APPLICATION OF FLUX maxguard™ ON COOLING WATER SYSTEM FOR PROTECTION FROM SCALE AND CORROSION

Client: M/s. Vidya Dairy, Anand

INTRODUCTION:
Scaling and corrosion problems have been the bane of industries for ages making them spend huge sums on traditional methods of tackling these problems by adding chemicals to the feedwater. These methods are not only insufficient to take care of the problem but also lead to deleterious effect on system performance. Excessive or improper dosage of strong acids or bases for pH control or cleaning may itself lead to further corrosion of the system. Several man-hours are wasted and the system has to be given shutdown during this period, leading to reduced productivity and wastage of resources. FLUX maxguard™ is an effective solution for tackling these problems overcoming the several shortfalls of the traditional methods of waterside maintenance.

FLUX maxguard™ (WORKING PRINCIPLES):
The FLUX maxguard™ is a unique device, which works on the simple principal of magnetically induced dynamic field generation and fluid ionization. The unique patented flux-collimator-pervader generates a dense magnetic field, which passes completely through a commercial steel pipe in a direction perpendicular to the flow. The pipe acts as the stator and the fluid passing through, the armature or rotor. This works like a dynamo generating a direct current, which renders the pipe several hundred millivolts negative and the fluid several hundred millivolts positive. This also results in partial ionization of the water molecules giving positive hydrogen ions and negative hydroxyl ions. Now the physical nature of the treatment comes into picture. The water chemistry is altered physically, not chemically. Nothing is added to or removed from
the water, but changing the relative charge of the pipe with respect to the fluid alters the behaviour or interaction of the water molecules with the pipe walls and with each other.

The positive hydrogen ions, which are generated by ionization, are attracted to the pipe. If any scales exist in the system the hydrogen ions attack these insoluble calcium carbonates and form soluble calcium bicarbonates, which easily dissolve in the flowing fluid. Calcium bicarbonate is an unstable compound and readily converts back to calcium carbonate after a period of time, however, as the pipe is now negatively charged, its deposition as scales on the pipe is physically prevented. The descaling process which results due to this above reaction is a very slow process and is more evident in recirculating systems and ones in which the rate of flow is slow enough to ionize a substantial amount of fluid flowing inside the pipeline. Generally, most of the descaling process is a result of the dislodging of the scales, which are physically repelled by the now negatively charged pipe and this is found to be true for large pipelines and once-through systems.

The scale forming carbonates are predominantly a combination of two crystalline forms, calcite and aragonite. Calcite is principally the hard scale, which has a denser crystal lattice than the aragonite, which is a soft scale. It has been documented that untreated water precipitates a ratio of calcite to aragonite of approx. 80%: 20%, while the ratio measures almost the opposite, at 30%: 70% for magnetically treated water. Thus the change in crystal structure of the carbonates after passing through the magnetic field changes their physical property and converts hard scale into soft scale.

The dipolar water molecule’s negatively charged oxygen is repelled by the negatively charged pipe, thus reducing its corrosive effect. The carbonates that cause scaling are negative and hence are repelled by the pipe. They remain in suspension until the water becomes supersaturated at which point they precipitate in the form of soft aragonite sludge at the bottom of the system.

Thus the FLUX maxguard™ gives total system protection regardless of the quality of water used and eliminates the use of water softeners and conditioners. Demineralised and deionised water is no longer required as the system gives maximum performance even with untreated water. Build-up of TDS and increase in pH in feedwater is no longer a problem as the FLUX maxguard™ is capable of protecting the system under the worst operating conditions.
CASE STUDY:

Presented below is a case study where the FLUX maxguard™ has been installed and its efficacy successfully demonstrated. The application concerned is the cooling water system of Vidya Dairy at Anand.

CASE HISTORY:

Vidya Dairy is a medium scale dairy, set up by National Dairy Development Board (NDDB), which also serves as an educational institution for human resources requirement of other commercial co-operative sector dairies.

The cooling water systems here consist of cooling tower, three condensers and compressors. Despite using soft water in the cooling circuit, the cooling was not as per requirements, the system got scaled and had to be cleaned annually during the shut down to remove the scales. The problem was acute in summer since the chilling was reduced due to fouling in condensers, resulting in the decrease in the ice formation. This resulted in a compulsion of purchase of ice from outside during summer. Under these conditions, the FLUX maxguard™ was approved to be installed and given a chance to prove its efficacy.

SYSTEM DETAILS:

Following is the detailed description of the equipment for the protection of which, the FLUX maxguard™ is installed.

Name of equipment : 3 nos. of shell and tube type vertical condensers 5196 mm high and 788 mm dia., the tubes of 10 mm OD SWG BS 3059.

Quantity of condenser water : 100 KL / hr

Cooling water source : 2 nos. of cooling towers with FRP fill.

INSTALLATION:

Four nos. of FLUX maxguard™ were installed throughout this system on March 4, 1999 the locations of which are as indicated in Schematic I.
OBSERVATIONS:

The performance of the same has been monitored since date of installation with help from the staff of Vidya Dairy. The parameters identified for evaluation of the performance of the FLUX maxguard™ are as per following:

1. Voltage on water
2. Cooling Water Analysis
3. Physical Observation
4. Power consumption of the system
5. Temperature drop of cooling water

1. Voltage on water:

The voltage generated by the FLUX maxguard™ can be measured with the help of a multimeter. The potential difference across the three condensers was observed periodically and was as under.

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Date</th>
<th>Voltage on cooling water (mV) +ve</th>
<th>Condenser</th>
<th>Condenser Sump</th>
<th>Cooling tower sump</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>1</td>
<td>06/3/99</td>
<td>180</td>
<td>137</td>
<td>147</td>
<td>180</td>
</tr>
<tr>
<td>2</td>
<td>12/3/99</td>
<td>171</td>
<td>138</td>
<td>153</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>17/3/99</td>
<td>170</td>
<td>152</td>
<td>141</td>
<td>160</td>
</tr>
<tr>
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<td>12/4/99</td>
<td>182</td>
<td>179</td>
<td>172</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>26/4/99</td>
<td>188</td>
<td>205</td>
<td>205</td>
<td>-</td>
</tr>
</tbody>
</table>

As seen from above readings, the cooling water in condensers 1, 2, and 3 have shown gradual increase in the voltage (+ve). This increase may be due to de-scaling of the system. The positive charge also shows that the FLUX maxguard™ is working effectively.
2. Cooling Water Analysis:

The following are the water sample analysis results that were regularly performed so as to enable us to conclude on the performance of the FLUX maxguard™.

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Date</th>
<th>Cooling Tower Sump</th>
<th>Condenser Sump</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pH</td>
<td>TDS</td>
<td>TH</td>
</tr>
<tr>
<td>1</td>
<td>12/2/99</td>
<td>9.46</td>
<td>2178</td>
</tr>
<tr>
<td>2</td>
<td>23/2/99</td>
<td>9.58</td>
<td>1956</td>
</tr>
<tr>
<td>3</td>
<td>06/3/99</td>
<td>9.42</td>
<td>1350</td>
</tr>
<tr>
<td>4</td>
<td>07/3/99</td>
<td>9.43</td>
<td>2378</td>
</tr>
<tr>
<td>5</td>
<td>08/3/99</td>
<td>9.18</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>09/3/99</td>
<td>9.18</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>12/3/99</td>
<td>9.42</td>
<td>1466</td>
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<tr>
<td>8</td>
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</tr>
<tr>
<td>9</td>
<td>22/3/99</td>
<td>9.1</td>
<td>1793</td>
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<tr>
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<tr>
<td>13</td>
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</tr>
<tr>
<td>14</td>
<td>26/4/99</td>
<td>9.56</td>
<td>1156</td>
</tr>
</tbody>
</table>

TDS was identified as an important parameter for evaluation of the FLUX maxguard™ performance but as the cooling tower was operated with raw water after installation of FLUX maxguard™, it was being bled daily to keep TDS levels low. Due to this, no conclusions could be drawn from above data as it was fluctuating, and not converging towards a specific value.

3. Physical Observation:

Physical inspection has been carried out periodically to observe internal condition of the system after installation of FLUX maxguard™. It was observed that initially all the scale were loosened and then gradually washed off with the flow, resulting in the system becoming free of scales.

The algae at the top of the condensers started to dislodge after installation. Algae require positive surface to bloom and the system (condenser) is polarized negative after installation of FLUX maxguard™.

Observations on the condenser tubes indicated the scales to have loosened and softened so that they could be removed by hand. The cooling water in the cooling tower sump and condenser sump was also found to be remarkably clean after installation of FLUX maxguard™.
The ice forming has become more efficient and now the thickness of the ice formed has increased significantly. The temperature and pressure in the Ammonia receiver has been observed to be well under the limit conditions since installation of FLUX maxguard™. The temperature that was generally attained during winter was achieved ever in summer as a result of FLUX maxguard™ installation.


The power consumption during 1999 has been observed to be lower than power consumption recorded in 1998, consistently. It has been also observed that after installation the temperature drop across the cooling tower has also increased by 1°C and has added to the power saving since the extra amount of cooling is being done at no additional cost.

4. Temperature drop of cooling water:

![Temperature Drop across Cooling Tower Graph](image)

It is evident from above graph that immediately after installation the temperature drop has increased sharply due to rapid de-scaling that was witnessed during the first week after FLUX maxguard™ installation. The temperature drop across cooling tower was found to be around 2°C prior to installation and after installation it has steadily increased by 1°C as a result of de-scaling triggered by FLUX maxguard™ installation.
ENERGY CALCULATIONS:

The following is the saving in terms of fan power that would have been consumed to achieve 3° C temperature drop across condenser instead of 2° C.

The temperature drop across condenser by 1° C can be expressed in terms of energy as follows:

Cooling water re-circulation rate = 100 m³/hr.
Temperature drop increase = 10° C
Extra energy available due to increased Temp. Drop = m Cp (Temp. Drop)
= 100 x 1 x 1 x 1000
= 1,00,000 kcal/hr
Mass of water that will be evaporated by this heat = 1,00,000 /548
= 176 kg of water

From Psychometric chart at 50% relative humidity and 85°F 0.015 kg of water /kg of dry air; so for 176 kg of water 11,733 kg of dry air is required.

Density of Air = 1.2928 kg/m³
So volume of air required = 11733/1.2928
= 9076 m³/hr. or 5436 ft³/hr.

From psychometric chart the volume of air required to evaporate the effective output of a fan is static air horsepower.

Static Air Horsepower = Q(hs)(d)/ 33000(12)
Where Q = air volume ft³ /Min., hs = static head, in of water, d = density of water at ambient temp, lb/ft³
We are assuming hs = 10 in of water;

d = 1000 kg / m³ = (1000) /((0.45) x (3.28))³ = 62.97 lb /ft³
SAHP = (5436 x 10 x 62.97) / 33000 x 12
= 8.58 hp or 6.39 kw or 153 units/day

Assuming power cost to be 4 Rs. Per unit,
Saving due to increase in temperature drop by 1° C = 153 x 4 = 612 Rs. per day.

The payback period of the FLUX maxguard™ can be calculated to be around one and half years based on power saving alone. Apart from this, labor cost, down time saving and savings in chemicals cost are added advantages. The cathodic protection to the system at no extra cost represents substantial saving due to increase in life of the system.
**INFERENCES:**

Thus the efficacy of the FLUX maxguard™ in removing the scale from the system was proved beyond doubt.

**ACKNOWLEDGEMENTS:**

The performance evaluation has been done with kind co-operation from Vidya Dairy; especially Mr. S.K. Nandi who has been instrumental in accepting the new technology; Mr. Samir Patel who provided us with his sharp observations regarding the performance of FLUX maxguard™ and all the students who have shown considerable interest towards the new technology and have been analyzing water samples and observing the temperature and pressure parameters and provided us with vital ingredient for this report. Last but not least our dealer Exello agencies and Mr. Manish Shah for his painstaking effort towards the monitoring and evaluation of FLUX maxguard™.