Plate and Operations Tracking System

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Keywords: Tracking, Operations, MES, AI, Industry 4.0, Safety.

INTRODUCTION

This paper explores the advantages of integrating an Operation and Plate Tracking System (OPTS). It highlights the benefits of automatic and manual plate tracking, operation monitoring, UT automation, and transportation tracking within industrial environments. Through a concise analysis, it elucidates how OPTS systems enhance efficiency, quality control, and logistical operations, serving as a cornerstone for operational excellence.

This paper also delves into the transformative potential of digital transformation, Industry 4.0, and AI technology in enhancing operational performance, quality assurance, and safety in plate mills. It scrutinizes how these advancements revolutionize industrial processes, fostering agility, precision, and adaptability. Through a nuanced examination, it elucidates the pivotal role of technological integration in driving efficiency, optimizing resource utilization, and mitigating risks within modern industrial landscapes.

DISCUSSION

Digital Transformation

Digital transformation in manufacturing entails integrating digital technologies to revolutionize processes, enhance efficiency, and boost competitiveness. It involves adopting IoT, AI, data analytics, and automation to streamline operations, improve product quality, and optimize supply chains. By digitizing workflows, manufacturers can achieve real-time insights, predictive maintenance, and agile production, ultimately driving innovation and customer satisfaction.

Identification and Tracking

In the broader context of manufacturing tracking, the primary step involves product identification. In steel plates, this is often accomplished through permanent marking, such as stamping. Stamping presents challenges, particularly because plate IDs are not easily readable by humans or digital devices. One of the main challenges in plate tracking arises from the storage method commonly employed in manufacturing facilities: plates are often stacked in piles. This stacking practice frequently obscures the plate ID, as one plate rests atop another. The inability to visually access plate IDs necessitates the registration of each plate’s storage location when the plates are stored. In some cases, labels are added, then the plate ID with a bar code can extend outside of the plate then the identification is easier.

Manual and Automatic Plate Tracking

Different approaches are used for plate tracking. In manual tracking systems, the operator responsible for moving the plates must record on paper or in a computer system the location of each plate. An even more basic method can be used where paper with the plate information is stored in boxes or slots representing each pile. In the manual computer-based systems, it also uses in many cases bar code readers to identify the plates ID and the locations, in this case each location (or pile) has a barcode in the proximity then the operator can use the bar code reader to read the location. This is also used to receive or ship plates at the entry/exit point of the areas. In automatic tracking systems, the tracking is accomplished by tracking the location of the material handling equipment used to move the plates around the facility. Plates are typically transported by the following methods inside manufacturing plants:

- Conveyors/Roller Tables
For conveyors and roller tables, tracking is usually conducted using sensors and PLCs in combination with the L2 tracking system and sensors, which may include encoders, lasers, proximity sensors, and light barriers. In recent years, AI-based vision systems have also been used to improve tracking while minimizing the required field sensors. The position of Transfer Cars is tracked using lasers, encoders, radars, and limit switches.

To track plates transported by cranes, including the initial and final position and movement, as well as pickup and drop-off detection utilizing highly accurate weighting systems, Figure 1 summarizes the concept.

The following methods can typically obtain the positioning of the crane:

- Encoders combined with limit switches
- Lasers
- Radars

Due to the environment in which cranes used at plate production facilities are installed, encoders, limit switches, and lasers require periodic maintenance, while radars are maintenance-free. Radio signals travel at the speed of light, commonly denoted \( c \), which is \( 299,792,458 \) m/s or approximately \( 186,282 \) miles/s. A velocity \( v \) is generally defined as:

\[
d = \frac{v \cdot t}{2}
\]

whereas \( d \)=distance and \( t \)=time

A radio distance sensor measures the time of flight (t) of a signal from the sensor to the target (distance d) and back (=2d) to determine the target distance. The main task with this simple equation is to determine the time of flight t with enough precision – it takes only 5 µs for the signal to run 1 mile and picoseconds accuracy to measure this distance with up to \( \frac{1}{4} \) or \( 5 \) mm precision. Radio signals are reflected by most surfaces. This was the initial use case of radar waves – detecting remote objects. Such reflections also exist in today’s precise distance and position measurement applications. The sensor emits a signal and receives a directly reflected echo, but also multipath echoes from other reflections. Only the direct signal that has taken the shortest route, the line of sight, is used for precise distance measurement, other reflections have taken a longer path, needed more time and are discarded. For longer distances a two-radar configuration is used, where one radar acts as the active reflector of the original radar with extremely tight synchronization, Figure 2 shows the concept:
Bridge and Trolley position is measured to know the crane position, Figure 3 shows a typical configuration:

The determination of pickup and drop-off points for the plates is made using weight sensors. This determination depends on whether the crane can only transport one of multiple plates, as well as the minimum plate weight, which will determine the appropriate weight equipment to use and the required accuracy. Figure 4 shows some typical equipment:

Forklift or transporters use two main systems: GPS/D-GPS/RTK for outdoor storage and 2D radio tracking for indoor tracking. Figure 5 shows the basic concept for 2D indoor positioning:
The positioning is determined by the triangulation signals provided by transponder antennas, shown in Figure 5 as yellow boxes. Plate tracking is accomplished by an L2 tracking system that collects information from the sensors in real-time and also interfaces with other plant systems to exchange the necessary plate, process, and production information. Figure 6 illustrates the concept.

Local computers are installed in the mobile equipment to improve the system's robustness and minimize interruptions caused by wireless network interruptions or delays. These computers use a local real-time database that synchronizes automatically with a central database. Figure 7 shows a typical hardware configuration for the system.
The system presents the plate tracking information in 3D and 2D screens. Figure 8 shows typical screens:

![Figure 8. Typical 3D and 2D screens.](image)

Integrated tracking is also provided for tracking location, inventories, and operations throughout the process. Figure 9 illustrates the concept:

![Figure 9. Integrated tracking](image)

Depending on the location and operation, different HMI hardware is used. Figure 10 shows the various HMI hardware used for plate tracking systems.

![Figure 10. HMI Interfaces](image)

Trailer and platform tracking is accomplished by adding passive RFID tags to them and providing RFID readers connected to the transporter or track HMI. Figure 11 illustrates the concept.
Operations are also tracked by checking the initiation, the process, and the finalization of each process. Simultaneously, all the plate information is retrieved and transmitted back to other systems, reducing operator errors, including test equipment such as manual and automatic UT equipment (Figure 12), the systems also automatically generate quality inspections forms allowing the operators to sign them.

Implementing a steel plate tracking and process system offers numerous advantages, notably in reducing operator errors, expediting plate searches, and providing real-time status updates. By automating the tracking process, the system minimizes the risk of human errors, enhancing overall operational efficiency and accuracy. This leads to streamlined operations and reduced downtime, ultimately improving productivity. Additionally, the system facilitates quick and efficient plate retrieval, eliminating the need for manual searching and saving valuable time. Real-time status updates enable stakeholders to monitor operations promptly, ensuring timely interventions and optimizing decision-making processes. Furthermore, the system enhances inventory management, enabling better resource allocation and cost optimization. Overall, the implementation of a steel plate tracking and process system represents a significant step towards enhancing operational efficiency, reducing errors, and improving overall performance in steel production facilities.

REFERENCES

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