Structural Evaluation on Sugarcane Bagasse Treated Using Sodium and Calcium Hydroxide

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Abstract. *Greater interest in recent years to the increase demand in using natural fiber reinforcement of polymers is to comply with the increasing stringent international protocols related to climate change and environmental awareness. Many studies have reported the development of renewable and biodegradable agricultural by-products as reinforcement fibers for biocomposites. One of the essential factors in producing strong biocomposites is the properties prepared from the natural fibers which results from the alkali treatment given. This research aims to evaluate the effect of different treatment duration on structural changes on sugarcane after alkali treatment using sodium hydroxide (NaOH) and calcium hydroxide ($Ca(OH)_2$) solutions. Calcium hydroxide was used as comparative solution in search for milder and more environmental friendly alkali solution as an alternative solution of NaOH. Fourier Transform Infrared (FTIR) confirmed the major removal of lignin and minor of hemicellulose. It shows that the structure did not change considerably with the additional treatment time. The weight loss measurement after each treatment shows a higher weight loss with the treatment with NaOH (40.5-57.75%) than the weight loss after $Ca(OH)_2$ treatment (25-46%). Scanning electron microscope (SEM) observed the morphology changes on the fiber surface from both treatments.*

Key words: sugarcane bagasse, alkali treatment, sodium hydroxide, calcium hydroxide.

1 Introduction

Indonesia is a major producer of agricultural products which the sugarcane is one of the main products with a total production of 28,7 metric tons per year (rank 9th in the world).[1] Agricultural production inevitably generates residues (by-products) that have limited use. Sugarcane stems consist of three major parts: the pith (5%), fibers (73%), and the rind

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(22%).[2] Sugarcane bagasse is the remaining substance (waste) after crushing the canes for sugar. Bagasse is a fibrous residue, one among the three other main byproducts of the sugar industry, i.e. cane tops, filter muds, and molasses. Currently sugarcane bagasse is used as primary energy source as fuel for the boilers in the sugar mills and the remaining is stored. However, the important part of the bagasse as an industrial waste is still underutilized. Added-value compounds that can be produced using bagasse are bioethanol, [3-6] protein-enriched animal feed ('single cell protein'),[7] and enzymes. Therefore various research works have been done to develop methods for further processing of bagasse to produce fuel and chemicals that offer economic, environmental, and strategic advantages. However, there were relatively fewer studies reporting on obtaining fibers from sugarcane bagasse compared to other agricultural by-products.

2 Materials and methods

2.1 Treatment of bagasse fibers

The first step in the bagasse preparation was neutralization of the bagasse by soaking in a 70% ethanol as an effective desinfectant or antiseptic agent for an hour to eliminate the stench generated due to bacterial fermentation reaction.[19] A ratio of volume of ethanol (litre) to the weight of bagasse (kg) used was 2.5:1. The neutralized fibers were drained and dried for 6 hours in air at room temperature. The fibers were then dried in the oven (Memmert type UN450) heated from room temperature to 200°C with a holding time of 30 seconds. Treatment was applied to the dried fibers by soaking the fibers in two different solutions of 10% vol. NaOH and 14 % vol. $Ca(OH)_2$ at 60-70°C for various treatment time of 2, 4, and 6 hours. At the end of treatment, bagasse fibers were rinsed couple of times in distilled water and a pH check was done to ensure they were clean from the alkali solution. Before the rinsed fibers went to the oven for drying, they were dried in air for 6 hours at room temperature. Lastly, those fibers were oven dried by increasing the temperature from room temperature to 200°C with a holding time of 30s.

Weight loss measurement on bagasse samples after treatment was carried out aiming to determine the delignification degree of both treatments in different time. The weight loss values obtained could inform the effectiveness of lignin removal during treatment. Bagasse samples were weighed when they were received as wet fibrous residue. Two other weight measurements were performed for oven dried bagasse samples both after neutralization and alkali treatment processes.

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