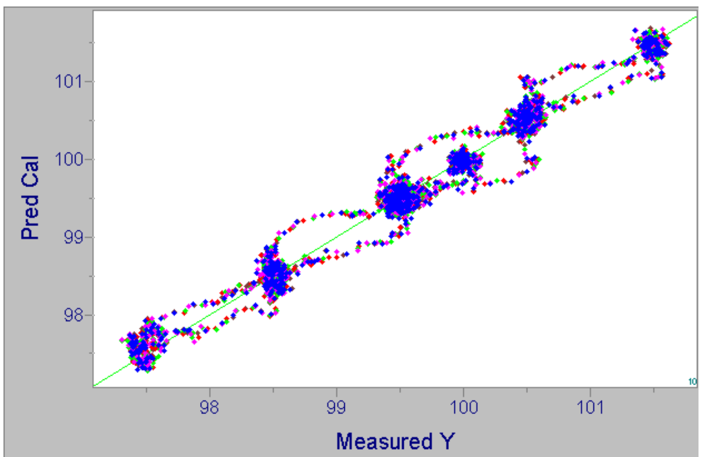
InfoMetrix®

Assessing Steady State and Building Inferentials

Downstream Applications

Working with a major oil refinery, we implemented a mechanism to evaluate whether this process line is stable and to use the process variables to assess a physical or chemical property of interest. The refinery process monitoring system does not explicitly evaluate steady state nor does it directly make tools available for building inferential sensors. It is critical to ascertain stability of the process as a qualifier for data being used in construction of an inferential as well as in routine prediction and to guide scheduled sampling. Steady state would need to be assessed differently under three situations, although each of these cases can use the same, commercially available software.



Pressure, temperature and flow can be used to estimate the octane values for a reformate unit (data from two rheniformers plus a reformate splitter). Note transitions from low to high octane and the reverse take different, non-steady-state paths.

Case 1: During Inferential Modeling

The process is defined to be in steady state if the process parameters vary in a manner consistent with the lab QC values.

Case 2: During Inferential Predictions

The process is defined to be in steady state if the process parameters match the settings that were measured during construction of the inferential.

Case 3: Independent of the Inferential

The process is defined to be in steady state if the change in process parameters is consistent with changes seen in prior periods.

Steady state does not mean unchanging (otherwise the inferential predictions cannot work), so it requires that we define what is an acceptable change. Similar to how the assessment would be done during predictions, we can use a fixed time range to establish a PCA model. Process instability, both dynamic and static, is determined by looking at a recent interval for three types of outliers (runs, change in mean and degradation of variance). A "steady state evaluator" works as a program called from the process control system and runs on a stand-alone PC with commercial software as the base. The advantage of having the software in place is that samples drawn from a process could be better scheduled to coincide with periods of stability (we noted in a recent test that 30% of a set of octane calibration samples drawn were collected during non-steady-state transitions).

Using the same pattern recognition tools that assess steady state, we can build robust inferentials without any additional data collection work. An example of building a virtual octane analyzer is shown above. We do not expect that a surrogate, in this case for an on-line NIR spectrometer, is always a good long-term solution. But, it can serve to supply useful process information when such a specialized sensor is not available or has been deemed to be too expensive for the application.

Business Model: A steady state monitor can work in a completely unattended manner; the program itself would determine what constitutes steady state. Such a monitor could exist on any computer workstation on the network and be available to analysts or process engineers without disrupting the refinery control system. In addition, simple inferentials can be built and evaluated very quickly and without a comprehensive study of the plant. If the steady-state system is in place, the additional cost of inferential construction is minimal.

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