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The Recycle of Batik Wax: an Effort towards Environmental Friendly Process

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***Abstract*—Batik industry, an industry that widely run in Pekalongan, emerges some environmental problems. The use of various chemical agents in the dyeing process could be harmful to the aquatic life especially when the liquid waste is released without any prior treatment. While during the batik process, dye stuff and batik wax are among the major components. Both of them are used in high quantity that the recycle process will significantly minimise the next operational cost as well as minimise the water pollution.**

The used batik wax was separated from the liquid waste, the physical impurities were taken out, then the solution was neutralised and bleached. The quality of recycled batik wax was then compared to that of the new one in terms of its covering ability.

It was found that the recycle of used batik wax has successfully improved the quality of used batik wax. The process was able to refine the used batik wax with efficiency of about 85%.

Keywords—recycle, batik wax, liquid waste, quality, recycled wax

I. INTRODUCTION

The rapid development of batik industry in Pekalongan brings paradise offer as it opens job opportunities, even for not highly educated people. The industry also contributes in gaining regional income.

Pekalongan, is a city economically supported by batik industry. Among small scale industries in Pekalongan, about 83.1% is batik industry (Fajri, 2013). There were 1342 small scale industry at 2011, in which about 1115 are batik industry (Fajri, 2013). Monthly, each industry could produce about 6,000 to 20,000 pieces of fabric (Nindita et al., 2012). Nindita, et al (2012) found that the production of 40 pieces fabric released about 202.4 L dyes sewage. Awareness must be given since in among thousand textile industries, only 0.6% (Fajri, 2013) process their sewages while the rest directly discharge it without any prior treatment.

Batik wax is an agent used to resist dye absorption based on the given motif. Once the fabric is dyed, all the wax has been applied is removed. This is done by heating the wax and scraping it off and also by applying hot water and sponging off the remaining wax. The rest of the wax is mostly discharged along with the dye solution, worsen environmental pollution. It is therefore the recovery of used wax is of important. The recycled wax could be reused in the next process thereby minimise operational cost. After the wax is removed, the generated solution is filtered to recover the wax. The hydrophobicity of the wax simplify the recovery process. However, filtration process does not produce good quality wax. Further process is needed to improve the wax quality thus it feasible to be reused in the next process.

II. THEORY

Batik is a traditional Indonesia cloth, it derives from the word '*ambatik'* which means 'writing dots'. UNESCO has selected batik as Indonesian cultural heritage. Batik has permeated in Indonesian live from beginning till end. Batik cloth is used widely, from the cloth to carry the baby, daily worn clothes, academic and business clothes, and even marriage dress. Technique, technology, and decorative pattern of batik in Indonesia are set as masterpieces of the heritage of humanity (Wardani and Sitinjak, 2014).

Batik, defined as a variety of typical decorative cloth, traditionally prepared by resist dyeing method. In this application, wax is used as a resist agent. It is therefore, Doellah (2002) stated that a batik cloth must fulfill two basic principles: made by resist dyeing method and has a typical colour and distinctive decorative batik.

Batik can only be prepared by using material cloth. Initially, batik was made on a medium construction cotton cloth, known as Cambridge. Later, batik was also made on silk cloth as well as others natural materials cloth. Should be noted that synthetic cloth cannot be used in batik technique. This is due to synthetic materials cloth needs to be dyed in high temperature (Murphy, 1999). While batik wax will be melted in high temperature, therefore the pattern won't be perfectly formed.

Traditionally batik prepared by using canting to apply the wax following the given pattern. The area covered by melted wax won't be coloured. Currently, wax application is also done using cap. A combination of cap and canting is also common recently.

Batix wax is a hydrophobic agent used to resist the permeation of dyes. Moreover, batik wax is also thermoplastic, melted by heating process and solidify in room temperature. This property is contributed by the fat and oily content, as well as paraffin. Commonly, wax consisted of beeswax and paraffin. Beeswax gives a malleable property while paraffin gives a friable property. To get adhesive property, resin is usually added in the mixture. The addition of animal fats increase the liquidity.

The best wax comes from Timor, Sumbawa and Sumatra; three types of waxes are commonly used. Klowong wax is used to cover the pattern outline and small pattern inside the main decorative pattern. Tembokan wax is used to cover larger area of motif, while bironi wax is used to cover the motif area to prevent the absorption of blue dyes as background.

To maintain the wax quality, it must be kept properly, in the appropriate temperature and humidity. Clogging occurs in the canting spout when the wax is too cool. While too hot wax resulted in the quick and uncontrollable flow. The artisan blow the canting spout to ensure the clearness therefore the pattern will be drawn nicely.

The decorative pattern applied since the beginning of the 19th century has recently been developed, refined, and enhanced. For example the pattern of ceplok which also been used in the decoration of Prambanan and Penataran temples. Ceplok motif has been used as an element of temple decoration as well as applied in batik pattern (Raffles et al., 2008).

III. Experimental

A. Material

Natural materials cloth of cotton is used in this research. High thread count (densely woven) cloth is selected. The best mori cloth of primissima was purchased in batik equipment shop in Pekalongan. While sodium hydroxide, acetic acid, and hydrogen peroxide were purchased from Merck. Water was used as solvent in every step of experiment. Naphtol dyes was applied to colour the cloth. Commercial batik wax was bought in batik equipment shop in Pekalongan.

B. Methods

The primissima cloth was washed and boiled to remove any impurities like starches, lime, chalk and other sizing materials. In the scouring solution, 1 g/l sodium hydroxide was added. The ratio of cloth to scouring solution was 1:30. Cloth was pre-washed and boiled in the scouring solution for about 30 minutes. The scoured cloth was then rinsed and hung over to dry. Wax was put in the small wok and heated by spirit burner until completely melted. Motif was prepared on the cloth using pencil, followed by applying first wax on the outlined pattern. After the first wax was applied, the cloth was immersed in the dyeing bath. Dyeing solution of naphtol dyes was prepared in the tubs. Boiled water was added into the tubs and stirred to get yellowish clear solution. In this experiment, naphtol was used in the concentration of 3 g/l. The prepared naphtolate solution was then added by water in room temperature to reach a defined volume. In the other tubs, diazonium salts was mixed with water in room temperature. Diazonium salts solution was prepared in the concentration of 9 g/l. A 15 x 15 cm^2 cloth sample was used. Cloth was prewashed in a solution contained wetting agent of 1 ml/l. After the cloth was drained, it was immersed in the naphtolate solution and dipped in about 5 mins. Cloth was drained and immersed in the diazonium salts solution for 5 mins and drained. Wax was removed by using boiled water contained 1 g/l sodium hydroxide. Once the wax was removed, the cloth was dipped in water in the room temperature till the wax was harden. The wax removal solution was set aside for further process of purification.

The used wax was taken from the solution and weighted to define its percentage in the waste solution. The used wax was then melted, some water was added. The wax solution was then filtrated using muslin of Monyl. The physical impurities were left in the muslin. The wax solution was neutralised by adding acetic acid to get the original pH. There were dyes particle and other impurities in the used wax. It was therefore heating process done. The solution was then settled to get pure wax. Hydrogen peroxide in various concentrations was added to bleach the used wax.

Some testing processes were done to check the quality of recycled wax. The melting point of recycled wax was check by heating the wax and observing the temperature when the wax started to melt. Observation was also done to the time needed to completely melt the wax. Furthermore, the melted wax was put and dropped to the cloth, observation was given to the time needed to solidify the wax. The pH of melted wax was also measured.

IV. Results and Discussion

A. Wax Concentration

In this research, wax concentration in the liquid waste was defined by:

$$C = \frac{m_{w+m} - m_m}{V} \quad (1)$$

where C denotes the concentration of wax in the liquid waste (g/l), m is mass (g), w is wax, m is muslin, and V is volume of liquid waste (l). It was found that the initial wax concentration was 18 g/l while based on the above equation, after recycle process, wax concentration was 16.23 g/l.

Quantitatively, it can be described that there was a decrease in the wax concentration of about 9.83%. It was triggered by the lagging of wax in the kettle or discarded during filtration process. The fine wax also passed through the muslin, decreased the wax concentration.

B. Wax Mass

Another testing of quality was done to mass of wax. During the recycle process, there was a decrease in its mass as seen in Table I. This was due to the broken of wax structure by the use of sodium hydroxide during dyeing and wax removal process. Dyeing process using naphtol dyes needs the addition of strong alkali as sodium hydroxide. The fat contained in the wax as well as paraffin were decomposed by sodium hydroxide. Furthermore, strong alkali was also responsible for the change of fat to be soap that is soluble in the water. Could be explained that some of the wax was dissolved in the water by sodium hydroxide as soap.

TABLE I. MASS OF WAX

Mass (g)		
Original Wax	***Waste Wax***	***Recycled Wax***
1.89	1.46	1.53

The recycled wax was a bit heavier than that of waste wax. The addition of acetic acid in neutralising solution pH and hydrogen peroxide in bleaching the wax contributed in the increase of wax mass. Acetic acid was able to reconstruct the broken wax therefore the soluble soap could rebuild fat structure.

C. Appearance and Handling

Observation done to the cloth fully covered with wax shown some differences in the appearance and handling of that of original, waste, and recycled wax. Table II describes the appearance and handling of each wax.

TABLE II. APPEARANCE AND HANDLING

Characteristic	***Original Wax***	***Waste Wax***	***Recycled Wax***
Appearance	Yellow Clean Clear	Black Dirty Opaque	Brown Clean Slightly clear
Handling	Smooth Flexible	Rough Stiff	Slightly rough Slightly Stiff

The change of appearance and handling of the waste wax occurred by the dyeing process, in which some of the dye particles were dissolved in the wax. Moreover, the application of wax as the use of strong alkali caused the fibre destruction and dissolved in the wax. Observation under microscope found some fibre particles in the filtrated solution.

The recycled wax has clearer appearance than that of waste wax. This was contributed by the addition of acetic acid that reduce the wax opaque. The use of hydrogen peroxide was also helpful in improving the wax cleanness.

In case of handling, original wax has the best flexibility. This property is affected by the fat content. The effect of using strong alkali during dyeing and wax removing processes brought to the destruction of fat content. It was therefore deliver the stiff handling. The handling of recycled wax was repaired by the addition of acetic acid. It successfully neutralised some of alkali as well as repaired the fat structure in the wax.

D. Wax Physical Properties

The physical properties of original, wax, and recycled wax are shown in Table III. It is seen that original wax has the highest melting point. High melting point is desirable due to the wax won't be easily burnt. Besides, the wax application process will be more efficient because the wax temperature is more controllable.

In term of melting time, revealed that the shortest was in the order of original wax, recycled wax, and waste wax. Shorter melting time is more preferable. While the solidify time also define process efficiency. Short solidify time force us to reheat the melted wax more frequently. Moreover, it will be dry before completely permeate and absorb into the cloth, result in the less sharp pattern. Thus the pattern applied using waste wax has the worst sharpness.

Observation in the original, waste, and recycled wax gave pH data of 5.30, 4.50, and 12.00, consecutively. The dyeing and wax removal processes were done in alkali condition, therefore the waste wax was very alkali. During the recycle process, some acetic acid was added, resulted in acid recycled wax.

TABLE III. PHYSICAL PROPERTIES

Characteristic	***Original Wax***	***Waste Wax***	***Recycled Wax***
Melting point (^oC)	132.60	116.60	128.50
Melting time (s)	142.30	155.30	150.50
Solidify time (s)	16.40	9.00	17.50
pH	5.30	12.00	4.50

E. Model Analysis

The above analysis showed that the recycle process was effective to improve the mass and brightness of wax, repaired the handling of wax. The melting point was able to be increased, melting time can be prolonged, and solidify time can be shortened. The recycle process successfully decreased wax pH close to that of original wax.

Model needs to be improve by the addition of type and amount of fat instead of only acetic acid. Other type of bleaching agent should also be tested. Complete scheme of recycle model is shown in Figure 1.

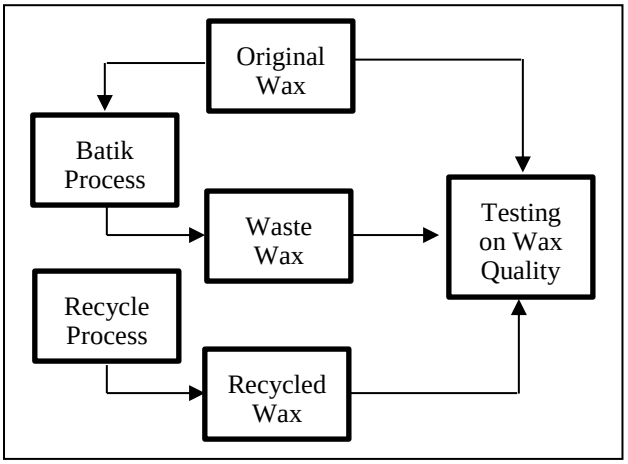

Figure 1. Scheme of recycle process

V. CONCLUSION

The recycle process of batik wax has been successfully done. The process was able to improve the wax quality that is applicable for the reuse in the next batik process. The recycled wax has good covering ability, almost the same of the original wax.

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