SpecAnalyzer a powerful Software for chemical process analysis

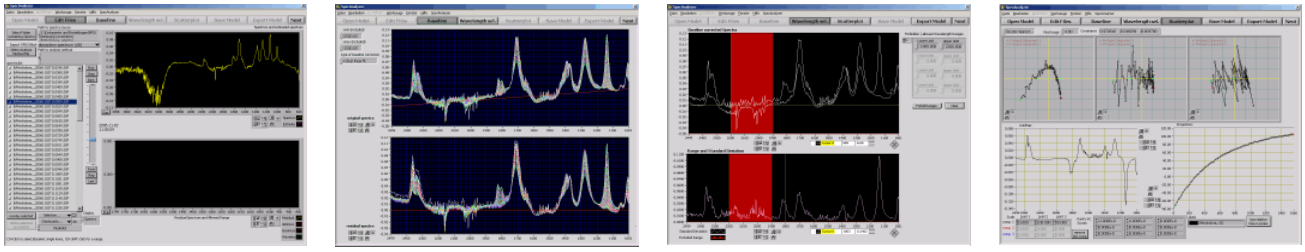
Introduction

During the last decade, spectroscopic methods have been recognised as powerful techniques for monitoring physico-chemical and chemical processes. One example is the recent process analytic technology (PAT) initiative of the FDI, which demonstrates the growing importance of spectroscopic methods to ensure the quality of pharmaceutical production processes. In addition, vibrational spectroscopic techniques are being used more and more frequently in pharmaceutical R & D, e.g. to support chemical process development or to assess the storage stability of formulation candidates.

In all of these applications, large numbers of spectroscopic data sets are generated which contain valuable information and are a potential source of improvement. However, this information is usually hidden in the spectroscopic data, and its exploration and development is often a time-consuming and complex task. In order to simplify this process and to provide a tool to simplify spectra evaluation, RPD TOOL has developed user-friendly spectra evaluation software which is based on an interactive data evaluation algorithm. The software enables an intuitive combination of the user's know-how of the process with the information hidden in the spectroscopic data sets.

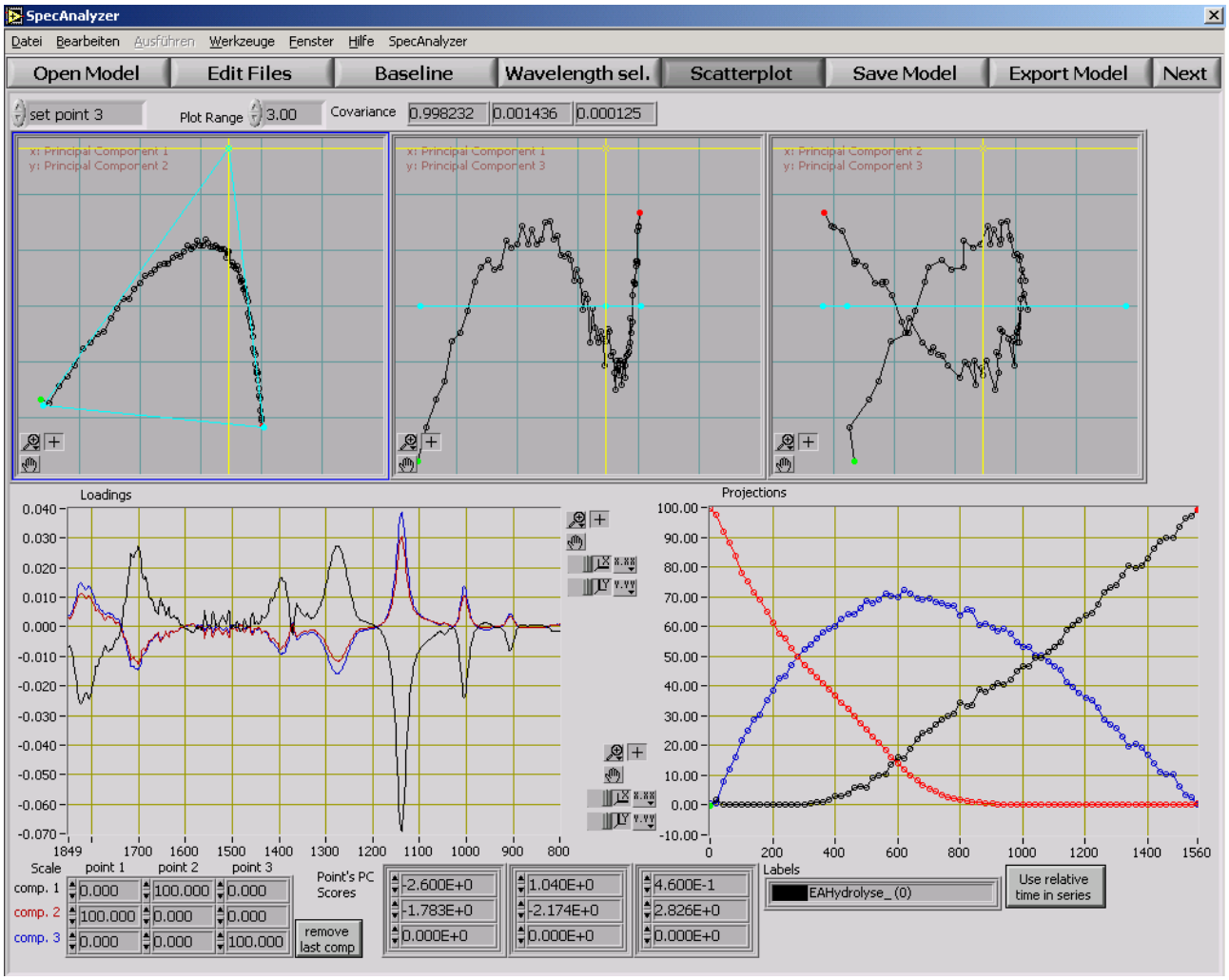
SpecAnalyzer

SpecAnalyzer consists of a series of graphical user interfaces and represents a proven workflow for systematic analysis of spectra data sets. The workflow consists of four steps: creating spectra data sets, data pre-treatment, wavelength selection and principal component analysis.



Interactive workflow for spectra data analysis of SpecAnalyzer. From left to right: user interface for creating spectra data sets, data pre-treatment, wavelength selection and principal component analysis.

The graphical user interface showing the result of the principal component (pc) analysis contains key figures of the pc analysis, a scatter plot of the first three pc's for the interactive graphical factor setting, a plot of the defined factors in the spectra space and a plot containing the calculated concentration profiles of up to three components (e.g. reactant, intermediate and product of a chemical reaction). Thanks to its straightforward interactive user interface, the scatter plot of SpecAnalyzer is a powerful tool for interactive in-depth spectra evaluation and/or the development of spectroscopic models for physico-chemical and chemical processes:



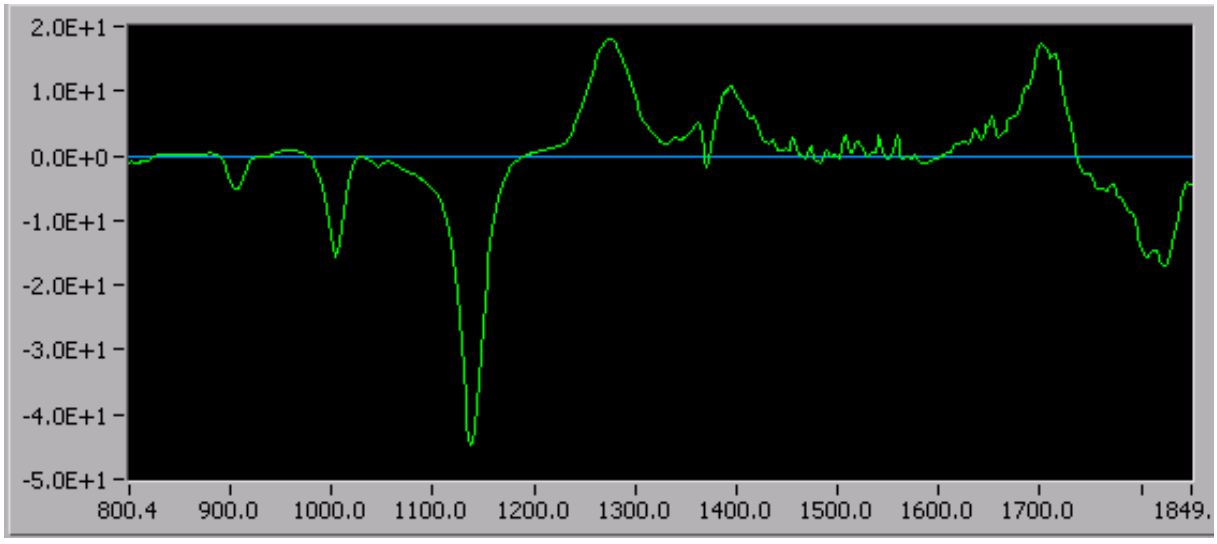
Scatter plot window of SpecAnalyzer. Top: array of scatter plots of the first three principal components (1st vs. 2nd, 1st vs. 3rd and 2nd vs. 3rd) with spectra shown as points and lined in chronological order. Bottom left: plot of the defined factors in the spectra space (X-axis: wave numbers). Bottom right: plot of the calculated concentration profiles of reactant (red), intermediate product (blue) and product (black) (X-axis: time scale [s]. Y-axis: concentration).

Application example: chemical process monitoring

For many reactions, determining turnover is a challenging and important task since both early and late abortion of the reaction may result in significant changes in the by-product spectrum and thus lead to non-conformity in the material quality of the batch. Spectroscopic techniques for on-line process monitoring can therefore be valuable tools for the correct determination of the reaction endpoint in order to ensure best yield and quality with the shortest possible cycle time. In many cases, a spectroscopic method is developed by calibrating the spectra with a well-established reference method such as HPLC or titration. However, developing robust calibration methods requires a large number of samples, and even small changes in the quality of solvents or reactants (e.g. supplier change, recycling of solvents) may alter the spectroscopic properties of the reaction mass and thus give rise to systematic errors. The use of a spectroscopic model instead of calibrated spectra to determine turnover is an alternative approach which has several advantages:

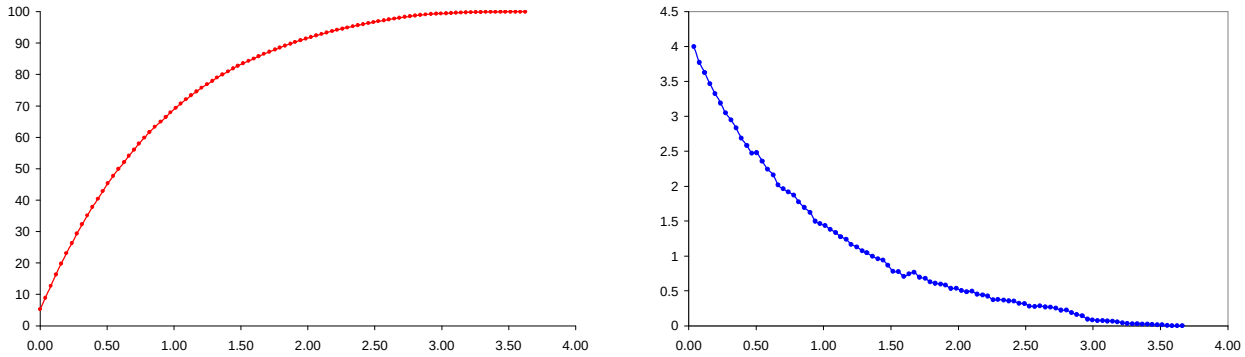
- *The development of a spectroscopic method requires much less time and resources compared with classical calibration of spectra with a reference method.*
- *The spectroscopic model can be focused on relevant absorbance bands of the species involved, which generally leads to most robust models.*
- *Calculated deviations of concentration profiles reflecting the reaction kinetic can be used for endpoint determination, which further increases the robustness of the method.*

The following plot shows an example of a spectroscopic model developed for the on-line mid-infrared (mid-IR) spectroscopic monitoring of a chemical reaction in production.



Spectroscopic model for process monitoring in production. X-axis: wave number [cm^{-1}]

The following plots show the calculated turnover (left) and conversion rate (right) of a production batch calculated from the mid-infrared spectra. Due to its higher robustness, the conversion rate has been used to determine the reaction endpoint.



Turnover (left) and conversion rate (right) of a chemical reaction monitored on-line with a mid-infrared spectroscopic method. X-axis: time [h], Y-axis: [%] (left), [%/h] right

Benefit

The intuitive and user-friendly spectra evaluation enables you to explore the valuable information hidden in spectroscopic data sets of reactions. You will achieve versatile benefit from SpecAnalyzer.

- *Get an in-depth understanding of your chemical processes*
- *Support your chemical process development*
- *Improve process safety by monitoring the concentrations of critical reactants*
- *Improve your yield and quality in production*
- *Ensure proper process monitoring and analytics*
- *Contribute to cost reduction in chemical process development and production.*

Please do not hesitate to contact us for further details of our unique technology!
Your RPD TOOL Team.