Modification of Passivation Unit in Continuous Galvanizing Line Solution for perfect passivation

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Abstract—Galvanizing is the process of giving a protective zinc coating to steel or iron, to avoid rusting. The most common method is hot-dip galvanizing, in which steel in coil form is dipped in a bath of molten zinc. Galvanizing protects in two ways:-It generates a coating of corrosion-resistant zinc which prevents corrosive substances from reaching the more delicate part of the metal and increase the life of steel. The zinc serves as protecting layer so that even if the coating is removed by scratching, the exposed steel will still be protected by the remaining zinc coating

Keywords—Passivation, hot air generator, blower, duct, Pareto analysis

I. INTRODUCTION

Passivation in continuous galvanizing line refers to a material becoming "passive," that is, being less affected by environmental factors such as air and moisture. Passivation involves a shielding outer-layer of base material, which can be applied as a zinc coating, or oxidation which occurs spontaneously in nature.

Passivation is required for galvanized steel to increase storage life, to prevent from white rust. For passivation there are two types of solutions are used one is chromic acid hexavalent and another is chromic acid trivalent. Chromic acid (hexavalent) is used for industrial use and chromic acid (trivalent) is used for home appliance galvanized steel.

The project work based on problems occurred in Passivation which create defect on galvanized steel strip

II. PROBLEM STATEMENT

Problems occurred in Passivation unit are

1) Deposition of Passivation solution on deflector roll which after drying unit of Passivation
2) Moisture accumulated in Dryer unit.
3) Powder formation of solution due to improper temperature in drying unit.
4) Dent generation on finish product
5) Processed material loss due to above problems
6) Loss of productivity.

To resolve this problem is project agenda to run the passivation unit smoothly and with full of its capacity.

III. VARIABLES OF THE PROJECT WORK

At start of project to resolve the problems factor affecting on problems listed out.

Variables/Parameters affecting on problems

1) Input strip temperature
2) Process line speed
3) Passivation solution temperature
4) Passivation solution concentration
5) Hot air generator temperature
6) Temperature of strip before entering dryer
7) Temperature inside the dryer
8) Output temperature of strip
9) Moisture in dryer

3.1 Role Of variables
1) Input strip temperature:
Role of this parameter in occurring problems in passivation is important because temperature of input strip for perfect passivation should be in certain range. From observation we come two points. Point one is when strip temperature is below atmospheric temperature it carries water with it which is not evaporated in dryer and improper passivation applies on strip. Point two is when strip temperature in the range of 55-65°C powder formation is observed on strip in hexavalent chromic acid.

2) Process line speed:
Process line speed is depending on thickness of the input strip. High in thinner gauge strip and low in thicker gauge material.

3) Passivation solution temperature:
As per supplier of the both solution passivation solution temperature should be in the range of 50-60°C.

4) Passivation solution concentration:
As per supplier of solution, for hexavalent chromic acid concentration range should be 15-20% by volume and for trivalent chromic acid concentration range should be 30-40% by volume.

5) Hot air generator temperature:
Hot air generator temperature is most important parameter on defect. At the start we are following the trial and error method for the drying the solution in dryer. Capacity of hot air dryer is 600°C. We started from the temperature setting from 450°C for observation.

6) Temperature of strip before entering dryer:
This is temperature between the spraying unit of the solution dryer. This is depend on the solution temperature as well as input strip temperature.

7) Temperature inside the dryer:
This temperature is plays important role in the drying of solution. Dryer temperature is maintained through duct carrying hot air from hot air generator. We are observing the drop of temperature through duct.

8) Output temperature of the strip:
This temperature is measured in between the dryer and deflector roll. Purpose of measuring strip temperature is to find out how to avoid the deposition of the solution on the roll.

9) Moisture in the dryer:
Effect of the moisture is improper drying in both types of solution which cause deposition of solution on roll. We find out the sources of the moisture in dryer. From observation, moisture formation is when we start the passivation unit after long time or if in process breakdown occurs.
IV. MODIFICATION IN PASSIVATION UNIT VERSES EXISTENCE CONDITION /PROPOSED WORK

In the proposed work
From observation we come to following modification required in exist Passivation unit .i.e. work done in modification Passivation unit.

4.1 Heating Coil:
Purpose of the heating coil to maintain the temperature of Passivation solution. Range of the Passivation solution temperature is 55-60°. So we are going to install electric heater in the solution tank.

4.2 HOT Air Caring Duct Design From HAG To HAD:
Purpose of the duct design is to avoid to temperature drop while carrying the hot air from HAG to HAD. We preferred the circular duct/pipe.

4.3 Inlet Blower:
It has installed in two sections. First at HAG section and second is at before dryer. previously only one blower is there which is at HAG.

4.4 Exhaust Blower:
Requirement of the exhaust blower to maintain the proper ventilation inside the dryer. This blower has installed at top of the dryer.

4.5 Dilution Fan:
Purpose of the fan is to cool the strip before the deflector roll.

V. PARETO ANALYSIS OF THE OBSERVATION OF VARIABLES

Pareto Analysis is a statistical technique in decision-making used for the selection of a limited number of tasks that produce significant overall effect. It uses the Pareto Principle (also known as the 80/20 rule) the idea that by doing 20% of the work you can generate 80% of the benefit of doing the entire job.

Pareto analysis made for find out which variable is more effective for the problems. In this we have done Pareto analysis of different variables for time and material diverted. This analysis is done for both passivation solutions. i.e. hexavalent and trivalent. following are the pareto analysis for both passivation solution from the readings taken when passivation is in running.

5.1 First Pareto analysis
First pareto analysis is done on all variable and material diverted due to this variable. From this pareto analysis and find out of this pareto analysis is which variable is more effective for material diversion
5.2 Second Pareto analysis-
This Pareto analysis is done to find out the operating temperature range for trivalent chromic acid. Readings taken for different temperature and time noted in minutes for deposition of solution on the deflector roll.

### Table No.I Effect of Variable on material diversion

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mtl. Diversion Quantity in MT</th>
<th>Cummulative Amount</th>
<th>Cummulative %</th>
<th>80% marker</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAD Temp.</td>
<td>25</td>
<td>25</td>
<td>63%</td>
<td>80%</td>
</tr>
<tr>
<td>Process Speed</td>
<td>5</td>
<td>30</td>
<td>76%</td>
<td>80%</td>
</tr>
<tr>
<td>Moisture</td>
<td>3</td>
<td>33</td>
<td>83%</td>
<td>80%</td>
</tr>
<tr>
<td>Exhaust Temp.</td>
<td>2</td>
<td>35</td>
<td>88%</td>
<td>80%</td>
</tr>
<tr>
<td>Incoming strip temp</td>
<td>1.8</td>
<td>36.8</td>
<td>93%</td>
<td>80%</td>
</tr>
<tr>
<td>Solution Temp.</td>
<td>1.5</td>
<td>38.3</td>
<td>97%</td>
<td>80%</td>
</tr>
<tr>
<td>Outgoing strip Temp.</td>
<td>1.3</td>
<td>39.6</td>
<td>100%</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>39.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table No.II Temp Vs Time for Trivalent solution

<table>
<thead>
<tr>
<th>Temp in Degrees</th>
<th>Time in Min.</th>
<th>Cumulative Time</th>
<th>Cumulative %</th>
<th>80% marker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp.150</td>
<td>420</td>
<td>420</td>
<td>10%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp.160</td>
<td>420</td>
<td>840</td>
<td>21%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp.165</td>
<td>420</td>
<td>1260</td>
<td>31%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp.170</td>
<td>420</td>
<td>1680</td>
<td>42%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp.145</td>
<td>410</td>
<td>2090</td>
<td>52%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp.140</td>
<td>400</td>
<td>2490</td>
<td>62%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp.135</td>
<td>360</td>
<td>2850</td>
<td>71%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp.130</td>
<td>300</td>
<td>3150</td>
<td>79%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp.125</td>
<td>240</td>
<td>3390</td>
<td>85%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp.110</td>
<td>230</td>
<td>3620</td>
<td>90%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp.100</td>
<td>210</td>
<td>3830</td>
<td>96%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp.90</td>
<td>180</td>
<td>4010</td>
<td>100%</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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5.3 Third Pareto analysis
This Pareto analysis is done to find out the operating temperature range for hexavalent chromic acid

**Table No. III Temp Vs Time for Hexavalent**

<table>
<thead>
<tr>
<th>Temp. in Degrees</th>
<th>Time in Min.</th>
<th>cummulative time</th>
<th>cummulative %</th>
<th>80% marker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp. 140</td>
<td>480</td>
<td>480</td>
<td>11%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp. 135</td>
<td>460</td>
<td>940</td>
<td>22%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp. 130</td>
<td>450</td>
<td>1390</td>
<td>33%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp. 125</td>
<td>440</td>
<td>1830</td>
<td>43%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp. 120</td>
<td>430</td>
<td>2260</td>
<td>53%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp. 115</td>
<td>400</td>
<td>2660</td>
<td>63%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp. 110</td>
<td>350</td>
<td>3010</td>
<td>71%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp. 105</td>
<td>320</td>
<td>3330</td>
<td>78%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp. 100</td>
<td>300</td>
<td>3630</td>
<td>85%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp. 95</td>
<td>230</td>
<td>3860</td>
<td>91%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp. 90</td>
<td>210</td>
<td>4070</td>
<td>96%</td>
<td>80%</td>
</tr>
<tr>
<td>Temp. 85</td>
<td>180</td>
<td>4250</td>
<td>100%</td>
<td>80%</td>
</tr>
</tbody>
</table>

**Chart III pareto analysis of Hexavalent solution**
VI. CONCLUSION

From the Pareto analysis suitable temperature range for the different solution we get is
1) For chromic acid (Cr+6) is 125-145°C
2) For chromic acid (Cr+3) is 135-165°C
3) For chromic acid (Cr+6) concentration range is 10-15% by volume
4) For chromic solution (Cr+3) concentration range is 28-35% by volume

VII. DISCUSSION

From the observations and analysis we have discussed following points for better performance of the passivation unit. We can say Standard Operating Procedure (SOP) for Passivation unit.
1) Start exhaust blower of Hot Air Dryer.
2) Start Hot Air Supplying Blower.
3) Start Hot Air Generator and Set the temperature for respective solution.
4) Open valve of hot air carrying duct after achieving temperature in HAG.
5) Take squeeze roll down and maintain the pressure 3 Kg/cm2.
6) Start passivation solution spray pump.
7) Adjust the spray as per requirement on the running strip.
8) Maintain the constant process speed.

VIII. BENEFITS OF THE MODIFICATION

1) Improvement in the surface quality of the product
2) Reduction in customer complaints
3) Increased productivity.
4) Saving in finished product loss
5) Increase in life of the solution.
6) Material will be processed as per the planning.
7) OTIF will be maintained.
8) Safe work environment.

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