stress than the outside surface because of which stress corrosion craking takes place. The suction holes also generally get plugged with fibres, chemical compounds. This highly porous matter absorbs any corrosive liquids such as acids etc., resulting in these deposits occuring nucleus for electro chemical or bacterial corrosion which ultimately results in cracking. For preventing formation of the deposits, a high pressure needle shower is being employed to clean the holes regularly.

Severe corrosion has been found in steel structures of the paper machine buildings. The humid air and vapours corrode the purlines and 'J, bolts of the AC Sheets of the roof. Painting the purlines with rubber paints, using Aluminium 'J' bolts instead of G.I. 'J' bolts and also improving the exhaust and ventilation system has been observed to have minimised the corrosion at APPM.

CONCLUSION :

Corrosion management is a continuous and on going process. Proper selection of material of construction of equipment, piping, etc., in the initial stages of design greatly reduces the menace of corrosion. However, in some of the cases superior material of construction may be highly expensive in which case one has to compromise to certain extent. But with the methodical approach to mitigate the corrosion problems by adopting timely remedial measures the industries have greatly over come the problems of corrosion.

It is desirable to have a separate team of engineers in the pulp and paper industry to exclusively monitor the corrosion related problems and to initiate appropriate action to combat the same.

ACKNOWLEDGEMENTS :

The authors thank the Management of Andhra Pradesh Paper Mill for their kind permission to present the paper.