BUSITEMA UNIVERSITY

FACULTY OF ENGINEERING

DEPARTMENT OF AGROPROCESSING ENGINEERING

DESIGN OF A SYSTEM THAT MONITORS "TEMPERATURE, PH, DISSOLVED OXYGEN AND ALCOHOL CONTENT", AND AUTOMATICALLY CONTROLS TEMPERATURE AND DISSOLVED OXYGEN DURING WINE FERMENTATION

BY

ODWONGO RONALD

BU/UG/2010/152

Main Supervisor: Mr.Kilama George

Co-Supervisor: Mr.Sserumaga Paul

SUBMITTED IN PARTIAL FULFILLMENT FOR THE AWARD OF BACHELORS DEGREE IN AGROPROCESSING ENGINEERING

MAY 2014

DECLARATION

By submitting this project, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof, that reproduction and publication thereof by Busitema University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Name ..... Oduayo Ronald

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Date: 06-06-2014

ACKNOWLEDGEMENT

The completion of this project was possible with the participation of learned and resourceful gurus comprising lot of Academic staff of the Department of Agro processing Engineering of Busitema University-the lecturers and in particular, my supervisors :Mr. Kilama George and Mr. Sserumaga Paul; individuals I consulted and made discussions with in particular Mr. Walugembe Amos, I extend sincere gratitude.

ABSTRACT

A system which monitors and controls wine fermentation parameters online was designed. Particularly, wine fermentation has been of major concern since quality and productivity have been low due to less emphasis on the technology for the control of the broth parameters online. The wine fermentation parameters that this project focused on are; temperature, pH, dissolved oxygen and alcohol content.

The system was modeled in the workshop using wood and wires to simplify understanding of the software designed system. The design of the system was accomplished using proteus software environment, and embedded C language for coding and simulating. The design has the microcontroller to receive readings input from sensors inserted in flow-cell filled with wine, and processes the data acquired, then sends the output to be displayed on the LCD screen. The simulation portrays the physical working of the system hardware when implemented.

The result of the designed system shows that the temperature, pH, dissolved oxygen and alcohol content are monitored from the LCD screen; temperature and dissolved oxygen are controlled i.e. instantaneous adjustments are performed online for any deviation of the optimum ranges of the parameters.

A real time, closed loop control system for monitoring and controlling wine fermentation parameters was successfully modeled, designed, and simulated. The system is best suited for commercial wine production, and with this, wine of standard quality are expected

APPROVAL

This report is presented as part of the requirement to attain a qualification of Bachelor's Degree in Agro-processing Engineering under supervision of;

Mr.Kilama George

Main supervisor

Mr.Sserumaga Paul

Co-supervisor

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ACRONYMS

TA – Total acidity

PPO - Polyphenol-oxidase

MLF – Malolactic fermentation

AAB - Acetic acid bacteria

i e – that is to say

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CHAPTER I

1.0 INTRODUCTION

1.1Background

The primary objective of industrial fermentation research and development is the establishment of economically viable process through increasing product yields and reduced operating costs. Historically the most important means of achieving this has been by strain improvement, using a variety of techniques, by growth medium development and improvement in nutrient feeding. In recent years however, tremendous progress has been made in the measurement of biotechnical parameters, bio processing instrumentation and bioprocess modeling and control.

Industrial fermentation research has led to innovation of online control of fermentation parameters to replace the traditional offline sampling laboratory analysis. Online regulation is usually restricted to the maintenance of a small number of environmental conditions, such as broth temperature, P^H and dissolved oxygen levels. This is achieved through the manipulation of fermenter heating and cooling, acid/alkali addition and aeration rate (stirrer speed), respectively(G. A. Montague, 1989)

Wine fermentation has been of major concern since quality and productivity have been compromised due to sophisticated technology for the control of the broth parameters online. Wine is an alcoholic beverage made from fermentation of grapes and other fruits. Fermentation in wine is the process whereby yeast converts sugar into carbon dioxide and ethyl alcohol (ethanol) and in the process energy is released inform of heat. There are three stages of fermentation (Shawna Linehan, 2011)

- Primary or aerobic (with air) fermentation

During the primary fermentation of wine, glucose and fructose are converted to alcohol (ethanol) by the action of yeast. Carbon dioxide is also produced and leaves the solution in gaseous form, while the alcohol is retained in the mix.

The by-products of primary fermentation are aromas, flavors, and heat. This stage generally lasts for about a week and is a critical stage for yeast reproduction. On average, 70% of

REFERENCE

F.Coviello, E. A. (22009). Design and feasibility study of an ethanol distillery in Guyana. United Nations Publication.

G. A. Montague, A. J. (1989). Fermentation Monitoring and Control - a Perspective. In A. J. G. A. Montague, Fermentation Monitoring and Control - a Perspective (pp. 147 - 188). Biotechnology & Genetic Engineering Reviews .

P.Jones, G. (2002). A monitoring and control system for wine fermentation. University of Adelaide.

Shawna Linehan, S. N. (2011). Application of a consumer preference Based Method for Designing Products to Wine. Method for Designing Products to Wine, 255 - 272.

Ma. Jesu´s Torija, N. R. (2002). Effects of fermentation temperature on the strain population of Saccharomyces cerevisiae. International Journal of Food Microbiology 80, 47 - 53.

da Silva Paes, e. (2009). Protective e¡ectof ions against cell death induced byacid stress in. FEMS Yeast Res 9, 701-712.

G.F.Colin. (1997). System for temperature control, especially in wine fermentation tanks. Fr. Demande.

Salivet, C. (1989). Continuous control of alcoholic fermentations. Rev. Fr. Oenol.

Whitford, D. R. (1987). Computer-controlled fermentation means for wines. PCT Int. Appl.

N. Angelov, B. B. (2000). Madel for control of dissolved oxygen . Nauchni Tr. – Vissh. Khranit. Vkusova Prom-st., Plovdiv.

Sablayrolles, J. M. (2000). Importance of oxygenation control during alcoholic fermentation. Ind. Bevande.

Iland, P. E. (2000). 'Techniques for Chemical Analysis and quality monitoring during wine making. Patrick Iland wine promotions, Campbelltown SA.