Paper Machine Optimization

Ruel, Michel

TOP Control Inc.
1635 Rive-Sud Blvd., St-Romuald, QC Canada G6W 6M5

Email: mruel@topcontrol.com
Web: www: topcontrol.com

ABSTRACT

What are the steps to follow when optimizing a paper machine?

Who should be involved in such a process?

How to benchmark the performance of the paper machine.

What will the benefits, the improvements and the impacts of the optimization be?

What will be the return on investment?

This paper will offer answers to those questions.

WHO SHOULD DO IT

The plant first needs to decide if they have all the expertise and the time to do it internally. In most cases, even if you have the expertise, time will be an important issue.

In the event the senior staff decides to do it using internal resources, they need to make sure their people have the skills needed. They also need to use the most modern tools to efficiently achieve results. For example, trial and error tuning methods are not the best way to achieve performance. The first step the plant will need to make is to train the employees.

The staff has to be experienced and motivated. External resources combined with key people is always a must when the consultant works in an open manner and shares his know-how with plant employees.

HOW TO DO IT

The following steps are suggested:

- Prepare a plan (with your consultant, if you decide to use one);
- Prepare the budget and the justifications for the return on the investment;.
- Select your team;
- Gather information, known problems; statistics, history from the different sources;
- Benchmark the paper machine;
- We do not recommend a complete survey. Based on our experience, the analysis of key variables and the most critical loops as part of the benchmark will reveal very accurate information of the actual performance level and will allow a very good comparison of before/after optimization. A detailed analysis is done while optimizing the paper machine. At this stage, your time and money will be better spent fixing problems than pinpointing them.
- Start from the stock preparation and move through the process up to the drying section (winders may also be included). Find and solve problems, repair or replace equipment as needed. Use a process optimization software providing all the necessary tools[2] to do your work, identify valve problems, oscillations, tune your loops etc. This tool should also help you document and justify all the actions and write detailed reports;
- For each loop, measure the before and after performance;
- Prepare a summary describing the actions, the new performances, benchmark comparison and economics.
- Follow the loop optimization steps outlined in a series of 3 articles [1].

HOW TO BENCHMARK THE PAPER MACHINE (BEFORE AND AFTER)

The following items are suggested:

- Monthly reports,
  statistics,
  uptime, efficiency,
  sheet breaks, maintenance calls,
  grades, speed,
  tonnage,
  energy consumption;
- Variability analysis
  Machine and cross direction;
- Rolls and strips analysis;
- Loop analysis (10-15 loops suggested),
  statistics,
  power spectral density,
  auto-correlation,
  valve wear (travel and reversals),
  IAE (integral of absolute error);
- Time for a grade change.

PROCESS OPTIMIZATION

Process optimization is more than loop tuning.

The most important loops need to be properly tuned once the problems in operation and with the equipment were fixed. The loops must be tuned to work in harmony, to remove interactions and to reduce variability.

For example, synchronizing the flow loops in the mixing tank will ensure the recipe will remain constant.

Tuning them at different speeds (for example, the level and the pressure in the head box) will decouple interacting loops.

At the same time, the PID parameters and the PV filter will be selected to reduce valve effort ensuring valve maintenance will be minimized in the future.

WHAT TO EXPECT

As a result of the analysis work, the following actions could be needed:

- Repairing, replacing, relocating, resizing, configuring:
  valve positioners,
  valves,
  transmitters;
- Modifying control strategies;
- Tuning the PID tuning parameters;
- Modifying the process operation;
- Modified the process;
- Replacement of pieces of process equipment.
- Our experience tells us that in most plants, these interventions could be considered minor. In fact, very few valves will need to be replaced. Major process modifications are rarely needed. On the other hand, process operation and control strategies are often improved, but the cost is minimal.

WHAT ARE THE EXPECTED RESULTS FOR THE CONTROL LOOPS

When comparing control loop performance, the following variables should be considered:

- variability,
- cycling,
- valve wear,
- robustness,
- performance (IAE or others).

LARGE IMPROVEMENTS FROM SMALL CHANGES

The following average results are typically found:

- The oscillations of the loops will be eliminated;
- The variability of most loops will be typically reduced by a factor of 2;
- Valve movement is usually reduced by a factor of 2 to 5.
- The overall variability (basis weight, humidity and dry weight) will be reduced; we regularly see a reduction of 50%,
- The uptime (efficiency) will increase, from 0.5% to 10% (most of the time 3-4%);
- The time to reach a steady state after a grade change will be shortened;
- The production people will learn a lot from the optimization process; since they will have participated in it since the beginning.
- Valve maintenance will be reduced since valve movement will be greatly decreased.

RETURN ON INVESTMENT:
BENEFITS VS. COSTS

The computable benefits are:

- Better performance of the paper machine: it starts easily after a grade change and breaks less often;
- Better efficiency of the paper machine;
- Increased production rate;

The non-computable gains are:

- Better knowledge of the paper machine;
- Better operation of the paper machine;
- People better trained to troubleshoot a paper machine problem;
- Better and more consistent product quality;
- Replicable expertise for other paper machines;
- Smooth operation;
- No more abuse of the equipment;
- Tools and data in place for predictive maintenance;
- Reduced maintenance in the future.

The costs for the entire process are:

- Support for training or/and support to plant employees;
- Purchase of analysis and data acquisition software;
- Labor time for optimization process;
- Maintenance by mill staff.

Typically, the return on investment (ROI) will be less than a month.

Process optimization is one of the biggest return on investment plants can do today, since the objective

is to be sure the actual equipment you already own works at its best.

Preventive maintenance instead of reactive maintenance is another major benefit.

In process optimization, you plan to use the equipment at its best, you do not need new installations with all their procurement costs, engineering, installation and future maintenance cost. In fact, the goal is to achieve the maximum performance possible with the actual equipment.

CONCLUSIONS

The return on investment is typically under one month. A better quality and a more efficient paper machine are not the only benefits; the staff will have a better understanding of the process. It will have a systematic approach to improving efficiency and quality through better process control.

ABOUT THE AUTHOR:

Michel Ruel is a registered professional engineer, university lecturer and author of several publications and books on instrumentation and control. He has 24 years of plant experience including these companies: Monsanto Chemicals, Domtar Paper, Dow Corning and Shell Oil. He is experienced in solving unusual process control problems, troubleshooting and optimizing processes and he is also a pioneer in the implementation of new techniques in process control. Michel Ruel is president of TOP Control Inc.

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1- RUEL,MICHEL, "Loop Optimization", *Control Magazine*, March, April and May 1999 issues.

2- Expertune software, Hubertus, Wi.