IMPROVING THE EFFICIENCY OF CONVENTIONAL DRINKING-WATER-TREATMENT PROCESSES IN THE REMOVAL OF ARSENIC

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ABSTRACT

Since Vietnam is one of the most rice producing countries in the world, a huge amount of rice hull waste produced every year has been raising environmentally significant concerns. This study aims to build a model of improving the efficiency of the treatment process of removing arsenic from drinking water using activated carbon derived from rice hull. In this model, the efficiencyof treatment process is optimized due to the combination of the advantages of iron and activated carbon. The iron hydroxide phases can improve maximum adsorption capacity and the activated carbon can offer a high surface area for adsorption.

Keywordss: *Drinking-water-treatment, removing arsenic, rice hull, activated carbon.*

INTRODUCTION

Arsenic contamination has been a considerable concern in many areas in Vietnam. Arsenic element existing in nature as As(III) and As(V). It is important to remove both species of arsenic from drinking water. Many studies have been conducted to produce activated carbon from rice hulls for arsenic removal. However, the arsenic removal rate of activated carbon is not high enough to fulfill health standards.

The most common process used to produce activated carbon is chemical process. During this process, carbonization and activation occur at the same time. A chemical (dehydrating) agent such as zinc chloride is used to decompose the cellulose of rice hull.

An issue during this process is thatthe efficiency of the removing metal irons is still limited. This study aims to improve performance of activated carbon, in order to improve the efficiency of the removing arsenic irons from drinking water.

2A model of improving the efficiency of the removing arsenic from drinking water process

This process combines the advantages of both, iron and activated carbon. The Iron hydroxide phases increase the adsorption capacity. Activated carbon can offer a high surface area for adsorption.

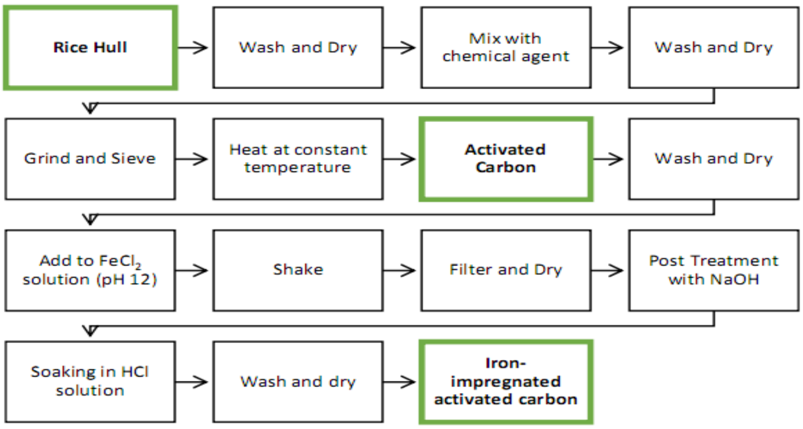

Figure 1. *Iron-impregnated activated carbon process for removing Arsenic irons**

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Table 1. *The description of producing Iron-impregnated activated carbon for removing Arsenic irons*

	Description	Temperature	Time	Equipment
Step 1	Washing 100g Rice Hull	RC		Deionized water
Step 2	Drying	80°C	5 hours	Furnace
Step 3	Mixing with 1.0 M NaOH solution	RC	10 hours	40g NaOH, 1 L Deionized water
Step 4	Washing until the base is undetected in the filtrate	RC		Deionized water
Step 5	Drying until constant weight	80°C		Furnace
Step 6	Grinding and sieving	RC		Siever and Grinder
Step 7	Covering with aluminum foil, placing in alumina crucible, capping with an alumina cover	RC		aluminum foil, alumina crucible with lid
Step 8	Placing in furnace	800°C	2 hours	Furnace
Step 9	Cooling	RC		
Step 10	Rinsing three times in deionized water	RC		Deionized water
Step 11	Drying Furnace	110°C	10 hours	Furnace
Step 12	Cooling	RC		
Step 13	$FeCl_2$ (5.5g) is dissolved in 100ml deionized water. Adding NaOH to ferrous chloride solution until pH 12	RC		5.5g $FeCl_2$, 100 ml Deionized water, NaOH
Step 14	Adding AC (30g) to solution without headspace	RC		Glass bottle with lid, 250ml
Step 15	Shaking		24 hours	Rotator
Step 16	Filtered			Filter Bag
Step 17	Drying	110°C	10 hours	Furnace
Step 18	Cooling	RC		
Step 19	Mix Fe-AC with 1M NaOH for 24 hours	RC	24 hours	40g NaOH 1L Deionized water
Step 20	Soaking	RC	24 hours	100 ml 38% HCl
Step 21	Washing and Drying	RC		Deionized water

∗ *RC: Room temperature*

DISCUSSION

Choosing chemical agent NaOH

In this process,the silica in the rice hulls reacts with NaOH forming sodium silicate which leads to a porous surface area. Using NaOH as a chemical agent results in a comparable low surface area with a big pore volume. It is used here for two reasons. Firstly,Qigang*et al.* [1] state in their report that the best results of coating activated carbon with iron take place using a macro pore activated carbon which means a low surface area and a large pore volume. This is because the large pores Fe^{3+} can enter deep into the activated carbon. Using activated carbon with small pores leads to an impregnation only on the surface of activated carbon. Secondly using NaOH will simplify the process since it is also used for further steps. The impact of NaOH on rice hulls is shown in the picture stated below.

Choosing impregnation with Fe^{2+}

In this process impregnation with Fe^{2+} is chosen. Iron forms an amorphous layer of iron oxides on the activated carbon surface. Due to this layer the net positive surface charge of the activated carbon is increased and therefore the arsenic removal capacity of activated carbon is enhanced. Arsenic adsorption to iron oxide-hydroxide surfaces can be described by the ligand exchange mechanism. In the adsorption process, arsenic species can replace hydroxyl ion (OH-) on the surfaces of iron oxide-hydroxides, forming inner-sphere complexes [3]. Furthermore ferrous is soluble at a wide range of pH and can diffuse deep into the internal pores of the activated carbon. The degree of impregnation onto the activated carbon surface is maximal when the net charge of the activated carbon surface becomes negative. The net surface charge is highly dependent on the pH. Therefore the pH of the ferrous solution is increased to pH 12 by adding NaOH.

CONCLUSION

The removal rates of toxic metals have been very promising and with adaptions like iron-impregnation the results can be even improved. The model of the process to produce iron-impregnated activated carbon for arsenic removal is a combination of a variety of processes and could improve the arsenic removal rate of activated carbon, in which iron hydroxide phases increase the adsorption capacity and activated carbon offer a high surface area for adsorption.

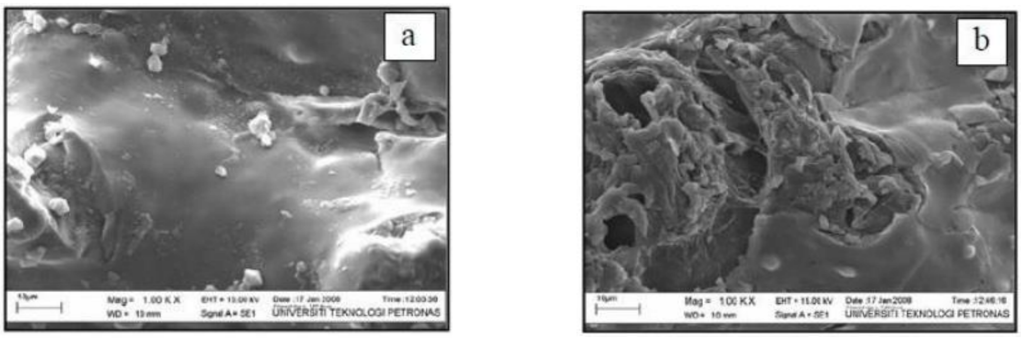

Figure 2. *Impact of NaOH on rice hulls; (a) Raw rice hulls and (b) Rice hull treated with NaOH*

(Adapted from [2])

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TÓM TẮT

NÂNG CAO HIỆU QUẢ QUÁ TRÌNH LOẠI BỎ THẠCH TÍN TRONG NƯỚC SINH HOẠT

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Việt Nam là một trong những nước sản xuất gạo nhiều nhất trên thế giới, vì vậy một lượng lớn vỏ trấu được tạo ra trong quá trình sản xuất gạo có thể gây ảnh hưởng đến các vấn đề về môi trường. Việc tận dụng nguồn vỏ trấu cho các ứng dụng hữu ích đang là vấn đề được quan tâm lớn. Mục tiêu của bài báo này là xây dựng một mô hình nâng cao hiệu quả của quá trình loại bỏ thạch tín trong nước sinh hoạt bằng than hoạt tính được tạo thành từ vỏ trấu. Trong nghiên cứu này, hiệu quả tối ưu của quá trình xử lý đạt được nhờ sự kết hợp ion sắt và than hoạt tính. Ion sắt nâng cao tối đa hiệu quả hấp thụ thạch tín, trong khí đó than hoạt tính được hình thành với lượng lớn diện tích bề mặt hấp thụ.

Từ khóa: *Xử lý nước uống, loại bỏ thạch tín, vỏ trấu, than hoạt tính.*

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