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Manufacturing Varnish from Liquid Smoke of Cashew Nut Shell Pyrolysis

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Abstract. Cashew nutshell waste from the industry is processed into liquid smoke by the pyrolysis method. During this process, the Gas Chromatography-Mass Spectrometry (GC-MS) analysis in liquid smoke produces a total of 33.7-36.6% phenol, which also acts as a synthetic substitute. Phenol is the raw material for phenolic resins used in manufacturing varnish. Therefore, this study aims to determine the varnish characteristics from the reaction between formaldehyde and phenol of liquid smoke from cashew nutshell waste. The substitution ratio between liquid smoke to phenol (w / w) is 1: 1, with the dissolution of the phenolic resin in 70% ethanol, at a density of 0.88 g / ml, a viscosity of 0.33 Cp, quasi-dry time of 1 hour, and hard drying time of 4 hours. All characteristics fulfill the Indonesian National Standard (SNI) No. 06-1009-1989, except for the evaporation level of 74.19%, which had a higher value. This result showed that liquid smoke from cashew nutshell waste pyrolysis is a potential alternative material used as a compound or substitute for phenol in manufacturing varnish.

INTRODUCTION

Cashew nutshell waste is a by-product of the cashew nut processing industry, which is processed into liquid smoke by the pyrolysis method. According to Hidayat et. al, the liquid smoke from cashew nut shells contains CNSL (Cashew Nut Shell Liquid) with a yield of 30-35% [1]. The main CNSL components are 94% cardanol acid compounds, and 6% cardols, which acts as impurities. The cardanol compounds comprise of a chemical structure similar to synthetic phenols. Therefore, it tends to substitute or replace synthetic phenol compounds from petroleum derivatives [2].

CNSL is a potential alternative material used as a phenol-substituting compound in manufacturing varnish. A homogeneous mixture of one or more synthetic or natural resin is comprised of drying oils, agents, and solvents. CNSL protects the paint layer and gives a sparkling effect on the surface of vehicles [3]. It is also a clear unpigmented coating. The term varnish is used to describe a clear group of liquids, forming a dry and glossy thin film layer when applied. According to Rokhati & Prasetyaningrum [4], during the manufacturing process, varnish is dried through evaporation from solvents, oxidation with air, and polymerization of several elements contained.

Ifa et al. [5], researched waste used to make varnishes. In addition, itsmanufacture from liquid smoke of cashew nut shell waste has been carried out by adding phenol content of 10%, a commercial varnish of 20%, chitosan [6], dammar/resin [7], Gondorukem [8], Copal [9], and tinner mixtures [3].

The purpose of this study is to make and determine the varnish characteristics from the reaction between formaldehyde and phenol of liquid smoke from cashew nutshell waste based on SNI. No 06-1009-1989.

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METHODS

The main ingredient in varnishes manufacturing is liquid smoke from the cashew nut shells pyrolysis with a phenol content of 33.7-36.6% (Ifa et al., 2018). Other materials needed are market lacquerware, distilled water, 20% formaldehyde, 45% NaOH, and 70% ethanol obtained from the Intraco Makassar store. This study starts with the manufacture of phenolic resin, which reacts with phenol and formaldehyde substituted by liquid smoke at a ratio of (w / w) 1: 1. In addition, substitution results are mixed with 20% formaldehyde at a mole ratio of 1: 2, with 45% NaOH added as a catalyst until it reaches pH 8. Polymerization is carried out at 60 ° C for 3 hours, with the condensation conducted for 1 hour to reduce the water content. The finished resin is further dissolved in 70% ethanol with a ratio (b / b) of 20% from the resin produced and analyzed [5].

RESULTS AND DISCUSSION

The varnish produced was then analyzed and compared with SNI standards No. 06-1009-1989, as shown in Table 1.

TABLE 1. The varnish characteristics from the liquid smoke produced

Varnish Characteristics	Research Results	Varnish SNI (NO. 06-1009-1989)
Evaporation material level (%), max	74,19	65
Specific weight at 28-30 ^{o}C (gr / mL) min	0,88	0,88
Dry time at 28-30 ^{o}C (hour) max		
- Pseudo dry	1	3
- Hard dry	4	6
Viscosity (Centipoise) max	0,3	0,4

The level of evaporated material produced is greater than SNI, due to the incompatible ratio of liquid smoke and phenol. An increase in the liquid smoke added leads to a rise in the varnish's water content.

The specific gravity obtained is in accordance with SNI of 0.88 gr / mL and affects the quality of the produced varnish. The specific gravity of phenol-formaldehyde determines the need for varnish topical on wood; therefore, an increase in density leads to a rise in topical need. The yield density is similar to commercial varnish specific gravity value of 0.89 [7].

A lower viscosity value below SNI is due to the unsuitable formulation of solvent concentration. Therefore, the varnish viscosity is influenced by liquid smoke concentration and reaction time. This shows that the varnish produced still has high water content, thereby influencing the dry time with an increase in topical application. Low viscosity causes the adhesion and hardness of the varnish to be low; therefore, varnish is easy to handle, with a very good flowing ability. These research results are in line with Sutanti study [10].

Table 1 showed that the drying time produced at 1 hour (pseudo), is faster than the SNI standard of 2 hours (Hard). These results are similar to the drying time for commercial varnishes at 1-2 hours [9], and 1-2.45 hours [11]. It is also in accordance with the ICI and resin varnish standard of 2-4 hours [9], and factory standard of 2-4 hours [7]. Dry time is a parameter used to determine varnish drying speed, and this occurs when solvents and other ingredients are evaporated by leaving in the open air. The phenol content in liquid smoke affects the speed and reaction time of the polymer chain formation. A longer reaction time leads to a rise in the polymer formed and an increase in molecular weight. The greater the molecular weight of the resin compound produced, the longer the drying time.

Viscosity is a parameter that indicates the resin molecular weight value. The varnish characteristic observations results showed that all parameters observed are in accordance with the SNI except the evaporation level.

CONCLUSION

Based on the research results, it can be concluded that the varnish characteristics obtained from the optimum conditions of cashew nut shells pyrolysis such as a density of 0.88 gr / mL, viscosity of 0.3 Cp, 1 hour pseudo dry time, and 4 hours hard dry time have fulfilled the SNI No. 06-1009-1989. However, the evaporation level at 74.19%

is still higher than SNI. Liquid smoke from cashew nut shells pyrolysis is a potential alternative material as a compound or substitute for phenol in the varnish manufacturing.

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