

The characterisation of organic components in the calcium and magnesium effluent streams at Sappi Saiccor

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Abstract

Sappi Saiccor is one of the few pulp mills that use the acid sulphite pulping process with hardwood feedstock to produce a high-grade cellulose pulp. The major constituents identified in the calcium effluent stream and the magnesium condensate effluent stream were a mixture of lignan isomers, episingaresinol and meso-syringaresinol and lignin-type precursors such as 3-(4'-hydroxy-3',5'-dimethoxyphenyl)-prop-1-ene, 2,6-dimethoxy-1,4-benzoquinone, 3-(4'-hydroxy-3',5'-dimethoxyphenyl)-1-hydroxy-propane-2-one, syringaldehyde and vanillin.

Keywords: effluent, analysis, lignan

Introduction

Sappi Saiccor, whose factory is situated south of Durban, South Africa, is an international leader in the manufacture of dissolving pulp using the acid sulphite pulping process with calcium and magnesium bases. Hardwood feedstock, *Eucalyptus grandis* and *Acacia mearnsii* wood, are milled and passed through the sulphite process to produce a high-grade pulp. The resulting effluent waste is generally pumped out to sea but increasing environmental consciousness has prompted Sappi Saiccor to find ways of reducing their effluent. The first step has been the characterisation of the effluent.

The major findings of this project are of importance to the industry as no work on the characterisation of the organic constituents of Saiccor's waste effluent had previously been undertaken. Furthermore, Saiccor differs from other manufacturers of dissolving pulp in that they use hardwood feedstocks and this is likely to lead to different breakdown products in their pulping and bleaching effluent streams. Although much work has been published on the components which occur in Kraft effluent streams, little has been published on the constituents of acid sulphite pulping and bleaching effluent streams.

The aim of this project was to extract and identify the major organic components of Sappi Saiccor's effluent. There are four main streams of effluent, namely, the calcium spent liquor, the magnesium condensate and two bleaching stage effluent streams as shown in Fig. 1. Attempts made by Saiccor, thus far, to reduce the amount of effluent pumped out to sea have included pumping a proportion of the calcium - spent liquor to an adjacent plant, where lignosulphonates are recovered for commercial purposes (Weightman, 2000; Thubron, 2000). Furthermore, the effluent from the magnesium stream is reduced by passing it through a recovery process. This involves first evaporating the effluent down in two stages to a thin liquor and thereafter burning the concentrated liquor and recovering the magnesium oxide. The only effluent produced here is the condensate that forms during the evaporation of the thin liquor before the burning stage.

Much research was carried out on spent sulphite liquors from 1950 to 1970. However, that research has now somewhat diminished as the pulp and paper industry has moved away from sulphite pulping towards Kraft pulping processes. Studies by Kvasnicka and McLaughlin (1955) on the butyl acetate extract of spruce sulphite liquor showed three main groups of components present, namely, tannins and condendrins and other phenols and neutral compounds such as hydrocarbons and esters. Further isolation and extraction techniques yielded, in particular, compounds such as vanillin, 3-(3-methoxy-4-hydroxyphenyl)-propanol-1 and 3,3'-dimethoxy-4,4'-dihydroxystilbene.

Studies based on laboratory sulphite pulped aspen wood using ammonia as the base showed the presence of many different types of compounds ranging from lignans to long-chain fatty acids. Pearl and Justman (1961) identified a number of saturated and unsaturated long chain fatty acids and their alcohol derivatives, such as myristic, lauric, palmitic, stearic and linoleic acids. The aromatic compounds isolated and identified were vanillin, syringaldehyde, *p*-hydroxybenzoic acid, vanillic acid and syringic acids. Isomers of the lignan liriioresinol (diasyringaresinol) were also identified as well as some flavonoids (Pearl et al., 1962).

Thereafter work was carried out on a commercial sulphite liquor sample. Studies by Pearl and Beyer (1964a, b) of an ammonia-based aspen spent sulphite liquor involved ether extraction and separation of the extract into various fractions. Some lignin-like or phenolic materials were identified, but only on hydrolysis of this fraction and it was therefore thought that these phenolic materials were complexed with carbohydrates. Some examples of the lignin precursors isolated were vanillin, syringaldehyde and *p*-hydroxybenzoic acid. The 'weak acid' fraction also contained phenolic compounds linked to carbohydrates, and on acid hydrolysis, compounds such as vanillic acid, syringic acid and *p*-hydroxybenzoic acid were identified. The 'strong acid' fraction was found to contain similar components on acid and alkaline hydrolysis. This early work was based on paper chromatographic techniques. Earlier studies on aspenwood, *Populus tremuloides*, revealed a large quantity of naringenin, which has been previously isolated from this species (Pearl and Beyer, 1963).

Studies on a sample of black liquor, obtained from a Kraft pulp mill using *Eucalyptus globulus*, were carried out by separating the liquor into various fractions (Neto et al., 1999). The aromatic acid

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