UNIVERSITI TEKNOLOGI MARA

Cawangan Terengganu
Kampus Bukit Besi

TITLE:

COMPARISON OF VARIOUS CLOSED TUNING RULES ON PID CONTROLLER PERFORMANCE
(LIQUID FLOW)

SUPERVISOR: MR. AZMI BIN MAHMOOD

NAME: NURUL AIDA BINTI GHANI
STUDENT ID: 2020472412

SCHOOL OF CHEMICAL ENGINEERING
COLLEGE OF ENGINEERING

2023

ABSTRACT

Flow control is essential in many chemical industries such as in dosing processes. Applications include the food and beverage industries, pharmaceutical industries, chemical research labs or pilot plants, and many more. PID controllers currently represent more than half of all controllers used in industry. However, in the absence of a mathematical model, the parameters must be determined experimentally. The method of determining the controller parameters that produce the desired output is referred to as controller tuning. Controller tuning enables process optimization by reducing the error between a process variable and its set point. The purpose of this study is to compare the effect of three different tuning rules on the performance of liquid flow process control. Open-loop test is carried out to obtain the process response curve which response rate (RR), time constant (T_c) and dead time (T_d) was analysed using a Reformulated Tangent Method (RTM). The controller governing parameters, Proportional Band (PB)-Integral Time (I)-Derivative (D) are calculated using the established tuning rules in the literature; Ziegler-Nichols (Z-N) rule, Cohen-Coon (C-C) rule and Takahashi rule. The performance of the process response for each of the tuning rules is evaluated based on settling criteria such as settling time (T_s) and the quantity of the integral absolute error (IAE). The result presented that the Cohen-Coon (C-C) tuning method give a better performance compare to the Ziegler-Nichols (Z-N) rule and Takahashi rule.

TABLE OF CONTENTS

CHAPTER ONE
BACKGROUND

1.1 Introduction

Process control refers to the methods used to control process variables during product manufacturing. For example, the proportion of one ingredient to another, the temperature of the materials, how well the ingredients are mixed, and the pressure at which the materials are held can all have a significant impact on the end product's quality. There are a few important variables that involved in process control such as set point, controller, final control element, process and measurement element. There are two systems involved in process control which is open loop system and closed loop system; a closed control loop exists when a process variable is measured, compared to a setpoint, and corrective action is taken if there is a deviation from the setpoint whereas an open control loop exists when the process variable is not compared and action is taken without regard for process variable conditions rather than in response to feedback on the condition of the process variable.

In this report, the procedure parameter that is being chosen is the liquid flow control loop. Liquid flow control loops are typically the fastest loops in a process. As a result, flow control equipment must have quick sampling and response times. Their dynamics are measured in seconds, whereas the dynamics of most other loops are measured in minutes. Compared to the time frame of these other loops, flow loops appear to act and respond instantly. Most loops are finely tuned to respond more quickly to changes in both set-points and disturbances. However, because flow loops are inherently fast, there is rarely an incentive to tune them aggressively. This separated flow loops from other loops; the considerations for mode selection and tuning of flow loops differ from those of other loops.

According to the (Ashlin, 2021), we must tune a controller so that it can match the characteristics of the control equipment to the process. The tuning resulted in a faster response to errors and a more stable system. The controller tuning is done to control how the final control element responds to a change in error. By changing the controller gain, the controller input changes, and as a result, the controller output changes. So, this would adjust the final control element to cancel the error, but it would not cause system instability. So, by performing controller tuning, the feedback controller parameters can be varied to obtain proper output.

As previously stated, these procedures necessitated general testing of the open loop first. An open-loop control system considers input but does not react to feedback to produce output. This is why it is also known as a non-feedback control system. This system has no disturbances or variations and operates under constant conditions. For closed loop system part, a feedback control system is another name for it. These systems record output rather than input and modify it as needed. It generates the preferred output condition as opposed to the original. It is not disturbed by any external or internal factors.

Before beginning to tune the liquid flow control loops, it is important to create a variety of reasons and criteria for determining which controller is appropriate and provides the best performance. Despite ongoing advances in control theory, the PID control algorithm remains the most popular technique for industrial process control. This is due not only because of its simple structure, which is fundamentally simple to understand and allows for manual tuning, but also to the fact that the algorithm performs adequately in the vast majority of applications. PID controller is also used in this report because it can keep the rigidity and speed of the closed-loop response.

This report will discuss about the various types of PID tuning techniques that have been implemented, as well as a comparison of some of them. Several tuning methods for PID controls have been proposed such as Ziegler-Nichols (Z-N) rule, Cohen-Coon (C-C) rule and Takahashi rule methods. There are three parameters that must be tuned in order to achieve the desired optimum value which is:

Symbol	Parameter
PB @ P	Proportional Band
TI @ I	Integral Time
TD @ D	Derivative Time

Table 1: Parameter of PID controller