FALCONEER Technologies LLC

MAKING PLANTS SMARTER AND SAFER

Reliable Process Monitoring Using FALCONEER IV

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The primary function of the FALCONEER IV system is to provide information to operators, engineers and managers about the state of the process being monitored so that they can run the process at the highest safety and efficiency levels. The information can also be used to decide on adjustments that will be made to meet other goals in the operation of the process. FALCONEER IV can provide that information on a continuing basis so that problems can be detected as early as possible. It can also generate and email reports to keep supervising personnel up-to-date on the state and behavior of the process. There are other ways to get such information, such as other commercial software or spreadsheets and other programs developed on-site, but FALCONEER IV has some advantages to those alternatives.

Operators need to know the actual state of the process so that they can keep it under control and steer it to whatever operational state that is needed. To do this, they need reports of the values of process parameters and of various calculated performance measures that clarify the process state at the time of measurement. Various charts are displayed by FALCONEER IV to show what process and performance parameters are doing over time and whether there are any problems such as erratic values or values out of desired ranges. For these values to be useful to the operators, however, these values have to be reliable. They have to be correct. If measured parameters differ from their actual values, performance parameters will be miscalculated and operators will be misled, which will result in mistakes that can reduce the efficiency, profitability and safety of the process. Some form of validity checking needs to be done, and done continuously, so that operators can rely on the information they are seeing and make well-informed decisions.

While other software (commercial or homegrown) can provide operators with charts and displays of process parameters, they either do not do anything to cross-check the values and determine whether the displayed values can be trusted, or they use very empirical methods. While these empirical methods may use sophisticated mathematics and statistics, they depend only on sets of numbers, which can be arbitrary as far as the methodology is concerned. These number sets usually come from historical data and are used to make some sort of abstract representation of what sets of process measurements should look like. When parameters deviate sufficiently from what that representation predicts, they are flagged for attention. One problem with this approach is that often more than one parameter deviates from the representation even though most (or all)

of those measurements are in fact accurate. It is difficult to identify which parameter is the one that needs attention, especially in the case when equipment failure (and not just sensor failure) has occurred. There may be times when the parameter that is actually incorrect is one that does not differ significantly from its predicted value. While some programs try to improve the accuracy of their interpretation of the data by applying rules, those rules are provided by engineers who have had many years of experience with the process; getting those rules from trained personnel is very expensive, time consuming and onerous. We have a better way.

Instead of trying to find patterns in historical data without knowing anything about the process that the data came from, FALCONEER IV takes advantage of the knowledge that engineers have about that process and how it should behave. This is done in an efficient way based on how the process was designed to work. Processes are engineered to work in a certain way, so engineers can describe how the process is supposed to work in terms of mass balances, flow balances, etc. These relationships between process parameters are written down as mathematical equations. Usually these mathematical equations are based on first principles, but they can also be based on empirical knowledge such as the operating curves of various pieces of equipment. As long as the process operates the way it was designed, the equations will be satisfied. As soon as something goes wrong (due to sensor failure, or equipment failure such as a leak or stuck valve or failing pump), some of the equations will no longer be satisfied. By noting which equations are not satisfied, and in what way they are not satisfied (a deviation in a positive direction or in a negative direction) it is possible to draw conclusions about which parameter is different from its measured or assumed value.

In the early days of our research, when we decided to use equation failures as our main diagnostic tool for process faults, we wrote many rules to decide how to infer the faulty parameters from the pattern of equation failures. Many man-years were needed to make a complete analysis system for a process with just a few parameters. Over the years our technology evolved so that now the interpretation rules are automatically created and used by FALCONEER IV; neither the engineers nor the operators have to provide any interpretation rules. The time it takes to set FALCONEER IV up to monitor a process is measured in only a few man-weeks instead of many man-years. FALCONEER IV also automatically creates additional mathematical equations (by eliminating a variable that appears in two given equations) to help it identify more accurately which of several parameters is the faulty one. The details of what the rules look like and how they and the secondary equations are constructed by FALCONEER IV may be found in other FALCONEER Technologies, LLC documents and in our United States Patent No. 7,451,003, "Method and System of Monitoring, Sensor Validation and Predictive Fault Analysis."

A common mistake made in other approaches to validating parameter measurements is to assume that the process is in a steady state. One of the lessons we learned very early is that the equations used to describe how the process was designed to operate should not only use measurements taken at a given moment in time, but they should also use measurements taken just a few moments earlier. By doing so, correct analyses can be made while the process is changing from one steady state to another. If this is not done, many incorrect conclusions will be inferred while

the process is in transition. Doing this means that correct conclusions about which parameters are faulty can be made before a steady state is reached, which is useful, especially when that next steady state would be one in which an interlock has been tripped!

Because our technology uses engineering knowledge about how the process was designed, it can more accurately and more quickly identify which parameters are reliable and which are not to be trusted. It also allows FALCONEER IV to extend this evaluation to performance parameters. If a performance parameter is calculated from unreliable parameter measurements or assumptions, it too is unreliable and operator decisions should not be based on those calculations. It also provides estimates of what the correct values are for those unreliably measured parameters. Because FALCONEER IV continuously validates parameter values, both measured and unmeasured, when it indicates that a parameter is what it should be, operators can be more confident in their understanding of the process state and what will happen when they make changes in the process control settings. Because FALCONEER IV builds on knowledge about how the process was designed to work instead of the experience of experts, which may be hard to formulate and may be incomplete, or on empirical methodologies that make no assumptions about the process being monitored, it can validate measurements more accurately and more quickly, and can be installed and maintained more easily than the alternatives. For all these reasons, FALCONEER IV is the right choice for monitoring your process.

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