

**COMPARISON OF POTTERY GRANULE AND BAMBOO BASED
ACTIVATED CARBON AS ADSORBENT TO REMOVE LEAD IN
DRINKING WATER**

By

Elza Karenina
11918003

BACHELOR'S DEGREE
in

CHEMICAL ENGINEERING STUDY PROGRAM
SUSTAINABLE ENERGY AND ENVIRONMENT CONCENTRATION
LIFE SCIENCE AND TECHNOLOGY



SWISS GERMAN UNIVERSITY
The Prominence Tower
Jalan Jalur Sutera Barat No. 15, Alam Sutera
Tangerang, Banten 15143 - Indonesia

Revision after the Thesis Defense on 1st of July 2024

STATEMENT BY THE AUTHOR

I hereby declare that this submission is my own work and to the best of my knowledge, it contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma at any educational institution, except where due acknowledgement is made in the thesis.



Elza Karenina

Student

15/06/2024

Date

Approved by:



Prof. Dr. Christoph Koch

Thesis Advisor

16/06/2024

Date

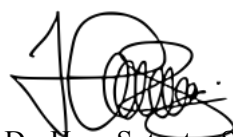


Silvy Yusri, S.Si., M.T.

Thesis Co-Advisor

16/06/2024

Date



Dr. Hery Sutanto, S.Si., M.Si.

Dean

11/07/2024

Date

Elza Karenina

ABSTRACT

COMPARISON OF POTTERY GRANULE AND BAMBOO BASED ACTIVATED CARBON AS ADSORBENT TO REMOVE LEAD IN DRINKING WATER

By

Elza Karenina
Prof. Dr. Christoph Koch, Advisor
Silvya Yusri, S.Si., M.T., Co-Advisor

SWISS GERMAN UNIVERSITY

Lead contamination in drinking water is a serious global health threat, especially for children and vulnerable populations, due to the corrosion of aging infrastructure such as lead pipes. Studies from Germany, France, the Netherlands, and West Africa reveal widespread unsafe lead levels in drinking water, causing severe health issues like anemia, kidney damage, and neurological disorders that can impair children's development. This study evaluates the effectiveness of activated carbon and pottery granules in removing lead from water. Activated carbon is affordable and accessible, while pottery granules, effective at a pH of 6 and across various temperatures, proved a practical and cost-effective solution despite requiring higher dosages. The findings support the implementation of pottery granules to meet drinking water standards and address lead contamination effectively, highlighting their optimal efficiency at 40 g/L and performance consistency at natural drinking water pH levels without the need for temperature adjustments.

Keywords: Lead contamination, Drinking water quality, Activated carbon adsorption, Pottery granules, Environmental health

© Copyright 2024
by Elza Karenina
All rights reserved

DEDICATION

Dedicated to fostering a healthier environment for all.

ACKNOWLEDGEMENTS

I am deeply grateful to the Swiss German University Indonesia and Ernst Abbe Hochschule Jena for providing the essential resources, academic support, and a conducive environment that enabled me to undertake and complete this thesis. These institutions have been pivotal in shaping my academic journey and fostering an environment of learning and growth.

I am deeply grateful to Prof. Dr. Christoph Koch for accepting me as his mentee and for his expert guidance, invaluable insights, and unwavering encouragement throughout my research journey. His expertise has shaped the direction and quality of this thesis profoundly.

I also extend sincere thanks to my co-advisor, Silvy Yusri, S.Si., M.T., for her patience, unwavering support, and significant contributions that have enhanced the clarity and depth of my work. Both Prof. Dr. Koch and Ms. Yusri have been instrumental in my academic growth, and I am privileged to have benefited from their mentorship and dedication to excellence.

Heartfelt thanks go to my parents for their unwavering support, encouragement, and belief in my abilities. Their sacrifices and encouragement have been the cornerstone of my academic achievements.

To my dear friends and partner, your steadfast support, encouragement, and understanding during moments of academic challenges have been invaluable. Your belief in me fueled my determination to persevere and succeed.

This thesis journey has been a significant experience, shaping my academic and personal growth in meaningful ways. I am grateful to everyone who has contributed to making this journey possible and rewarding.

TABLE OF CONTENTS

	Page
STATEMENT BY THE AUTHOR.....	2
ABSTRACT.....	3
DEDICATION.....	5
ACKNOWLEDGEMENTS.....	6
TABLE OF CONTENTS.....	7
LIST OF FIGURES	9
LIST OF TABLES.....	11
CHAPTER 1 - INTRODUCTION.....	12
1.1 Background	12
1.2 Research Problems	15
1.3 Research Objectives	15
1.4 Significance of Study	16
1.5 Research Questions	16
1.6 Hypothesis.....	16
CHAPTER 2 - LITERATURE REVIEW	18
2.1 Theoretical Perspectives.....	18
2.2 State of The Art.....	19
2.3 Methods of Removing Lead from Water	20
2.4 Adsorption Method	23
2.5 Bamboo Activated Carbon.....	24
2.6 Pottery Granule	26
2.7 Atomic Absorption Spectrometry (AAS)	28
2.8 X-ray Fluorescence (XRF) Spectrometry	29
CHAPTER 3 – RESEARCH METHODS	32
3.1 Venue and Time	32
3.2 Materials and Equipment	32
3.2.1 Materials	32
3.2.2 Equipment.....	32

3.3 Experimental Design	32
3.4 Experimental Procedure	34
3.4.1 Surface Area Analysis.....	36
3.4.2 Acid Cleaning of Glassware	36
3.4.3 Drinking Water Analysis	37
3.4.4 Adsorbent Dosage	37
3.4.5 pH Adjustment	39
3.4.6 Temperature Adjustment	39
CHAPTER 4 – RESULTS AND DISCUSSIONS.....	41
4.1 Particle Size Analysis of Adsorbents	41
4.2 Analysis of Initial Lead Concentration in Drinking Water	42
4.3 Adsorbent Dosage	44
4.3.1 Pottery Granule	44
4.3.2 Bamboo Activated Carbon.....	49
4.3.3 Comparison of Adsorbent Dosage Result.....	53
4.4 pH Adjustment	54
4.4.1 Pottery Granule	56
4.4.2 Bamboo Activated Carbon.....	58
4.5 Temperature Adjustment.....	60
4.5.1 Pottery Granule	60
4.5.2 Bamboo Activated Carbon.....	61
4.6 Cost Efficiency	62
4.6.1 Adsorbent Dosage Cost.....	62
4.6.2 pH Adjustment Cost.....	63
4.6.3 Temperature Adjustment Cost	66
4.6.4 Cost effectiveness comparison.....	67
CHAPTER 5 – CONCLUSIONS AND RECCOMENDATIONS	69
5.1 Conclusions	69
RECOMMENDATION	71
REFERENCES	73
CURRICULUM VITAE	78

LIST OF FIGURES

Figures	Page
Figure 1: Simple Distillation Set-up (Merck, n.d.)	21
Figure 2: Parts of a Distiller (Michael Kamrin et al., 1990)	22
Figure 3: Basic Mechanism of Adsorption in Water Treatment (Worch & Eckhard, n.d.)	23
Figure 4: Components of an AAS (Visser, n.d.)	29
Figure 5: Components of an XRF (Horiba Scientific, n.d.)	30
Figure 6: Experimental Design	33
Figure 7: Experimental Procedure	35
Figure 8: Illustration of Experimental Procedure of The Adjusted Sample	35
Figure 9: Adsorbent Retained on Filter Paper to be Dried in Drying Cabinet	38
Figure 10: Lead Standard Calibration Curve	43
Figure 11: Lead Removal Percentage vs. Pottery Granule Dosage (Before Glass Wear Acid Cleaning)	44
Figure 12: XRF Analysis Result Before Glassware Acid Cleaning: Adsorption Percentage by Pottery Granule	46
Figure 13: XRF Analysis Result Before Glassware Acid Cleaning: Blank Correction by Pottery Granule	46
Figure 14: Lead Removal Percentage vs. Pottery Granule Dosage (After Glass Wear Acid Cleaning)	47
Figure 15: XRF Analysis Result After Glassware Acid Cleaning: Adsorption Percentage by Pottery Granule	49
Figure 16: AAS Analysis Result After Glassware Acid Cleaning: Lead Removal Percentage by Pottery Granule	50
Figure 17: XRF Analysis Result Before (Dark Blue) After (Light Blue) Glassware Acid Cleaning: Adsorption Percentage by Bamboo Activated Carbon..	51
Figure 18: AAS Analysis Result After Glassware Acid Cleaning Removal Percentage by Bamboo Activated Carbon	52
Figure 19: Effect of pH on The Speciation of Lead in Aqueous Solution (Niu et al., 2019).	55

Figure 20:	Distribution of Lead Species in Aqueous Medium by pH, with Experiments Conducted at The Dashed Line Indicating Ph 7.0. (Oliveira et al., 2019).	56
Figure 21:	AAS Analysis Result: Lead Removal Percentage vs. pH Adjustment (Pottery Granule)	57
Figure 22:	AAS Analysis Result: Lead Removal Percentage vs. pH Adjustment (Bamboo Activated Carbon).....	59
Figure 23:	AAS Analysis Result: Lead Removal Percentage vs. Temperature Adjustment (Pottery Granule).....	60
Figure 24:	AAS Analysis Result: Lead Removal Percentage vs. Temperature Adjustment (Bamboo Activated Carbon)	61

LIST OF TABLES

Table	Page
Table 1: State of The Art.....	19
Table 2: List of Standards	37
Table 3: List of Samples of Adsorbent Dosage Experiment.....	38
Table 4: Particle Size Distribution of Bamboo Activated Carbon and Pottery Granules	41
Table 5: Results of Initial Concentration in Drinking Water Samples	43
Table 6: Lead Removal from Solution Before and After Glassware Acid Cleaning	48
Table 7: Lead Removal from Bamboo Activated Carbon Before and After Glassware Acid Cleaning.....	52
Table 8: Cost of Each Adsorbent Dosage	63
Table 9: Calculation of Total Price to Adjust to Desired pH Level for Each Adsorbent	66
Table 10: Cost Electricity Used for Cooling Solution	67
Table 11: Total Cost Comparison	67