Using performance monitoring and optimization tools for a paper machine start-up

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Abstract: In today’s highly competitive worldwide market, it is becoming extremely important for the management people to make sure that all resources are affected where needed the most. Performance monitoring is a unique way to ensure that everyone is working on top priorities toward the same common goal. This paper shows, using real case examples, how performance-monitoring software can help you prioritize work according to economic significance, pinpoint and diagnose process control loop and equipment problems.

With the proven OPC (OLE for Process Control) communication standard, it is now possible to easily interface with most platforms (proprietary communication protocols). Since most manufacturers (of DCS, drives, scanners, etc.) now support OPC connectivity, we can access all instruments from the control room. This communication standard allows monitoring application and data collection, either from stored data in a historian or from a real-time raw format. This data can then be consulted in a raw format for three weeks and in a compressed format for at least two years without overloading the storage capacity of a standard server platform. With this OPC standard link, raw data can be sampled quickly enough to avoid aliasing phenomena, or ghost frequencies, for most industrial dynamic encountered. The system also includes tools to analyze the process and to optimize and tune loops. Advanced tools, such as power spectral density analysis, cross correlation, and statistical analysis, help experienced users to analyze problems in greater depth.

Concept

Raw (uncompressed) data will be used by new technology monitoring software to assess and measure the performance of the plant, unit operation process or single control loops. This performance is benchmarked according to the period of time during which the plant was considered to work at its optimum desired performance. An assessment period is defined as the period of time during which the KPI (Key performance Indicator) is calculated. For instance, an assessment period can be defined based on a work/shift duration. Many KPI can be calculated for each assessment period. However, not all of them are important for the plant. KPI will inform groups of users, such as management, engineering, operation and maintenance of the plant, about the unit operation performance and control loops related to performance, the equipment availability, the presence and sources of problems as well as the equipment health or wear. The relationship between KPI, assets and users is shown in Fig. 1. KPI gives a health measurement of the assets and informs users about the performance of these assets, allowing the users to increase their efficiency. The end result is that the users can focus their efforts wherever the impact on production quality and assets health gives the largest return on investment (ROI).

Performance Monitoring System

A continuous performance monitor can identify which areas are under-performing and which of these will offer the greatest economic returns; the system will identify the controllers and equipment not performing well. The software digests real-time data coming from the plant and generates emails, reports and lists of loops that are outside predetermined performance limits. It pinpoints areas to focus on, optimizing the efforts of your work force.

The software also includes the tools to drill down and to analyze problems. The tools to optimize the process and to tune loops are also part of it.

The start-up (or maintenance) becomes proactive, since the software prioritizes the areas, loops, and equipment needing attention.

Paper Machine Start-up

The following is a real case example of what has been made possible by using a performance monitoring software to audit and assist the loop tuning and optimization of the control loop during the commissioning of a large paper machine. The success of a paper machine start-up is insured by the execution of good engineering practices, using state-of-the-art methods, until the passage of the sheet on the machine. The contribution of every specialty involved is critical in order to reach the optimal performance criteria of the paper machine’s finished product. We are looking here at the entire process: the operating method and procedure, the equipment availability and finally, the process control strategies.

Obviously, during the start-up, the process difficulties will first be considered: control strategy, control loops tuning, loop dynamic interaction, process inter-locks, etc. The software for the supervision and the audit performance, analysis...
and assistance to the tunings, and diagnostics of the control loops was implemented to the system right from the beginning. It was decided that every control loop and main quality-measuring signal would continually be monitored, and then completed by a performance audit based on the performance indexes. The goal here is to direct all the efforts invested in the loop tuning and optimization, control strategies revision and debugging of the control loops towards the loops, areas or units operation that have the greatest impact on the finished product.

The first step was then to install and properly configure the performance audit software.

The second step was to configure each controller with start-up tuning values robust enough to allow the passage of the sheet on the paper machine and prevent the process from being oscillatory during a load disturbance or a set point change.

The third step was to apply some performance indexes for each loop and use the performance report generated by the system in order to detect problems of equipment, correlation, or oscillation, and then direct the test progression toward areas with the most significant economic benefits.

During the start-up, many events occur, such as manual/auto transfer, valve manipulation, and set point changes; the software will use the changes to analyze the dynamics and capture the process models. Hence when a loop requires tuning, the process model being known, the tuning parameters are instantly obtained for any performance criterion.

Some open and closed loop tests were done on every loop. These tests are useful for the identification of loop process parameters (process gain, dead time, time constant), the knowledge of the valves' state (hysteresis, stiction, and installed characteristics such as linearity of process gain at different operating zones), and the choice of the controller gain $K_p$, integral action $K_i$, derivative action $K_d$ and filter time constant $T_f$ tuning values, considering the interactions with the other control loops. Also, by referring to the performance report recommendations, some extra open or closed loop tests were done in priority on every identified loop, i.e., those being economically profitable. As a result, the overall effort to install, configure and set-up this software represents less than 2 days for 200 loops.

Here are a few examples of problems identified and resolved, based on the performance audit reports and the usage of modern diagnostics and control loop tuning tools.

**EXAMPLE 1**

In the case of a problem with the pumping capacity of a redundancy system, debottlenecking was done in 20 minutes. A performance report identified a recently tuned loop as non-performing, Fig. 2. According to the "output at limit" index, the output was at its limit 100% of the time at specific periods and, according to the IAE index, it was over 100% above the acceptable threshold. The P&ID reading and the analysis of the archive signals led to the identification of the losing capacity of Pump No.2, as compared to Pump No.1, as shown in Figs. 3 and 4. Later on, a defective gasket was identified.

**EXAMPLE 2**

Figure 5 shows the tuning of a glycol heating circuit in oscillation affecting the steam distribution of the paper machine. The case shows where the start-up tuning figures estimated were too aggressive. This group contained eight heating units. According to the "oscillation" index, a group of loops from the same sub-system oscillated at 100%. According to the "oscillation period" index, the sorting by oscillation period regrouped eight heating units and one glycol exchanger within the same oscillation period. According to the "oscillation strength" index, the glycol exchanger temperature TIC loop was the cause of this oscillation. Figure 6 shows the successive TIC and heating units' tunings. The tuning time of the whole system (nine loops) lasted 90 minutes.
EXAMPLE 3
A consistency loop was identified as the worst performing loop. An analysis of the KPI metrics showed an increase of the standard deviation output as well as more valve travel and valve reversal. But at the same time, the variability of this loop remained low and there was no production or quality problem for the operation.

The maintenance technician went for a visual check of the valve. What he found was some valve linkage loose. If no repair had been done, the valve steam would have been decoupled from the actuator and a shutdown of the paper machine would have occurred. Fixing the problem on the valve brought back the KPI of this loop to its optimum performance.

CONCLUSION
In conclusion, the start-up process, accomplished with the assistance of a performance audit with diagnostic and control loop tuning software, leads to a fast progression of troubleshooting, tuning and optimization work. This is based on a precise and meaningful performance report and a post-tunings analysis of the performances obtained.

Three examples illustrate how quickly problems are identified and how the plant can focus its resources where they are really needed.

These new technologies pay for themselves from the very beginning, at start-up, and remain available for normal operation. Therefore, the normal operation will certainly benefit from the performance monitoring software to follow-up process evolution and performance. Furthermore, knowing that a loop tuning represents the biggest ROI in process control today, this reinforces the idea of monitoring, assessing and prioritizing strategic loops in order to tune them when required and to understand why new tuning is necessary. This entire ready-to-use information is derived from the automated data mining being done by the performance monitoring software in the background. Finally, once problems are pinpointed, modern tools are available to solve them.

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Résumé: En raison de la forte concurrence sur les marchés actuels, il est extrêmement important que les dirigeants s'assurent que toutes les ressources soient allouées là où elles sont le plus nécessaires. La surveillance de la performance est une façon tout à fait spéciale de s’assurer que toutes les priorités tendent vers un but commun. La présente communication fournit des exemples de cas réels qui démontrent comment un logiciel de surveillance de la performance peut aider à établir les priorités d’un travail selon son importance économique et à déterminer et diagnostiquer les problèmes liés à l’équipement et à la boucle de commande du processus.


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