



**Faculty of Engineering**

**THE PERFORMANCE OF WATER FILTER DEVELOPED USING  
COMMERCIAL ACTIVATED CARBON SYNTHESIZED FROM  
COCONUT SHELL IN REMEDIATING LOW QUALITY  
DRINKING WATER**

**Alynah Binti Mail**

**Bachelor of Engineering with Honours  
(Chemical Engineering)  
2013**

UNIVERSITI MALAYSIA SARAWAK

Grade: \_\_\_\_\_

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Final Year Project Report

Masters

PhD

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Alynah binti Mail (23104)  
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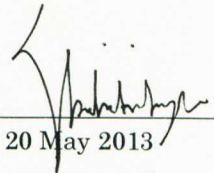
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Mr. Ibrahim Bin Yakub  
(Supervisor)

20-05-2013

Date

PERFORMANCE OF WATER FILTER DEVELOPED USING  
COMMERCIAL ACTIVATED CARBON SYNTHESIZED FROM  
COCONUT SHELL REMEDIATING LOW QUALITY  
DRINKING WATER AT RURAL AREA

ALYNAH BINTI MAIL

Thesis is submitted to  
Faculty of Engineering, University Malaysia Sarawak  
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Dedicated to my beloved family and friends who always encourage me and

gave me support during the time of completing this thesis.

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Thank you and May Allah bless all of us, Amin.

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# ABSTRACT

The water filter was designed by using commercial activated carbon synthesized from coconut shell. Tests were conducted to investigate the performance of the water filter in removal of hardness, iron metals, and turbidity of water samples. The effects of using different types of cleansing agent and filter design on the quality of drinking water were analysed. The performance of water filter was assessed and the reductions of aimed parameters were monitored. Results showed that more than 70% reductions of hardness can be achieved by the water filter designed using activated carbon post-preparation using heat. Furthermore, total iron and turbidity removals differed with different cleansing agents and filter designs. Total iron was found to reduce > 90% removals, 99.3% of turbidity was removed. It was concluded that activated carbon filter with additional filter such as sponge, ceramic and cleansing process is very good treatment option for drinking water.



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# ABSTRAK

Pengubahsuaian terhadap penapis air telah dilakukan dengan menggunakan karbon pengaktifan kommersial. Ujian telah dijalankan untuk mengkaji pencapaian atau kebolehan penapis air bagi menyingkirkan kandungan bahan pepejal, logam dan kekeruhan dalam air. Kesan penggunaan ejen pembersih yang berbeza dan rekaan jenis penapis terhadap kualiti air minuman telah dianalisis. Penilaian terhadap kebolehan penapis dan perbezaan penurunan terhadap parameter tertentu juga telah dipantau. Hasil kajian menunjukkan penurunan kandungan bahan pepejal lebih daripada 70% dihasilkan oleh penapis tersebut. Bagi kandungan logam (iron) dan tahap kekeruhan, penurunan yang baik dapat diperhatikan di mana ejen pembersihan digunakan dalam jenis penapis yang berlainan. Penurunan sebanyak lebih daripada 90% dicatatkan untuk logam (iron), manakala 99.3% penurunan dicatatkan untuk kekeruhan. Secara keseluruhannya, penapis karbon pengaktifan dengan penambahan beberapa penapis tambahan seperti span halus, seramik serta ejen pembersih juga boleh di jadikan salah satu kaedah rawatan untuk air minuman.

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# ABBREVIATIONS

AC	Activated Carbon
BSF	Biosandfilter
CCF	Ceramic Candle Filter
CF	Ceramic Filter
CPBB	Coniferuspinus Bark Biomass
EDTA	Ethylenediaminetetraacetic Acid
GAC	Granular Activated Carbon
IOCS	Iron-Oxide Coated Sand
KOH	Potassium Hydroxide
MBSF	Modified Bio Sand Filter
SIPP	Silver-Impregnated Porous Pot
SJK (C)	Sekolah Jenis Kebangsaan Cina
UNICEF	United Nations Children's Emergency Fund
USA	United State of America
VOC	Volatile Organic Compound
WHO	World Health Organization
ZnCl <sub>2</sub>	Zinc Chloride

# NOMENCLATURE

°C	Degree Celcius
μm	Micro meter
g	Gram
kg/m <sup>3</sup>	Kilogram per meter cube
L	Liter
m <sup>2</sup> /g	Meter square per gram
mg/L	Amount of Ash
ml	Milliliter
mm	Millimeter
nm	Nano meter
NTU	Nephelometric Turbidity Unit
ppm	Part Per Million
TCU	True Color Unit

# CHAPTER 1

## INTRODUCTION

### 1.1 General Overview

Water is a colorless, tasteless and odorless substance that is vital to many kind of life. 70% of the earth consists of water. Water exists on this earth in many places and forms which include oceans, polar ice caps, clouds, rain water, rivers and freshwaters. Water moves continuously through the consistent cycle of evaporation, precipitation and back to the sea. Water is the most fundamental to human life. Water is the source of life on earth and human civilization (Huddart and Stott, 2010).

People use water for drinking, washing, cooking, bathing, cleaning and recreation. The United Nations suggests that each person needs 20-50 litres of water a day to ensure the satisfaction of the basic needs. Worldwide, industry uses about twice as water as household, mostly for cooling in the production of electricity. Approximately, 70% of water sources used for agriculture and irrigation, and only 10% of water used for domestic purpose (AQUASTAT, 2013).

As shown in **Table 1.1**, 2500 of 3800 cubic kilometers, which is nearly 70% of the total global consumption are used for agricultural, mainly through crop irrigation. While industrial use accounts for about 20% and municipal use

is about 10%. Particularly Asia contains about 70% of the world irrigated area, which is the reason irrigation consumes a large amount of water to withdraw only for that area.

**Table 1.1** Global water uses in the 20<sup>th</sup> century (Shiklomanov, 1999).

Use (cubic kilometers)	1900	1950	1995
<b>Agriculture</b>			
Withdrawal	500	1100	2500
Consumption	300	700	1750
<b>Industry</b>			
Withdrawal	40	200	750
Consumption	5	20	80
<b>Municipalities</b>			
Withdrawal	20	90	350
Consumption	5	115	50
<b>Reservoirs (evaporation)</b>			
Withdrawal	0	10	200
<b>Total</b>			
Withdrawal	600	1400	3800
Consumption	300	750	2100

As estimated by UNEP (2002), by the year 2025, two out of three people will live in water-stressed areas. As expected, 25 countries in Africa will be experiencing water stress by 2025, which the supply is predicted below 1,700 m<sup>3</sup> per capita per year. Today, 450 million people in 29 countries suffer from water shortages. The major problems that faced by the world nowadays is clean water supplies and sanitation, with 20% of the global population still have problem in accessing safe potable water.

Surface water pollution can cause water-borne disease and continue to be a major cause of illness in developing countries. Polluted water is estimated to affect the health of 1.2 billion people, and cause the death of 15 million children year after year (UNEP, 2002). Due to that fact, it is very essential for potable water to be free from biological, chemical and physical sources of contamination. Clean water is also needed by plants, animals, and the habitats that support biological diversity. Besides, water in certain quality is needed to grow food, to power cities and run the industries (Palaniappan et al., 2010).

Human bodies might lose water through several ways such as through kidney, breathing, and respiration. Insufficient water supply to body system could lead to body system problems including improper food digestion and nutrient absorption to all parts of the blood stream.

## **1.2 Drinking Water Quality And Health**

Quality of water is the key to all of the roles that water plays in our lives. Basically the quality of water is assessed against both microbial indicators and chemical parameters, but most of the cases, microbiological contamination become the major concern when considering the quality of drinking water since it is responsible for the illnesses and deaths reported which related to unsafe potable water. Safe potable water should be free from pathogens, low concentrations for toxic chemicals, clear and tasteless and colorless. By only depending on visual examination, taste and odour, are often unreliable for perceptions about water quality. Waters that look or smell unpleasant may be

safe to drink. Apart from that, clear odourless waters may contain chemicals or microbial contaminants that are harmful to human health.

Drinking water can be collected from three different sources, which are from groundwater, surface water and rain water. Groundwater is water in the spaces between rocks and soil. Most of drinking water sources in the world are from groundwater which tends to be of good quality and less treatment is needed. Surface water is taken from a stream, river, lake, pond and other similar sources. This type of water basically is unsafe to be consumed unless it is treated. Rainwater is water that is collected and stored by using roof top, ground surface or rock catchment (CWAST, 2008).

Drinking water is one of human needs and it is the right for every man, woman and child to have safe drinking water. According to WHO/UNICEF (2008), about 884 million people around the world do not have improved drinking water and 2.5 billion people still have less access to improved sanitation. Among of them are those of families live in remote rural areas and urban slums, living in the poverty-disease trap, for which improved sanitation and drinking water could offer a way out. Besides, people need clean water to maintain their health and also able to improve people's health, strength to work and ability to go to school (CWAST, 2008).

WHO (2008) estimated that 88% of unsafe water, inadequate sanitation and poor hygiene can cause diarrheal disease. Because of the water issued, more than 4,500 children die every day from diarrhea and other diseases. For every child that dies, countless others, including older children and adults, suffer from poor health and missed opportunities for work and education.

As well known, chemical quality of water is also linked to the health issues. Naturally-occurring chemicals in drinking water are dangerous to health, although the present of nitrates in the water can cause a serious health risk to young infants. Besides, chemicals such as fluoride and arsenic can cause prolonged health problems. Other chemicals which may present in drinking water such as iron or manganese are predicted be affecting the acceptability of drinking water, but have limited direct health significant. It might be affect the taste of water, can cause staining of food and clothing, which then lead to rejection of water source by consumers (Howard et al., 2003).

### **1.3 Activated Carbon (AC) Filtration**

AC filtration is an effective water filter which can reduce certain organic compounds and chlorine in potable water. Furthermore, it also can reduce the amount of lead, dissolved radon and any compounds that can cause harmless taste-and-odor. Nowadays, it becomes the major concern among homeowners regarding their water supply that may affect health or cause other problems such as odor and taste (Dvorak and Skipton, 2008).

AC is black in color, and solid substance which could be granular or powdered. AC has a very large surface area which can be estimated around 30,000 square yards. Adsorption is the process that occurs when certain contaminants are accumulated on the AC surfaces. The reason that a chemical is adsorbing onto AC is because of the “dislike” nature of the water or could be due to attraction to the AC (D'Itri et al., 1990).