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Minimizing Zinc Coating Section Downtime of Continuous Galvanizing Line in Steel Industry

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Abstract
Galvanizing is a technique of smearing a protective Zinc coating on Steel or iron, to avert its rusting. The usual practice to produce galvanized steel is through hot dip galvanizing method. It is a continuous line where annealed sheet is immersed into molten Zn bath with Sink roll assembly guiding the sheet and air knife system maintaining proper coating of Zn onto the sheet. Due to high vibration sink roll bushes get wear frequently and scratches are formed on sheets, as a quality defect. The vibration causing element is to be identify and resolving it reduces the sink roll changing frequency and increases Zn coating section availability time, also minimizes the scratch formation on sheet during coating. The data were collected, analyzed and implemented to increase the availability time of Zn coating section, and thus the productivity.
Keywords: Corrector and Stabilizer roll , Cause and effect analysis ,Dross formation, Hot dip galvanizing, Pareto analysis , Sink roll assembly vibration, Zinc coating,

1. Introduction

Galvanizing is a technique of coating a protective Zinc coating on Steel or iron, to prevent it's rusting. The usual practice to produce galvanized steel is through hot dip galvanizing method Zinc acts as an sacrificial material protecting the base metal iron from corroding or when scratch is formed. Hot dip galvanizing is a continuous process in which sheet is cleaned by alkali solution to remove coolant and other dust particles, generally cleaned by alkali solution, metallurgical changes is acquired by annealing, annealed sheet is immersed in molten Zn bath and passed through tempered rolling mill to induce require roughness on sheet and alter the elongation point of sheet to some extent. Its annual production is approximately 25000MTPA.

Being continuous process, downtime of equipment will affect the complete process and productivity in one or other way. Sink roll assembly, which guides the annealed sheet through molten Zn bath is an vital equipment of Galvanizing line and as assembly will be completely in molten Zinc environment, it need to be changed frequently to maintain quality coated steel. Every sink roll change need 4 hours from stop to start of the process and frequent changing of assembly ultimately increases line downtime and decreases productivity. Hence minimizing sink roll changing frequency increases the line availability time for production**.**

2. Literature Survey

Till date lot of research has been conducted for effective utilization of Zn coating section at galvanizing line which provides positive results towards profitability & customer satisfaction at the respective work areas. The approach of all the researches was same as to increase the line availability time with respect to coating section by reducing sink roll assembly changing frequency and controlling mechanical failure of auxiliary units. Productivity can be increased by adopting practices to reduce downtime that will ultimately increase available time. In order to properly diagnose a defect, it is necessary to investigate all manufacturing steps, final inspection and customer claims. It is essential to reducing delays by defining corrective and preventive actions. First by Pareto analysis we can sort all different defects with their relative significance to the total rejection. Then Root Cause Analysis can be used to perform a comprehensive, systematic review of critical incidents. It includes the identification of the root and contributory factors, determination of risk reduction strategies, and development of action plans along with measurement strategies to evaluate the effectiveness of the plans. It is an important tool for a thorough understanding of “what happened”. A root cause is the most basic reason for an undesirable condition or problem. If the real cause of the problem is not identified, then one is merely addressing the symptoms and the problem will continue to exist.

Pratik J Patel and *Sanjay Shah* studied that if manufacturing industry is taken into account; quality control tools have been used to study and improve quality taper shank drills [1] by studying whole process and applying QC tool in every stage of process.

Irena Ograjenšek, an economist have proposed to companies to adopt the TQM and use these QC tools to increase the service factor in overall [2], as service accountability is more than 75% in most developed country. *Chiragkumar S*.and *Chauhan* studied with bearing industries, rejection and rework being major concern in these industries, QC tools has been used to minimize the same, especially with taper roller bearing [3]. In hot dip galvanizing, coating quality, weight and thickness being crucial part of processes, many models have been proposed to get the good control over it. *Kazunari Andachi* and *Harumi Shigemoto* proposals focused on gas wiping methods where excess coating is wiped off by when gas blow through nozzles.[4] *Yeon Tei,xyz,* proposed an apparatus and also formulated a mathematical model which interlinks the process parameters and helps to get control on coating thickness[5]. *Stefania Salokyova* studied the impact of vibration on rate of change technical state of a machine. It has been carried out on a Lathe machine by linking three parameters viz. machining precision, noise level of machine and resizing of electricity on too machine with the technical state of machine. These three criteria have been analyzed using Signal Express Software to convert them into statistical data and by analyzing it is occluded that rate of change of technical state is directly proportional to size of vibration. [6]

Galvanized steel in present era plays a important role in everyday lives. It has various filed usage of transport, construction, power transmission, and where ever long life is needed, graphical representation is shown in Fig 2.1.Zinc being vital for human health and ecosystems is effectively recyclable and it is a key raw material for hot dip galvanizing.

3. Process Description

3.1 Line Description

The hot dip galvanizing line includes annealing furnace and rolling mill as a important section other than Zinc coating section which serves the purpose of relieving internal stresses and imparting roughness of galvanized sheet. One of the most important characteristics of the line is that nearly half of the product mix is for the automotive outer panels that require a high level of surface quality. The just-in-time oriented coil schedule is established to meet customer orders. As a result, due to the wide product mix, the jet stripping system experiences many thicknesses, grades, line speeds and of course, coating weight transients.

3.2 Hot dip Galvanizing

Preheated steel strip coming from the annealing furnace is passed through a molten zinc bath at 460°C. The thickness of the film deposited on to the strip as it emerges from the bath is controlled by jet stripping, which consists in forcing excess zinc to flow back in to the bath by directing a high velocity and horizontally extended gas jet at the moving strip (Fig 3.1).

4. Problem Definition

Zinc Coating section being heart of Continuous Galvanizing line, its downtime hampers the production to a great extent. As sink roll and its auxiliary units are immersed in molten Zn bath, this assembly is to be change frequently to get effective performance and quality of coating. Every sink roll change takes 4 hours and it is being carried out every ten days once. Assembly changing frequency is to be decreased so that line availability time will be increase and thus productivity. By problem categorization and priority index it’s been identified that high vibration of sink roll assembly is leading to wear and tear of sink roll bushes and further increasing the vibration. Decreasing this vibration causing element will increase effectively of sink roll assembly by decreasing its changing frequency. 2.5 mm/s is the allowable vibration and collected vibration reading is tabulate in Table 4.1

5 Minimizing the vibration

By carrying cause and effect analysis as shown in Fig 5.1, three main causes haven been validated which is adding to high vibration, those are drive shaft unbalancing problem, high inclination angle of drive shaft and material composition problem of drive shaft. All three main causes are related with drive assembly of Corrector and Stabilizer roll. After conducting brain storming session with all concerned persons, Stabilizer and Corrector roll drive system is modified to non-drive and sink roll bush thickness have been increased from 10 mm to 25 mm. PDCA methodology is used to implement the solution and vibration reading of post modification is tabulate in Table 5.1

6 Results and discussions

6.1.1 Cost Reduction

For every sink roll change, complete line must be down for 4 hours.
Rated capacity of CGL at JSW is 60T/H
Conversion cost, i.e. conversion of CRFH coil to Galvanized coil is Rs 3000/T
Calculation is as follows
Sink roll changing for onetime is
=CGL downtime X Rated capacity X Conversion cost
= 4Hrs X 60T/H X Rs3000/T

= 720000 / Sink roll assembly change
Loss due to 3 sink rolls assembly change per month = 720000 X 3 = Rs 2160000 / Month
Due to Quality diversion
On an average 60 T per month is diverted with quality defects pertaining to scratch.
= Quality diversion / Month X Conversion cost/T
= 60T/Month X Rs 3000/T
=Rs 180000/ Month
Cost of Consumables spares = Rs 600000 / Month
Total cost = 29.4 Lacs/ Month
After changing Stabilizer an corrector roll from drive to non drive and by changing the bush design, sink roll changing frequency have been reduced and cost benefits are
Sink roll changing for onetime is
=CGL downtime X Rated capacity X Conversion cost
= 4Hrs X 60T/H X Rs3000/T
= 720000 / Sink roll assembly change
No loss with respect to quality pertaining to scratch
Cost of Consumables spares = Rs 200000 / Month
Total cost = 9.2 Lacs/ Month

7 Conclusions

Corrector and Stabilizer roll drive system have been changed to non drive and sink roll bush thickness is increased to 25mm (from 10 mm). Post modification vibration reading is found to be less and roll changing frequency reduced from once in ten days to once in a month. Costs have been reduced from 29.4 Lacs to 9.2 Lacs per month. A large amount of material loss, inventory loss and cost in over all have been decreased. Line availability time have been increased by eight hours, as roll changing frequency have been decreased from once in 10 days(12 hours downtime) per month to once in month (4 hours downtime per month. Vibration is reduced and comparison is graphical represented in Fig 7.1

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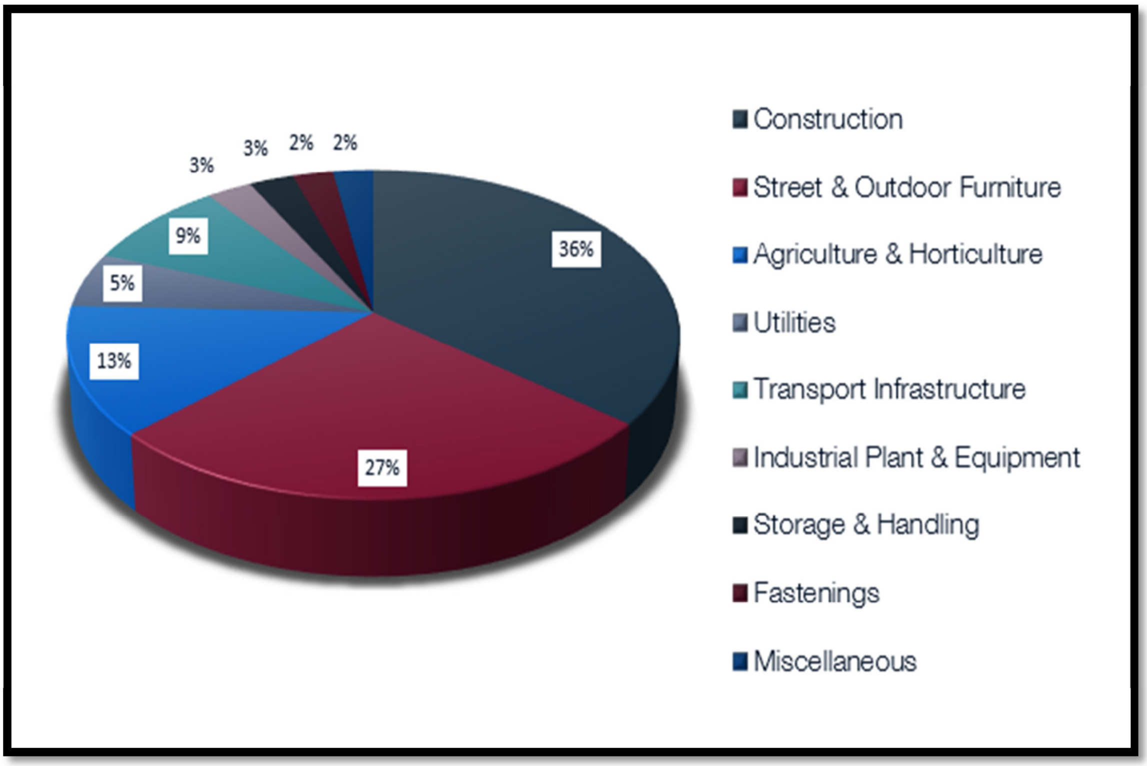

Fig 2.1; Application of Galvanized steel

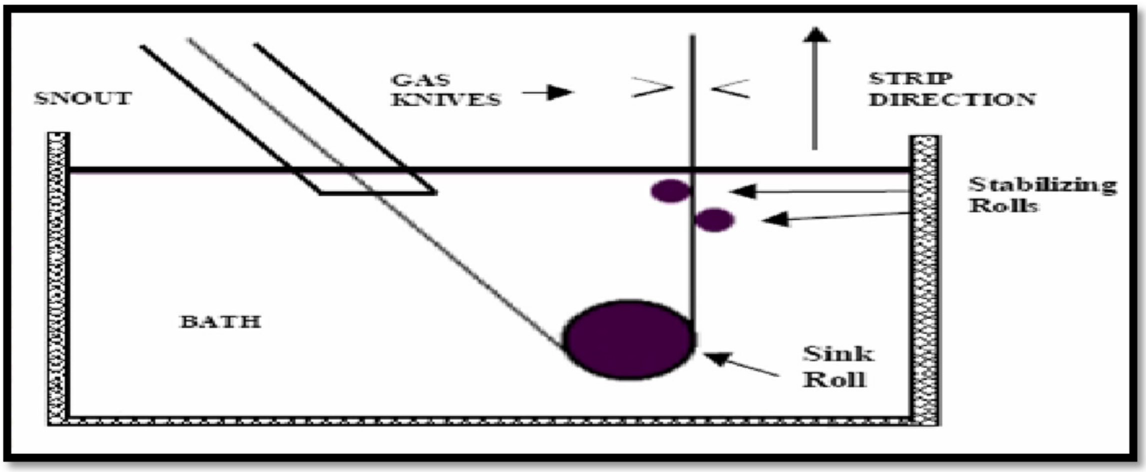

Fig 3.1: Zn pot Overview

Table 4.1: Average of vibration readings prior modifications

Sl no.	Point no.	Vibration value in mm/s
1	Point 1	2.64
2	Point 2	2.46
3	Point 3	2.43
4	Point 4	2.41

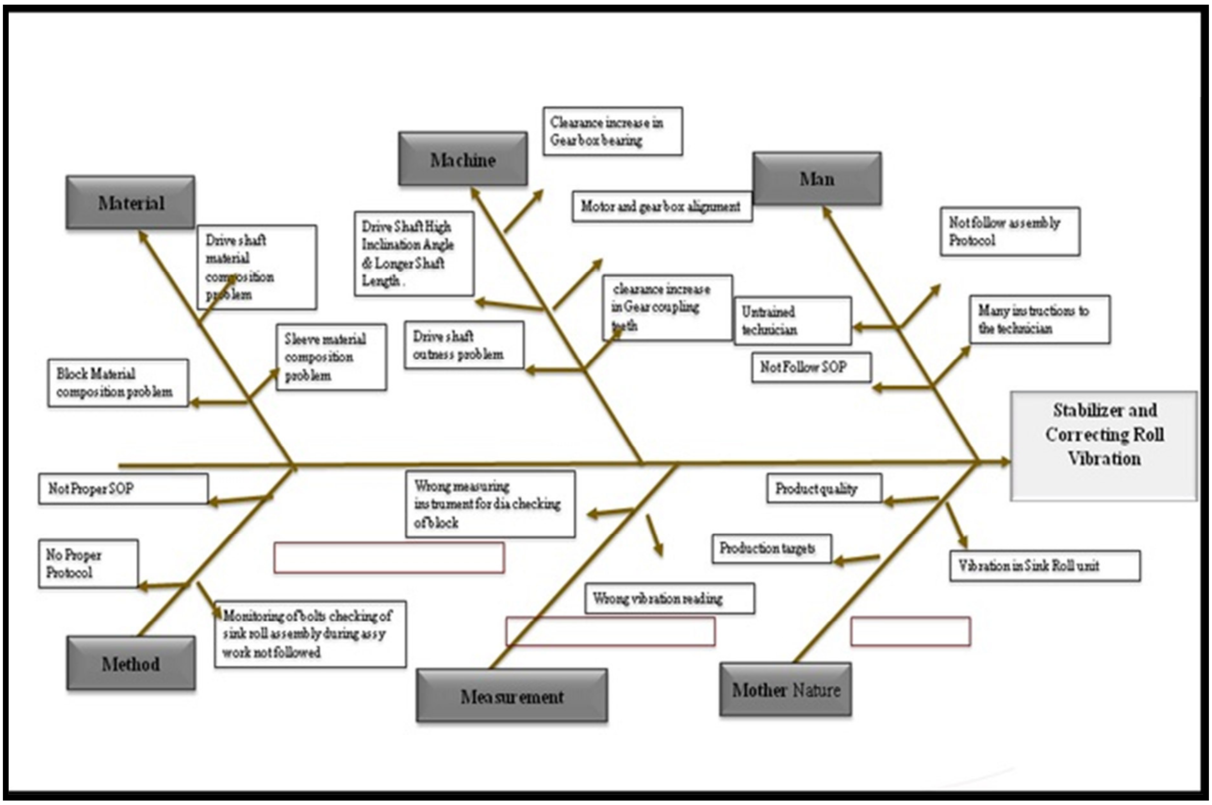

Fig 5.1: Cause and Effect diagram

Table 5.1: Vibration reading after modification

Sl no.	Point no.	Vibration value in mm/s
1	Point 1	1.09
2	Point 2	1.27
3	Point 3	.29
4	Point 4	1.19

Table 6.1: Production loss due to Quality

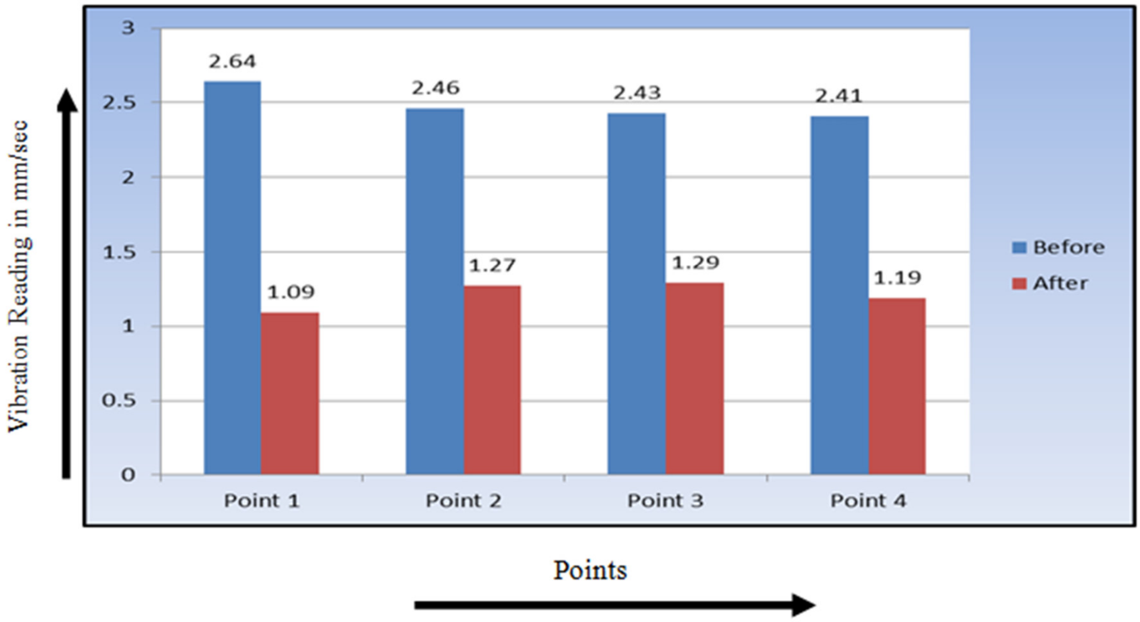

Fig 7.1: Graphical representation of Vibration reading comparison

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