

FORMIC ACID PULPING OF RICE STRAW

Suhardy Daud, Siti Shuhadah Md Salleh, Mohd Nazry Salleh,
Farizul Hafiz Kasim and Saiful Azhar Saad

*School of Materials, Bioprocess and Environmental Engineering, Universiti Malaysia Perlis
(UniMAP), Jejawi 02600 Arau, Perlis.*

*Tel : 04-9798609, Fax : 04-9798178, email : suhardy@unimap.edu.my

Abstract

Many cereal straws particularly rice straw have been used as raw materials for paper production. But the main problem for the decreased use of straw in the paper industry is the remaining of black liquor which contains lignin and silica are factors currently limiting the use of straws in paper mills. In this study, we present processing techniques and pulp properties obtained through cooking rice straw with formic acid. The results showed the silica content in straw is 9.78 % and after pulped with formic acid, the content of silica is 1.22 %. Therefore, formic acid pulping can preserve most of silica derivatives in the straw.

Keywords : Rice straw, pulping, formic acid, soxhlet and silica.

Introduction

Pulping generally refers to various industrial processes used to convert raw plant materials or recycled paper into a fibrous raw material known as pulp, which is used primarily to make paper or paperboard products (and, to a smaller extent, other products derived from cellulose such as synthetic rayon). The pulping processes were done to remove as much lignin as possible and avoid the decomposition of cellulose during the process. There are various pulping processes that have been used in industries. The most common process is chemical pulping using NaOH which is known as Kraft pulping. This process has many advantages compare to other processes but the waste is difficult to be treated [1].

Pulps are categorized by pulping process, with two major categories known as chemical and mechanical. Actually both types of processes typically use a combination of chemical and mechanical means to reduce wood into pulp. Chemical pulping relies mainly on chemical reactants and heat energy to soften and dissolve lignin in wood chips, followed by mechanical refining to separate the fibers. Mechanical pulping often involves some pre-treatment of wood with steam heat and or weak chemical solution, but relies primarily on mechanical equipment to reduce wood into fibrous material by abrasive refining or grinding.

Chemical pulp is produced by mixing wood chips with chemicals. The chemical pulping processes involve reaction or 'cooking' of wood chips with a solution of chemicals in a heated digester vessel for an extended period (up to several hours or more). It is doing by combining wood chips and chemicals in huge vats known as digesters. The effect of the heat and the chemicals dissolves the lignin that binds the cellulose fibers together, without breaking the wood fibres. The fluid that contains lignin and other dissolved material is then dried and used as fuel. Principal chemical pulping processes include the alkaline (or Kraft) pulping process, acid sulphate, and semi-chemical pulping. In this study, we present processing techniques and pulp properties obtained through cooking rice straw with formic acid.

Materials and Method

For formic acid pulping process, the rice straws were soaked in the cooking liquor (95 % w/w acid formic) at 80 °C for 2 hours. After that the sample were filtrated. The liquid (black liquor) was removed. Then the powders (solid) were extracted by using the Soxhlet method. The same process was done for sugarcane bagasse.

For NaOH pulping process, the rice straws were soaked in the cooking liquor (95 % w/w NaOH) at 80 °C for 2 hours. After that the sample were filtrated. The liquid (the black liquor) was removed. Then, the powders (solid) were extracted using the Soxhlet method. The same process was done for sugarcane bagasse.

Result and Discussion

From the Table 1, it can showed that sugarcane bagasse has 9.78 % content of silica and 90.22 % content of carbon. The data were interpreted by using SEM-EDX. Rice straw has 36.14 % content of silica and 63.86 % content of carbon respectively. The content of silica in rice straw is higher compare to sugarcane bagasse. Therefore, sugarcane bagasse is more suitable as raw material for paper production compare to rice straw. It is because high silica content can reduce the quality of paper. These handicaps can cause the need to add alkali to reduce or prevent silicate deposits or install a specific device to remove silica from the black liquors during pulping process. The need to add alkali to reduce or prevent silicate deposits to remove silica from the black liquors is currently limiting the use of rice straws in paper mills [2].

Table 1: Chemical elements in raw materials (sugarcane bagasse and rice straw).

Raw Materials	Content of SiO ₂ (%)	Content of Carbon, C (%)
Sugarcane bagasse	9.78	90.22
Rice straw	36.14	63.86

Table 2 : Percent extraction of lignin and cellulose from sugarcane and rice straw by using Soxhlet method.

Sample	% extraction of cellulose	% extraction of lignin
Rice Straw (Formic Acid Pulping)	39.30	10.24
Rice Straw (NaOH Pulping)	30.27	4.72

The result of Soxhlet extraction of cellulose and lignin content in rice straw and sugarcane bagasse from the different pulping process can be seen in Table 1. It showed that the percentages of cellulose for rice straw are 39.30 % w/w for formic acid pulping and 30.27 % w/w for NaOH pulping. The yield of cellulose for formic acid pulping is higher compare to NaOH pulping.

Lignins, which are the combined glues that hold plant cells together, are undesirable in a finished paper product. They age poorly, turn brown, become acidic over time, are waterproof, and resist the natural bonding of cellulose fibers to each other. If lignin not removed and left in contact with the surrounding cellulose fibers in paper, their acidity will break down the cellulose and the paper will become brittle [3]. The delignification of the rice straw after the formic acid and NaOH pulping will yielded 10.24 % w/w and 4.72 % w/w lignin content. It showed that the formic acid pulping is more effective to remove the lignin content in the pulp compare to NaOH pulping.

References

1. International Labour Organisation (1993). *Small scale paper making*, Canada.
2. Hoang, Q.L., Yves, L.B., Michel, D. and Gerard, (2001). A. formic acid pulping of rice straw, *Industrial Crops and Products*, 14, pp.65-71.
3. J.C .Roberts, (1996).*The Chemistry of Paper*.1st Edition, RSC Paperbacks Inc. USA.