

Loss control and prevention by corrosion management in Indian paper industry

TYAGI M.K.*, RATHI B.H.**, SANWAL J.S.***

INTRODUCTION

The word 'CORROSION' has been defined as the deterioration of a substance by reaction with its environment and this results in waste of natural resources, manpower and impact on natural economy. In nature the forces that cause corrosion are constantly remaining in action as one would see at the sea. It has been seen that corrosion brings many more productive machines to a grinding halt or useful structures to a crumbling skeletons.

The basic cause of corrosion is the instability of metals in their refined forms which makes metals to revert to their natural state through the process of corrosion e.g. the action of rain over iron to form rust i.e. iron oxide. Corrosion of metal occurs in various forms. Most are electrochemical in nature. The forms of corrosion can be easily recognized since their characteristics are well known and hence necessary action to overcome the problem of corrosion can be taken up with the method available from the literature.

For a successful corrosion management the knowledge of fundamental corrosion science and method of its prevention/control is a must. Due to corrosion metal losses are enormous. Corrosion eats away more than 2% of the total bulk of metals every year. Burden imposed by corrosion of metals on paper industry is an appreciable proportion of its income and it is due to —

- 1 Cost of replacement ;
- 2 Loss in quality of product by contamination;
- 3 More pollution in environment;
- 4 Loss of production due to breakdowns caused by corrosion

- 5 Loss of efficiency of equipments
- 6 Fatal accidents
- 7 Drainage of costly chemicals

Hence it can be inferred that the corrosion comes down to being a pain in the neck or worse for pulp and paper industry and hence it is of utmost importance to take all the measures to minimize or prevent the corrosion of various forms in the industry.

The following description should help in identifying the various forms of corrosion in paper industry with their normal causes and the remedy to overcome the problems to a great extent.

TYPES OF CORROSION IN VARIOUS SECTION OF PAPER MILLS

PULP MILL :

The following types of corrosion usually occur in this section :

- 1 General corrosion
- 2 Pitting corrosion
- 3 Erosion corrosion
- 4 Stress corrosion
- 5 Localized corrosion
- 6 Galvanic corrosion

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PAPER MACHINE

- 1 General corrosion
- 2 Selective corrosion
- 3 Pitting corrosion
- 4 Stress corrosion
- 5 Localized corrosion

CHEMICAL RECOVERY & UTILITY SECTION

- 1 General corrosion
- 2 Localized corrosion
- 3 Pitting corrosion
- 4 Erosion corrosion
- 5 Intergranular corrosion
- 6 Stress corrosion

GENERAL CAUSES OF CORROSION

There are various factors which cause corrosion in paper industry which are listed below :

- 1 The equipment in kraft paper mills are made of iron or iron alloys and they are subjected to various conditions of temperature, pressure, chemical composition and other operating variables which differs from mill to mill.
- 2 Corrosion in kraft mill digesters and unbleach pulp processing section is due to depolarising effect of polysulphide, thiosulphate, dimethyl disulphide and other organic substances. Black liquor to white liquor ratio also affects corrosion.
- 3 Low pH values
- 4 High chlorides concentration and free chlorine content
- 5 High sulphate concentrations
- 6 High temperature
- 7 High rate of fluid flow and deposits
- 8 Presence of carbon monoxide and sodium chloride
- 9 Presence of SO₃ formed during black liquor combustion causes corrosion in boiler and electrostatic precipitator, if the temperature of flue gas leaving the boiler is not maintained above the acid dew point.
10. High electrolyte concentration in white water
- 11 High zinc content alloy
12. Corrosion due to water - pH of the water and dissolved oxygen play an important role in causing

corrosion mainly in boilers and it depends upon the source of water.

Research done by W.F. Langlier (1936) led to an index which is called Langlier Saturation Index. It correlated the pH_w of the water and the pH_s saturation of calcium carbonate in water into a mathematical correlation.

If $\text{pH}_w - \text{pH}_s = 0$ No scale, No corrosion by water.

= +ve the sealing tendency of water

= -ve the corrosive tendency of water.

CORROSION MANAGEMENT :

To begin with it is necessary to classify corrosivity of various chemical and substances in use together with the existing environmental conditions and preventive action over corrosion is to be taken on preferential basis depending upon the corrosion potential of the metals. In paper industry in India, due to high cost of replacement and limitation in resources, methods of corrosion control should be carefully examined and then implemented for better utilization of available resources. For this, few guidelines are described below which will be useful for corrosion control and prevention study :

I. PLANT CORROSION TEST

In order to have an idea of the type and rate of corrosion in particular equipment or a pipeline, some non-destructive types of tests are to be carried out. These are :

1. Magnetic thickness gauge.
2. Ultrasonic and gamma-ray instruments for measuring metal thickness.
3. Boroscope for internal tube inspection.

To carry out these tests, the specimens of the same metallurgy should be introduced at a proper position in the equipment or a pipeline and it should be subjected to the same operating and environmental conditions and the tests are to be carried out periodically.

For destructive types of test, the specimen can be removed and tested in laboratory for a corrosion.

II. Evaluation of losses – it is divided in two parts :

- a. Statistical approach,
- b. Fundamentals of loss control

a. Statistical Approach

To evaluate the effectiveness of the corrosion control measures, the following points are to be considered and followed.

i. Collection of data–

Various data regarding the dimensions, weight, life and composition of the metals of the equipments at a periodical basis should be collected to see the loss control due to corrosion after implementing the control measures. It is better to have the data before and after implementation of corrosion control measures on the same equipment. Because the two identical equipments working in the same conditions may differ in their nature towards corrosion due to various reasons.

ii. Compiling of the Data -

The collected data showing the loss control etc. should be compiled in tabular form for better comparison.

iii. Study of the data–

The compiled data to be studied thoroughly in terms of financial impact on the industry and reduction in losses due to corrosion control measures.

Following table can give all informations at a glance.

b. Fundamentals of Loss Control :

- i. More breakdowns, damages and other losses due to corrosion of equipment show something wrong in the management system.
- (ii) Certain sets of circumstances producing more corrosion loss can be predicted and controlled in advance.
- (iii) Corrosion loss should be managed like any other function of the company by planning, organizing and controlling.
- (iv) The key to effective control performance in management procedures is to fix accountability.
- (v) The function of corrosion control is to locate and define the operational/design errors that allow corrosion to occur.

CORROSION COMBATING & STREAMLINING THE SYSTEM :

The following points need to be considered as a measure for combating corrosion :

(a) Selection of material :

It should be based on experience with materials under similar conditions and with due considerations to the practical aspect and various limitations. It should also be ensured that desired composition or type of material which take care of corrosion is selected.

(b) Proper process design & control :

Selection of the process should be such that utilization of corrosive chemicals is less and modified

S. No.	Name of Equipment	Weight		Remarks	Dimensions		Remarks	
		Before	After		Before	After		
1	2	3	4	5	6	7	8	
Performance/Life Before		Remarks		Cost of Preventive methods/treatments		Capital investments		Over all Remarks
9	10	11	12	13	14			

equipments with proper access for inspection and maintenance should be provided. Surface finish of the equipments should be good.

(c) Plant layout :

Layout of plant should be such that the equipments installed therein are away from any atmospheric corrosion by means of pollution.

(d) Use of inhibitors :

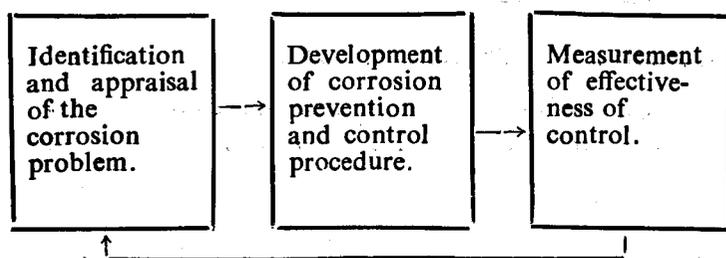
The substance which is used as an additive for minimising corrosion may be termed as 'inhibiter' for combating corrosion. It is generally used in closed system since its maintenance cost is low due to recirculation. The increase in concentration increases the effectiveness but actual requirement should be carefully studied and it is purely based on the experience.

(e) Coating and lining :

The use of various coatings and lining materials in combination and its application depends upon carefully studying the process and other operating parameters.

(f) Task force :

Scope and functions of the task force is given below :



g) In plant measures to be taken in Paper Industry—

i) White Liquor Sulphidity—It has been observed that higher sulphidity in sulphate liquor causes more corrosion. Hence sulphidity of white liquor should be optimised sacrificing for the strength properties of pulp and 18-20% sulphidity content while liquor has been observed to be optimum.

(ii) Black Liquor Oxidation : Oxidation of black liquor causes stability of sulphur in compounds resulting is less evolution of H₂S during vacuum evaporation and direct contact evaporation of black liquor ultimately reducing corrosion therein.

(iii) Indirect heating of digester greatly reduces corrosion in digester.

(iv) In order to counter-act corrosion of digester wall, over laid welding of digester with stainless steel is suggested. The work of this Stainless Steel cladding requires good workmanship and much skill.

(v) During bleaching of pulp with chlorine or chlorine compounds, precaution should be taken to have better chlorination of pulp and also free available chlorine should be kept at the minimum acceptable level in hypochlorite solution.

(vi) Where ever possible, steel tanks should be replaced with lined RCC tanks e.g. ESP chambers, back water tanks etc.

vii) In paper machine, metallic wire could be replaced with synthetic wire since synthetic wire is more resistant towards corrosion.

viii) Biological activity which cause severe pitting corrosion, is more where there are many stagnant, quiescent locations and the systems where the frequency of cleanups is low which should be avoided as far as possible.

ix) Pitting corrosion and erosion is observed in felt rolls in paper machine. FRP lining of these rolls will solve the problem to a extent.

CONCLUSION

It is concluded that in order to control and prevent corrosion in Paper Industry, one should have thorough knowledge of fundamentals of corrosion science and control procedures together with awareness. Necessary precautionary steps should be taken and Government should also encourage the industry to take necessary steps in the direction by suitable incentives.

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