UNIVERSITI TEKNOLOGI MARA

FUZZY LOGIC CONTROLLER FOR GLYCERIN BLEACHING TEMPERATURE CONTROL

ZAKARIAH BIN YUSUF

Thesis submitted in fulfillment of the requirements
for the degree of
Master of Science

Faculty of Electrical Engineering

June 2012

ABSTRACT

Bleaching process is one of the vital parts in the glycerin purification process to remove the colour from the crude glycerin. Glycerin needs proper bleaching temperature control to avoid quality degradation of the produced oil. The temperature setting must be adequate to maximize the absorption but it must not exceed the optimal point. The conventional method of controlling this kind of process is incapable of giving satisfactory result. This thesis presents two Fuzzy Logic Controllers, which are Fuzzy PD and Fuzzy PI to accommodate the problem. The controllers were designed with different membership functions and rules in order to achieve the desired performance. Furthermore, it will be integrated with Smith predictor. The performance of the proposed fuzzy logic controllers are benchmarked against PID in term of rise time, percentage overshoot and settling time. Error criterion evaluation such as IAE, ISE and ITAE are used to evaluate the controller performance. Self-tuning Fuzzy Logic controller is proposed to counter the mismatch model for Smith predictor. The simulation results indicate that fuzzy controllers gave better control performance compared to PID. Fuzzy PD controllers provide excellent performance with fast settling time with no overshoot were recorded. The application of Smith predictor shows improvement in the step response performance and error criteria. Self-tuning fuzzy logic controller managed to reduce the mismatch delay problem for Smith predictor structure. Self-tuning Fuzzy PD controller can track the set point up to 100% mismatch delay from the process model while self-tuning Fuzzy PI controller is only capable to track up to 50% mismatch delay.

ACKNOWLEDGEMENTS

First and foremost, I would like to praise God Almighty and thank Him for giving me strength and ability to endure the hard times I have been through and through. Without Him, I am sure I would not able to complete my research journey.

Hereby, I would like to extend my utmost gratitude and heartfelt appreciation to the individuals who made this thesis an enriching and invaluable experience. A special thanks to my supervisor, Prof. Dr. Mohd Nasir Taib for guidance and endless advice, the knowledge offered and the time spent in improving this thesis and the invaluable time for the understanding and willingness to help.

I wish to express sincere appreciation to my family who has made this happen, without support from my parent I would not to reach this far. I also want to thank my wife Nazurah, for the love, encouragement, support, and understanding. Finally, I would like to thanks to all fellow friends in the Advance Signal Processing Research Groups (ASPRG) for their friendship and continuous support during my study.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 Thesis Background

Glycerin is known as a very useful raw ingredient in many products such as pharmaceutical, food, cosmetic, home products and many more. Glycerin is safe and non-toxic material and it is able to match with many chemical properties. Therefore, that makes glycerin as a preferred solvent agent in many product [1]. The physical characteristic of the glycerin is normally colourless, odorless and it has a sweet taste. It possesses a unique combination of physical and chemical properties that are usually utilized in home products. In addition, glycerin is highly stable under typical storage conditions and stable chemical structure it is matched with many other chemical materials [1, 2]. The glycerin also safe and virtually non-toxic, non-irritating in its variety of usage, no harmful effect to the environment and very suitable for food and pharmaceutical products [2]. Glycerin can be found in many sources for example palm oil, sunflower, soya bean, petrochemical, animal fat etc.

The crude glycerin can be obtained through many process methods such as hydrolysis, saponification and transesterification process [3]. Natural glycerin is normally produced from the hydrolysis of fats splitting process [4]. The crude glycerin obtained from this method need further purification to obtain better quality of glycerin where this process is called as a purification process [5]. The process of glycerin purification normally involve many stages including bleaching, evaporation, heating, distillation, filtering etc [1, 5, 6]. Bleaching stage is a vital part in producing purified glycerin [4]. The purpose of this stage is to remove the pigment colour from the crude glycerin. Bleaching also has its own stages such as mixing, heating and