

WATER LEVEL CONTROL PID TUNING FOR A BOILER STEAM DRUM
USING FUZZY LOGIC

By

HAFIDZ AKBAR

22052011

MASTER'S DEGREE

in

MASTER OF MECHANICAL ENGINEERING - MECHATRONICS
FACULTY OF ENGINEERING & INFORMATION TECHNOLOGY



SWISS GERMAN UNIVERSITY

The Prominence Tower

Jalan Jalur Sutera Barat No. 15, Alam Sutera

Tangerang, Banten 15143 - Indonesia

JULY 2024

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 acknowledgment is made in the thesis.

Hafidz Akbar

Student

Date

Approved by:

Dr. Ir. Henry Nasution, M.T., IPP

Thesis Advisor

Date

Dr. Ir. Hanny J. Berchmans, S.T., M.T

Thesis Co-Advisor

Date

Dr. Ir. Maulahikmah Galinium, S.Kom., M.Sc

Dean

Date

ABSTRACT

WATER LEVEL CONTROL PID TUNING FOR A BOILER STEAM DRUM USING FUZZY LOGIC

By

Hafidz Akbar

Dr. Ir. Henry Nasution, M.T., IPP, Advisor

Dr. Ir. Hanny J. Berchmans, S.T., M.T, Co-Advisor

SWISS GERMAN UNIVERSITY

One of the most crucial things that has to be closely monitored in order for the boiler to safely and effectively produce a continuous flow of steam is the water level in the boiler's steam drum. Strict water level monitoring and management are necessary to prevent significant boiler damage and explosion risks. PID controllers, a subclass of classical controllers, are used in industrial processes extensively. The trial-and-error method of PID controller parameter tuning is practical since it is straightforward and applicable to boiler systems. However, because there are many combinations and permutations involved, the trial-and-error process takes a long time.

This study compares the numbers of K_p , K_i , K_d input from the trial-and-error, ziegler-nichols and fuzzy logic method and apply the PID parameters into a model test which represent water level control in a boiler steam drum by utilizing Arduino as a microcontroller to run and record the actual simulation of the methods while fuzzy logic PID parameters are obtained by utilizing Arduino software.

Keywords: PID Tuning, Water Level Control, Fuzzy Logic, Ziegler-Nichols, Trial-and-error

COPYRIGHT PAGE

© Copyright 2024
by Hafidz Akbar
All rights reserved

DEDICATION

I dedicate this works for:

My parents, my wife, and my son.

Also, my brother and sisters.

Lastly for my friends and colleagues who assisted me to complete this thesis.

ACKNOWLEDGEMENTS

First and foremost, I would like to praise God for His blessings and grace that He has given to me, so that I can complete this Thesis at Swiss German University (SGU).

I extend my profound gratitude and appreciation to my advisor Dr. Ir. Henry Nasution, M.T., IPP, and my Co-advisor Dr. Ir. Hanny J. Berchmans, S.T., M.T who have assisted me throughout the completion of this thesis in spite of being busy with his duty as a lecturer in SGU. Their invaluable help and suggestions have contributed to the success of this project.

I would also like to thank my family for their prayers and encouragement. My special thanks go to my friends and colleagues for always listening and supporting me during the period of this thesis.

Last but not least, my gratitude goes to SGU and staffs for providing the facilities to complete this thesis and to those who are directly or indirectly involved in this thesis. Thank you very much.

Hafidz Akbar

TABLE OF CONTENTS

STATEMENT BY THE AUTHOR.....	2
ABSTRACT.....	3
COPYRIGHT PAGE	4
DEDICATION	5
ACKNOWLEDGEMENTS	6
TABLE OF CONTENTS.....	7
LIST OF FIGURES	9
LIST OF TABLES	10
1. INTRODUCTION	11
1.1 Background	11
1.2 Research Problems	12
1.3 Research Objectives	13
1.4 Significance of Study	13
1.5 Research Questions	13
1.6 Hypothesis.....	13
2. LITERATURE REVIEW	14
2.1 Water Level Control in a Boiler Steam Drum.....	14
2.1.1 Single element drum level control	16
2.1.2 Double element drum level control.....	16
2.1.3 Three elements' drum level control	17
2.2 PID Control	18
2.2.1 Trial and Error Method	20
2.2.2 Ziegler-Nichols Method.....	21
2.3 Fuzzy Logic Control.....	22
2.3.1 Fuzzy Sets	22
2.3.2 Membership Function	22
3. RESEARCH METHODS	24
3.1 Research Flow Chart	24
3.2 Root Cause Analysis – Fishbone Diagram.....	25
3.3 Model Test Equipment	26

3.4	Specification of Model Test Equipment.....	27
3.5	Calibration of Model Test Equipment.....	29
4.	RESULTS	30
4.1	PID Tuning with Trial and Error Method	30
4.2	PID Tuning with Ziegler-Nichols Method	32
5.	DISCUSSION	33
5.1	Comparison among the three methods	33
6.	CONCLUSIONS, RECOMMENDATION, AND FUTURE RESEARCH	34
6.1	Conclusions	34
6.2	Recommendation.....	35
6.3	Future Research.....	36
	GLOSSARY	37
	REFERENCES	39
	APPENDICES	41
	CURRICULUM VITAE	65

LIST OF FIGURES

Figure 1 Steam drum water level control system for an Industrial Boiler	15
Figure 2 Three element boiler drum level control	17
Figure 3 Block diagram of unity Closed Loop control system.....	18
Figure 4 Research Flow Chart.....	24
Figure 5 Fishbone Diagram of the research	25
Figure 6 Model Test Equipment	26

LIST OF TABLES

Table 1 Model Test Equipment	27
Table 2 Calibration of Proportional Valve	29
Table 3 Result of Trial and Error Method	30
Table 4 Result of Ziegler-Nichols method.....	32