Waste Minimization and Cost Reduction in Process Industries

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Abstract—The complete process of iron angles processing; machining and coating by Kalpataru Power Transmission Ltd. has been studied in detail. The different phases of production of the iron/steel angles include automation, CNC machines, Robo arms, overhead cranes and other mechanical equipments. After the straightening, shearing, punching, stamping, heating & bending operations are performed upon the different sections; each set of parts follow a sequence of processes. Once the sections are done with the machining processes, they follow the hot dip galvanization process. Surface Fluxing is the primary stage; followed by Steel Galvanizing and finally dichromate quenching. All the sections are arranged in their respective jigs. These structures or frames are handled by the overhead cranes and dipped in various tubs and lifted from them. Initially, the sections perform hot caustic degreasing followed by Hydrochloric acid pickling. Now these sections are rinsed in water and then soaked in a hot pre-flux. Before dipping into the Zinc tub, these sections are dried in the oven so that wet sections do not splash zinc off the tub. After taking out from the zinc tub, it is quenched in warm water. In the final step of this phase, all these sections are submerged into the dichromate solution to emboss a glossy texture. Here, in the whole coating process, it happens that the sections are to be immersed into various liquid tubs. So, when removing them out, many of the sections fail to be retrieved and remain inside the tub. So this decreases the production though negligible but with a feasible solution, it appears to be worth practicing. The objective of the project is to reduce the loss of iron angles and molten zinc during the coating of iron angles before dispatching.

Keywords: Waste Minimization, Transmission Towers, Cost Reduction, Process Industries, Hot Dip Galvanization, Zinc Coating

I. INTRODUCTION TO ZINC COATINGS

A. Introduction
For over a century, zinc [6] has enhanced the longevity and performance of steel. Zinc coatings provide the most effective and economical way of protecting steel against corrosion. Zinc-coated or galvanized steel offers a unique combination of high strength, formability, light weight, corrosion resistance, aesthetics, and recyclability. Galvanized steel sheet is an ideal material for a multitude of building and manufacturing applications - from automobiles to household appliances to residential, commercial and industrial construction.

B. Environmental Performance
Zinc-coated steel is an environmentally responsible choice. New research is shedding light on the role of essential elements such as zinc in the environment. Zinc is an integral part of our environment and exists naturally in rock, soil, air and water. Zinc is also an essential element for all life, from humans and animals to plants and micro-organisms.

C. Technical Performance
There are many factors to consider when selecting the most appropriate zinc coating. In addition to corrosion protection, the coating’s formability, adherence, appearance and cost should also be considered.

1) Barrier Protection: Zinc coatings [9] provide a continuous, impervious metallic barrier that does not allow moisture to contact the steel. Without moisture, there is no corrosion, except in certain chemical atmospheres. The effectiveness of zinc coatings in any given environment is directly proportional to coating thickness.

2) Cathodic Protection: Another outstanding protection mechanism is zinc’s remarkable ability to galvanically protect steel. When base steel is exposed, such as at a cut edge or scratch, the steel is cathodically protected by the sacrificial corrosion of the zinc coating adjacent to the steel.

3) Painted Zinc Coatings: Zinc coatings are easily painted. Paint acts as a barrier protecting the underlying zinc coating. Zinc is an excellent substrate for paint coatings because if the paint film is broken, zinc’s high corrosion resistance prevents undercutting of the paint film.

4) Formability and Adhesion: The formability and adhesion of continuous galvanized zinc coatings are excellent and in most cases match the formability of the underlying steel.

5) Surface Appearance: Zinc and zinc alloy coatings can differ in appearance depending on customer needs and consumer preferences. Galvanized coating finishes can vary from extra smooth and featureless to a flowery "spangle" pattern.

D. Assembly
Assembly refers to the technique of joining galvanized sheet steel products, mainly to themselves. In any application, the joining method should suit the metallic coating and will be determined either on the basis of its performance or the properties and characteristics of the galvanized product.

Fig. 1: Hot-dip Galvanization Process Sequence
There are several effective joining methods such as welding, mechanical fixing and adhesive bonding.

II. CONTINUOUS GALVANIZATION

Continuous galvanized steel is made under precise, factory-controlled conditions during which flat rolled steel coils are upgraded to high-quality, zinc-coated steel using high-speed continuous lines that control not only the coating quality but also the strength and formability of the steel product. Zinc is applied either by dipping in molten zinc or by electroplating.

In the continuous hot-dip galvanizing process, coils of rolled steel are continuously unwound and fed through cleaning and annealing sections before entering a molten zinc bath at speeds up to 200 meters per minute (650 feet/minute). As the steel exits the molten zinc bath, gas "knives" wipe off the excess coating from the steel sheet to control coating thickness. The steel strip then undergoes a series of mechanical or chemical treatments. Depending on customer requirements, the coated sheet can be passivated, oiled and recoiled, and cut to length and palletized before shipment to the fabricator. All galvanized coatings are metallurgically bonded to the steel they protect. This ensures coating adhesion - critical for manufacturing processes that stamp, roll or draw the steel into its final product shape.

III. PRODUCTION PROCESS SEQUENCE

The raw sections from different party come from the storage yard initially to the Heavy Straightening Machine. Here the worker will have the design and information sent by the supplier as follows:

- type of material (if MS or HT)
- shop no. to be forwarded
- firm name that has placed the order
- weight of section lot and its dimensions

Even material rejection takes place at this preliminary stage. Three shades have been formed to follow an optimum sequence of operations, effectively and efficiently. Then it goes for other mechanical processes like marking, cutting, stamping, and punching, drilling, hot bending according to the different designs that have been provided at each station. There are manual as well as Semi- automatic CNCs’. Some of the sections are even required to be bent at a specific point. For this, the methods used depend upon the dimensions of the materials as for heavy and thick sections would go under hot bending.

After the preliminary stage of all these machining processes, then these sections of different dimensions are forwarded to the galvanization section. Here, the sections are first arranged into a frame that bears many rods which carry these sections. Then they follow a series of immersions into various liquids.

Here, primarily the sections are arranged in a frame like structure. This too varies with the dimensions of the sections we are using. First, these sections are dipped in the caustic soda/degrease for about 10 mins. This is to remove the carbon, grease and other dirt’s from the sections. Then it is dipped into an acid tank (50% acid & 50% water) for about 15 mins. There are about 3-4 tanks here, this is because after a period of usage, it turns red and this has to be replaced by new solution through the valves for exhaust and intake. Now the next step is to dip into water tank for about 2-5 mins. This is to prevent the material from being red. This would also make sure the flux inside the next tank does not get dirty, where we shall keep the sections immersed for about 2-3 mins. Now, the sections are taken out and filled into another frame which is kept in the oven to dry them thoroughly before moving for the zinc coating process. Then the sections are entered into the only Zinc tub as it is costly followed by the immersion into the hot water tank.

Finally these coated sections are taken to the dichromate solution tank to give a shining (yellow) feel to them. Then it follows the filing process for cleaning the sections before dispatching away to the ordered firms. Actually, throughout all these dipping processes, the soaking time depends upon the cross-sections of the material. All these moving tasks are carried out by the operators loaded at the overhead cranes/ Jib Cranes.

IV. LITERATURE REVIEW

Simpson, D. indicated that firms’ investments [1] in waste reduction resources provided them with significant advantages in the form of decreased pollution and cost reduction. The results suggest that waste reduction resources better position firms to predict and effectively respond to institutional pressures. From a policy perspective, the benefits of waste reduction resources can be highlighted and more specific payback calculated for specific resource types.

Chakraborty, A. et al. reports that the ever-changing production campaigns [2] complicate the management of recovery and treatment options for unavoidable effluents at pharmaceutical plants. Each campaign produces large amounts of by-products differing in their number, amount as well as composition. Future business strategies designed to address changing market demands add uncertainty to this already challenging design problem. In such a dynamic and uncertain environment, the selection of operating policies as well as decisions to support future business operations by plant investments such as new reactors and separators is a formidable task.

Chaaban, MA concludes that almost all countries in the world [3] are adopting industrialization as a main component in their sustainable development strategies. Many industries are generating hazardous wastes which pollute the environment and lead to health problems. This can be avoided by the development of industrial processes which reduce hazardous wastes and pollution. Recycling of wastes is essential to prevent hazardous wastes and to increase the efficiency of production. It is also necessary to manage the disposal of enormous quantities of hazardous wastes.

Linninger, A.A. et al. gives an insight on the Pharmaceutical and specialty chemical [4] production that often causes high waste to product ratios. This can be explained by complex reaction mechanisms that require complicated multi-step production routes as well as stringent product purity and quality requirements. Therefore, a large number of different types and Levels of waste are leaving pharmaceutical production campaigns and need material recovery and/or adequate treatment. The design of waste reduction and pollution prevention efforts is complicated by
the variability or the waste loads and compositions as well as the uncertainty associated with federal and local regulations. Therefore, a design methodology including a rigorous treatment of the influence of uncertainty is essential for the design of plant-wide waste management strategies at multipurpose plants.

Kirsch, F.W. and Maginn, J.C. states that the major process operations [5] are degreasing and rinsing, acid pickling and rinsing, pre-fluxing and galvanizing. All these operations, except galvanizing, result in the formation of waste streams requiring off-site disposal. Bottom dross from the galvanizing kettle and zinc oxide skimmed from the surface of the molten zinc are sold as usable products. The team's report, detailing findings and recommendations, indicated that most waste was generated in acid pickling and rinsing and that the greatest savings could be obtained by continuous air agitation to extend the life of the pickling acid and rinse by enabling more complete removal of dissolved iron when those solutions are treated.

Jauhar, S. emphasizes that the value analysis helps in identifying [6] unnecessary costs of any product by focusing on the product function. Using creative ideas invariably minimizes unnecessary costs even if it does not eliminate them totally. This paper addresses the application of value analysis concepts for cost reduction in the galvanization process. By this paper we can see that how we can use value analysis concept for solving the problem of any type with the best suitable option of reducing the cost of galvanization to the best possible extent. In short, Value analysis is versatile and a systematic way solve to many problems related to any aspect of manufacture, such as quality, production, maintenance, parts availability and many others. It directly contributes to improvement of operating performance and reduced costs.

V. RESEARCH AND RESULTS

A. Problem Definition

To reduce the cost of production and minimization of waste produced in the process industry by reducing the loss of iron sections and molten zinc during the coating of the iron angles.

B. Problem Explanation

Here, in the whole coating process, it happens that the sections are to be immersed into various liquid tubs. So, when removing them out, many of the sections fail to be retrieved and remain inside the tub. So this decreases the production though negligible but with a feasible solution, it appears to be worth practicing. The objective of the project is to reduce the loss of iron angles and molten zinc during the coating of iron angles before dispatching.

C. Proposed Solution

Here we will make use of raw magnet to collect all those left out sections in the tubs. A long rod that is welded to a metal ring of the same material is inserted in a triangular rod with extended parts to hold the raw magnet has been designed to collect those missed out sections from the tubs.

D. Methodology

Initially, we observed the various types of raw magnets available in the industry along with their costs, specifications and grades. There, according to our specific requirement of collecting the section from the hot bath tubs, we had selected the Alinico type Raw Magnet that had got high heat resistance. These raw magnets are capable of carrying up to 50 kg of weight. And most of the sections manufactured over here do not fall above this margin.

VI. CONCLUSION

With all the regular observations made at the production firm, we had come to some promising solutions that would satisfy the objective of reducing the waste and cost of production. Here, we have managed to secure all the sections throughout the process by implementing the proposed strategy. The sections that fail to be retrieved from the bath tubs would be immediately recovered by the worker with the help of the raw magnet designed by our specifications. Hence, with the implementation of the suggestions put forward to the management, there is a good scope of eliminating the loss of material and optimizing the production.

VII. REFERENCES