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Maintenance Plan for a Heidelberg Vane Foiling Machine

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***Abstract*— *Preventive Maintenance Plan for a Heidelberg vane foiling machine. The machine's performance had decreased from 130,000 folios to 100,000 folios per 24 hours. This drop in efficiency impacted productivity, delivery times, and generated additional costs and client dissatisfaction. The primary goal was to restore and optimize the machine's performance by identifying the causes of the efficiency reduction and implementing necessary preventive maintenance.The object of this study is the Heidelberg vane foiling machine, a key asset in the foiling process that ensures high quality and production efficiency. The methodology follows a preventive maintenance approach, which includes visual and functional inspections, general and deep cleaning, component lubrication, and the replacement of worn or damaged parts. All activities were documented and performed according to manufacturer standards and industrial maintenance best practices. It is estimated that regular, comprehensive maintenance will increase the machine's performance and prevent future breakdowns*

***Keywords*— *Heidelberg, foiling machine, preventive maintenance, performance, productivity*

I. INTRODUCTION

The company study case is a medium-sized printing company that holds the top position in sales and quality within its region. It was founded in 1984 by Mr. Martin Fernández Salgado and Mrs. María Eugenia Vázquez Ahumada. The company's mission is to provide high-quality, innovative, and sustainable printing solutions. Its vision is to be a leader in the printing industry, known for its innovation, quality, and commitment to sustainability.

The company's product offerings serve various sectors, including editorial, marketing, corporate, events, and government. The department responsible for foiling production has eight machines, including the Heidelberg foiling machine. The staff in this department includes machine operators, maintenance technicians, production supervisors, and quality control personnel. The primary product of this area is foiled material used in special finishes for packaging, cards, and labels. The company's main production process is centered on the processing of foiled material, and the Heidelberg foiling machine is a crucial part of these operations. However, due to operating 15 hours per day, the machine tends to experience a breakdown approximately once every two months. This results in prolonged downtime of a week or more while waiting for an external technician to arrive for repairs. This challenge directly impacts the operational efficiency, which is currently at 83.33%, and the productivity of the foiling department, which produces 100,000 folios in 24 hours

Objective

Preventive Maintenance Plan for the Heidelberg foiling machine to improve operational efficiency to 90% and reduce the prolonged downtime to a maximum of two days, thereby ensuring the continuity of the production process.

Hypothesis

Conduct a preliminary inspection of the machine to identify critical areas that require maintenance.

Disassemble the machine to access its internal parts for a thorough review.

Analyze the key parts identified during disassembly to assess their condition and determine necessary maintenance actions.

Replace worn or damaged parts and perform the necessary adjustments to ensure the machine's correct operation.

Develop a preventive maintenance plan based on the findings from the machine's inspection and analysis.

II. JUSTIFICATION

Implementing a preventive maintenance plan is a crucial strategy to enhance operational efficiency and ensure production continuity. Preventing failures is more cost-effective than making repairs, which leads to savings on operating costs. Maintaining the machine in good condition also ensures product quality, which strengthens customer satisfaction and the company's reputation. Furthermore, it improves worker safety by reducing unexpected failures. The project aims to position the company as a model of efficiency in the foiling industry, which will improve its profitability and competitiveness. An efficient and productive company contributes significantly to regional economic development, creating stable jobs and promoting environmental sustainability through the optimization of resources

THE PROJECT'S SCOPE INCLUDES THE FOLLOWING:

Operational Efficiency Optimization: The plan will ensure the machine's efficiency, reducing downtime and increasing productive capacity.

Personnel Training: Production staff will receive training in preventive maintenance, which will improve their technical skills and internal human resource management.

Operating Cost Reduction: Preventing failures will reduce the need for expensive repairs and dependence on external technicians, thus lowering operating costs.

Product Quality Improvement: Keeping the machinery in good condition will ensure that the foiled material meets quality standards, boosting customer satisfaction.

The project is grounded in various maintenance concepts and methodologies.

Condition-Based Maintenance (CBM) uses real-time data to evaluate equipment condition and predict failures. The

Failure Mode and Effect Analysis (FMEA) is a systematic methodology for identifying potential failure modes, their causes, and effects.

Predictive Maintenance (PdM) uses monitoring techniques and data analysis to predict when a failure will occur, employing tools like vibration analysis, thermography, and oil analysis.

Visual and Sensorial Inspection is a basic but crucial technique for identifying critical areas, involving direct observation for signs of wear, damage, or other anomalies.

Infrared Thermography detects temperature differences to reveal excessive friction or electrical problems. The

Manufacturer's Service Manual is an essential guide for specific disassembly and assembly instructions, diagrams, and safety precautions.

Other methodologies include

Procedure-Based Maintenance (PM), which focuses on standardized procedures for maintenance tasks , and

Disassembly and Assembly Analysis (D&A), which involves meticulously planning and documenting each step of the process. The

Tagging and Tracking Method labels each component during disassembly to ensure correct reassembly.

Reliability-Centered Maintenance (RCM) evaluates component functions and failure modes to prioritize critical parts for inspection. The

Analysis of Tasks and Procedures (TAP) breaks down disassembly tasks into detailed steps, including the necessary tools and safety precautions.

Further techniques and concepts include:

Reliability, Availability, and Maintainability (RAM) Analysis, Vibration Analysis for detecting issues in rotating components, Oil Analysis for evaluating lubricants and detecting internal wear , and Non-Destructive Testing (NDT) for assessing component integrity. The project also uses Life Cycle Analysis (LCA) to predict the remaining life of key components , and relies on.

Corrective and Preventive Maintenance strategies. The Total Productive Maintenance (TPM) methodology aims to maximize equipment efficiency by involving all employees in maintenance. Finally, the Six Sigma methodology is mentioned as a data-driven approach to improve process quality and reduce defects in maintenance.

Legal Framework

The project is guided by several applicable ISO standards:

ISO 9001: This standard ensures that preventive maintenance activities are planned, documented, and controlled to guarantee consistency and effectiveness.

ISO 14001: This standard helps integrate environmentally responsible practices, such as proper waste management and efficient resource use during maintenance activities.

ISO 12647 and ISO 16762: These are specific to the graphic arts industry. Preventive maintenance should include the regular calibration of color management systems as specified by ISO 12647 to ensure product quality and consistency. The plan also follows the manufacturer's specifications as recommended by ISO 16762.

ISO 12100 and ISO 13849: These safety standards are fundamental. Adhering to ISO 12100 protects operators by ensuring safety design principles are followed , while ISO 13849 requires verification and maintenance of safety-related control systems to prevent accidents.

Manufacturer’s Standards: The project emphasizes the importance of following the specific recommendations from the Heidelberg manufacturer, including recommended maintenance intervals, lubrication procedures, and adjustments.

III. METHODOLOGY

The research is applied and quantitative, with a focus on improving operational efficiency through a preventive maintenance plan. The methodology is inductive, deriving general conclusions from the analysis of specific data from the machine and its production environment.

Data was collected using the following operational techniques:

Direct Observation: Monitoring the machine's operation to identify failure patterns and critical areas.

Historical Data Analysis: Analyzing past maintenance and failure records to identify trends and common causes of breakdowns.

Surveys: Polling technical and production staff to gather information on machine use, failure frequency, and current maintenance practices.

Analytical tools included:

SWOT Analysis: To evaluate the current state of the machine and the production department.

Pareto Chart: To identify and prioritize the most frequent failures.

Root Cause Analysis (RCA): To pinpoint the fundamental causes of the machine's failures.

The project was executed in four phases:

Phase 1: Preliminary Inspection: To identify critical maintenance areas through visual inspection, operator interviews, and historical data analysis.

Phase 2: Disassembly and Component Analysis: To evaluate the condition of internal parts by disassembling the machine, inspecting key pieces, and documenting worn or damaged components.

Phase 3: Preventive Maintenance Plan Development: To create a plan based on the findings, including replacing parts, developing a maintenance schedule, and establishing maintenance protocols.

Phase 4: Implementation and Training: To put the plan into action, train technical staff on the new procedures, and monitor the plan's effectiveness.

IV. RESULTS AND DISCUSSION

After implementing the preventive maintenance plan, the machine's performance showed significant improvements.

The preliminary inspection identified several critical issues, including significant wear on rollers, damage to vanes, loose electrical connections, minor alignment deviations, and substantial residue buildup.

The maintenance actions taken included replacing worn rollers and damaged vanes, adjusting electrical connections, replacing worn cables, and performing a deep cleaning. As a result, the machine's operation became optimal, smooth, and free of vibrations.

The project's outcomes were quantified in the test results. The annual frequency of failures was reduced from 6 failures per month (before) to 1.5 failures per month (after). This represents a 75% reduction in the frequency of failures. Operational efficiency increased by 20%, allowing the machine to produce 120,000 folios in 24 hours, up from 100,000. Unscheduled downtime was also significantly reduced, dropping from seven days bimonthly to four days.

The implementation of the preventive maintenance plan proved crucial for enhancing both operational efficiency and the machine's lifespan. The process, from a thorough preliminary inspection to detailed disassembly and component analysis, precisely identified worn components and those needing immediate replacement. A key result was the 75% reduction in failure frequency, which significantly boosted the machine's reliability and availability for scheduled production cycles. The 20% increase in operational efficiency, reflected in the jump from 100,000 to 120,000 folios per day, not only improved productivity but also optimized resource use and enhanced the company's competitiveness. The reduction in unplanned downtime, from seven to four days, was a result of a proactive maintenance approach that anticipated failures and prevented major breakdowns. This creates a more constant and predictable production schedule. The plan also establishes a maintenance standard that can be applied to other machines within the company, ensuring continued improvements and minimizing unexpected failures. The project provided tangible, quantifiable results, validating the effectiveness of a preventive maintenance approach for critical equipment

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