Quality Analysis of Activated Coconut Shell Charcoal Briquette Dust in Water Purification at Various Water Sources

Herry Pinatik, and Dedie Tooy

Abstract**—**This study aimed to make and analyze the quality of activated coconut shell charcoal briquette dust in the water purification for some types of water sources according to density, biodegradable iodine (I_2) absorption, and water turbidity. The method involved calculating the density and I2, as well as turbidimetry to measure the turbidity of the water sources. Results showed that the activated charcoal briquette dust met Indonesian quality standards (SNI) with a density of 0.45 g/mL (SNI 0.45–0.48 g/mL) and I2 absorption of 885 mg/g (SNI ≥750 mg/g). In the purification of several types of water sources, turbidimetry used on samples of murky water without soaking the briquettes produced results of 87 NTU (control samples) and bottled drinking water samples of 0.03 NTU. After being immersed for up to 30 min in several types of water, activated charcoal briquette dust produced a turbidity of 3.01 NTU in well-drilled water, 3.03 NTU in river water, and 3.07 NTU in pond water. Results suggest activated charcoal briquette dust can therefore lower the turbidity of drinking water according to SNI standards (0.01–5.00 NTU).

Keywords — Activated coconut shell, charcoal briquette dust, water purification.

I. Introduction

NEARLY 60% of Indonesia's population works as a farmer and depends primarily on agriculture to meet its economic needs. Coconut (*Cocos nucifera, L.),* the dominant crop, is grown mostly in North Sulawesi Province, located in the eastern part of the country. In Indonesia, coconut production per year totals 3,189,897 tons where in North Sulawesi is 270,684 tons [5].

The oil in coconut meat is primarily used as industrial feedstock, while the coconut shell is limited to household uses including energy and household goods such as coconut cups and crafts. Unfortunately, there are still many shells are left strewn on the ground until damaged and dry after the meat is removed after processing, robbing the shells of any economic value. In order to increase its economic value, recently, the coconut shells are widely used as a raw material for making activated charcoal. The activation process uses $C0_2$ gas, water vapor and chemicals to create highly porous and absorbent charcoal, excellent for use in water purification.

Many factories produce activated charcoal from coconut shells in Indonesia. High-quality activated charcoal is marketed domestically and internationally, while so-called activated charcoal dust is no longer sold, and instead left strewn or scattered on warehouse factory floors, or discarded by the company because of its harmful effects on human health.

Despite being industrial waste, coconut shell activated carbon powder is a valuable water purifier. The powder can be mixed with glue made from tapioca flour or other safe and natural materials and processed into a briquette for an easy and practical solution to water purification.

The scarcity and poor quality of water resources around the world, including in coconut-rich North Sulawesi, poses a serious problem to human life and activity both for those living in villages and urban centers. The influence of global climate change is regarded as one of the factors that negatively affects water quality in plain areas (with dug wells, river water) as well as in the mountains and valleys. Consequently water quality in Indonesia is suffering, and many are exposed to water that is cloudy, yellowish in color and has a strong odor. Much of the drinking water consumed is produced by Governments Regional Water Company, and is both expensive and uses chemical purification materials that can endanger human health.

Prevailing techniques of water purification in Indonesian society, involve several stages over one type of raw material, but the cost is relatively expensive and not environmentally friendly [6]. Despite the efforts of governments, private agencies and academicians, the cost of finding a low-technology water purification technique is relatively high. This is due to increasing populations, increased demand for individual uses such as drinking and hygiene, and even manufacturing industry needs.

This study aims to analyze the quality of coconut shell activated charcoal powder briquettes in density levels, absorption of iodine (I_2), the value of water turbidity, and the overall level of water purification, in several types of water sources.

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II. Research Methods

A. Location and Duration of Study

This research was conducted over two months at the Laboratory of Environmental Engineering of the Faculty of Agriculture, University of Sam Ratulangi Manado Indonesia.

B. Materials and Equipment

The materials used for the making of briquettes are: activated charcoal powder from the coconut processing industry, wheat starch for the manufacture of adhesives, water, 0.1 N iodine solution, sodium thio sulfate solution 0.1 N, starch solution 1%, water samples up to 1 liter each from three sources: drilled well, river, and fish pool.

The tools used are briquette pressing equipment, stove, oven dryer, glass measure, analytical scales, O-haus scales, mixer, plastic containers, glass cup and turbidimeter (turbidity level calculation tool) with neofluoro turbidimeter units (NTU).

C. Methods of Data Analysis

Two methods of analysis were used: mathematical calculations for density level (*p*) and biodegradable iodine (I_2), and turbidimetry that measure the turbidity levels in some types of water sources. The turbidimetry method is used to measure the ability of briquette activated charcoal powder to improve the level of turbidity and clarity of various types of water sources, during the period of ± 30 minutes, repeated as many as three times:

S_0: bottled mineral water (control)
S_1: well water samples
S_2: river water samples
S_3: pond water samples

D. Procedures

Procedures used in the study include four phases, namely:

1. Preparation of materials and Briquette-making

This includes the following activities:

a. Cleaning and sorting the activated charcoal powder, including separating foreign objects, and sorting by size (small pieces or dust) and weight (keeping pieces up to 225 g).
b. Making the adhesive solution: mix 75 g corn flour with 225 ml of water (ratio 1:3), cook in pan for ± 15 minutes, stir to form a uniform starch adhesive. The starch adhesive is advisable because it is synthetic but does not contain chemicals [7].
c. Mixing the briquette by stirring 75 g of starch adhesive with 225 g of cleaned and sorted activated charcoal powder (ratio 1:3) for ± 10 minutes, using a wooden stirrer, to form uniform mixture briquettes.

2. Pressing Briquettes.

Briquettes are formed from the crude mixture by placing it in a manually-operated machine. The mixture is compressed and elongated by moving a lever, and is pushed through the holes on the press tool. It is then blow dried ± 5 minutes in order to facilitate cutting into approximately 3 mm thick pellet-shaped briquettes.

3. Drying.

Cut briquettes are placed in a drying oven at a temperature of ± 60° C for 10 hours or until the moisture content reaches 2.5%. This is intended to guarantee briquettes are not easily broken or shattered, and that they last a long time immersed in water. In theory, the smaller briquettes will bind dirt particles in the water at a higher rate. After finishing the drying process, briquettes are analyzed according to density *(p)* and the absorption of iodine.

4. Testing.

The capabilities of the charcoal powder briquettes were tested on each water source. Briquettes weighing as much as 50 grams were submerged in three different measuring cups of 500ml for each water source, river water, pond water, and well water. The ratio of water samples to briquettes was 1: 10. Length of immersion time was ± 30 minutes, or when the water color changed from yellow to clear. Test results were compared to bottled mineral water. Purification levels were determined by turbidity measurements, both before and after submerging the briquettes, occasionally including longer soaking time with longer soaking time. Turbidity value describes the purity of water, and is described using a NTU value.

E. Variables observed and analyzed

1. Briquette Density (*p*) is obtained through the ratio of weight (w) and volume (V) of the briquettes using equation 1.

$$p = \frac{w}{V} \tag{1}$$

Where *p*= density briquettes (g/ml)
w= weight of briquettes (g)
V= volume of measuring cup containing briquettes (ml)

2. Capacity of iodine absorption using the titration method: Iodometry, following the Indonesian National Standard (SNI 1995 no: 06-3730) [3]. Iodine is absorbed (I_a) can be calculated by the equation 2.

$$I_a = \frac{10 - \frac{V \times N}{0.1} x 12.69 x 5}{W} \tag{2}$$

3. Turbidity value of water, measured using turbidimetry, is included in the sample of water that has undergone briquette-soaking for 30 minutes. The results are turbidity values recorded from the turbidimeter using NTU.

III. Results And Discussion

A. Briquette density

In the study, we conducted three variations in the thickness of briquettes to see its effect on the density value. The results can be seen in Table 1.

TABLE 1
Results of Measurements of The Thickness Variation on Briquette Density Values

Thickness Briquette (mm)	Density values (gr/ml) Repetition I	Repetition II	Repetition III	Average Density (gr/ml)
3	0,47	0,48	0,48	0,47
5	0,46	0,45	0,46	0,45

7	0,40	0,42	0,44	0.42

Table 1 show that briquette thickness has a variation in density ranging from 0.42 to 0.47 g/ml. According to the Indonesian National Standard [4], density requirements of activated charcoal in the granule form for water purification purposes are between 0.45 to 0.50 g/ml. From the results in Table 1 above, briquettes with a thickness of 3 mm and 5 mm have a density of 0.47 g/ml and 0.45 g/ml respectively and therefore meet the SNI density requirements. The briquettes with a thickness greater than 7 mm, however, obtained an average density of 0.42 g/ml and therefore do not meet the SNI activated charcoal density requirements.

The data indicate the smaller the thickness of activated charcoal powder briquettes, the better the density value. Therefore, the recommended briquette thickness is 3 mm.

Density value affects the ability of activated charcoal to absorb impurities or solid particles attached to or located in turbid water [1]. Maximum density value according to SNI is 0.50 g/ml [3]. This means that if the density value of solid activated charcoal briquettes or pellets is higher than the standard rate, the ability of briquettes to absorb dirt on the turbid water will be lower due to the absence of wide pores in the briquettes which serve to bind fine particles of dirt located within the water. As the pores of activated charcoal briquette powder shrink, presumably only some particles are successfully absorbed, while many particles continue to stick or bind to the water. Briquette density in the standard range of 0.45 to 0.50 g/ml specified by the SNI allows the larger pores to facilitate absorption of dirt or other particles which are inherent in murky water.

While size affects the density value of the briquettes, another determining factor is the pressure generated at the time of pressing the raw briquettes by means of a screw-type manual press tool [2].

B. Absorption Measurements of Iodine

The data show that the average absorption of iodine by activated charcoal briquettes for three variations in the thickness range is between 883-922 g/ml, which can be seen in Table 2.

TABLE 2
IODINE ABSORPTION OF THREE VARIATION OF BRIQUETTE THICKNESS

Briquette thickness (mm)	Iodine absorption (g/ml) Repetition I	Repetition II	Repetition III	Iodine absorption Average (g/ml)
3	925	924	918	922
5	899	897	894	896
7	885	884	881	883

Table 2 shows that the absorption of iodine is the highest 922 g/ml with briquette thickness of 3mm, and the absorption of iodine is lowest at 883 g/ml with briquette thickness of 7mm. These results indicate that briquette thickness affects the absorption of iodine: the lower the thickness, the higher the absorption of iodine. Briquettes with a thickness of 3 mm have an iodine absorption value of 922 g/ml.

The content of iodine absorption and binding serves to absorb dirt or water suspension just as mud, sand and smell due to metal particles or chemicals that enter the water. It can be seen, that after absorbing dirt or water suspension the color of the water becomes cloudy, yellowish and smells [3]. The high iodine absorption rate of activated charcoal powder briquettes fulfill the SNI recommended range of 922 g/ml, and are in the SNI feasibility standard of at least 750 g/ml biodegradable iodine.

C. Testing the Level of Turbidity in Briquette-Purified Water Samples

The goal was to facilitate the ability to bring a large volume of turbid water down to the recommended turbidity value using activated charcoal briquettes. This study began by measuring the turbidity of the three types of water samples (S_1 [well water], S_2 [river water], S_3 [fish pond water] samples) using a turbidimeter without soaking the briquettes, as shown in Table 3.

TABLE 3
WATER TURBIDITY VALUES

Water sources	Water Turbidity Values (NTU)
S_1 (well water)	86,01
S_2 (river water)	88,02
S_3 (fish pond water)	87,02
Average	87,01

Based on Table 3, the average water turbidity value on the three water sources was 87.01 NTU. A comparison was performed by measuring the turbidity of bottled mineral water samples (0.03 NTU).

The results of water turbidity measurements on the three (3) water samples using activated charcoal powder briquettes that were immersed for 30 minutes, with three repeat treatments, averaged 3.01 to 3.07 NTU, which can be seen in Table 5. In addition, the color of the water changed from yellowish to somewhat clear and the odor disappeared.

According to the SNI, the water turbidity value in water suitable for consumption ranges from 0.01 - 5:00 NTU.

IV. CONCLUSIONS

Activated charcoal powder briquettes are of the highest quality for water purification purposes with a thickness of 3 mm and a density value (p) of 0.47g/ml. An iodine content of 922 g/ml lowered the turbidity value of murky and odorous water from three water samples from 87.06 NTU to 3.07 NTU or lower. After soaking the briquettes for 30 minutes, the turbidity value of the water met SNI recommendations of 0.01 – 5.00 NTU for cooking and consumption.

Utilization of coconut shell processing waste into activated charcoal powder briquettes for water purification is an alternative solution addressing the water crisis in Indonesia. It is inexpensive, practical and environmentally friendly, as well as a direct economic benefit to the community.

Activated charcoal powder briquettes are found to be useful not only in turning factory waste into a product that is inexpensive to produce, but it also serves as an alternative solution to water purification that is inexpensive, simple, practical, hygienic and environmentally friendly environment because briquettes do not contain chemicals ingredients or other additives that endanger human health or the environment.

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