

DEVELOPMENT OF NONLINEAR PI CONTROLLER OF WASTEWATER
TREATMENT PLANT

By

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BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

DEVELOPMENT OF NON-LINEAR PI CONTROLLER OF WASTEWATER
TREATMENT PLANT

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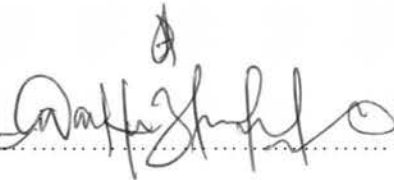
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I hereby declare that this thesis entitled “Nonlinear PI Controller for Wastewater Treatment Plant” is based on my original work except for quotations and citations which have been duly acknowledged. I also declared that it has not been previously or currently submitted for any degree at UTeM or other institutions.

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DEDICATION

I dedicate this thesis for

My beloved parents, Wan Saifuddin bin Wan Ibrahim & Kaniza binti Abu Bakar

*My sisters and brothers, Wan Zahira, Wan Zahidah, Wan Syahrizam, Wan Syahrani,
Wan Sufian and Wan Alimusa*

My classmates 4Bent and my supervisor, Dr Sharatul Izzah binti Samsudin

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ABSTRACT

Wastewater treatment plant (WWTP) is basically a process involves in cleaning up the sewage which is released from domestic and commercial sources. However, the WWTP is difficult to be controlled due to its nonlinearity of the system. The focus in this project is to enhance the quality of the treated water by controlling the dissolve oxygen (DO) and substrate-by using nonlinear PID controller. A nonlinear gain function is applied to the PID controller for a wider range of control performance. It is expected that the developed nonlinear PID controller is successfully perform to control a simple wastewater plant in different SISO and MIMO control structures.

Keywords- Wastewater Treatment Plant, Controller, Nonlinear PID, DO, Substrate

ABSTRAK

Pelan rawatan air sisa (WWTP) pada dasarnya adalah proses yang melibatkan proses membersihkan kumbahan yang dilepaskan daripada sumber domestik dan komersial. Walau bagaimanapun, WWTP adalah sukar untuk dikawal kerana ketidaklurusan sistemnya. Fokus dalam projek ini adalah untuk meningkatkan kualiti air yang dirawat dengan mengawal oksigen larut (DO) dan substrat dengan menggunakan pengawal PID linear. Fungsi keuntungan tak linear digunakan untuk pengawal PID untuk pelbagai yang lebih luas prestasi kawalannya. Ianya dijangkakan bahawa pengawal tak linear PID yang dibina itu berjaya untuk mengawal loji air sisa dalam struktur kawalan SISO dan MIMO.

Keywords- Loji Rawatan Air Sisa, Pengawal, Nonlinear PID, DO, Substrat

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LIST OF ABBREVIATION

WWTP	-	Wastewater Treatment Plant
DO	-	Dissolve Oxygen
PID	-	Proportional, Integral, Derivative
Knon	-	Nonlinear Gain
SISO	-	Single Input, Single Output
MIMO	-	Multiple Input, Multiple Output

CHAPTER I

INTRODUCTION

1.1 Background of Project

Basically, the wastewater treatment plants were built to collect and transport wastewater from residential and commercial areas that have a relatively high concentration of biodegradable organic and inorganic compounds that can be easily utilized by microorganisms for cell growth and life maintenance. The quality of water control is important to maintain a healthy life.

As the population arises, the need of proper wastewater treatment control is highly demanded (Azman, Shaari, and Kok 2011). Therefore, the extension of advanced control strategies of WWTP are in highly suggested in ensuring a good water level (Haimi et al.,2009). But, due to complexity of the wastewater treatment plant, a nonlinear PI controller is proposed in order to control the performance of the WWTP. PID controller is the most common control algorithm which applied in wastewater control (Vlad et al. 2014).

During past decades, several ways are used in order to enhance the PID controller has been introduced to industrial control. One of the idea is by using the nonlinear gain function which is the combination of error, e to achieve a better tracking and better noise rejection. It will be achieve by creating a small linear area in the nonlinear function when e is near to zero (Zaidner et al. 2010).

This project is the enhancement of the current control system that has been used in the WWTP. A new nonlinear gain function is introduced for a wider range of the controller. It is expected that the developed nonlinear PID controller is successfully perform to control a simple wastewater plant in different SISO and MIMO control structures hence compatible to applied to other complex nonlinear systems.

1.2 Problem Statements

In this project, the focuses are in two problems which are the improvement of the treated water quality and the enhancement of the nonlinear PID controller. For a better of water control, it aimed to control the substrate and dissolve oxygen (DO). DO is the most important and crucial parameter in the WWTP due to the significant influent on behavior and activity of microorganism living in the activated sludge (Holenda et al. 2008). Next, the limitation of linear PID controller in controlling the nonlinear system is overcome by introducing the nonlinear gain function.

1.3 Objectives

- To study the wastewater treatment plant control system.
- To develop the best nonlinear gain function of Nonlinear PID controller.
- To study the performance of SISO and MIMO control structure of WWTP.

1.4 Scope of Project

This project is focus in developing a nonlinear PID controller. At the beginning of the work, the PID controller need to be defined and all the theoretical understanding of PID controller need to be covered. The nonlinear PID controller is the cascaded of the

controller with the nonlinear gain function. The nonlinear gain functions were studied from the previous studies while the performance for each gain functions were analyzed by using Simulink@ MATLAB software. The best nonlinear function with good performance is then chosen. When the best nonlinear gain function is applied, it then tested to an activated sludge plant model.

1.5 Outline of the Thesis

This thesis consists of five chapters which include introduction, literature review, methodology, results and discussions and results and the last part is conclusion and recommendation. In chapter 1, the project is briefly described and the objectives of the project is defined.

Chapter 2 is the literature review part which consists of the theoretical of the project. In this part, all the theoretical understanding is covered and this parts is one of the crucial works during PSM1. The next chapter is methodology parts. In this chapter, the methods used in completing this project is describe and discussed. The flow chart of both PSM1 and PSM2 is included which shows the steps in completing this project.

Chapter 4 is covered about the results and discussion of the project. The results of project is screenshots and tabulated in Table in order to analyzed the results. Then, all the results is discussed briefly. The last chapter of the thesis is conclusion and recommendation. In this part, all the parts of the project is conclude and the objectives of

the project need to be achieved. The, recommendation is made to give idea in improving the project for future use.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

Wastewater Treatment Plant (WWTP) is the process involves in cleaning up the sewage which is released from households and commercial sources. It is naturally aimed to removes substances, organic materials and phosphate from the water before releasing it to the recipient. Not only that, it is also an act to produce a wastewater stream that can be discharged back into the environment and minimize the solid waste produced (Rocca 2012). Two main objectives that superiorly motivate the study of the WWTP are due to t)

quality standards such aimed by Jesse (Rocca 2012)and Yang(Yang et al. 2014)and supported by the cost reduction purposes such covered in another thesis (Muga and Mihelcic 2008). The WWTP has become part of a production process where the quality control of the effluent is highly considered. Therefore, enhancement advanced control strategies of the WWTP are always demanded to ensure a good level of treated water (Haimi et al., 2009).

