EFFECT OF RAW WATER QUALITY ON COAGULANT DOSAGE AND OPTIMUM pH

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Praise the LORD GOD because of the blessed and strength HE gave unto me,
Sincere thanks to my lovely husband, Johnny and daughter, Jwelyn Ystefanie because of your moral support, sacrifice and became my backbone,
Thanks Apak and Mama for your love all these years,
In loving memory brother, Jeruslavin Benson (18th June 2003); You always in our heart and this is a gift for you..

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ABSTRACT

Removal of turbidity, suspended solids (SS) and natural organic matter (NOM) using coagulation are well known because of the ability of the process in destabilizing the colloids particles and reducing the repulsion force between the particles. The objectives of the study are to explore the effect of the selected water quality parameters (i.e initial pH, initial temperature and SS) and to develop a statistical relationship between the water quality parameters and the optimum dosage and pH. The study was conducted using jar test procedures using synthetic water prepared using kaolin as the source of SS. The experiments were designed using Response Surface Method (RSM) with final turbidity as the response. RSM was found to be better approach than one-factor-at-a-time (OFAT) in determining the optimum dose and pH. Initial pH and SS was found to have significant effect to optimum dose at 90% confidence level ($\alpha = 0.1$) and temperature was the only factor having significant effect on optimum pH at 80% confidence level ($\alpha = 0.2$). Probably due to the complexity of the nature of the coagulation process, the relationship between the parameters and the response was only developed for optimum pH.

ABSTRAK

Penggunaan proses pengentalan untuk menyingkirkan kekeruhan, bendasing terampai dan jirim semulajadi organik didalam air sangat popular kerana kebolehannya dalam menidakstabilkan zarah-zarah koloid dan mengurangkan daya tolakan di antara zarah. Objektif utama kajian ini adalah untuk melihat kesan daripada parameter kualiti air yang terpilih (pH awal, suhu awal dan kepekatan pepejal) dan juga untuk menghasilkan hubungkait statistik antara parameter kualiti air dengan dos optimum dan pH optimum. Kajian telah dijalankan menggunakan prosedur Ujian Balang dengan penggunaan air sintetik yang telah disediakan menggunakan kaolin sebagai pepejal terampai air. Ujikaji telah direkabentuk menggunakan Kaedah Response Surface (RSM) dengan mengambilkira kekeruhan adalah sebagai hasil tindakbalasnya. Didapati bahawa RSM adalah jauh lebih bagus berbanding dengan pendekatan menggunakan Satu-Faktor-Pada-Satu-Masa (OFAT) dalam menentukan pH optimum dan dos optimum. Adalah didapati bahawa pada 90% tahap keyakinan ($\alpha = 0.1$), pH awal dan nilai awal pepejal terampai mempunyai kesan yang penting terhadap dos optimum manakala hanya suhu sahaja didapati memberi kesan penting terhadap pH optimum pada 80% tahap keyakian ($\alpha = 0.2$). Hubungkait antara parameter dan hasil tindakbalas hanya boleh dibangunkan untuk pH optimum, kemungkinan besar disebabkan oleh tindakbalas pengentalan yang agak kompleks.

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LIST OF SYMBOL

mg	-	milligrams
g	-	grams
L	-	litre
mL	-	millilitre
°C	-	Degree Celsius
FTU	-	Formazin Turbidity Unit
NTU	-	Nephelometric Turbidity Unit
p-value	-	level of confidence in percentage
$CaCO_3$	-	calcium carbonate

CHAPTER 1

INTRODUCTION

1.1 Preamble

In drinking water treatment, coagulation process is use to destabilize colloidal materials or contaminants. Followed by solid-liquid separation processes such as flocculation, sedimentation, or dissolved air flotation (DAF) and filtration, the processes are capable to remove the colloidal particles from the water (Pernitsky, 2001).

Chemicals that are used for coagulation process is called coagulant. Currently, there are many types of coagulant available in wastewater treatment but the most frequently used are alum or ferric sulphate. These chemical coagulants are in positive charged and it will react with colloidal suspension of organic and inorganic solids that are usually negatively charged. Besides the man-made coagulant, other traditional coagulants originated from the plant origin such as Moringa Olerfera seeds which can be found in India and Strychnos Potatorum are seldomly used. The uses of other traditional coagulant from soil origin include bentonite or clay, algae, chitosan and dough from millet bread are also reported (Anselme and Narasiah, 1998).

Many factors have been reported to affect the coagulation process. These include turbidity, organic matter and pH, ultraviolet (UV), alkalinity or acidity and temperature (Pernitsky, 2003). While some studies have been conducted to relate these parameters to coagulant dosage, the standard method commonly used to determine the coagulant dosage is by using Jar Test.

1.2 Problem Statement

The effectiveness of the coagulation process is highly dependent on the dosage of the coagulant and the pH of the water during the process. However the effectiveness of this process and the relationship between the raw water quality and the coagulant dosage and optimum pH can hardly be predicted until today mainly due to the complexity of the chemistry of the coagulation process. Hence, the dose of coagulant and pH of the process mainly depend on the results of the Jar test which is conducted at the water treatment plant. Typically, the Jar Test will be carried out in a daily basis and also in the event of changes in raw surface water characteristics.

Since Jar Test is a tedious experimental process and time consuming, this study intends to develop a relationship between raw water quality parameters and the optimum coagulant dosage and the pH based on statistical approach. Such relationship is anticipated to ease the operator in plant to determine the optimum dosage and pH in the coagulation process.

1.3 Aim

The aim in this study is to ease the process of determining the optimum chemical dosage and pH for coagulation process in water treatment.

1.4 Objectives

There are two main objectives of the study:

a) To explore the effect of the selected water quality parameters on the optimum dosage of coagulant and pH.

b) To develop a statistical relationship between the selected water quality parameters with the optimum coagulant dosage and pH.

1.5 Scope and Limitation of The Study

The study covers a comprehensive experimental works at laboratory scale. Synthetic water prepared by using kaolin was used in the study. The experimental work was designed using Response Surface Method (RSM). Three independent water quality variables were chosen, namely initial turbidity, pH and temperature. Optimum coagulant dosage and pH were used as the response variables based on the

lowest turbidity achieved after the jar test. Aluminium sulphate (Alum) was used as the coagulant.

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