Conservation of Energy and Water Using the Polyamine Treatment Program: . Experiences in Medium Pressure Boilers Paper Mills

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ABSTRACT

Corrosion and scaling have been the biggest threat in the steam/power generation systems over the years. Despite advances in technological interventions related to industrial processes (Metallurgy, improved water treatment, etc.), Corrosion and scaling continue to be major hurdles in effective and efficient management of Power Plants. This Paper Provides an overview of the corrosion and scaling problems faced by boilers of recycled fibre mills as well integrated paper mills. It also explains a unique treatment to overcome them.The salient features of this paper are :

1. Problems related to Corrosion/scaling in boilers across various industrial sectors and their adverse effects; Significance of water treatment
2. A unique cost effective solution- Modern film barrier approach, Multicomponent aliphatic polyamine based chemical treatment
3. Methodology, working principles of th treatment and its application, monitoring parameters
4. Advantages such as energy conservation, cost effectiveness and other operational benefits.
5. Successful implementation - some case studies across industrial sectors together with Client-indsutries feedback of treatment program

Introduction

The recent global trends across multi-sector plants reveal a greater preference for amine based treatment to avoid corrosion, Scaling and carry over in the steam generating system. In India, Amine based boiler feed water treatment came into existence in 1980 and has gained immense popularity over the years. Over 180 customers in India are using this Amine based Eloguard treatment and are benefiting through this. As the treatment is aliphatic polyamine based (100 % organic formulation), it does not impact any TDS in the boiler and hence the energy and water wasted due to blow down can be conserved to a great extent. Due to these benefits, many boilers have switched over to Polyamine based treatment from the conventional phosphate based treatment. In India more than 50 paper mills having boiler pressure rating ranging from 10 bar to 87 bar are using Polyamine based Eloguard treatment.

This treatment is eminently suitable for recycled fibre mills. Many such paper mills, especially in western India are successfully carrying out this treatment for many years. As the dosing of this chemical is only on the LP side, monitoring the treatment is easy and additional manpower is not required Further, it has been inferred by the power plant officials of these mills that the polyamine based chemical treatment takes care of the metallurgy very well wherein the boiler operations are prone to load fluctuation subject to the production requirements. This has been practically observed with over 30 such recycled fibre mills across country.

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A brief note on traditional approach and the drawbacks

Traditionally, multiple chemicals like phosphates, hydrazine or sulphite, sludge conditioner, etc. were used to reduce the corrosion & scaling in the boilers. In general, Oxygen scavenger like hydrazine hydrate is dosed in the LP side and phosphate based sludge conditioner is dosed on the HP side. Unfortunately, such programs have the following major drawbacks:

- **Tight control :** The treatment requires tight monitoring of chemical residuals and pH for its effectiveness. Chemical dosage at two different points
- **Energy loss through more blow down :** Addition of salts like TSP leads to increased solid load on the boiler (consequently more blow down) and can cause deposits/under deposit problems. Make up water consumption also increases in the event of more blow down
- **Hard deposits :** Precipitated Ca/Mg, Hydroxyapatite sludge can form hard deposits. Also the treatment does not provide any protection to condensate system against corrosion by oxygen, carbon dioxide (acids), ammonia (due to decomposition of hydrazine)

- **Phosphate hide out :** Phosphate hide out, a typical problem, would become inevitable in most installations causing corrosion and other related problems

- The protective magnetite layer grows with time leading to reduction in heat transfer and incidents of under deposit corrosion e.g. Caustic attack

A unique solution Eloguard, the polyamine based treatment program

Eloguard Description

Eloguard is a multi-component polyamine based liquid formulation for boiler water conditioning programs and is a single product replacement for the Antiscalent, Sludge conditioner and oxygen scavenger. This treatment program provides a fool-proof protection to the complete boiler / turbine condensate system. It is also an eco-friendly and non-toxic blend of the following functional constituents:

- Aliphatic film forming amines
- Neutralising and alkalizing amines
- Organic complexing, scale controlling, de-oxygenating agents
- Organic dispersant

Eloguard has to be dosed through LP dosing system preferably to the outlet of the deaerator. Eloguard should be added continuously as a diluted solution (dilution with DM water) using a positive displacement feed pump through an LP dosing system. The dosage rate should be optimized based on the Feed water quality

Eloguard treatment Working principles

Polyamine film barrier

The aliphatic polyamine groups have an affinity to metals and this leads to an amine sorption on exposed metal surfaces (Chemisorption). Filming amines present in Eloguard formulation are dehydrating agents and these amines extract the absorbed water from the metal surface and occupy the respective vacant sites forming an inhibitor film. The filming amines are large molecules (chains) having both hydrophilic (water compatible) and hydrophobic (water repellent) ends in their structures. The film acts as a physical barrier between water and the metal surface. The hydrophobic hydrocarbon chains prevent wetting of the metal surface and protects the boiler tubes from corrosion and scale formation Refer diagram 1

Neutralising and Alkalising Amines

Having a wide range of distribution ratio, these amines protect the entire Boiler-Turbine-Condensate system against low pH and carbonic acid attack.

Complex organics, scale controlling, dispersant and De-oxygenating agents

While deoxygenating agents provide secondary protection against residual oxygen, other controlling agents arrest crystal growth, binds silica, prevent scale formation and carry over. They also ensure that impurities are well dispersed and prevent crystalline growth to reduce scale & deposits.

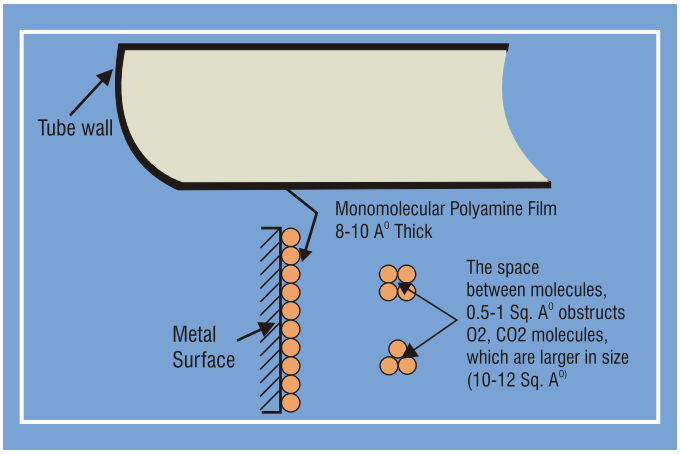
Regulation of Eloguard dosage

Eloguard dosage is regulated by monitoring the pH of the return condensate. The dosage should be adequate to ensure a turbine/Exhaust condensate pH of 8.3 - 8.8 as this ensures no low pH corrosion and also that there is a residual polyamine of 0.2 - 1 ppm to ensure protection to the post boiler/condensate system.

Formation of Amine film

The formation of a non-sticky amine layer on the metal surface had been confirmed by a team of research scholars (B Allard et al) who had carried out an extensive study on the filming amines and its application in boiler feed water conditioning. The formation of continuous film amines on the metal surfaces has been verified in Laboratory examinations of specimens taken from Economiser tubes. Surface coatings visible in Scanning electron micrographs (SEM) were analysed using electron spectroscopy (ESCA) and Secondary ion mass spectroscopy (SIMS) and the organic nature of these films as well as the presence of nitrogen adjacent to the metal surface were confirmed (Reference: 1)

Diagram 1



Benefits of Eloguard (Polyamine based) Treatment

Single product, Cost effective treatment

Eloguard is a safe, non-toxic and non-carcinogenic product and is by itself a cost effective product-replacement for the Antiscalent, Sludge conditioner and oxygen scavenger. It is(that is) also easy to handle. As the dosing of Eloguard is only on the LP side, it is easier to dose, monitor and control. As the HP dosing chemicals are not required, the energy costs being incurred for the HP dosing system can be saved.

Energy savings

Eloguard is a 100% organic formulation and thus there is no contribution to TDS by virtue of its addition to the system. So the boiler water TDS levels can be maintained with lesser blow down as compared with phosphate based treatment. Consequently, the make up DM water consumption will also come down which ensures overall savings in boiler operation costs. Cost Benefits have been tabulated for a power plant using this treatment in the recent past

Improved Silica Management

Binding silica in water phase enhances silica tolerance in boiler water. Prevents glassy deposits on turbine blades by forming non-sticky polyamine film on wet blade surfaces.

Increase in Turbine Efficiency

Boilers operated on phosphate treatment continuously supply phosphates to the generated steam and with this steam into the turbine. Since the phosphate is quantitatively deposited in the turbine, phosphate carry over results in a marked efficiency reduction of the steam turbine. The aliphatic polyamine based chemical, Eloguard does not contain phosphate which results in cleaner turbines, thus maximising turbine efficiency

Customers' experience and water parameters maintained with Eloguard treatment

As mentioned above, Eloguard treatment is being successfully carried out in more than 50 paper mills having power plants with the boiler operating pressure ranging from 10 bar to 87 bar. The users are experiencing trouble free operations and are able to incur a huge savings in terms of maintenance of boiler & TG after switching to Eloguard treatment. A customer in south claimed that substantial savings could be incurred after switching over to ELoguard from conventional phosphate based treatment towards maintenance of TG which otherwise runs into lakhs. To denote the water parameters being maintained with Eloguard treatment in paper mills located in the western India, a few case illustrations are discussed below:

Case 1 : Eloguard treatment in a medium pressure boiler (42 kg/cm^2 pressure) in a paper mil

A renowned paper mill in west India using amine based Eloguard treatment at their boilers for about 15 years (Boiler pressure 42 kg/cm2, Avg. Steam generation 15 TPH; 1.5 MW back pressure TG). The treatment is well established and no problems have been reported so far.

System details

Boiler operating pressure	42 kg /cm^2
Avg. Steam generation	380 – 400 TPD
Power generation	1.5 MW – Back pressure TG
Eloguard treatment started in	1999

Water parameters

CBD- Continous Blow Down
IBD- Intermediate Blow Down

Parameters	Feed water	CBD water	IBD water	Condensate
pH	8.8	9	9	8.8
Conductivity	5 – 6	15 – 16	16 – 20	4 – 6
Silica ppm	< 0.02	2	2	< 0.02

(Water samples collected and analysed during Jan 2013)

Case 2 : Eloguard treatment in a medium pressure boiler (38 kg/cm^2 pressure) in a paper mil

A renowned paper mill in west India using amine based Eloguard treatment at their boilers for more than a decade (Boiler pressure 38 kg/cm^2, Avg. Steam generation 30 TPH; 3 MW back pressure cum condensing TG). The treatment is well established and no problems have been reported so far.

System details

Boiler operating pressure	38 kg / cm^2
Avg. Steam generation	720 TPD
Power generation	3 MW – Ext. Cum condsg TG
Eloguard treatment started in	2002

Water parameters

Parameters	Feed water	CBD water	TG condensate	Process condensate
pH	8.6 – 9	8.9 – 9.2	8.6 – 9	8.6 – 9
Conductivity	5 – 8	16 – 25	6 – 8	6 – 9
Silica ppm	< 0.02	4 – 6	<0.02	< 0.02

(Water samples collected and analysed during Jan 2013)

Case 3 : Eloguard treatment in medium pressure boilers (32 kg/cm^2 pressure) in a paper mil

A renowned paper mill in west India using amine based Eloguard treatment at their boilers for more than 5 years (Boiler pressure 32 kg/cm^2, Avg. Steam generation 2 X 12 TPH; 2.5 MW back pressure TG). The treatment is well established and no problems have been reported so far.

System details

Boiler operating pressure	32 kg / cm^2
Avg. Steam generation	570 TPD (2 X 12 TPH)
Power generation	2.5 MW – Back pressure TG
Eloguard treatment started in	2007

Water parameters

Parameters	Feed water	CBD water	Main steam	Process condensate
pH	8.6 – 8.8	8.8 – 9	8.5 – 8.8	8.4 – 8.7
Conductivity	5 – 8	15 – 20	4 – 7	5 – 9
Silica ppm	< 0.02	2 – 4	<0.02	< 0.02

(Water samples collected and analysed during Jan 2013)

Common

In the above installations, blow down is in the range between 1- 2 %. Consumption of chemicals works out to be around 5 ppm on steam generation

The well maintained parameters emphasises that the treatment is in order and the users experience a trouble free operation of boiler and TG.

Likewise, the treatment is being successfully carried out in many paper mills across various parts of India. Further, the treatment is being carried out in large integrated paper mills in India for more than 2 decades where high pressure boilers are in operation (> 65 bar pressure). The treatment is very well established in recovery boilers too and we have many such references.

Client industries Feed back

There is ample evidence of positive feedback from our clients which suggests a scaling down in costs while using Eloguard. The Confederation of Indian Industries (CII) recommends the treatment as well as renowned sugar mills strongly advocate this program. With about 20 years in the field and presently more than 180 clients across diverse sectors as Paper, Sugar, Petroleum, Steel, Cement and Power Industries are benefiting from this treatment. About 40 customers are using this amine based Eloguard treatment program for more than 10 years

Conclusion

As far as boiler feed water treatment is concerned, under the prevailing situation, it is apparent that the amine based treatment would be a better choice. The amine based Eloguard treatment is a unique cost effective boiler feed water treatment program. It has consistently proved to have a clear edge over the phosphate based treatment and has carved a niche in boiler water treatment programs. The same has been practically proved and experienced by the power plants across various industrial sectors. Therefore, it can be concluded that the energy and water can be saved significantly by switching over to amine based Eloguard treatment program from the conventional phosphate based treatment program.

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