402f Monitoring and Fault Diagnosis by Multivariate Statistical Methods in Chemical Processes

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Process monitoring, early fault detection and diagnosis are important in chemical and manufacturing processes for safety, controlling product quality and minimizing waste. Large multivariable processes are difficult to monitor by traditional methods. The multivariate statistical methods, which systematically reduce the number of related variables and transform the system to a simpler form, are highly developed within the field of chemometrics, but they deserve to be explored and applied to process data in other areas. Previous publications dealing with such cases reported individual applications of such methods, leaving a gap for a comparative study to illustrate the power of these techniques in analyzing, monitoring and diagnosing operational problems.

In this study, Principle Component Analysis (by NIPALS algorithm) and Partial Least Square (by NIPALS and Kernel algorithms) are coded in MATLAB 6.0 with a graphical user interface for off-line process monitoring and fault diagnosis in continuous and batch processes. The concept of ‘high leverage point plot' was introduced to identify out-of-control variables in continuous processes, and ‘dissimilarity index', which is easier to implement than the classical scor plots was introduced to differentiate the ‘bad' batches from the good ones in batch operations.

Data from literature (simulated PVC plant data) as well as from real industrial plants (textile glue production plant and bakers' yeast plant) were used to assess the effectiveness of the illustrated methods. Comparative studies revealed that score plots detected out of control observations more accurately than the other control plots like SPE, Hotelling T2 and high leverage point plots. Hotelling T2 and SPE graphs predicted almost the same out-of-control observations with the leverage graphs. The results of dissimilarity index were similar to those of score plot for the identification of ‘good' or ‘bad' batches. This work, thus, study provides a thorough analysis of multivariate statistical methods for process monitoring and fault diagnosis in chemical processing industries, and highlights the relative merits of individual techniques.