Application of Multivariate Analysis Tools to Industrial Scale Fermentation Data

The analysis of batch process data can provide insight into the process operation, and there is a vast amount of historical data available for data mining. Empirical modelling utilising this data is desirable where there is a lack of understanding regarding the underlying process (Formenti et al. 2014). This may be the case for fed-batch fermentation processes, where mechanistic modelling is challenging due to non-linear dynamics, and non-steady state operation. There is also a lack of sensors for key parameters which are considered to define the quality of the batch, such as product concentration (Nomikos and MacGregor 1995). Multivariate analysis is a powerful tool for investigating large data sets by identification of trends in the data. However, there are also challenges associated with the application of multivariate analysis tools to batch process data. This is due to issues related to the different batch lengths, different data sampling intervals, noise in the measurements, and both online and offline data. The importance of the pre-processing stages are often underappreciated (Gurden et al. 2001).

In this work, a 30 batch dataset from a production process operating at Novozymes A/S is analysed by multivariate analysis with the aim of predicting the final product concentration, which is measured offline at the end of each batch. Many modelling iterations were required using different pre-processing methods, in order to extract the trends from the data set. The final model gave an average prediction error of 7.6%. The success of the final regression model was heavily dependent on the decisions made in the pre-processing stages, where the issues of different batch lengths, different measurement intervals, and variable scaling are considered. Therefore a methodology is presented for future application of multivariate methods to industrial scale process data to cover these considerations.

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