Enhancing Paper Mill Performance Through Advanced Diagnostics Services

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ABSTRACT

The demanding needs on the paper sector to maintain quality with lower production costs call for reduced energy consumption, minmal downtime and optimal use of raw materials.The extent to which these needs can be addressed are dependent on the consistency and reliability of assets in a plant.
Adapting a well thought through maintenance strategy that inlcudes preventive, predective and advanced services can help address a vast array of perational challenges that hamper overall plant productivity. Innovative, cost-effective and remote- enabled advanced maintenance services with intelligent software tools are now readily avaialble for continuous automatic data collection and performance diagnosis of different assests in the mill. This allows service experts to login through a secure remote internet connectionfor troubleshooting and resolve issues in a quick and cost-effective manner. A single advanced services delivery platform can be used to maintain mutiple assests to reduce the ovreall maintenence costs while significantly boosting plant productivity.

Introduction

Paper mills today are equipped with modern Distributed Control Systems (DCS), quality control systems (QCS) and Drives. However due changes in process behavior, mechanical wear and tear, performance of these systems gradually reduces over time. To sustain optimal performance of the paper machine, paper mills need to change their maintenance practice from being reactive to more proactive and predictive. This helps access and troubleshoot likely issues way ahead of a breakdown that can lead to heavy production losses. However, paper mills today have the option of using advanced diagnostics services that are extremely proactive and predictive by nature of deployment to address several 'unknown issues' in plant operations.

However, currently available advanced diagnostic services involve carrying out periodic assessments to determine performance gaps and implement relevant corrective actions to sustain plant performance. A three-step methodology, *Diagnose, Implement and Sustain* is the basic premise of an advanced service strategy. The “diagnose” phase involves benchmarking current performance to identify and evaluate improvement opportunities. In the implementation phase, identified corrective steps are implemented to improve the performance parameters. As part of the last step, the 'sustain' phase ensures continued performance improvements either remotely or on-site. .

An advanced diagnostics platform is used to perform automated and continuous data collection and performance diagnosis. Deploying such service delivery platforms helps reduce time taken for troubleshooting and fixing the problems well ahead of a conventional service approach. Service experts can access these service delivery platforms through a secure remote connection and deploy services in a quick and cost-effective manner. With decreasing maintenance budgets and increasing complexity of operations, advanced services delivery platforms will help reduce maintenance costs without compromising on plant uptime and the performance of the paper mill.

Performance of control loops has major influence on the product quality and operating costs of paper machine. Effective utilization of the data available from the control loops to diagnose performance issues can help improve product quality and reduce downtimes enabling better production scheduling at lower costs and quickly. Diagnosing performance issues related to the control loops involves special software tools for collecting and analyzing relevant data from the control system to identify the issues.

Following sections explain about the advanced services for improving the performance of control loops in a paper mill.

Technical Solution

Reliability of paper mill assets like DCS, QCS, drives and motors has a direct impact on the operational efficiency of a paper mill. Special attention needs to be paid to their maintenance taking timely corrective actions to prevent unplanned downtimes. Advanced service delivery platforms are designed to meet these maintenance needs of paper mills and are connected to the plant automation systems through secure OPC (Object Linking and Embedding for process control) connection for data collection and are also provided with remote connection through internet. Figure 1 shows the schematic of such service delivery platform.

The Advanced Services delivery platform hosts multiple software applications that perform automatic data collection and performance diagnosis analysis continuously. It is one common single platform for on-site delivery of advanced services related to

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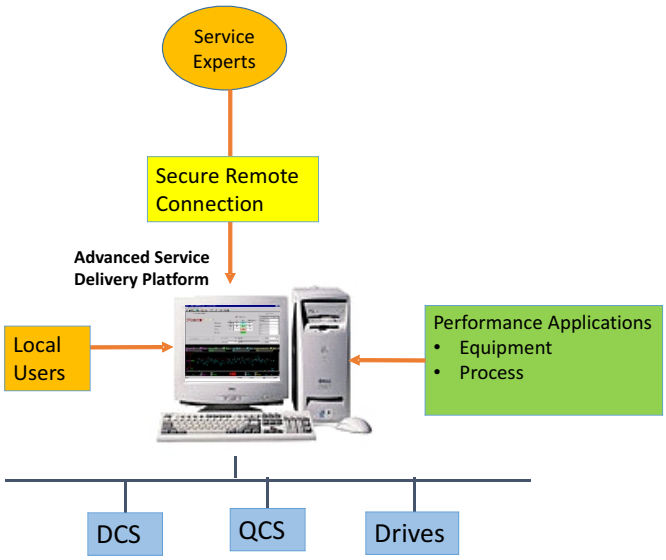

Figure 1: Schematic of Advanced Services delivery platform

various equipment and process units in the mill. A software application is similar to 'apps' or TV channels, each being specific for a particular asset. Mill engineers have the freedom to choose as many as these apps based on their requirement. Each software application automatically collects required data from the respective asset and calculates the key performance indices (KPIs) that are analyzed to diagnose performance issues. The tasks of data collection and performance diagnosis are carried out non-stop continuously throughout the year. Hosting of multiple performance diagnosis software applications dealing diverse equipment such as drives, QCS and DCS in the same platform reduces the overall maintenance costs in the paper mill. An Advanced Service delivery platform is provided with archiving features where the data collected from all the equipment and corresponding diagnostics results are stored in the local historian. Analysis of the historical data and diagnosis results helps mill engineers in planning preventive maintenance schedules and implementing corrective actions to sustain the high performance of the equipment and process units in the paper mill.

Equipment and process experts can login to the advanced service delivery platform through secure remote connection to analyze the data collected and troubleshoot the problems faced in the plant [2]. This approach helps provide immediate and easy access to services that keep production running, maximizes equipment life cycle and deliver operational excellence. These services also offer substantial savings with regards to costs associated with providing an on-site service engineer

Control Loops Performance Service

PID control loops are important assets as a typical DCS in a paper mill handles more than a hundred control loops. As an asset, a PID control loop includes hardware consisting of sensor, transmitter, control valve and software consisting of the control algorithm implemented in the control system. PID Controllers are designed to regulate the process, reduce product variability and improve the operations. It has been reported in literature [3] that only 30% of the control loops are performing satisfactorily, while 70% of the loops were having performance issues. Performance of control loops degrades over a period of time due to inadequate maintenance of final control elements, sensors, transmitters and also changes in the process behavior.

Much attention is not given to the performance and maintenance of these control loops and often the potential in improving the performance of the paper mill is undermined. Operations in a paper mill are characterized by sheet breaks, stoppages due to equipment maintenance issues, grade changes accompanied by corresponding changes in the operating conditions. In this dynamic scenario, performance of the control loops plays major role in the production and quality of the paper produced.

A well performing PID controller will be able to reject the disturbances during normal operation and quickly respond to set point changes during grade changes and also stabilize the operation quickly after a startup. Continuous performance diagnosis of PID control loops will help in quickly identifying the problems and implementing the corrective actions to main the performance of the paper machine. For each PID loop, the control performance monitoring and diagnosis tool collects data about the process measurement, controller output and set point and calculates the values of various KPIs, which are then used to determine if the loops are having various controls, process, and signal condition issues.

Typical issues diagnosed include sluggish and aggressive controller tuning under the control category, controller output saturation, control valve stiction, intermittent and persistent disturbances under the process category and excessive noise, spikes, quantization under the signal condition category. PID tuning parameter values are evaluated to identify the outliers by comparing with expected values based on control loop category such as flow, pressure, temperature and level. Advanced techniques such as PCA (Principal Component Analysis) are used to analyze the interactions among various process variables. Large variations and oscillatory behavior of process variables has adverse impact on the performance of the paper mill. The oscillatory response could be due to reasons such as aggressive tuning of PID controller, sticky control valve and variations in one of the upstream process flows. Power spectrum analysis of the data collected helps in identifying the source of oscillatory disturbances that are present in the mill.

It is very cumbersome and time consuming for the mill engineers to collect data from each control loop and analyze it to diagnose the performance issues. Advanced services delivery platform with control loop performance application [4] helps reduce time taken by mill engineers for performance diagnosis of control loops. Once problems are identified, corrective actions are implemented to improve the performance of the paper machine.

Deployment of control loop performance improvement service using the advanced services delivery platform helps in reducing the variability of key process parameters such as basis weight and moisture of paper produced. With reduced variability, one can shift the operating setp point closer to the limit as shown in Figure 2 and this shifting of the target set point will result in reducing the raw material, energy and chemicals consumption.

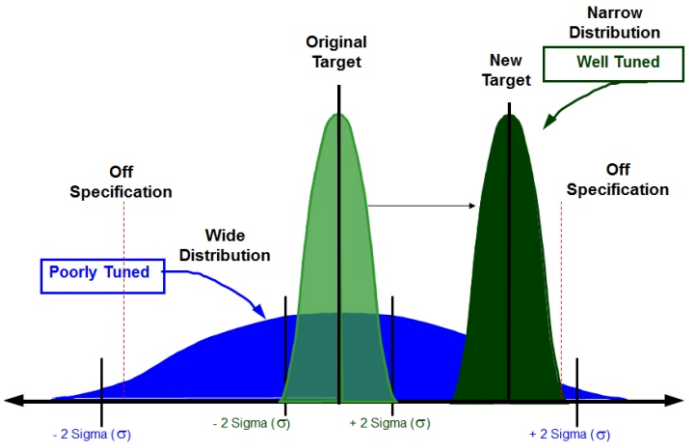

Figure 2: Process variability reduction and shifting of targets

Results and Observations

This section briefly discusses the results related to the Control Loop performance application and the improvement obtained after implementing the corrective actions such as tuning of PID controllers.

In a paper mill, in addition to the scanner level control loops for basis weight, moisture and caliper, some of the other important process control loops include Stock Flow and its consistency, chest levels and their consistencies, additives flow, Steam dryers pressure and head box pressure. During normal operations, these control loops are subjected to process disturbances, grade changes, control valve and field instruments maintenance issues.

Advanced Services delivery platform is used to continuously monitor the performance of control loops in a paper machine. The user interface displays the trend of number of loops diagnosed with the three categories (Control, Process and Signal Conditioning) of performance issues. This trend is useful in tracking the performance of the control loops before and after carrying out the corrective and predictive maintenance activities. Detailed breakup of the loops under three categories and also the detailed view of the specific control loops is also available for easy understanding of various performance issues present in the control loops. Once the performance issues are identified, the required corrective actions are implemented as part of the maintenance activities and typically it involves maintenance of sticky control valves and tuning of the PID control loops. Tuning of PID control loops reduces the variability and this reduction in the variability allows shifting of the targets as shown in Figure 3 below for basis weight and moisture as an example.

It also results in increased paper production resulting from less sheet breaks and reduced rejects from off specification paper. Improved quality from more uniform sheet fetches higher sale price.

Figure 4 below shows an example of the improvement in response time after tuning of the Steam Pressure control loops. The closed loop response time has reduced from 10 to 4.2 minutes, an

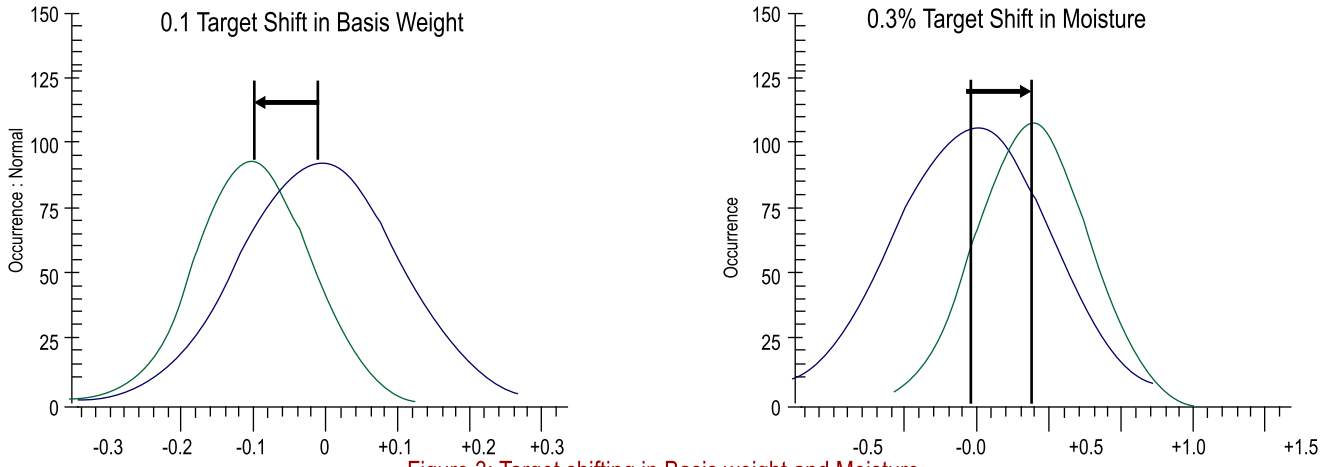

Figure 3: Target shifting in Basis weight and Moisture

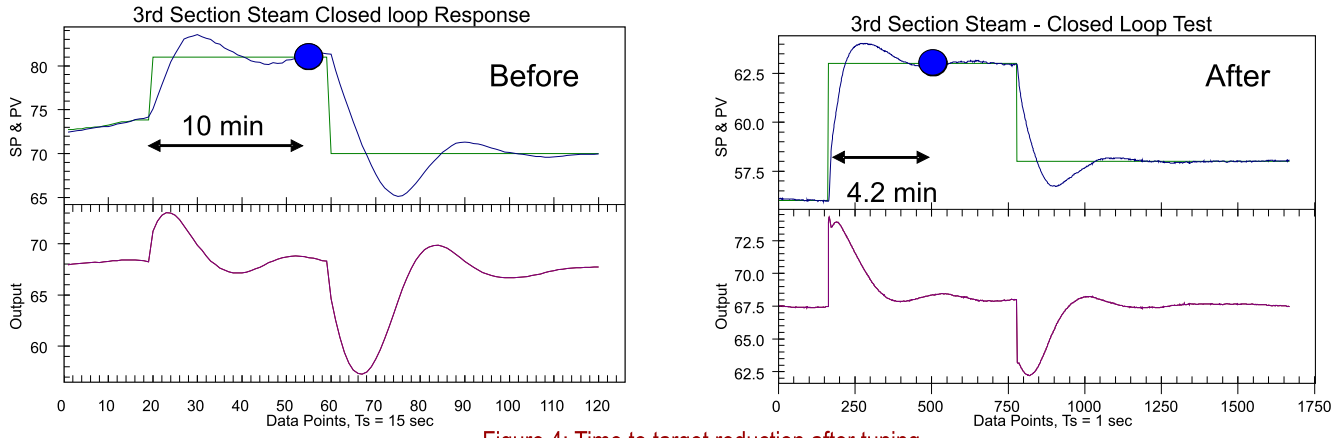

Figure 4: Time to target reduction after tuning

improvement of 58%. With properly tuned control loops, the control system takes less time to reach the target set points and this results in increased production due to faster grade change, faster recovery from sheet breaks, faster start up times and faster recovery from process upsets.

Similarly benefits such as savings associated with usage of chemicals, yield improvement and energy consumption can be realized by taking proactive maintenance activities in pulp mill. Thus advanced maintenance services directly help in improving performance and profitability of the pulp and paper mills.

Conclusions

Advanced maintenance services methodology of Diagnose, Implement and Sustain helps in reducing the downtime and operate the pulp and paper mills at their peak performance. A single advanced service delivery platform allows proactive maintenance of multiple systems such as the DCS, System, QCS and Drives used in Pulp and paper Mills. This service delivery platform is equipped with sophisticated software tools that perform continuous automatic data collection and analysis to diagnose the problems with the equipment and process units in the mill throughout the year. Service experts can login to the platform remotely to analyze the available data to fix the problems faced in the mill. It greatly reduces the maintenance costs and time to troubleshoot the issues in the mill. Pulp and Paper mills will benefit greatly by replacing traditional maintenance strategies with a proactive approach using advanced services delivery platforms. It reduces breakdowns, decreases operating costs and improves product quality and enhances mill productivity.

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