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

Suparno and Rina Rahmawati

***Abstract*—An Atomic Absorption Spectroscopy has been used to analyze absorption of $Fe^{+3}$ ions by activated carbon made of Paraserianthes Falcaria wood. This was done to make use of this easily grown plant as material for producing carbon suitable for heavy metal filtration system. Carbon made of Paraserianthes Falcaria wood was grinded and sieved to 100mesh. This carbon was chemically and physically activated before being used to absorb $Fe^{+3}$ ions in simulated waste water. The concentration of $Fe^{+3}$ ions in the simulated waste water and the activated carbon mass were varied. The results show that the absorption efficiency increases with the increase of activated carbon mass. On the other hand the absorption efficiency deceases with the increase of $Fe^{+3}$ ions concentration in simulated waste water.**

***Index Terms*—Paraserianthes Falcaria, activated carbon, Fe+3 ion, atomic absorption spectroscopy.**

## I. Introduction

Natural disaster such as earthquake, tsunami, flood, and landslide often force people living in the disastrous area to stay without clean water. The well water was contaminated. The power line was cut off. Electricity network was disabled and other infrastructure was destroyed. This makes people even harder to find access to clean water. In fact no one can stand without clean water for relatively long period of time.

Various techniques have been used to produce clean and fresh water such as reverse osmosis, absorption, filtration, and sedimentation. Reverse osmosis have been used to neutralized sea water. Absorption has been used to clean dirty water by means of various absorbents including coconut shell carbon [1]. Filtration has been used to filter the pollutants, and contaminants out of the water. Sedimentation technique has also been used to sediment the dirt that is dispersed in the water leaving the upper part of the water to be clean.

Activated carbon has been widely used as absorbent in various filtration systems. This has also been used as sedimentation agent with the same purpose to obtain clean water in areas hit by natural disaster [2]. Characterization of activated carbon has been done by many researchers for various reasons [3]-[5]. Apart from being used in water management system [6]-[8] activated carbon has also been used in medical area [9]-[11]. Besides absorption due to its porous character, the large surface area of activated carbon has been 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.

## II. Carbonation and Activation

Carbonation took place in a carbonation chamber. *Paraserianthes Falcaria* wood was burnt in a combustion chamber at 400$^{o}$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.

$$V_1 M_1 = V_2 M_2 \quad (1)$$

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].

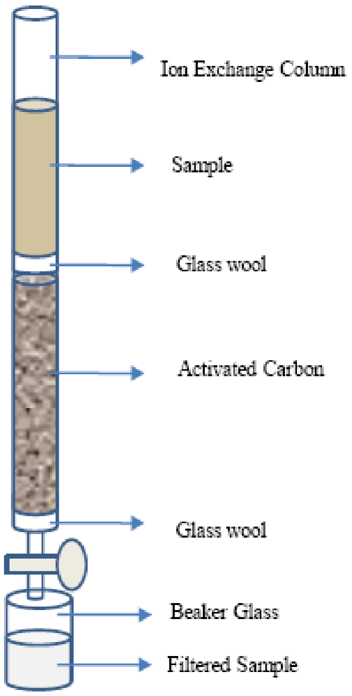


Fig. 1. Ion exchange column for filtration.

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 0.05M concentration, and six other samples of 100ml volume of 0.1M concentration.

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

The absorption efficiency, $A_f$ was determined by using Equation 2.

$$A_f = \frac{(C_0 - C_1)}{C_0} x100\% \quad (2)$$

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

## IV. Absorption Profile

Five different masses of carbon were prepared for data collection for each sample concentration ranging from 5g to 25g with the increment of 5g. The absorption efficiency of *Paraserianthes Falcaria* activated carbon on 0.01M *Ferric Chloride* sample concentration versus mass of carbon is presented in Fig. 2.

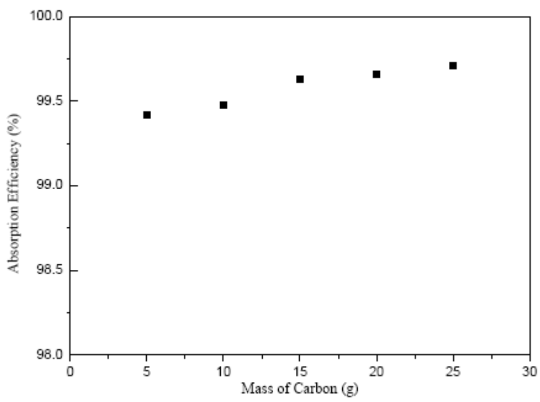


Fig. 2. Absorption profile of activated carbon on 0.01M sample concentration.

The data show that the absorption efficiencies of Paraserianthes Falcaria activated carbon on $Fe^{+3}$ are extremely high. It ranges from (99.42 ± 0.00)% for 5g mass of carbon to (99.71 ± 0.00)% for 25g mass of carbon. This probably due to relatively low concentration of sample and relatively large pores of carbon available for filtration. The data also show that the absorption efficiency steadily increases with the increases of mass of carbon.

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

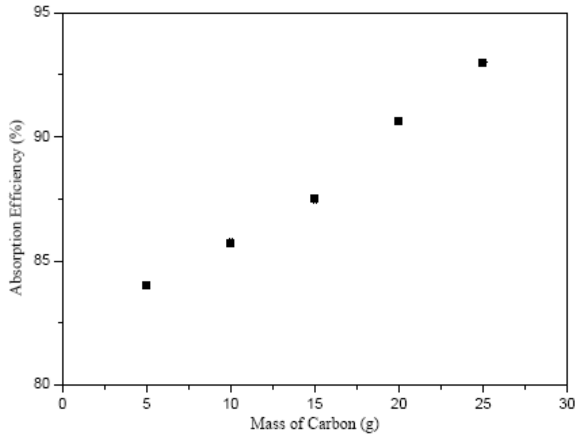


Fig. 3. Absorption profile of activated carbon 0.05M sample concentration.

The absorption efficiency of *Paraserianthes Falcaria* activated carbon on 0.1M *Ferric Chloride* sample concentration versus mass of carbon is presented in Fig. 4.

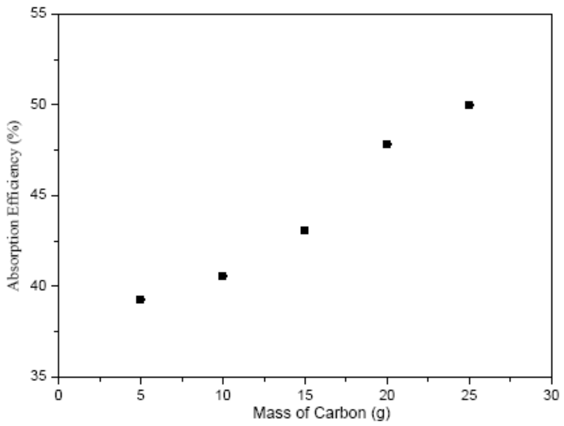


Fig. 4. Absorption profile of activated carbon 0.1M sample concentration.

The data in Fig. 4 show much lower absorption efficiencies compared to those of previous two sets of data. This might be understood as too excessive amount of sample that has to be absorbed and adsorbed by the same amount of pores contained in the same mass of carbon. Much more $Fe^{+3}$ stay in the solution and recorded by the AAS, so that the absorption efficiency calculated by Equation 2 will be lower. Note that the concentration of sample presented in Figure 4 is ten times higher than that of in Fig. 1.

The comparison of the three absorption profiles is presented in Fig. 5. These data show that *Paraserianthes Falcaria* activated carbon is extremely superior for the absorption of relatively low *Ferric Chloride* concentrations. It still shows 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.

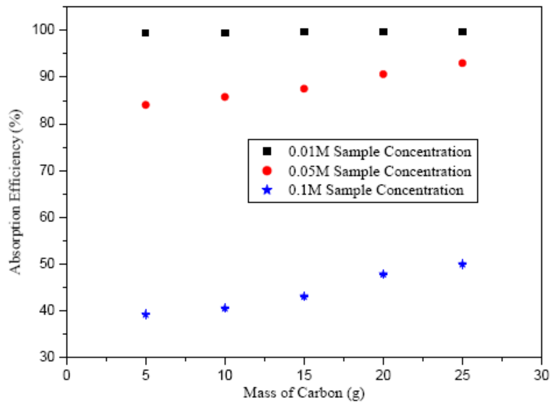


Fig. 5. Overall absorption profile of activated carbon.

## 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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