A fast and accurate near infrared spectroscopy method for the determination of cellulose content of alkali cellulose applicable for process control

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A novel near infrared (NIR) spectroscopy method for the determination of the cellulose content of alkali cellulose, an intermediate product in viscose fibre production, is presented. This method is especially suitable for the purpose of process control. The method is realised in diffuse reflectance mode. A fast sample preparation step consisting of the compression of the coarse bulky alkali cellulose is introduced, in order to homogenise the sample material. The measurement takes 10 min, including the preparation step. For calibration of the method, samples taken directly from the production line have been used in combination with samples prepared in the laboratory. Validation conducted in a production environment yields a root mean square error of prediction of 0.36% w/w for cellulose content, which is sufficient for the detection of deviation from standard production parameters. It is found that the source material for the alkali cellulose influences the NIR spectra. Analysis of the source material indicates that the hemicellulose composition, i.e. a poly- or oligosaccharide dissolvable in caustic lye, has an impact on the NIR spectra. Different types of source materials can be discerned from their NIR spectra.

Keywords: NIR spectroscopy, diffuse reflection, process control, process analysis, viscose, alkali cellulose

Introduction

Alkali cellulose is an important intermediate in viscose fibre production. The viscose fibre is processed into textiles and sanitary products, such as clothes, automobile interiors, tampons and cotton pads; therefore it represents an economically important product. The cellulose fibre viscose serves as an important alternative to cotton. The cultivation of cotton requires environmentally problematic, intensive soil irrigation. Viscose fibre, being a sustainable resource, will play an increasingly important role in the future. Therefore optimisation of its production is a highly relevant issue.

Viscose is processed from dissolving wood pulp, which is predominantly extracted from both hardwood and softwood. The composition of the pulp in detail depends on the wood species that is the source of pulp and on the process with which the pulp is produced. Dissolving pulp consists of a very high content, 90–99% w/w, of alpha-cellulose, with the remainder consisting of beta- and gamma-cellulose. Because of its high molar mass, alpha-cellulose is insoluble in alkali. Beta-cellulose is soluble in alkali, but precipitates once the alkali is neutralised. Gamma-cellulose is soluble in alkali and