Establishing a Basis for Performance

John Gerry
ExperTune Inc.
www.expertune.com

KEYWORDS

process monitor, performance assessment, performance metrics, controller monitor, control loop, PID tuning, instrument diagnostics, condition based maintenance, reliability centered maintenance, performance baseline, key performance indicator, KPI, process improvement, asset management, controller tuning

ABSTRACT

To get a useful historical perspective from performance monitoring, several key items must be established. Loop health must be defined in terms of performance metrics and then a method for combining these metrics in a useful way must be set up.

The first step is for the plant to choose the metrics that will make up loop health. This may vary somewhat depending on the loop type. Once these metrics are chosen, a method for combining the metrics to arrive at a single health number must be decided. This method defines the baseline of performance for every loop. Different categories of loops will have a different basis for performance. For example, flow temperature, pressure, and level may all have a different basis of performance. Also the plant may want the basis of performance to be based on historical metrics or a time when the plant was running well.

DEFINITION OF LOOP HEALTH

To get metrics on the health of entire unit operations, plants, and the entire company, in addition to putting this all in a historical perspective requires a definition of loop health. Loop health can be defined as a combination of metrics or assessments. The method of combining them can be difficult to determine. Here is one way that allows for flexibility in the assessment:

1. Assessments that are key to the performance of the business are chosen.
2. Next establish baseline values and threshold values for each key assessment for every control loop. This sounds like a daunting task but can be made simple as discussed in a later section.

3. Next assign an economic weight to each loop. A possible overall loop health assessment then becomes:

Loop Health = Average of % Towards Thresholds for each key assessment (1)

Where: % Towards Threshold = 100 x (Threshold - Assessment) / (Threshold - Baseline)

Assessment = current value of the metric

Threshold = User chosen threshold value

Baseline = User chosen baseline

Assessments occur on a unit operation basis and the period of this calculation should be adjustable. A good value for assessment time on a fast unit operation (one with dead times under 1 minute) might be 4 hours. On a slow moving unit operation (with dead times over 4 minutes) , a good value might be 12 hours.

With this definition of loop health, the health of an entire unit operation can be determined by averaging the individual assessments of all the loop health weighted by the economic weighting factor. Economic weighting is a divisor applied to the loop health value. The high economic importance divisor is always 1. Average might be 2 and low would be 4. This way, two loops with the same health will appear at different priorities based on the weighting.

If baselines and thresholds are set so that the typical percent towards threshold is between 0 and 100%, then the average percent towards threshold for each loop will be in the range of a region between 0 and 100%. This can make for a simple way of targeting loop health as value between 0 and 100% where 0 is the healthiest and increasing percentages indicate increasing opportunity to make the plant run better by optimizing that loop.

HOW TO CHOOSE A BASIS FOR PERFORMANCE

Choosing a basis for performance seems like a daunting task. However, it can be fairly simple. This paper looks at 2 potential methods. The first method is a simple method that chooses the performance basis dependant on the type of loop. The second is dependant on loop type and using data based on a time period when the plant is running well. The latter method is potentially more accurate, but if you do not have a time period when the plant was running well, the first method suffices.

CHOICE OF KEY PERFORMANCE METRICS

Key performance metrics will vary from plant to plant. One possible set of performance metrics are:

Metric Abbreviation	Metric Name	Definition
Avg Abs Error	Absolute Error	Error between set point and PV
SP Crossings	Set Point Crossings	Number of times PV crosses the set point
Output Standard Dev	Output Standard Deviation	Standard deviation of controller output.
Harris (normalized)	Harris (normalized) or CLPA	Statistical measure of performance compared to minimum variance control.
Oscillating	Oscillation detection	Likelihood that the loop is oscillating or not.
Osc – valve	Oscillation caused by valve	Likelihood the loop is oscillating because of valve stiction or hysteresis
Valve travel	Valve travel	Distance valve moves in %

Note that all of the metrics should be normalized in units and normalized over time.

Why these key assessments? Avg Abs Error, and SP Crossings, are inferential quality variables. For example, they may represent how close the plant can push up against constraints.

Output standard deviation and valve travel for many processes can be an indication of an opportunity to achieve the same performance with less valve movement, reducing maintenance costs. Maintenance costs are reduced since the valve will last longer if it moves less.

Harris (normalized), Oscillating, and Osc - Valve, are problem indicators. Loops that are oscillating are almost always problem loops.

PERFORMANCE METRICS BASED ON LOOP TYPE - NO BASELINE DATA AVAILABLE

If the plant currently does not have data collected for the loops to be monitored, then the baseline of performance can be chosen dependant on the loop type alone. For example, on a flow loop the baseline for average absolute could be set to zero as this represents an ideal value. The threshold for average absolute error might be set at 10%. This would allow % towards thresholds for flow loops to average between 0 and 100%. SP crossings are not important in flow loops, so this metric would not be used. Output standard deviation for flow loops may generally be between 0 and 25% - a flow loop may have to be working hard to handle flow upsets. A baseline then would be 0% with a high threshold of 25%. Most other loop types would have a high threshold of roughly 10%.

Standard templates can be built for each of flow, pressure, level, averaging level, and temperature loops.

PERFORMANCE METRICS BASED ON LOOP TYPE - DATA AVAILABLE

If assessed operating data from the plant is available, then templates can be set up that use this data to set baselines and thresholds. For example, we may want to set the baseline of average absolute error on a flow loop to zero. However we can use the data to set the threshold. The threshold could be the six sigma value of the past 10 assessments of average absolute error. The threshold value for output standard deviation could be set in the same manner.

For example if a threshold is set to the six sigma value, and we assume a bell shaped distribution of the assessments, then 99.7 of all assessments should be below this value.

TEMPLATES SIMPLIFY THE DAUNTING TASK

Templates for either method of choosing baselines and thresholds can be set up very quickly to allow the health of entire classifications of loops. For example, first one would set up a template of baselines and thresholds for flow loops using one of the methods described above. Then, the user would make a selection of all flow loops in the plant and apply the template to all of the flow loops.

CONCLUSION

A basis for performance can be determined by first establishing key assessments. Next a method for determining baselines and thresholds can be performed even if there is not working plant data. Setting up loop health for a large plant can happen very quickly once the plant chooses the method of setting up baselines and thresholds.

REFERENCES

Performance Monitor Raises Service Factor Of MPC, ISA, Houston, October 2003

Plantwide Performance Monitor Bridges Resource Gap, ISA, Houston, October 2003

Real-Time Six SigmaISA, Houston, October 2003

A practical approach for large-scale controller performance assessment, diagnosis, and improvement, Journal of Process Control,Volume13, 2003, (c) Eastman Chemical Company

Learn How To Assess And Improve Control Loop Performance ISA, Chicago, Oct 2002

Prioritizing and Optimizing Problem Loops Using a Loop Monitoring System ISA, Chicago, October 2002

Process Monitoring and Loop Prioritization Can Reap Big Payback and Benefit Process Plants ISA, Chicago, October 2002

"How To Measure And Combat Valve Stiction On Line", by John Gerry and Michel Ruel, Presented at ISA2001, Houston, Texas.

"Loop Optimization: Troubleshooting", Control Magazine, April 1999.

"Assessment of Control Loop Performance", Thomas J. Harris, The Canadian Journal of Chemical Engineering. Volume 67. October. 1989