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Removal of COD and TSS From Dye Solution Using Sand Filtration and Adsorption

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Abstract

This research was conducted in order to obtain proper compositions and the standard condition for the simple filtration equipments and optimum operational conditions in adsorption column. The research was carried out by analyzing parameters COD and TSS. The result showed that the process was able to reduced parameters observed from filtration step until the process in adsorptions column. The optimum conditions for sand filter equipment were 10 cm sand height, at least 7 cm fibers, 3-4 cm gravel. In the adsorption column, the optimum conditions for green waste water were flow rate at 40 ml/min 60 min adsorptions time, and 60 cm bed height. While purple for waste water; 20 mL/min of flowrate, 60 min of adsorption time, and the 60 cm of bed height

Keywords: dye solution, COD, TSS, sand filtration, adsorption column

Abstrak (Indonesian)

Penelitian mengenai pengolahan limbah cair hasil pencelupan benang songket dengan metode filtrasi dan adsorpsi telah dilaksanakan. Penelitian bertujuan untuk mendapatkan komposisi dan ukuran yang tepat bagi alat penyaring sederhana dan mendapatkan kondisi operasi yang tepat bagi kolom adsorpsi. Parameter pengamatan adalah kadar COD dan TSS. Hasil penelitian menunjukkan bahwa telah terjadi penurunan kadar limbah sejak tahap penyaringan hingga proses di kolom adsorpsi. Kondisi optimum alat penyaring sederhana adalah ketebalan pasir 10 cm, ijuk minimal 7 cm, kerikil 3-4 cm dan penambahan tawas sebanyak 2g/L limbah. Pada kolom adsorpsi kondisi optimum adalah kecepatan alir 40 mL/menit, waktu tinggal di kolom 60 menit dan ketinggian unggun batubara 60 cm.

Kata kunci: limbah cair pencelupan, bahan-bahan berbahaya, filtrasi pasir, kolom adsorpsi

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INTRODUCTION

There are several centres in Palembang Songket industry that can be found in the district of Ilir Barat II and the area 14 Ulu. The process of making Songket certainly was preceded by activities of dyeing yarn. Each dyeing process wastewater will produce 40 L/day for one set limar for one type of colour, while the colour that is used sun dry. The number of business units dyeing yarn in Palembang Songket are 83 units. Within a month its produced 1200 L of waste water, or 438,000 L/year for one type of colour. When the colour used consisted of 5 different colours it will produce liquid waste as much as 2.19 million L/year. The majority of the industry Songket is a domestic industry which is not equipped with adequate waste water treatment [1].

Liquid effluent will primarily have an impact on the water environment. Negligence in the management of the waste water would endanger the Musi river, which will cause a decrease in water quality or even damage the whole aquatic ecosystem. Management is not only dealing with the waste water itself but can also be carried out or started from the production process itself [2]. The main difficulty of dyeing effluent treatment is the removal of pigment and organic matters. Dyes from wastewater contained in the particles dense. With the removal of solid particles, the pigment density can be reduced. The concentrated pigment also cause death to aquatic biota and oxygen deficiency [3].

There have been many studies done on wastewater treatments such as coagulation-flocculation followed by sedimentation [4], flotation [5], oxidation and reduction processes [6], and the latest is using membrane technology [7]. All of these technologies have advantages and weaknesses. The most frequently used process is adsorption. Several types of adsorbents were used in the process of waste treatment, among others: the active carbon [8], clay [9] and coal granules [10]. In this study, dyeing yarn Songket was treated using an integrated method, coagulation, sand filtration and activated carbon made of granular coal to remove the COD and TSS content.

MATERIALS AND METHODS

Materials

Waste water contained pigment purple and green were obtained from local Songket industry, alum was purchased from local chemical supplier, river sand, coconut fibers and gravel were purchased from local market whilst coal granules provided by PT Bukit Asam.

Methods

The initial sampling of wastewater was conducted by gathering liquid waste yarn dyeing results from Songket industry to be discarded and collected in big plastic can of 20 L. Liquid wastes taken contained purple and green pigment.

A small portion of the liquid waste (approximately 1 L) was checked in the laboratory to examine the content of COD and TSS. Liquid waste was added with alum and then stirred to formed homogeneous solution. The solution was filtered in order to reduce the intensity of the pigment color in the liquid waste. The filtrate is collected in a large plastic size 20 L transparent and sample was taken a small portion to be examined its content in a laboratory. At this stage a number of variables experiment including dose of coagulant, the thickness of sand, fibers and gravel, the inlet flow velocity and flow rate were evaluated.

Adsorption column which had been installed with granular activated carbon coal was fed with liquid waste with a specific discharge. In the adsorption column there are four sampling points that reflect the height of the bed. At any given time, samples were taken from certain point of column. All of the samples obtained were subjected to analysis of COD and TSS in Chemical Analysis Laboratory Chemistry Department, Faculty of Mathematics and Science, University of Sriwijaya Indralaya.

RESULT AND DISCUSSION

Dyeing of yarn used for making Songket the process was preceded by the concoction of dye followed by addition of fresh water 40 L. Yarn was soaked for 15 min in order to achieve homogeneous dyeing process and well penetrated into the yarn.

Surface morphology of sand be used in filtration and adsorption

Figure 1 shows the SEM image sand be used for filtration and adsoprtion process. The sand filtration having hydrophobic character. Because of this characteristic, the sand was able to make a strong interaction with suspended solid and then make a cake layer. The cake layer trapped on the pore surface contain most of the small particle include colour and dissolve solids. The capabilities of granular activated carbon coal to adsorb foulants are come from the negative charge on it. The negative charge of granular activated carbon coal neutralizes the positive charge of impurities of dye make it attracted and trapped on the surface of adsorbent [10]. From the figure, it is seen that the surface of adsorbent is full of foulants.

Effect of the filtration process on reducing COD

Prior the filtration process, sample was added with the coagulant, aluminum sulfate, about 2 grams per litre of waste water. This step was supposed to make bigger molecule of pollutant so it was easy to sediment on the surface of sand. The effect of the filtration process to decrease COD values is shown in Figure 2. It is shown decreased substantially on wastewater green colour about 96%. This means that the process of adsorption of chemical compounds is progressing well. Likewise, the intensity of the colour of the liquid waste is very much reduced. For liquid waste in purple, the amount of decrease reached more than 50%. With the state of the liquid waste filtration result was mauve. It can be concluded that there is a close correlation between the dye with COD. The decrease in the value of COD is always followed by a decrease in the intensity of the colour of the waste and vice versa.

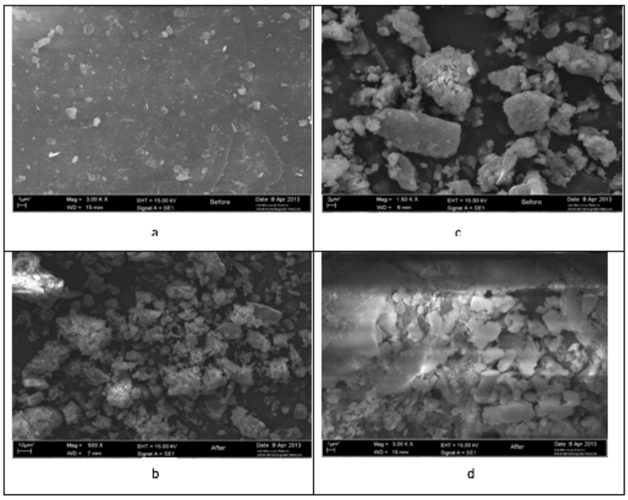

Figure 1 SEM images: a) Before filtration b) After filtration c) Before adsorption d) After adsorption

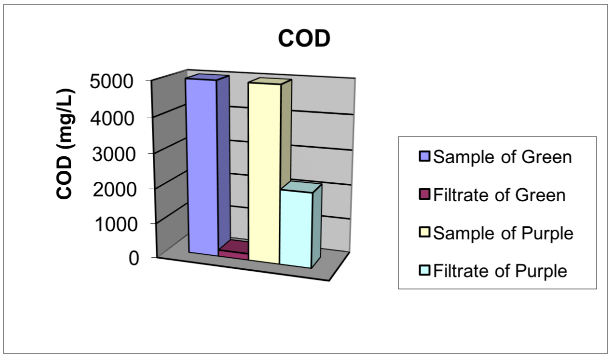

Figure 2 The effect of filtration process on COD

Effect of the filtration process on reducing TSS

The effect of the filtration process on the decrease of TSS is shown in Figure 3. It is quite noticeable that decrease in TSS showed large value for green waste around 99%. This means that almost all of colloidal particles in the liquid waste can be adsorbed by the sand. With the addition of coagulant alum the screening process quicker and easier. Purple effluent TSS lessen was almost 50%. This situation may be due to the nature of a very strong purple colour binds to water (hydrophilic). Therefore, it still needed further process in this case chosen was the adsorption process.

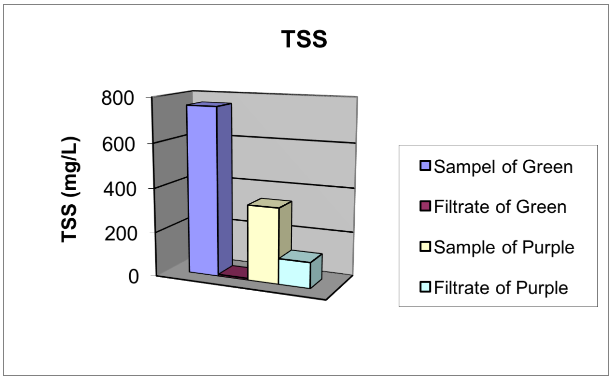

Figure 3 The effect of filtration process on TSS

In the waste treatment process carried out, dye filtration obviously occurred by sand media. This is evident from the colour samples of filtration is considerably reduced in intensity than the initial sample waste. The sand used is a fine river sand. In the structure above the sand, fibers in the middle and gravel under the screening process takes place in a simple. Preceded by the addition of alum coagulant which aims to enlarge the molecule particle filtering process takes place more easily.

The composition and the optimum size for the filtration process as follows: coagulant dose: 2g /L of waste, the thickness of the sand at least 10 cm, the thickness of the fibers 7 cm, and the thickness of the gravel between 3-4 cm.

Effect of adsorption processes to decrease the value of COD

The effect of adorption process to COD values is shown in Figure 4. It is showed that adsorption process goes well. Lowering COD is significant both for wastewater green or purple. In wastewater treatment, green colour was seen that liquid waste processing with incoming feed flow rate higher (40 mL/min) is better than a flow rate of 30 mL/min. It is inversely proportional to the circumstances at the sewage treatment purple. This situation is caused by the processing of green waste does not necessarily need intensive contacts between activated carbon coal with waste since most of the impurities have been absorbed by the sand filter. As for the waste purple still require intensive contacts. Therefore, the smaller the flow rate used, the better the result.

There are four different bed heights i.e. 20 cm, 40 cm, 60 cm and the bottom of the column. Among all bed height variation, it was indicated that the height of bed, 60 cm is the best condition. Higher bed height means longer contact occured before the results obtained. The height of the bed is proportional to the adsorption time provided more contact occured hence longer time for adsorption. Variable time of 60 min is the maximum adsorption time that can be achieved in this study.

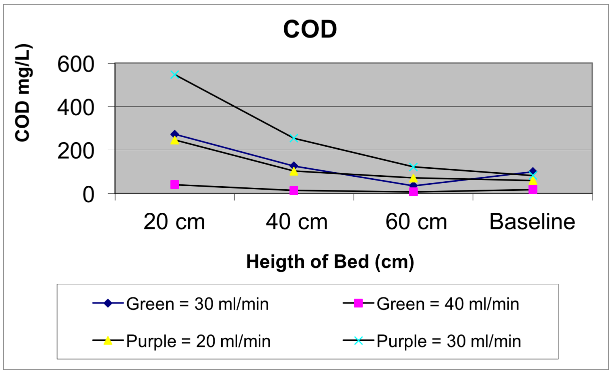

Figure 4 The relationship between the adsorption process to COD

Effect of adsorption process to decrease TSS

Effect of adsorption process against TSS values shown in Figure 5. As showed in figure, the best conditions for a green liquid waste treatment are flow rate 40 mL/min with a bed height 60 cm and adsorption time 60 min. For purple liquid waste, the best conditions are a flow rate 20 mL/min, a height 60 cm and a bed of adsorption time 60 min. The adsorption process has a great influence on the removal of most of the TSS. This was confirmed in purple wastewater treatment, where the majority of colloidal particles can be removed. This means the treatment of wastewater by adsorption column can be used to remove the colloidal particles which hard to remove by filtration processes.

Adsorption is very useful for separating a compound or substance from a liquid phase. The process usually followed by accumulation or concentration of the surface of another phase (solid phase). In a typical process, the particles of the solid phase is packed in a column and the liquid to be absorbed flowed through the solid phase resulting in a process of adsorption until solid phase is become saturated and the desired separation can no longer take place.

From the table and graph ilustrated results of sample analysis is was indicated that for green waste processing with debit feed 40 mL/min had better result than the discharge 30 mL/min. In contrast to the purple colour waste, process with debit feed 20 mL/min is better than the discharge 30 mL/min. This means that for green waste processing with a larger flow rate result in successfully adsorbed waste. In contrary, the purple colour waste processing at smaller flow rate gave better result.

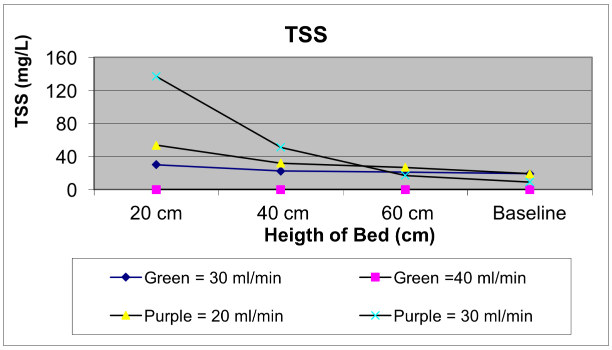

Figure 5 The effect of adsorption process on the value of TSS

Variation of adsorption duration time was shown in the graph, both green and purple colour waste gave better result of adsorption process in longest time. This fact is shown by graphs that at t=60 min, the rate of decrease in waste parameters experiencing the process mostly displayed good result

At the beginning of adsorption process, (t = 0 min) waste particles can not be well adsorbed by activated carbon originated from coal. This is probably due to the diffusion process of newly waste particles to the surface of the coal so that just small amount of particles were adsorbed. At time t = 30 min, particle diffusion process wastes have been entered into the pores of activated carbon coal waste and more particles are adsorbed. Recently at t=60 min, almost all the particles of waste have been trapped in the pores of coal and even result in coal becomes saturated. This can be seen from the parameter value of the sample point basis column showing the recovery in waste parameter values.

For bed height variation, shown in the graph either on the green or purple colour waste that the longer adsorption takes place, the better the adsorption process. Therefore the optimum height of the bed either on sewage treatment green and purple are at h = 60 cm.

CONCLUSION

It can be concluded from above discussion that the composition and size of the sand filter tools are: sand with a thickness 10 cm, fibers with a thickness at least 7 cm, gravel with a thickness 3-4 cm, coagulant alum 2 g/L of waste. The optimum operating conditions for the tools adsorption column is: feed the input flow rate 40 L/min, a 60 min adsorption bed height 60 cm.

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