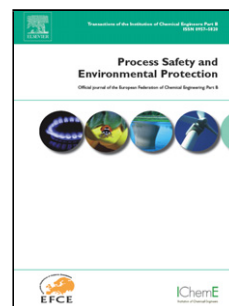


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A Feasibility Study of a Novel Electro-Membrane Based Process to Acidify Kraft Black Liquor and Extract Lignin

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Abstract

Lignin extraction from black liquor is of utmost importance for decreasing the load of the recovery boiler and consequently increasing the production capacity of Kraft process. A feasibility study of a novel acidification technique (acidification with electrodialysis using bipolar membrane (EDBM)) was carried out to drop the pH of Kraft black liquor and extract lignin. In order to evaluate the technical feasibility of the proposed method, the acidification of the Kraft black liquor was performed in two different pathways i.e. electrochemical acidification by means of EDBM process and chemical acidification using sulfuric acid. The results have indicated that the implementation of the proposed method resulting in use of less chemicals than the chemical acidification method and simultaneously produced caustic soda. The experiments performed in the course of this study addressed the advantages and challenges of this electro-membrane based process in the Kraft black liquor acidification application.

Keywords

Bipolar membrane, electrodialysis, Kraft black liquor, lignin extraction, electrochemical acidification, chemical acidification

1. Introduction

The recovery system constitutes an important aspect of the financial profitability of a kraft pulp mill. The recovery system fulfills two major functions [1,2] : a) the recovery and regeneration of chemicals produced by cooking wood chips and b) the production of energy such as steam and electricity. Initially, the recovery system was designed to recover and regenerate chemicals contained in the used cooking liquor (black liquor), caustic soda (NaOH) and sodium sulfide (Na₂S), which are the major components of the cooking liquor used for pulping (white liquor). Secondly, the recovery boiler, a key element of a conventional recovery system, produces steam by burning dissolved organic materials from the cooking of wood chips. The capacity of the recovery boiler is often limited by the heat load and/or the solid load from the black liquor, therefore limiting pulp production. The recovery boiler usually operates at its maximum steam production capacity (thermal load) which was established in the original design. The heat load of a recovery boiler can be reduced by precipitating a fraction of the lignin contained in the black liquor solids. It is therefore clear that partial extraction of the lignin contained in the black liquor induces an effective decrease in the heat load as well as in the solid load fed into the boiler. The purpose of this paper is to present basic information and highlight the advantages of electrochemical approaches of lignin precipitation as an improvement over traditional chemical options.

Several approaches have been proposed to extract lignin from the black liquor for the purpose of reducing the load on the boiler, the main one being chemical acidification [3-6]. It consists in neutralizing the alkalinity of black liquor by adding acid agents such as sulfuric acid and/or carbon dioxide to reduce the pH of black liquor to precipitate the lignin. Precipitation of lignin by chemical acidification has the effect of increasing the load of inorganic materials in the recovery boiler.

In the perspective of sustainable development in the pulp and paper industry, we propose electrochemical options for the acidification of black liquor to precipitate lignin consisting in neutralizing its alkalinity through electrochemical reactions such as electrolysis or by extracting the alkaline salts by conventional electrodialysis [7]. This approach can eliminate the use of chemicals such as carbon dioxide and sulfuric acid and generates no additional effluents; on the contrary, it will reduce the amount of sodium sulfate waste

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