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Analysis of Paper Fiber Types based on Color Change

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Abstract: This study aims to see the paper fiber and how the strength of the paper fiber from a visual perspective. The paper fibers tested consisted of ten different types of paper, with the principle that the Phloroglucin solution consisted of Phloroglucin powder, HCl, and Alcohol. Lignin when reacted with Phloroglucin solution will change to a purplish red color which indicates that the paper comes from mechanical fibers (contains wood). Based on the test results of newsprint, casing paper and board paper changed to a purplish red color which indicates that the paper comes from mechanical fibers (contains wood). Meanwhile, HVS paper, art paper, BC Putih paper, ivory paper and doshlag paper did not change color, which means that there was a chemical process to remove wood resin or lignin from the paper.

Keywords: paper, fiber, phloroglucin, mechanical, chemical.

Introduction

Paper is an important part of human life. Paper is useful as media for recording and disseminating data and information; packaging requirements; test laboratory; yarn/textile spinners, and tissue. Paper consumption can be one of them a measure of a nation's progress. As picture, the United States ranks The first paper consumption in the world was 345 kg/capita, while Indonesia is in 1st place thirteen amounted to 30.1 kg/capita in 2011 (Kompas, 2009; APKI, 2013).

The main requirements for raw materials are pulp and paper namely cellulose content and high hemicellulose. Lignin levels and low extractivity can influence paper yield and color. Fiber long and the cell walls are quite thick affects paper strength (Sutiya et al. 2012). Every plant has the largest constituent component, namely the lignocellulosic component consisting of cellulose, hemicellulose, and lignin. In the process of making paper components The plants that influence these are cellulose and lignin. Hemicellulose together with lignin binds and unites cellulose fibers. In the paper making process, cellulose has an important role because it contains fiber used as raw material for manufacturing paper, so as to get the fibers on cellulose needs to undergo a lignin removal process. The high lignin content in paper will causes the paper to turn brown if Too long exposed to sunlight can cause texture the paper becomes stiff (Bahri, 2015).

Cellulose is a polymer of straight chain polysaccharides composed of glucose or cellobiose units with β-1-4-glucan linkers. In cellulose there are fibers which are used as raw material for making paper. Cellulose chains are arranged by hydrogen bonds called microfibrils. Cellulose microfibrils have an amorphous and crystalline form of about 2/3. The crystalline fiber structure makes cellulose difficult to degrade enzymatically. Cellulose, hemicellulose, pectin and protein will form a network structure that strengthens plant cell walls (Nikmatin et al., 2012). Lignin or wood substance is a component that fills the space in the cell walls between cellulose, hemicellulose and pectin. Lignin functions as an important part in water distribution in plant stems. The polysaccharide components in plant cell walls are hydrophilic so they are permeable to water, while lignin is more hydrophobic. Lignin is present in all vascular plants except bryophytes (Setiati et al.,

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2016). According to the structural elements, lignin is divided into 2 classes, namely guaiacyl lignin (found in softwood as a result of polymerization of coniferyl alcohol) and guaiacyl-syringyl lignin (hardwood resulting from a copolymer of coniferyl alcohol and sinapyl alcohol). Lignin is insoluble in simple solvents, but alkaline lignin and sulfonate lignin are soluble in water, dilute alkali, salt solutions and buffers (Simatupang, 2012). In the paper making process, lignin is a compound that inhibits bonds between fibers and causes the fibers to become stiff and the fibers are difficult to break during milling, which causes the bonds between fibers to become lower. In addition, high lignin content can cause brownish paper, so the lignin in the raw material for making paper must be removed or minimized (isolated) using a delignification process (Dewi et al., 2015).

A sheet of paper has fibers which act as the structure of the paper itself. The fibers in paper can be compared to the bones in the human body. A human body without bones would not have a sturdy and rigid shape. Paper is one of the basic necessities for stationery, art and household purposes. Paper is very important in everyday life both on a small and large scale, paper in the form of thin sheets produced by compressing fibers originating from pulp that has undergone drying, plus several additional materials that stick together and intertwine, fibers that Usually used are natural fibers containing cellulose and hemicellulose (Dharosno and Pundu, 2020).

Paper is an important part of human life. Paper is useful as a medium for recording and disseminating data and information; packaging requirements; laboratory experiments; yarn/textile spinners, and tissue (Anggraini Indrawan et al., 2015). Paper is a fiber network arranged into a sheet. These fibers can come from the deposition of several types of plants, minerals, animal hair or other materials that are processed with or without the addition of other substances from a suspension in liquid, steam or gas. The results of this process produce a single sheet of paper that has strength (Mandegani and et al, 2016). Paper is made from raw materials that contain fiber, namely fibers from wood and non wood materials (Nata, Niawati and Muizliana, 2013)

Pulp is a semi-finished material, if further processed it will produce paper, rayon fiber and others. The main raw material for making this pulp is cellulose. Cellulose can be obtained from fibrous plants (Mufridayati and Humaidi, 2016). Wood as a basic material in the paper industry contains several components, including: Cellulose, composed of long, straight chain glucose molecules, which is the most preferred component in making paper because it is long and strong (Mufridayati and Humaidi, 2016).

Graphics are not far from something called paper. Apart from the many benefits of paper, the fiber must also be tested with the aim of seeing the paper fiber and fiber strength. Paper is a product that comes from utilization of cellulose as raw material. Paper can be made from any semi-finished material (pulp) that contains cellulose (Apriani and Malik, 2019). Cellulose is a glucose polymer. Cellulose has a linear chain form with β-1,4 glycosidic bonds. The linear chains in cellulose make it insoluble and crystalline. Cellulose is not easily degraded chemically or mechanically (Mandegani and et al, 2016).

The quality of the paper sheets produced is basically influenced by the properties of the raw material, especially the specific gravity, dimensions of the fibers and their derivatives and their chemical components. The chemical components of raw materials, among others, influence the consumption of cooking ingredients, the ease with which chemicals penetrate, and the specific gravity influences the suitability of the pulp cooking process. while fiber morphology influences the quality of the bonds between fibers and the ease with which they fibrillize (Fatriasari, W. & Hermiati, 2008).

Experiments and observations regarding paper fibers have also been carried out by (Rita, 2012) observing paper fibers which discovered the natural geometry of 70 gsm HVS paper which resulted in observations that the paper fibers were parallel to the long side of the paper. The final shape and pattern produced will vary from one another according to the character of the paper when faced with different stylistic directions. This prompted the author to test the fibers of several types of paper.

Materials and Methods

Tools

Watch Glass, Measuring Cup, Goblet, Stirrer, Analytical Balance, Brown Bottle

Material

The paper to be tested, Phloroglucin 1 gram, HCl 12.5 cc, Alcohol 25 cc

Test Principles

Phloroglucin solution consists of Phloroglucin powder, HCl, and alcohol. When lignin reacts with the Phloroglucin solution it will turn red which indicates that the paper comes from mechanical fiber (contains wood).

Method

Research uses methods quantitative descriptive, where the data is obtained is measured and created in shape structured tables. Phloroglucinol solution is a lignin element detection solution. stated that the presence of lignin can be determined qualitatively by using phloroglucinol staining and this solution will cause the color to change to red. Lignin will react with the acid phloroglucinol solution and change color to red, the more red the material being tested indicates the more lignin content.

A. Prepare tools and materials to be tested
B. Weigh 1 gram of Phloroglucin on a watch glass using an analytical balance
C. Put 25 cc of alcohol in a glass cup
D. Then add the Phloroglucin which has been weighed and 12.5 cc of HCl
E. Stir the solution until homogeneous and put it in a brown bottle
F. Drop the solution on the paper to be tested
G. Observe whether there is a color change or not

Results and Discussion

There are two factors that influence crack resistance, namely fiber length and bonds between fibers. The longer the fiber, the greater the BS of the paper, but what is more influential is the bond between the fibers. Many bonds between fibers will cause the paper to be more resistant to pressure that comes perpendicular to the paper so that the paper does not crack easily. That is why paper that contains more virgin pulp has a higher BS than paper that contains a lot of recycled fiber because there are a lot of bonds between the fibers in virgin pulp.

In Testing Paper Fiber Types:

a. If the paper changes color to red after being dripped with Phloroglucin solution, then the manufacturing process is through a mechanical process so that wood fiber or lignin is still present. In the mechanical process, pulp is milled without removing the wood sap in the paper.
b. If the paper does not change color then a chemical process has occurred. In the chemical process, the wood sap or lignin in the paper is lost.

The paper that has been produced will show which are natural fibers and fibers that have been mixed with chemicals. If the paper is mechanically processed, the paper will not change color or will not contain other colors, while chemically processed paper will turn purplish red.

Table 1. Paper Fiber Test Results.

No.	Color of Test Results	Color of Test Results
1	Newsprint	Red
2	Art Paper 100	Doesn't Change Color
3	Art Paper 150	Doesn't Change Color
4	HVS 70 Paper	Doesn't Change Color
5	HVS 60 Paper	Doesn't Change Color
6	HVS 80 Paper	Doesn't Change Color
7	Casing Paper	Purplish Magenta
8	White BC Paper	Doesn't Change Color
9	Ivory Paper	Doesn't Change Color
10	Doshlag Paper	Doesn't Change Color
11	Board Paper	Purple

Discussion

Art paper has different characteristics from paper in general, namely that it does not tear easily, the color does not fade and does not peel easily. The physical properties of art paper consisting of grammage, tear strength and tensile strength are

not better than ordinary paper in general (Rahmah and et al, 2013).

Cellulose is composed of glucose units which come from the photosynthesis process of plants. The longer the cellulose chain, the stronger the paper, resistant to heat, chemical and biological degradation (Rahmah and et al, 2013).

Based on the newsprint test results, the casing paper and board paper turned purplish red, indicating that the paper came from mechanical fiber (containing wood). Meanwhile, HVS paper, art paper, White BC paper, ivory paper and doshlag paper do not experience color changes, which means a chemical process occurs to remove wood sap or lignin in the paper.

The main requirements for raw materials are pulp and paper namely cellulose content and high hemicellulose. Lignin levels and low extractivity can influence paper yield and color. Fiber long and the cell walls are quite thick affects paper strength (Sutiya et al. 2012).

Lignin is a complex polymer. Together with hemicellulose, lignin forms a natural glue which acts as an adhesive and strengthens the mechanical properties of wood. Lignin is found in the middle lamella and cell walls and functions as an adhesive between fibers. Lignin is the largest part of cellulose which has a main role as a binder between cellulose fibers in wood or non-wood.

The characteristics of the pulp are not yet white determined by fiber morphology and chemical components of raw materials used (Sixta, 2006). Fiber comes from a variety of raw materials have morphology and chemical composition varies greatly depending on location geography, climate, age and soil conditions. In addition, there are variations in chemical composition as well can occur in different parts even though they are of one type the same plant (Daud, Kassim, Aripin, Awang, & Hatta, 2013).

Conclusions

The conclusion was that the paper changed color to red after being dripped with Phloroglucin solution, so the manufacturing process was through a mechanical process so that wood fiber or lignin was still present. In the mechanical process, pulp is milled without removing the wood sap in the paper. If the paper does not change color then a chemical process has occurred. In the chemical process, the wood sap or lignin in the paper is lost.

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