

UNIVERSITI TEKNOLOGI MARA

TECHNICAL REPORT

PREDICTING CHLORINE RESIDUALS
IN WATER DISTRIBUTION SYSTEM :
CASE STUDY IN PENANG

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ABSTRACT

Chlorination is the most widely practiced form of disinfection in Malaysia. Chlorine plays an important role in maintaining the water quality in distribution system through a residual. In order to determine the optimal chlorine residual, it is necessary to predict the chlorine decay in water distribution network. Firstly, chlorine decay in bulk water need to be described clearly to understand the decay characteristics. The combination of first and second order model of ordinary differential equation was found to be one of the most suitable models for this purpose (Hua et al., 1999). In this report, an analytical solution for this model was developed where the second order decay equation is used for the initial phase to find decay constant k_1 while for the second phase the first order decay equation is used to find decay constant k_2 (Kowalska et al., 2006). This is because the first 4 hours of the initial phase has immediate consumption and after the first 4 hours the chlorine consumption is slower. From the data obtained, this project use Microsoft Excel and Harmonic Mean Method to find the decay constant k_1 and decay constant k_2 . This project also used Sum of Square Error (SSE) to observe the error between the first order model and the combination of first and second order model. Based on the graph of chlorine residual (mg/L), it shows that the time taken for predictive chlorine residual to reach its minimum level is faster than that the actual chlorine residual. However, the results obtained from the proposed analytical solution was considered accurate in predicting of chlorine decay behavior.

1 INTRODUCTION

1.1 Introduction

Drinking water is essential for human being. So, it is very important to maintain the quality of drinking water. The quality of water generally deteriorate during the delivery process from a distribution system to customers' tap. These water sources contain pathogens and microorganisms that are potentially dangerous to human's health. The most commonly used method for drinking water disinfection in Malaysia is by chlorination. It is also an advantage since the cost used is cheaper than other methods and able to remain within the distribution system for a longer time (Rahman et al., 2013). Chlorine is unstable, that can react with various of organic and inorganic compounds in bulk water or on wall. Despite the role of chlorine that can control the spread of disease from bacteria and microorganism, its side effect required regulation and standards to limit to an optimum level. According to World Health Organization,WHO (2011), the chlorine residual is set to be around 0.2mg/L and 1mg/L.

According to Walt (2002), as the water travel through distribution network, the chlorine concentration will decrease due to several factors. When chlorine is added to water, it will naturally disappear through natural evaporation and it also reacts with pipe, tank walls and the compound within the water bulk. The quality of water also change depending on the age of wall. The decay of chlorine is getting faster as the increase of the age wall. Subsequently, chlorine has ability to produce odour which customers find easy to recognize and it becomes the causes of customers' complaint if the amount used is too much. Many investigations are conducted in the formation of chlorination disinfection by-products that is potentially harmful to human's health if the amount of chlorine is too excessive (Rahman et al., 2013). Therefore, the proper management of chlorine concentration in water distribution system is essential so that the acceptable and a safe product is supplied to the customer.