1 ABSTRACT

This study focuses on online spectrometric applications of the Raman effect for process control equipment in natural gas utilizing plants. This subject springs from the upcoming variable calorific value in the Dutch natural gas distribution grid which makes innovation necessary to maintain safe and competitive processes. Further insight in the industrial landscape and the innovative drive is given in the first chapter. Available techniques are discussed and the strengths and weaknesses that come with the introduction of Raman technology are considered.

To gather insight into the technology a full chapter is focused on Raman theory and natural gas. The fundamental principles upon which the technology is based are discussed as well as the concept of spectroscopy. Natural gas is a complex mixture of components and impurities. The varying concentrations of the components in the natural gas influence key parameters. For a detailed look on natural gas both literature and computer experiment are deployed to report composition ranges, and predicted spectra.

One of the main subjects is the experimental setup that can be used to measure Raman scattering. Following the route of the light, the components are each discussed and their function in the whole described. A completely new process interface is designed for this application and subjected to robustness and efficiency simulations. Other simulations and experiments are done to attempt optimization of the interface between the collection fiber and spectrometer entrance slit.

The physical instrumentation only has a detector signal whereas the composition and key parameters are the valuable results. The processing of a detector signal to a proper result is stepwise discussed with examples and flow charts. Calibration of the detector, cosmic ray detection, and dark current and background correction are shown. Additionally some ideas are shared about the implementation and restrictions of multivariate modelling.

Finally at the discussion it is discussed what worked well, and where the instrumentation may be optimized with suggested alterations. Both the instrumentation and the operational effectiveness of the application are discussed whereby the results are taken into account. It was found that only few goals were met, spectra can be recorded from the main components although they differ little over their tested concentration range. Future research should be focused on increasing the sensitivity of the measurement, which is found to be the main weakness, and on developing advanced algorithms for the determination of key parameters of natural gas.

The study reveals that to maintain optimal cost and process control, fast and accurate analysis methods need to be developed that can measure the anticipated compositional changes. The main question is "is Raman spectroscopy a viable technology for the compositional analysis of natural gas mixtures?"