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Paraserianthes Falcaria Activated Carbon for the orption of Heavy Metal Fe^{+3} in Simulated Waste Water

Suparno and Rina Rahmawati

—An Atomic Absorption Spectroscopy has been lyze absorption of Fe^{+3} ions by activated carbon serianthes Falcaria wood. This was done to make sily grown plant as material for producing carbon r heavy metal filtration system. Carbon made of thes Falcaria wood was grinded and sieved to This carbon was chemically and physically activated g used to absorb Fe^{+3} ions in simulated waste water. ration of Fe^{+3} ions in the simulated waste water and d carbon mass were varied. The results show that ption efficiency increases with the increase of carbon mass. On the other hand the absorption decreases with the increase of Fe^{+3} ions concentration d waste water.

***Terms*—Paraserianthes Falcaria, activated carbon, atomic absorption spectroscopy.**

I. Introduction

l disaster such as earthquake, tsunami, flood, and often force people living in the disastrous area to out clean water. The well water was contaminated. er line was cut off. Electricity network was disabled r infrastructure was destroyed. This makes people der to find access to clean water. In fact no one can thout clean water for relatively long period of time.

s techniques have been used to produce clean and ter such as reverse osmosis, absorption, filtration, mentation. Reverse osmosis have been used to ed sea water. Absorption has been used to clean ter by means of various absorbents including coconut rbon [1]. Filtration has been used to filter the s, and contaminants out of the water. Sedimentation e has also been used to sediment the dirt that is d in the water leaving the upper part of the water to

vated carbon has been widely used as absorbent in s filtration systems. This has also been used as ntation agent with the same purpose to obtain clean n areas hit by natural disaster [2]. Characterization of ed carbon has been done by many researchers for s reasons [3]-[5]. Apart from being used in water ment system [6]-[8] activated carbon has also been n medical area [9]-[11]. Besides absorption due to its s character, the large surface area of activated carbon en explored for adsorption [12]-[15]. Activated carbon is available in form of powder and granular. Aispuru has been using granular activated carbon for biofiltration [16]. Many researchers has been using coconut shell as material for manufacturing activated carbon. However as the need of coconut shell charcoal increases the supply of coconut shell carbon reduces. In order to maintain the supply level of carbon some alternative materials for making carbon should be found. In an effort to find suitable material for making carbon as absorbent, *Paraserianthes Falcaria* locally known as *Sengon Laut* was introduced to make activated carbon. This wood was chosen since it is easily found through out Indonesian archipelago and is easily grown. This plant grows incredibly fast. It may reach up to seven meters high within the first year of planting and it is possible to mass produce *Paraserianthes Falcaria* by opening new plantation grounds in large areas all over the country. Therefore the supply of *Paraserianthes Falcaria* wood for manufacturing carbon will be secured. This new plantation will also be beneficial to support the green living style. More oxygen needed for everyone will be produced by new plantation of *Paraserianthes Falcaria*. Furthermore the plantation will counter balance the deforestation process that is happening in many places in the country. By applying credible and accountable management system the supply of *Paraserianthes Falcaria* wood for manufacturing carbon may be sustainable. In addition to the above, the waste product of the wood factories using *Paraserianthes Falcaria* wood as raw material may also be used for making carbon.

script received November 9, 2013; revised January 16, 2014.
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II. Carbonation and Activation

Carbonation took place in a carbonation chamber. *Paraserianthes Falcaria* wood was burnt in a combustion chamber at 400°C for 4.5 hours. This process was done in an air proved chamber to make sure that oxidation that results in ash does not occur. The process, which is called pyrolysis results in carbon instead of ash. This carbon was then grinded into very small powder and sieved to 100 meshes.

This 100 mesh carbon powder was chemically activated. The carbon powder was soaked in a strong acid, which was 12% Phosphoric Acid, H_3PO_4 for 24 hours. This was aimed to destroy any organic materials present in the pores of the *Paraserianthes Falcaria* carbon. Any material presents in the pored reduces the absorption capacity of the carbon. Therefore, chemical activation is extremely important to enlarge the pores by removing any organic materials from the pores.

After being chemically activated the carbon was rinsed using clean water to flush all destroyed material from the pores. This rinsing was also used to neutralize the pH of the

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carbon to approximately neutral (pH 6 to 7), since an unpublished research showed that the absorption profile show the highest absorption occurs at pH 6-7.

Before being used the carbon was physically activated by heating it in an oven at 200°C for 60 minutes. This was aimed to enlarge the capacity of the pores by vaporizing any water molecules left in the pores. All carbon powder used in this research was chemically and physically activated in the same way.

III. Sample Preparation and Experimentation

The simulated standard sample was prepared by dispersing 16.22 grams of *Ferric Chloride*, $FeCl_3$ in a liter of water to make a dispersion of 0.1M $FeCl_3$. Two other samples with concentrations of 0.05M and 0.01M were derived from the above standard sample by using Equation 1.

$$V_1M_1 = V_2M_2 \quad (1)$$

where V_1 is volume of the standard sample, M_1 is concentration of the standard sample, V_2 is volume of the prepared sample, and M_2 is concentration of the prepared sample.

It should be noted that all samples are relatively stable colloidal solutions. The dispersed particles are charged, so that there will be electrical double layer around the particles that prevents the particles from aggregation [17]-[19]. Various techniques may be used to determine the surface charge of the colloidal particle [20]-[22] and the applications of these techniques have been published [23]-[25].

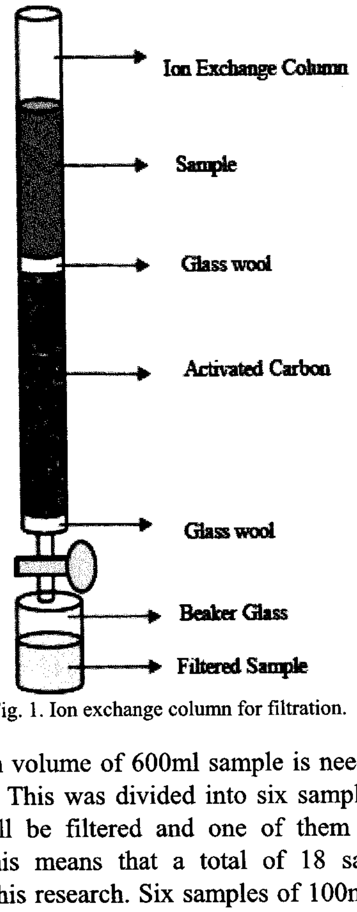


Fig. 1. Ion exchange column for filtration.

A minimum volume of 600ml sample is needed for each concentration. This was divided into six samples of 100ml each, five will be filtered and one of them will be left unfiltered. This means that a total of 18 samples were prepared for this research. Six samples of 100ml volume of 0.1M concentration, six samples of 100ml volume of (
concentration, and six other samples of 100ml volu
0.1M concentration.

Five samples of the same concentration were filtered
five different masses of carbon, one for each mass of c
Which were 5g, 10g, 15g, 20g, and 25g. Filtration p
was done in an ion exchange column. Some glass wo
laid on the bottom of the ion exchange column t
activated carbon powder above it. Five grams of act
carbon was put above the glass wool and another sh
glass wool was laid on top of the carbon. The 100ml s
was poured into the column to be filtered. Each of the f
sample was placed in a marked file and ready for A
Absorption Spectroscopy (AAS) analysis. This pro
was repeated for all 15 samples. The unfiltered sampl
for each sample concentration, were also sent fo
analysis. These three original unfiltered samples were
standards for determination of absorption efficiency.

The absorption efficiency, A_f was determined by Equation 2.

$$A_f = \frac{(C_0 - C_1)}{C_0} x100\%$$

where C_0 is the concentration of Fe^{+3} in the unfiltered
and C_1 is the concentration of Fe^{+3} in the filtered s
Graphs of the absorption efficiency against the m
carbon for the three sample concentrations are pr
below.

IV. Absorption Profile

Five different masses of carbon were prepared f
collection for each sample concentration ranging fro
25g with the increment of 5g. The absorption effic
Paraserianthes Falcaria activated carbon on 0.01M
Chloride sample concentration versus mass of ca
presented in Fig. 2.

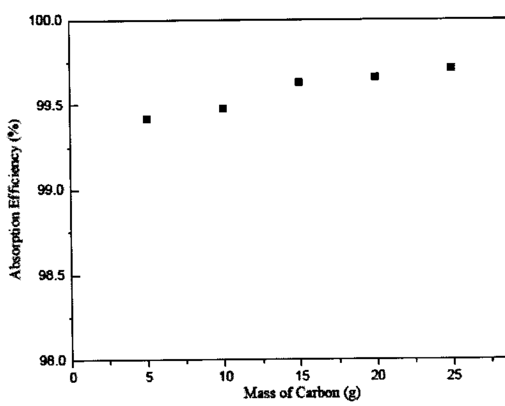
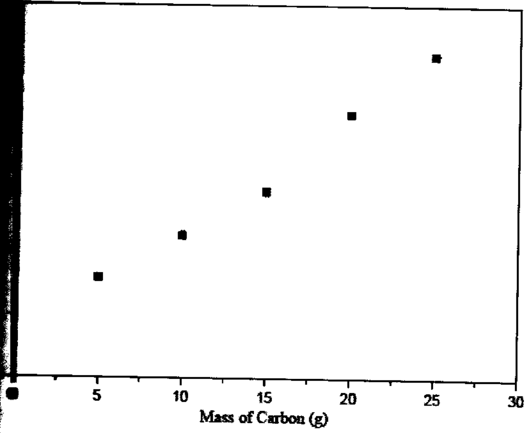


Fig. 2. Absorption profile of activated carbon on 0.01M sam
concentration.

The data show that the absorption efficien
Paraserianthes Falcaria activated carbon on F
extremely high. It ranges from (99.42 ± 0.00)% for
of carbon to (99.71 ± 0.00)% for 25g mass of carb
probably due to relatively low concentration of sa

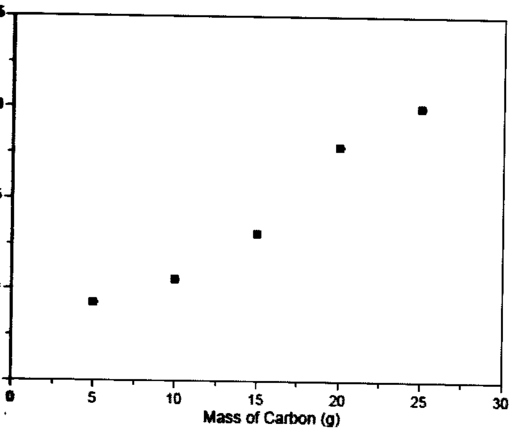
pores of carbon available for filtration. The that the absorption efficiency steadily the increases of mass of carbon.

efficiency of *Paraserianthes Falcaria* on 0.05M *Ferric Chloride* sample versus mass of carbon is presented in Fig. 3. that the absorption efficiencies of carbon for concentrations are significantly lower those of 0.01M. The higher the sample the lower the absorption efficiency. On the the absorption efficiency increases sharply with of mass of carbon.



rption profile of activated carbon 0.05M sample concentration.

bsorption efficiency of *Paraserianthes Falcaria* carbon on 0.1M *Ferric Chloride* sample ation versus mass of carbon is presented in Fig. 4.



sorption profile of activated carbon 0.1M sample concentration.

ata in Fig. 4 show much lower absorption es compared to those of previous two sets of data. t be understood as too excessive amount of sample be absorbed and adsorbed by the same amount of tained in the same mass of carbon. Much more Fe^{+3} e solution and recorded by the AAS, so that the n efficiency calculated by Equation 2 will be lower. the concentration of sample presented in Figure 4 is higher than that of in Fig. 1.

omparison of the three absorption profiles is in Fig. 5. These data show that *Paraserianthes* activated carbon is extremely superior for the n of relatively low *Ferric Chloride* concentrations. hows relatively high absorption coefficient for moderate Ferric Chloride concentration i.e. 0.05M. The absorption efficiency fell off sharply for 0.1M. This might suggest to increase the mass of carbon for relatively high sample concentration.

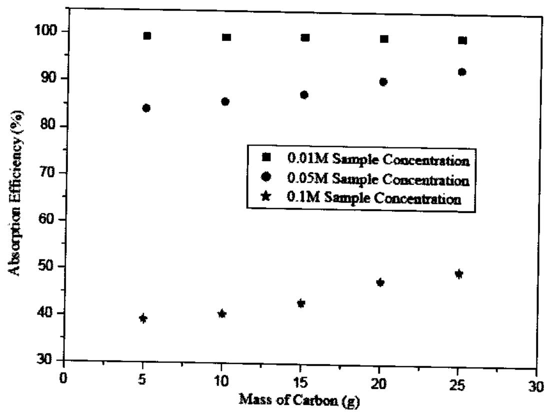


Fig. 5. Overall absorption profile of activated carbon.

V. Conclusion

Activated carbon made of *Paraserianthes Falcaria* wood was proven to be efficient for the absorption of heavy metal Fe^{+3} in Ferric Chloride, especially in relatively regime of Ferric Chloride concentration, (0.01 – 0.05)M. The absorption efficiency for this concentration range fell between (84.02 ± 0.07)% to (99.71 ± 0.07)%. This suggests that *Paraserianthes Falcaria* wood may be used as alternative material for manufacturing carbon for filtration system instead of coconut shell.

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