Multivariate data analysis, also called chemometrics, is a method widely used to deal with large datasets. The purpose of multivariate data analysis is to find a relation between two or more input variables *e.g.* principal component analysis, or to provide a multivariate input–output space mapping *e.g.* partial least squares. In the context of PAT these methods are typically applied to spectroscopic data. One of the biggest challenges when dealing with a large amount of raw data is the efficient integration of several sensors, for which real-time data acquisition and supervisory control platforms need to be implemented. Such control systems should integrate the signals from all different PAT instruments and provide real-time process monitoring and control capabilities.[14] An example of a data acquisition, synchronization and control platform for batch and crystallization processes is the Crystallization Process Informatics System (CryPRINS) software developed at Loughborough University, UK.[15] The CryPRINS software provides a communication interface *via* file transfer, object linking and embedding for process control (OPC), RS232 serial communication or dynamic data exchange with a variety of PAT instruments. This platform allows the application of feedback control strategies *e.g.* supersaturation control, direct nucleation control, during both batch and continuous crystallization processes.

9.4 Systematic Steady-state Detection Using Econometrics

Steady-state (SS) is a fundamental property of continuously operated processes. The rigorous statistical definition of stationarity implies that several statistical descriptors (mean, variance, and covariance) have defined and constant values for a series of measurements. The automated and on-line SS detection is motivated by process modeling, monitoring and control applications. Since continuous processes are modeled using SS models, SS data should be used for model identification. In this case the automated adjustment of SS models is performed when the process is at SS. Once SS is identified, further data processing methods that can be triggered include fault detection and data reconciliation. Another on-line SS detection application is related to unsupervised process optimization: according to this strategy, after the perturbation of input variables the process is run until SS is automatically detected. The method triggers then the implementation of new inputs. This type of experimental plan automation fits within the PAT-based process monitoring and control strategies. Since the time to achieve steady-state changes with operating conditions, this flexible process control method has the advantage of being able to cope with different process dynamics.

An inherent draw-back of continuous operation is that during start-up the product characteristics are not uniform and the amount of off-spec material that needs to be reworked is proportional to the time needed to reach steady-state.[16] Therefore, it is important to systematically detect SS conditions and to separate off-spec and in-spec material.