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Forming of absorption band from yellow cane (*Sacharum Officindrum*) carbonized using Fourier Transformation Infra-Red (FTIR)

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Abstract. The absorption band has been made from the yellow sugar cane by the Infrared Spectra Fourier Transformation (FTIR). This research was conducted to determine the absorption band formed at wave number with the method of coating at temperature of 350 °C and method of coagulation at temperature of 500°C, 600 °C, 700 °C, 800 °C. Characterization of the yellow sugar cane absorption tape is used by FTIR. From the results for very special Si-O bonds appear at 700 °C and 800°C at 470.63 cm⁻¹ to 1118.71 cm⁻¹ and absorbtion 9%- 11%.

1. Introduction

Bagasse is a solid waste that comes from sugarcane stem juice to be taken. The existence of this abundant bagasse is a by-product of the bagasse industry. From one factory, bagasse is produced around 35-40% of the weight of the milled sugar cane. In the 2006 milling season, data obtained from the Indonesian Sugar Expert Association showed that the amount of sugar cane milled by 57 sugar mills in Indonesia reached around 30 million tons, so the bagasse produced was estimated at 10 million tons [1].

Bagasse contains 48-52% water, 3.3% sugar and 47.7% fiber. From the results of X-Ray Fluorescence (XRF) analysis of bagasse ash (bagasse) it is known that in bagasse ash contains minerals such as Si, K, Ca, Ti, V, Mn, Fe, Cu, Zn and P. The largest content of these minerals is silica (Si) of 55.5%. The content of silica in large bagasse ash, bagasse ash has the potential as raw material for making silica gel so that it has more added value by utilizing solid waste produced by sugar mills [2, 3].

Research conducted by Hanafi and Nandang in Tangerang, regarding the study of the effect of silica from sugar cane ash on the strength of ceramic products [4]. Silica extraction process from sugarcane residue with filtering at 350°C followed by the extraction at 500°C, 600 °C, 700 °C and 800°C. The SiO₂ crystalline form after coagulation at 500 °C and 600°C was amorphous and after 700°C ambient temperature and 800°C is crystalline.

Based on several studies that have been done, this study has been conducted to determine the absorption band formed from the yellow sugar cane (*Sacharum Officindrum*) using Fourier Transformation Infra-Red (FTIR) and X-Ray Diffraction spectra without purification only using temperature variations.

2. Experimental

This research was carried out in 3 stages: the refining stage of the sample in the laboratory of Soil Science, Faculty of Agriculture, Tadulako University, the stage of grafting and sampling at the



Analytical Chemistry laboratory of the MIPA-UNTAD Faculty, XRD at the Universitas Indonesia and the characterization stage at the Gadjah Mada Universitas Chemical Laboratory.

In the preparation of the test material, the material used is yellow sugar cane. In the manufacture of this test material, the method of temperature was 350°C and the temperature was 500°C, 600 °C, 700 °C and 800°C. As for the characterization of the test material using the FTIR tool to get the absorbing tape from the authoring and blending yellow sugar cane.

3. Result and Discuss

Characterizations using FTIR at Gadjah Mada University, aims to obtain absorption bands formed in the ignition of yellow sugar cane. The results of characterization using FTIR can be explained in the figure 1.

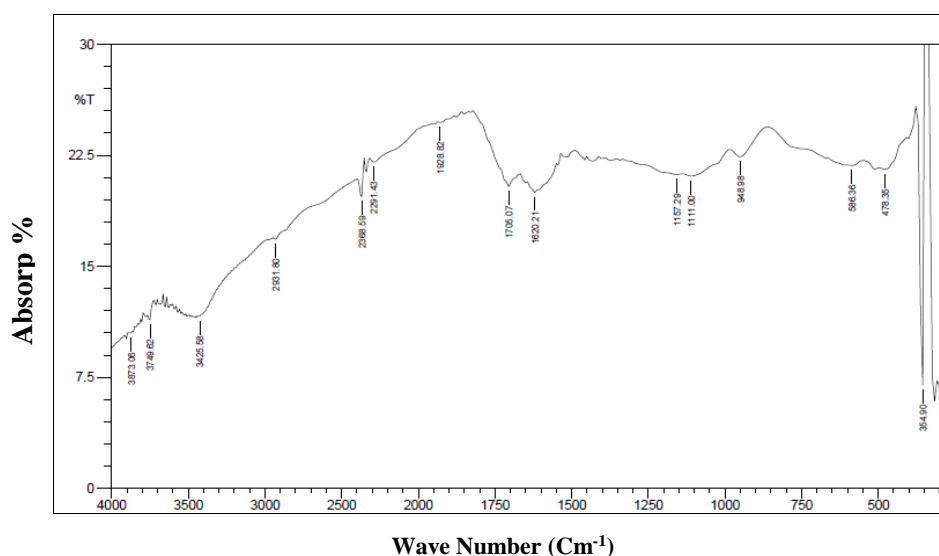


Figure 1. FTIR Pattern of Yellow Sugar Cane at 350°C

Based on figure 1 in the carbonized sample it can be seen that the characteristics of this sample are C-C bonds at wave numbers 354.90 cm⁻¹ and absorption 6.96%. Based on figure 2, the characteristics of the sample at a temperature of 500 °C are C-C bonds with weak absorption; this means that the C-C bond is very strong at wave number 324 cm⁻¹ absorption 2.967%. Based on figure 3, the absorption oxygen C-O at wave number 424.34 cm⁻¹-1111.0 cm⁻¹ and absorption 21%-23 % carbon bond has begun to decrease from the previous temperature. Based on figure 4, at a temperature of 700 °C a Si-O at wave number 1064.71cm⁻¹-1118.71 cm⁻¹ and absorption 9%-11% bond appears and the absorption carbon bond increases from the previous temperature. This is because the strongest bond is Si-O. Based on figure 5, it is clear that Si-O bonds are very characteristic at 800°C at wave number 470.63cm⁻¹-1118.71cm⁻¹ and absorption 9%-11%.

In each carbonization treatment of sugarcane dregs there is a single carbon bond, carbon double bonds, carbon hydrogen single bonds and silica oxide bonds. In order to reduce the carbon content in bagasse, research must be carried out at high temperatures. From the results of the characteristics of each treatment, it is clear that the difference in absorption bands is formed. This is influenced by each treatment of temperature, the higher the temperature, the better the absorption band or the content of silica (Si) is produced [3].

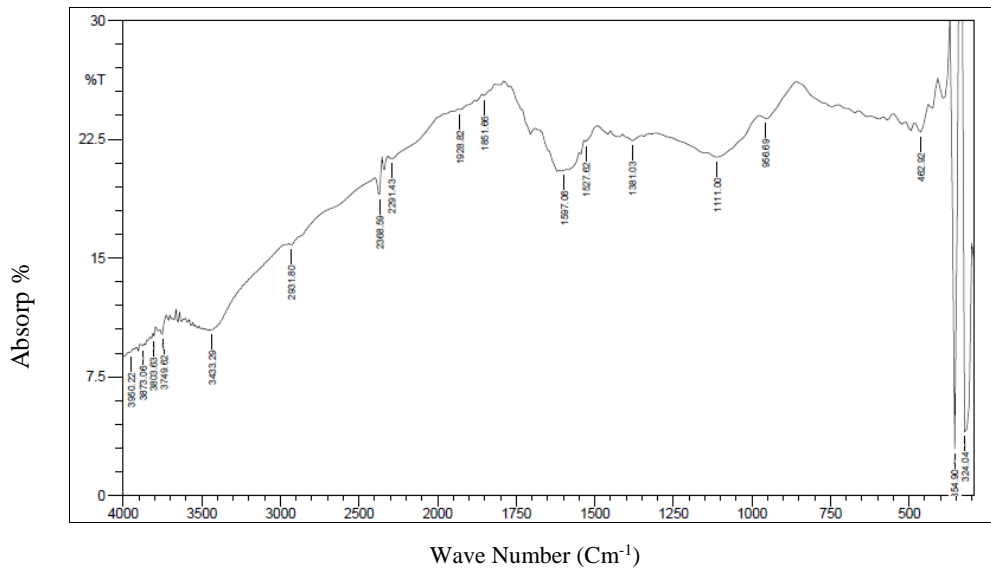


Figure 2. FTIR Pattern of Yellow Sugar Cane at 500°C

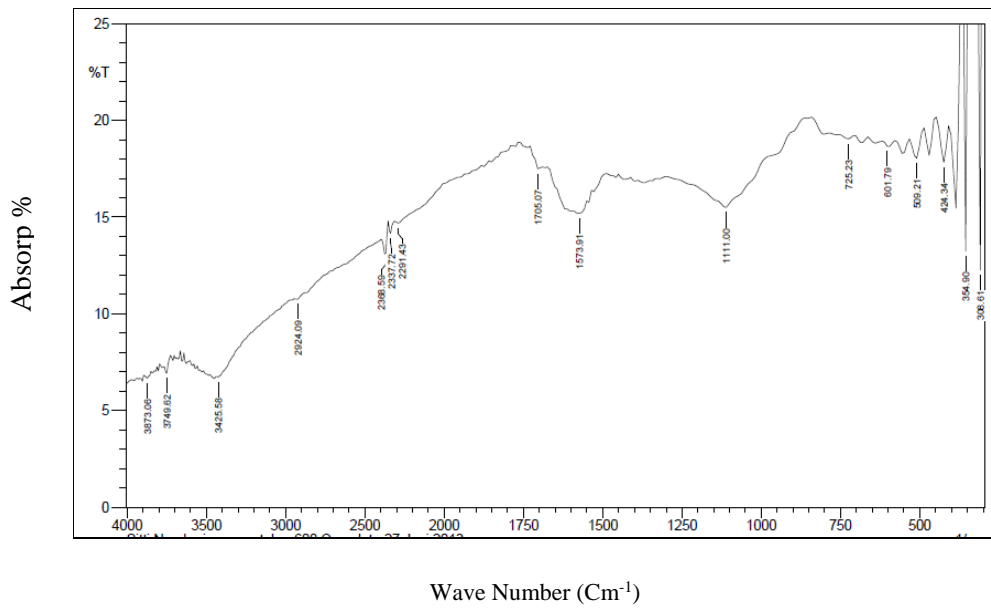


Figure 3. FTIR Pattern of Yellow Sugar Cane at 600°C

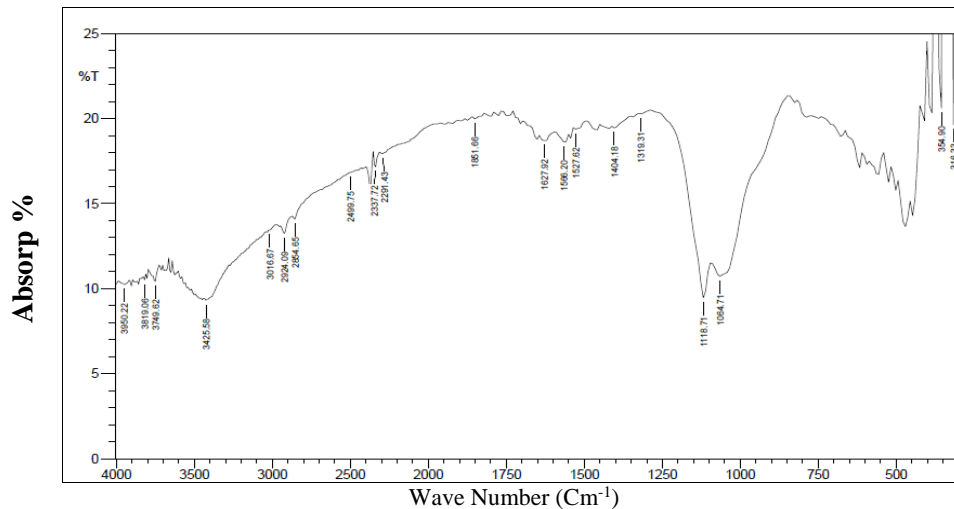


Figure 4. FTIR Pattern of Yellow Sugar Cane at 700°C

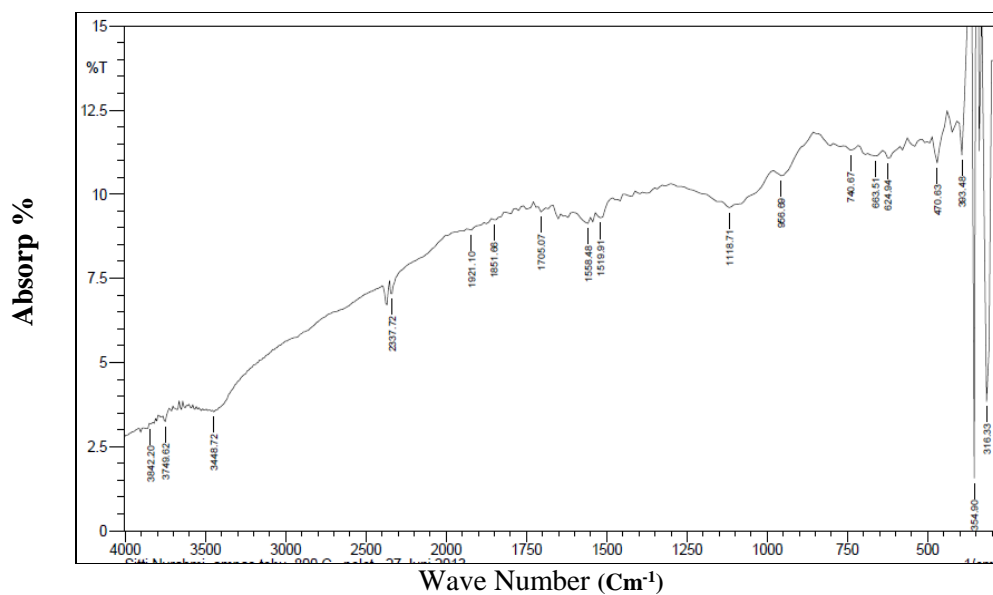


Figure 5. FTIR Pattern of Yellow Sugar Cane at 800°C

If traced each FTIR graph produced meets the requirements for infrared radiation infiltration, with the following conditions:

1. Absorption of infrared radiation can cause molecular excitation to a higher vibration energy level and the amount of absorption is quantized
2. Normal vibration has a frequency equal to the frequency of electromagnetic radiation absorbed
3. The absorption process (IR spectra) can only occur if there is a change in both the value and direction of the moment of the two polar bonds.

The IR absorption spectrum is a simultaneous change of vibrational energy and rotational energy of a molecule. Most organic molecules are large enough so that the spectrum of infiltration is complex. The basic concept of vibration spectra can be explained by using a simple molecule consisting of two atoms with a covalent bond. Using Hooke's Law, the two atoms are connected with a spring. The

equation derived from Hooke's Law states the relationship between frequency, atomic mass, and the force constant of the bond.

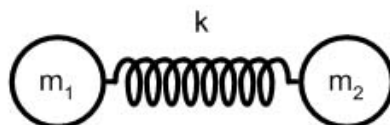


Figure 6. Schematic of Hooke's Law [9]

In this vibration, the atom moves along the bond that connects it so that there will be a change in distance between the two, even though the bond angle does not change. The C-C bond at wave number 354.90 cm^{-1} , C-O carbon oxygen bond and Si-O bond, and each of these formation undergoes an infrared absorption process against each bond with the formation of strain vibration and bending vibration^[6]. This is in accordance with the explanation that:

3.1. Stretching Vibration

In stretching vibration, the atom moves along the bond that connects it so that there will be a change in distance between the two, even though the bond angle does not change (figure 7). Strain vibration is of two types, namely:

- A symmetric stretch, which is a unit of moving structure simultaneously and in a single plane.
- Asymmetry stretch, that is, the unit of structure moves together and is not in the same direction but still in a flat plane.

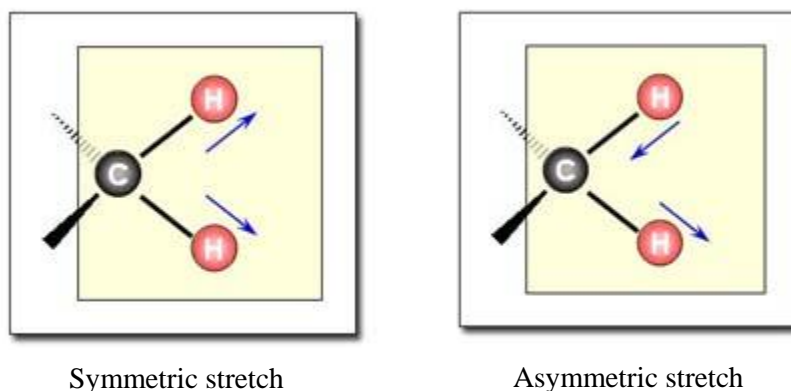


Figure 7. Symmetric stretch and Asymmetry stretch [9]

3.2. Bending Vibration

If the three-atom system is part of a larger molecule, it can lead to bending vibrations or deformation vibrations that affect the oscillation of the atom or molecule as a whole. This bending vibration is divided into four types as shown in figure 8, namely:

- Rocking Vibration*, the structure unit moves asymmetrically but still in a flat plane
- Scissoring Vibration*, the moving unit structure swings symmetry and is still in a flat plane
- Wagging Vibration*, the structure unit moves wagging out of the flat plane
- Twisting Vibration*, The rotating structure unit surrounds the bond that connects with the parent molecule and is in a flat plane

The result of the vibration is that the bond between Si-O at wave number 470.63 cm^{-1} - 1118.71 cm^{-1} and absorption 9% - 11%. This results in accordance with the X-ray pattern of the diffraction for heating temperatures of 700°C and 800°C of the XRD pattern.

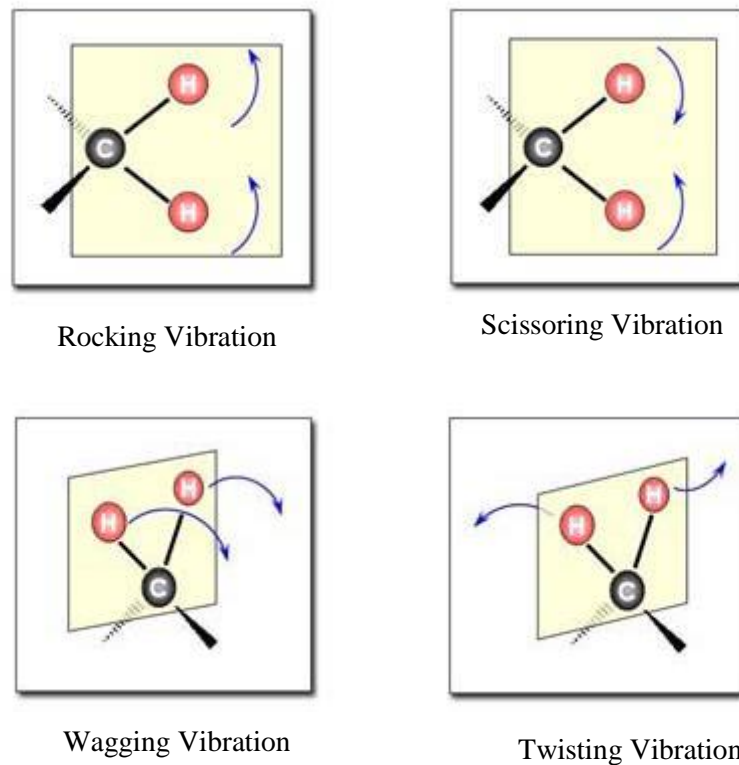


Figure 8. Four types of bending vibration [9]

In figure 9, a sample of yellow sugar cane at a temperature of 700°C has a maximum intensity at 2θ of 25.96° - 27.48°, with the XRD pattern showing a widening peak. Widening of the peak shows that SiO₂ in yellow sugar cane according to FTIR results there is a Si-O bond but XRD results show a low degree of crystallinity [7]. This explains that from the characterization process, the yellow sugar cane still has amorphous SiO₂ intensity [8].

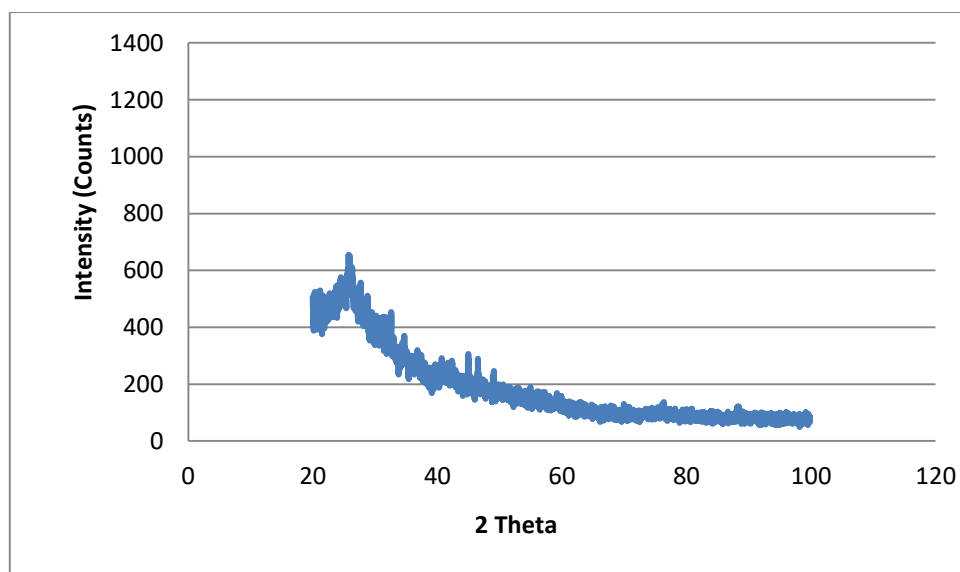


Figure 9. XRD pattern of yellow cane sample at 700 °C and 800 °C

Morphological results with Scanning Electron Microscopy (SEM) at 200X magnification (figure 10) also showed that the arrangement of the distribution of particles in amorphous solids was partly regular and slightly similar to crystalline solids. But this order is limited and does not appear in the whole solid.

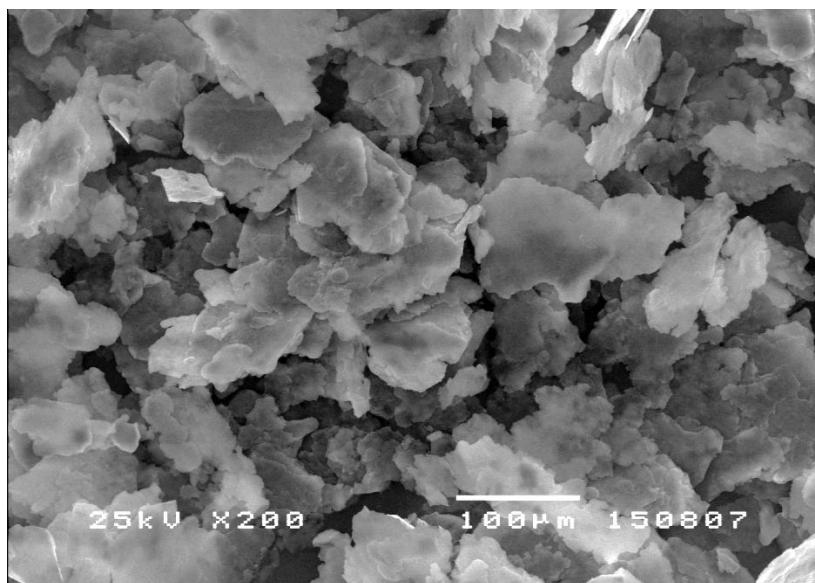


Figure 10. Image of Morphology with 200X magnification of yellow cane at 700°C and 800°C

4. Conclusion

Based on the result and discussion, it can be concluded that the absorption band formed on the wave number by the method of coating and combining is carbon-carbon single bond (CC) at wave number 354.90 cm^{-1} , single bond carbon oxygen (CO) at wave number 324 cm^{-1} , carbon carbon bond (C = C) at wave number 1519.91 cm^{-1} - 1620.21 cm^{-1} , bond single carbon hydrogen (CH), single bond hydrogen oxygen (OH) wave number 3873.06 cm^{-1} . At a temperature of 700°C and 800°C appears the single bond of silica oxygen (Si-O) which is characteristics of sugar cane ash. The Si-O bond appears at a wave number of 470.63 cm^{-1} to 1118.71 cm^{-1} . However, XRD results show that SiO₂ peak intensity at 700°C and 800°C is amorphous. Morphological results also showed that the arrangement of the distribution of particles in amorphous solids was partly regular and slightly similar to crystalline solids. But this order is limited and does not appear in the whole solid.

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