CHARACTERIZATION OF LIGNIN BY MULTI-DETECTOR GPC

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ABSTRACT

Lignin is a complex polymer found in vascular plants binding the cells and cellulose fibre in wood. It is the second most abundant natural polymer formed of aromatic alcohols known as monolignols.

With a plethora of actual and potential applications, from bio-fuel to asphalt antioxidant, understanding the distribution of molecular weight, molecular structure and viscosity of this natural polymer is critical to the understanding of the materials performance and end-product properties.

Gel-permeation chromatography (GPC) is the most widely used tool for the measurement of molecular weight and molecular weight distribution of natural and synthetic polymers. Historically, the elution volume of an unknown sample was compared with that of known standards to estimate molecular weight and distribution. However, this so-called 'conventional calibration' is limited by the structural differences between standards and samples, meaning that the measured molecular weight is only a relative value if the standards and samples are different polymers. This is particularly true for lignin due it its unusual molecular structure in solution.

Static light scattering (SLS) detectors measure the intensity of light scattered by the sample as it elutes from the chromatographic column. Since the intensity of the scattered light is proportional to the samples molecular weight and concentration, they allow the direct measurement of the sample molecular weight independent of its elution volume. A viscosity detector can be used to measure the intrinsic viscosity which can be combined with the molecular weight data to calculate hydrodynamic radius. These data allow detailed structural information of a polymer to be generated in a single GPC measurement which can be compared with other samples by the use of Mark-Houwink plots.

A major challenge that needs to be overcome while working with lignin is that it often fluoresces in solution. Light scattering data can then be distorted due to the interference originating from the fluorescent molecules adding to the amount of light scattered during the measurement.

In this paper, we analyzed a set of lignin samples, using several techniques, highlighting these difficulties and illustrating how reliable information can be obtained by careful choice of experimental conditions and methods.