BUSITEMA UNIVERSITY
*Pursuing Excellence*

# FACULTY OF ENGINEERING

## DEPARTMENT OF CHEMICAL AND PROCESSING ENGINEERING

# DESIGN AND CONSTRUCTION OF A CONTINOUS FLOW WATER BOILER CHAMBER FOR AN INTEGRATED SOLAR-ELECTRICITY POWERED BOILER


**BY**

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## DECLARATION

I, **Twambaze Emmanuel BU/UP/2013/165,** declare that this project report is my original work organized with the help of my supervisors and has never been submitted to any institution of learning for any academic award.

Signature.....

Date.....30th/05/2017.....

DEDICATION

I dedicate this report to my parents Mr. Nzitatira Charles and Ms. Ajobo Santa and my brothers and sisters for you are the reason I have come this far.

ABSTRACT

Most of Uganda's households depends so much on water heating and in an attempt to improve the energy saving, the developing technology has to meet the needs of the users. A Solar Water Heating system is an enormous form of renewable energy heating system which uses sunshine as the source of fuel. In addition the integration of solar water heaters and electrical heating system is more advantageous form of water heating and is generally environmentally friendly. The available water boilers operate on batch processing and hence cannot meet the continuous demand of boiled water. Therefore, the objective of the study was to design, develop and test solar-electricity powered continuous flow water boiler chamber majorly for households and small scale restaurants which would help in continuous provision of boiled water and further save energy as a result of load sharing.

The design of the various equipments parts was carried out by analyzing the effects of heat on them. This led to the selection of proper materials to withstand the heat and contain heat within the chamber to avoid burns to the users. Engineering drawings of the various components were drawn before the various components were constructed. Then prototype assembly was done last according to the engineering drawings. A fully functional prototype resulted after all the above operations. In addition testing of the prototype was carried out and the results revealed that higher sun intensity combined with low flow rates led to higher temperature output compared to low sun intensity. Boiling water at lower flow rate attained temperatures between 70°C -75°C and doubling the flow rate led to a reduction of outlet water temperature from the boiling chambers. Furthermore this study also showed that flow rate is an important factor to consider in boiling water using a continuous flow water boiling system

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I would like to thank my family and friends for being so supportive throughout the process of this research process. Without their advice, encouragement and guidance, understanding this work would have never been completed.

## APPROVAL

This is to certify that **Twambaze Emmanuel** prepared this project report under my supervision and is now ready for presentation to the Department of Chemical and processing Engineering of Busitema University for an award of a Bachelors degree of Agro-Processing engineering with my approval.

Signature……

Dr. Catherine Wandera Date15/6/2017

Signature……

Miss Jacquline Aboo Date……/……/……

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ACRONYMS

GMP- Gallons per minute

NREL- Renewable Energy Laboratory

TDS- Total Dissolved Solids

TPR- Temperature and Pressure Relief valve

GCV- Gross Calorific Value

SWH- Solar Water Heaters

LIST OF FIGURES

# CHAPTER ONE

## 1.0 Introduction

This chapter presents the general information about the research project giving its background, problem statement, purpose of the study, its justification, objectives, and scope of study.

## 1.1 Background

There has been a development in Uganda's industrial secondary sector, where value addition takes place, **(Scherer, 1996)** *and* **(Adams and Brock, 2005)**. The Ugandan Government's Policy Vision for Renewable Energy is to make modern renewable energy a substantial part of the national energy consumption **(Liu, Masera & Esser, 2013)**. Hotels and restaurants use electrical boilers and solar water heaters of various kinds to produce process boiled-water, the daily water consumption at some hotels is approximately 500 liters of hot water. The larger capacities such as gas, wood and oil fired boilers are used at industrial processing plants. Water heating is the second largest energy user in our homes and accounts for about 20% of household energy costs with electrical kettles and immersion heaters accounting for 56.9% of the household electrical appliances **(Kwong et al., 2014).**

The availability of solar energy and its use for heating water is a resource that has been used since ancient times. However, current technologies allow optimization and its widespread use **(Vitali, A. 2013)**. The versatility and controllability, instant availability and consumer-end cleanliness, electric energy is an indispensable, multi-purpose form of energy. The improvement in the heat exchanger design has enabled in increasing the efficiency of boiling water. Conventional Solar water heaters of capacities 50liters to 100 liters are being used at some commercial processing firms to minimize the heating cost **(Lucon et al., 2015).** Process boiled water is used for cooking, making boiled water products such as tea, cleaning of processing equipment, bathing and can be used for sterilizing equipments when in steam form.

Although there has been advancement in boiler technologies used for boiling water, commercial restaurants, hotels, households and hospitals still face a problem of meeting the instantaneous demand of hot water. The design for these boilers does not meet the convenience of boiling water in cases where there is instantaneous high demand of boiled water products. This has led to delays in most of processing operations hence increasing on the downtime of production, this further reduces on the daily production efficiency. Food processors in the restaurants and households face a challenge of high costs of electricity and relatively high poverty levels that directly impact on the purchasing power of the domestic market. The aim of this study is to design and construct a solar-electricity boiler

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