

BIOGAS PRODUCTION USING WASTE MILK FROM DAIRY FARM
IN KUNINGAN, WEST JAVA

By

Afidha Shidqi Azmi
11504025

BACHELOR'S DEGREE
in

CHEMICAL ENGINEERING - SUSTAINABLE ENERGY AND ENVIRONMENT
FACULTY OF LIFE SCIENCES AND TECHNOLOGY



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

June 2020

Revision after Thesis Defense on 8 July 2020

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.

Afidha Shidqi Azmi

Student

Date

Approved by:

Dr. -Ing. Evita Herawati Legowo

Thesis Advisor

Date

Dr. Irvan Setiadi Kartawiria S.T., M.Sc.

Thesis Co-Advisor

Date

Dr.Dipl. -Ing. Samuel Priyantoro Kusumocahyo

Dean

Date

Afidha Shidqi Azmi

ABSTRACT

BIOGAS PRODUCTION USING WASTE MILK
FROM DAIRY FARM IN KUNINGAN, WEST JAVA

By

Afidha Shidqi Azmi

Dr. -Ing. Evita Herawati Legowo, Advisor

Dr. Irvan Setiadi Kartawiria S.T., M.Sc., Co-Advisor

SWISS GERMAN UNIVERSITY

Dairy farm waste such as cow dung and waste milk are pollutants that can be mitigate by produce it into biogas that can be an eco-friendly, very efficient and also to reduce environmental pollution around dairy farm. The research objectives of this study were to analyze the best condition to produce biogas from waste milk and the influence of temperature and ratio of substrate and inoculum for digestion process. The research method is changed from laboratory research into literature review format. The results showed that biogas production with food waste and waste milk can use cow dung, chicken manure, swine waste water, sludge and horse manure as inoculum. The ratio of inoculum and substrate between 0 : 100 until 70 : 30. The most influential factors in producing methane in biogas production is ratio of inoculum to substrate and temperature. It is concluded that for biogas production using waste milk as substrate and cow dung as an inoculum, the best condition is in thermophilic condition (55 °C) with a ratio of cow dung and waste milk 70 : 30 for 30 days digestion process.

Keywords: Biogas, Cow dung, Waste milk, Temperature, Ratio.



DEDICATION

I dedicated my effort for my parents, my grandma, my big family, my special person,
my beloved friends who always support me and love me forever



ACKNOWLEDGEMENTS

First, I am very grateful to Allah SWT., the Almighty God who has mercy, power and guidance on me.

I would like to say thank you very much to my mother who always love, encourage me every day. She understands what I feel. And including, my dad who always support and guide every step of life with my decision for future. Thank you to my brother who always care about me. Thank you to my big family who always support and love me. Moreover, to my cats, especially Yaya and Naomi who always makes cheerful.

I gratitude to Dr. -Ing. Evita Herawati Legowo as my lovely advisor and Dr. Irvan Setiadi Kartawiria S.T., M.Sc. as my co-advisor, for encouragement, patience, valuable advise, guidance and support to finish my thesis and study. Thank you to all Lecturers of Swiss German University (SGU).

I would like to say thank you for biggest support and facility for my thesis work; Board of Directors and staff of PT.WAP Andalan Indonesia (WAPCO), Head and Lecturers of Departement of Industrial Engineering Institute of Technology Bandung, Head of Physics Engineering study program Institute of Technology Bandung, Board of Chairmans of KSU Karya Nugraha, Kuningan, West Java, My sincere gratitude to Departement of Energy and Mineral Resources (ESDM) of West Java Province that give the knowledge and reference of development on energy sector especially biogas production in West Java Province and Kuningan District.

Biggest gratitude to Hendirwan Junior Wibowo, who always encourage me, help me when I had problem and give me advise. Special thanks to Dhanu Koentoro who guide and give other reference. Also Vania, 'Akutang Meshtypo' squad, Novaria Putri, Alvina Faraditya, Aurelia Sylvi, and my PS4 friends that I can't say one by one who support me and colouring my day. I would say thank you to SEE'16 friends who spend time with me and supporting each other during study.

I hope this thesis will be useful for reference especially to my SEE junior who need inspiration on sustainable energy and environment.

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	10
CHAPTER 1- INTRODUCTION	13
1.1. Background	13
1.2 Problem Statement	14
1.3 Research Objective	15
1.4 Significance of Study	15
1.5 Research Questions	15
CHAPTER 2 - BASIC LITERATURE REVIEW	16
2.1 Energy condition	16
2.2 Milk	17
2.3 Biogas	22
2.4 Biogas Production	24
2.4.1. Inoculum	24
2.4.2. Substrate	25
2.4.3. Anaerobic Digester	25
CHAPTER 3 - RESEARCH METHOD	28
3.1 Venue and Time	28
3.2 Materials and Equipments	28
3.2.1 Materials	28
3.2.2 Equipments	28
3.3 Experimental Design	30
3.4. Literature Review	32
3.4.1. Introduction	32
3.4.2. Design of Literature Review	33

CHAPTER 4 - RESULTS AND DISCUSSIONS	34
4.1 Results	34
4.1.1 Biogas Research using cow dung as inoculum	34
4.1.1.1. Biogas Production using coffee waste as substrate	34
4.1.1.2. Biogas Production using cocoa waste as substrate	38
4.1.1.3. Biogas Production Food Waste as Substrate	41
4.1.2 Biogas Research using Waste Milk as Substrate	47
4.1.2.1. Biogas Production using Cheese Whey as Substrate	47
4.1.2.2. Biogas Production using Spoiled Milk as substrate	51
4.1.2.3. Biogas Production using Mastitis Milk as Substrate	53
4.1.3 Effect of Temperature on Biogas Digester	55
4.2. Discussions	57
4.2.1 Biogas Production using Cow Dung as Inoculum	57
4.2.2 Biogas Production using Waste Milk as Substrate	59
4.2.3 Effect of Temperature on Biogas Digester	61
4.2.4 Summary of Biogas Production	62
CHAPTER 5 - CONCLUSION & RECOMMENDATION.....	67
5.1 Conclusion	67
5.2 Recommendation	67
REFERENCES	68
CURRICULUM VITAE.....	70

SWISS GERMAN UNIVERSITY

LIST OF FIGURES

CHAPTER 2

FIGURE 2. 1 DAIRY MILK PRODUCT 17

FIGURE 2. 2 DAIRY FARM IN KUNINGAN, WEST JAVA 19

CHAPTER 3

FIGURE 3. 1 BIOGAS ANALYSER 29

FIGURE 3. 2 EXPERIMENTAL FLOWCHART..... 31

FIGURE 3. 3 LITERATURE REVIEW FLOWCHART 33



LIST OF TABLES

CHAPTER 2

TABLE 2. 1 COMPOSITION OF FRESH MILK.....	18
TABLE 2. 2 CHARACTERISTIC OF WASTE MILK	20
TABLE 2. 3 COMPOSITION OF FRESH MILK AND MASTITIS MILK	21
TABLE 2. 4 BIOGAS SPECIFICATIONS	22
TABLE 2. 5 BIOGAS QUALITY STANDARDS IN INDONESIA AND GERMANY	23
TABLE 2. 6 CHARACTERISTICS OF FRESH MANURE AND DIGESTED MANURE.....	24
TABLE 2. 7 TYPES OF INOCULUM AND ITS C/N RATIO	25
TABLE 2. 8 SUBSTRATE COMPOSITION	25
TABLE 2. 9 TEMPERATURE CONDITION IN ANAEROBIC DIGESTION..	27

CHAPTER 3

TABLE 4. 1 GAS COMPOSITION FROM BIOGAS USING COFFEE WASTE AND COW DUNG	35
TABLE 4. 2 METHANE GAS PRODUCTION USING COFFEE PULP AND COW DUNG.....	36
TABLE 4. 3 METHANE CONTENT AND METHANE YIELD ON ITS BIOGAS PRODUCTION	37
TABLE 4. 4 METHANE PRODUCTION BY USING SGC AS SUBSTRATE... 	38
TABLE 4. 5 RATIO COCOA : WASTER AND FERMENTATION TIME OF MIXED SAMPLE	38
TABLE 4. 6 BIOGAS PRODUCTION USING HYDROTHERMAL PRE- TREATMENT.....	39
TABLE 4. 7 METHANE CONTENT AND YIELD WERE PRODUCE ON ITS BIOGAS	40
TABLE 4. 8 METHANE YIELD ON BIOGAS USING COCOA SHELL	40
TABLE 4. 9 RATIO AND BIOGAS YIELD OF KITCHEN WASTE AND COW DUNG.....	42
TABLE 4. 10 BIOGAS AND METHANE YIELD AND METHANE CONTENT PRODUCE ON BATCH TEST	42

TABLE 4. 11 BIOGAS AND METHANE YIELD AND METHANE CONTENT PRODUCE ON CONTINUOUS TEST	43
TABLE 4. 12 BIOGAS PRODUCTION USING FOOD WASTE AND COW DUNG.....	44
TABLE 4. 13 RATIO, TS ADDITION AND METHANE CONTENT ON ITS BIOGAS PRODUCTION.....	45
TABLE 4. 14 BIOGAS PRODUCTION BY USING ALKALINE AND HYDROTHERMAL PRETREATMENT	45
TABLE 4. 15 RATIO, BIOGAS AND METHANE YIELD PRODUCED WITHIN ITS METHANE CONTENT.....	46
TABLE 4. 16 RATIO USED AND METHANE YIELD AND CONTENT PRODUCED ON ITS BIOGAS.....	47
TABLE 4. 17 RATIO OF CWW : CM AND METHANE CONTENT OF CWW AND CM	48
TABLE 4. 18 METHANE PRODUCTION USING CW AND SW.....	48
TABLE 4. 19 BIOGAS PRODUCTION AT 34 °C AND 10% TS.....	49
TABLE 4. 20 BIOGAS PRODUCTION AT 34 CELCIUS AND 8 % TS	50
TABLE 4.21 BIOGAS PRODUCTION AT 25 °C AND 8% TS.....	51
TABLE 4. 22 BIOGAS PRODUCTION USING SPOILED MILK AS SUBSTRATE.....	52
TABLE 4. 23 METHANE PRODUCTION AND ITS CONTENT USING DAIRY MILK AS SUBSTRATE.....	52
TABLE 4. 24 METHANE PRODUCTION AND METHANE CONTENT ON ITS BIOGAS PRODUCTION.....	53
TABLE 4. 25 METHANE CONTENT OF BIOGAS USING WASTE MILK AND COW DUNG.....	53
TABLE 4. 26 BIOGAS PRODUCTION USING MASTITIS MILK AND COW DUNG.....	54
TABLE 4. 27 RATIO, MILK ADDITION AND VOLUME BIOGAS PRODUCTION	55
TABLE 4. 28 METHANE CONTENT AND BIOGAS PRODUCTION IN 3 TEMPERATURE CONDITION	56
TABLE 4. 29 RESULT OF %CH₄ , %CO₂, %H₂S THAT PRODUCED ON BIOGAS PRODUCTION.....	56

TABLE 4. 30 SUMMARY OF BIOGAS PRODUCTION USING COW DUNG AS INOCULUM AND FOOD WASTE AS SUBSTRATE	62
TABLE 4. 31 SUMMARY OF BIOGAS PRODUCTION USING COW DUNG AS INOCULUM AND COCOA WASTE AS SUBSTRATE	63
TABLE 4. 32 SUMMARY OF BIOGAS PRODUCTION USING COW DUNG AS INOCULUM AND COFFEE WASTE AS SUBSTRATE.....	63
TABLE 4. 33 SUMMARY OF BIOGAS PRODUCTION USING SEVERAL TYPES OF MANURE AS INOCULUM AND CHEESE WHEY AS SUBSTRATE.....	63
TABLE 4. 34 SUMMARY OF BIOGAS PRODUCTION USING SEVERAL TYPES OF MANURE AS INOCULUM AND SPOILED MILK AS SUBSTRATE.....	65
TABLE 4. 35 SUMMARY OF BIOGAS PRODUCTION USING COW DUNG AS INOCULUM AND WASTE MILK AS SUBSTRATE.....	66
TABLE 4. 36 SUMMARY OF EFFECT OF TEMPERATURE ON BIOGAS PRODUCTION	66



SWISS GERMAN UNIVERSITY