



**BUSITEMA
UNIVERSITY**
Pursuing Excellence

**FACULTY OF ENGINEERING
DEPARTMENT OF AGRICULTURAL MECHANIZATION
AND IRRIGATION ENGINEERING**

**DESIGN AND CONSTRUCTION OF APEDAL POWERED
SOAP MIXER FOR RURAL DWELLERS
FINAL REPORT**

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ABSTRACT

A bicycle pedal-powered soap mixer is to be designed and developed. The machine is to consist of a chain drive and gear amplification mechanisms that turn impeller blades in a large stainless steel container, where soap ingredients are stirred and blended. The machine is expected to be economically viable, can be used by unskilled workers, save time otherwise spent in traditional mixing and can be adopted for human-powered process units which could have intermittent operation without affecting the end-product. Soap production can be enhanced by making use of this pedal-powered soap mixer, which with little human effort makes the soap to properly mix and trace within few minutes.

The study further goes through the design and selection of the different components of the prototype and assembling of the prototype. After construction, it was tested and preliminary testing results are also included in the booklet. The overall project evaluation and the weaknesses of the design are also included in here and the possible solutions in form of recommendations for future designers.

DECLARATION

I Mukhwana Jerome, hereby declare to the best of my knowledge that all the work endorsed in this project is my original work and has never been presented to any institution of higher learning for any academic award. Acknowledgement has been done to all the sources of data in this compilation.

Signature.....  Date..... 19/06/2014



APPROVAL

This final year project report is to be submitted to the Faculty of Engineering for examination with approval from the following supervisors;

MAIN SUPERVISOR

Mr. Odongo Samuel Atochon

Sign..........

Date..........

CO-SUPERVISOR

Mr. Mugisha Moses

Sign.....

Date.....

DEDICATION

I dedicate this project report to my dear parents Mr. Nabende Pius and Mrs. Nabende Teopista, my beloved sisters, brothers and friends whose love, encouragement and moral support has pushed me this far.

ACKNOWLEDGEMENTS

Great thanks to the almighty God for the gift of life, knowledge and courage that has enabled me complete my project in time.

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May the almighty God reward you abundantly!

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LIST OF ACRONYMS

AMI	Agricultural Mechanization and Irrigation Engineering
CAD	Computer Aided Design
INS	Iodine Number Solubility

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CHAPTER ONE: INTRODUCTION

1.1 Background

Soap remains an essential ingredient in modern living, used daily for medicinal, laundry purposes, household cleansing and personal hygiene. Until recently, its production remained a primitive art, its manufacture being essentially the treatment of fat with alkali, a chemical process which is the same whether production is done in a backyard or in a factory. The simplicity of the process has led to its worldwide practice as a small business operation (LEAP, 2010).

Traditional soap making demands hours of stirring by hand and in the local soap industry, production involves strenuous human efforts. The mixing of ingredients is done manually with a stick or wooden ladle and this requires a lot of energy and time input by the soap producer. The final product is usually not uniformly mixed due to fatigue usually suffered by the operator (Ajaq *et al.*, 2010). Mixing is the most output determining process in soap making since the raw materials are insoluble.

Large factory operations are exclusively based on the modern continuous process, which produces soap in about 15 minutes but requires machinery that is expensive, and demands close production control and a very large output is required to be economically viable.

With Regard to the above facts, this project is geared to providing remedy by designing and fabricating a pedal-powered soap mixer which will use a stirring system comprised of a bicycle pedaled chain drive and gear amplification system that turns impeller blades in a large stainless steel container.

1.2 Problem statement

In the rural Uganda today, very few households access soap because of its increasing price despite the fact that the materials needed in soap production are readily available in these areas. This high price is mainly as a result of the production stages soap undergoes especially the *mixing phase*. Traditional soap making demands hours of stirring by hand which comes with delays in achieving the final mixture, poor quality of the final product, and too much fatigue.

References

- 1) AE Pedal Power, News and Information about Pedal Power Transportation, Tools and Technologies. Available at <http://www.alternative-energy-news.info>
- 2) Charles E.O (2003). Virtual Chembook, Elmhurst College. Available at: <http://www.elmhurst.edu/~chm/vchembook/index.html>
- 3) Gray J.B and Uhl V.W (1987). Mixing Theory and Practice, Vol.2, Academic Press
- 4) Modak J.P and Moghe S.D (1998). Design and development of a human-powered machine for the manufacture of sand bricks. Human Power, Vol.13 No.2
- 5) Colgate-Palmolive (2009). The Fact Sheet from the Consumer Information Service, pp. 1-3, Australia
- 6) Linden Economic Advancement Programme (2010). "Business Opportunity Profile - Laundry Soap Production", pp. 11-16, Guyana