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Self-Cleaning Shower for Pickling lines

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Abstract
This case aims to develop potential Product for reducing maintenance downtime in the rinsing systems utilized within the pickling lines at STEEL MILLS CRM. Rinsing systems play a critical role in the postpickling process, where they are employed to remove residual pickling acid from metal sheets. Given the highly corrosive and acidic environments in which these systems operate, traditional rinsing mechanisms often experience significant challenges, including frequent clogging and the need for regular maintenance interventions.
Keywords: *Pickling lines, Metal Processing, Rinsing Systems*

1. INTRODUCTION

The metal processing industry is vital to numerous sectors, including automotive, construction, and manufacturing. One of the critical operations in this industry is the pickling process, which effectively removes surface impurities such as rust, oxides, and scale from metal sheets. This preparatory step is crucial for enhancing surface quality and ensuring optimal adhesion for subsequent treatments, such as coatings and galvanization. However, the efficiency of the pickling process hinges on the effectiveness of the rinsing phase that follows, where residual pickling acid must be thoroughly eliminated to prevent quality issues.Rinsing systems are strategically positioned after the pickling tanks to ensure that any remaining acid is completely washed away from the metal sheets. This step is essential, as incomplete rinsing can lead to corrosion, diminished product performance, and potential failures in the field. Consequently, maintaining high product quality is paramount for manufacturers, directly influencing customer satisfaction and brand reputation.

Despite their importance, conventional rinsing systems face significant operational challenges. They operate in highly corrosive environments, making them prone to clogging due to the accumulation of particulates and residual chemicals. This clogging not only disrupts the rinsing process but also necessitates frequent maintenance, resulting in considerable downtime. Such interruptions can severely impact production efficiency, leading to increased operational costs and delays in delivery schedules.

The implications of maintenance downtime extend beyond logistical concerns; they can affect the entire production line. In a competitive industry where time efficiency is critical, the need for frequent maintenance on conventional rinsing systems can result in lost productivity and diminished profitability. Therefore, addressing these maintenance challenges is crucial for improving operational performance.

This case study aims to investigate the factors contributing to the high maintenance demands of rinsing systems in STEEL MILLS CRM's pickling lines. By identifying the root causes of clogging and other operational inefficiencies, the research will explore innovative solutions, including the use of advanced materials, improved design strategies, and enhanced monitoring technologies. The ultimate goal is to reduce maintenance downtime while ensuring the highest standards of product quality are met. Through this investigation, the study aspires to provide actionable insights that will contribute to the advancement of rinsing system performance, thereby supporting STEEL MILLS CRM in achieving operational excellence in its metal processing operations

Fig 1: Effect of Corrosive Work Environment on Conventional Systems

2. METHODOLOGY

The purpose of this exercise was to analyses the root cause issue with nozzle clogging. Once the root cause is, established development of new product can be initiated.

Methodology to be followed as per below.

- Examine existing headers.
- Investigation of the type of contamination & contamination source
- The underlying cause of nozzle clogging.
- Design suggestions, if necessary.

2.1 Examine existing headers.

Material of construction in existing rinsing system is SS316L. The rinsing process is divided into sections; rinsing water is recirculated from respective water tanks.

The Ph level in the tanks rises as residual acid content is mixed into the tank while rinsing process.

Investigation of the type of contamination in the inlet media.

As Evident from the site observation, Inlet media in the headers is identified as the HCL with Ph concertation 1.5. General corrosion, pitting, and stress corrosion cracking of austenitic stainless steels such as 316 are caused by hydrochloric acid. [1].

The protective oxide layer on the surface of stainless steel is dissolved by hydrochloric acid. The aforementioned oxide layer is in charge of preventing steel corrosion. As the layer dissolves in HCL, the fresh layer of stainless steel is exposed to acid, causing pitting corrosion. Residual generated from the reaction is of red amorphous powder type.

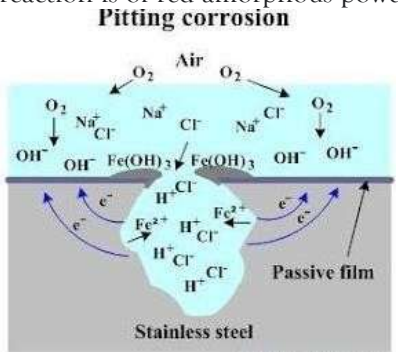

Fig 2: Pitting Corrosion Mechanism of HCL on SS

2.2 Nozzle clogging cause

Primary type of clogging residual observed in the nozzle is of red colored amorphous powder. It is suspected to be rust generated by corrosion of pipe internally by HCl. Severe rusting residual can be observed inside of the existing nozzles.

Hence, root cause of clogging can be estimated due to rusting residual of pipe by HCL. Photos attached below for reference.

Fig 3: Clogged Nozzles

KEY CHALLENGES

To design a product that can operate in pickling lines without requiring any maintenance. Following key challenges were identified,

- Barrier between inlet media & Stainless steel.
- Robustness to handle in sheet collisions during spring back actions.

- Maintaining same flowrate as per conventional designs.
- No modification to the rinsing tanks.

3. PROPOSED SOLUTION

With consideration of the key challenges and existing site conditions. As Rinsing system is composed of two primary components Ie.

1) Nozzle
2) Header piping

Individual development of the two systems are Rinsing system were identified into two sections for independent innovation.

1) Nozzle:

Earlier nozzles opening cross-section was observed to be narrow & prone to clogging. New clog- free type nozzle design is selected to minimize clogging.

Fig 4: Old Nozzle vs New Nozzle C/s

As evident in fig.4 conventional nozzles have marrow passageways & hence are subjected to clogging due to material build up. To avoid clogging due to material build up new nozzle design is selected where convex curves of the nozzles is in contact with the water & hence any debris is not allowed to form between the passageways.

Extensive test were performed to ensure both nozzles share same flowrate for given pressure.

2) Piping System:

MOC of conventional piping system is SS316L, as we know residual powder generated from the SS pipes is source of clogging material. Hence to eliminate the clogging material build up a barrier between inlet media & SS piping is required.

Hence, composite type header piping is selected. When choosing a composite type header, the ID of the header system is kept at an appropriate ratio, with only a 12% increase in fluid velocity in the pipe. This is useful for rinsing applications and maintains the flowrate consistent to conventional system. Plastic liner material is utilized to create the barrier between HCL & the SS pipe.

SS pipe is used as reinforcement & FRP coat is given to the pipe to avoid contact between corrosive environment to SS pipe. In order to avoid modifications in the pickling tank, inlet connection is given to piping system by adding an elbow to the piping system as illustrated in fig.5

Fig 5: Self Cleaning Shower Prototype

A brush arrangement is provided that is internally linked to the drain valve and can be activated by turning the drain valve's wheel. By turning the drain valve's wheel, the drain line is opened to drain the residual debris, and the internal brush arrangement is activated to clear the residual from the nozzles.

All the internal material is maintained in plastic to avoid rust generation.

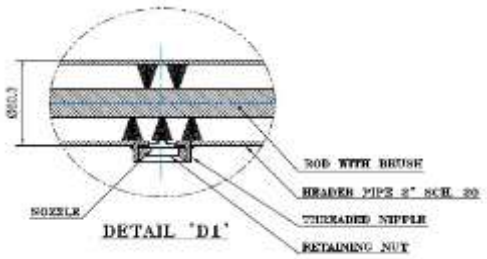

Fig.6.Brush arrangement in Self cleaning Header

4. RESULT

One of the critical components that affects product quality in cold rolling mills is the nozzle and cleaning systems that has been innovated to be aimed at keeping the rinsing system running at maximum efficiency with the least amount of maintenance required, thereby reducing pickling line maintenance downtime.

5. CONCLUSION

This research aims to provide actionable product into improving the performance of rinsing systems in STEEL MILLS CRM's pickling lines. By addressing the root causes of maintenance downtime, the product will contribute to enhanced operational efficiency and superior product quality, supporting STEEL MILLS CRM in maintaining its competitive edge in the metal processing industry.

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