9 Analysis of Papermaking Process Waters and Effluents

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9.1 Introduction

Not only pulping, but also papermaking, involves complex chemical phenomena. Dissolved and colloidal substances are released into process waters from pulps and are carried over to papermaking operations. This material represents a multitude of different components, which interact with one another and with the pulp fibers, fillers, and process chemicals at the wet end of the paper machine. Along with the trend of minimizing the use of fresh water until the water system is nearly a closed cycle, the concentrations of dissolved and colloidal substances are increasing in papermaking waters. The highly turbulent conditions, the varying pH, and the presence of microorganisms are further factors to be taken into account when managing the wet-end chemistry. This is of critical importance, both for paper machine runnability and paper quality. Furthermore, these dissolved and colloidal substances will end up in the mill effluents, if not carried with the paper or taken out in the form of solid rejects.

A significant amount of wood material is dissolved and dispersed in mechanical pulping and the subsequent bleaching. Since mechanical pulps are seldom well washed, most of the dissolved and colloidal substances are carried over to the wet end of the paper machine. Chemithermomechnical pulping (CTMP) results in the dissolution in process waters of up to 10% of the wood material, and sometimes even more. CTMP process waters contain essentially the same components as pulping and bleaching waters from TMP and other mechanical pulps, although in larger amounts. However, CTMP mills are mostly nonintegrated, and the pulp is extensively washed before delivery. Therefore, CTMP process waters do not occur in the further processing stages, namely production of fluff and tissue products, and paperboard. Also, chemical pulps and recycled pulps are usually thoroughly washed in the pulp mill and deinked, respectively, and do not carry over as much dissolved and colloidal material as mechanical pulps. However, beating of the pulps in the paper mill results in additional dissolution of fiber material.

Standard methods for measuring summative parameters have traditionally been predominant in analysis of papermaking process waters and effluents. However, such parameters provide little information on the true chemical character of the components. For a deeper understanding of the complex phenomena and mechanisms in papermaking chemistry, information of individual dissolved and colloidal components at the molecular level is necessary,
demanding more sophisticated chromatographic and spectrometric techniques. Effluents discharged from paper mills should also be analyzed at the molecular level in order to achieve a thorough understanding of possible environmental effects. The traditional methods used in wood chemistry research are often too laborious and tedious for paper mill process analyses, where a large number of samples need to be analyzed in a reasonable time, and at a reasonable cost.

The emphasis of this chapter is on modern methods for the analysis of dissolved and colloidal substances in paper mill process waters and effluents. Methods are presented that provide information on individual components and component groups, but are still practical enough to be applied in industrial laboratories, and for paper mill process analyses. A recently developed practical integrated scheme for workup and analysis of paper mill pulp streams and process waters is described. Standard methods for process water and effluent analysis, and techniques for on-line process analysis are also briefly discussed.

Research methods needed for isolation and analysis of substances in paper mill waters are only briefly discussed, since these methods are treated in more detail in other chapters of this book.

9.2 Dissolved and Colloidal Substances

9.2.1 Material from Mechanical and Chemimechanical Pulps

Mechanical Pulps. In mechanical pulping and bleaching, 30–60 kg of wood material is dissolved or colloidal dispersed into the process waters for each ton of pulp produced. The main components of this material are hemicelluloses, pectic substances, lipophilic extractives (wood resin), lignans, and lignin-related substances. Alkaline peroxide bleaching causes degradation and additional dissolution of wood material, but some components dissolved in pulping are reprecipitated. Typical amounts of dissolved and colloidal substances released into waters from thermomechanical pulps (TMP) of spruce wood and in consecutive peroxide bleaching of the pulps are given in Table 9.1.

In mill practice, the amount and composition of dissolved and colloidal substances carried over to the paper machine is influenced by many process factors, such as quality of wood furnish, pulping process conditions, possible washing of the pulp, and the water system configuration, including the degree of closure of the mill. Coagulants such as alum or organic cationic polymers, so-called fixing agents, are commonly used in paper mills, especially to deposit colloidal material onto pulp fibers, resulting in cleaner process waters.