

UNIVERSITI TEKNOLOGI MARA

**REMOVAL OF 2, 4, 6 TRICHLOROPHENOL
FROM SIMULATED WASTEWATER
VIA PROGRESSIVE FREEZE
CONCENTRATION: EFFECT OF INITIAL
CONCENTRATION WITH THE USAGE OF
RESPONSE SURFACE METHODOLOGY AS THE
MEANS OF OPTIMIZATION**

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ABSTRACT

2, 4, 6-Trichlorophenol (TCP) has been used primarily in various pesticide formulations and as a wood preservative. Only the slightest amount of TCP in wastewater is harmful and it can be the cause of many diseases, thus the importance to remove the TCP from wastewater is crucial. Progressive freeze concentration (PFC) process is a versatile process that can be used to separate solution from its contaminant. PFC is a method of separating solution and solvent into a singular layer of ice on the wall where coolant is applied. In this study, PFC was used to remove TCP from a simulated wastewater. The aim for this study is to determine the effect of initial concentration on effective partition constant (K) and TCP reduction (T_R). The second objective of the study is to determine the optimum condition for initial concentration and operation time of PFC system via Response Surface Methodology. The experiment was done by varying the initial concentration of the PFC system by 50, 100, 150, 200, 250 ppm which represents the concentration of TCP in wastewater from industrial plants. From the results of the experiment, initial concentration of 50 ppm brings out the highest efficiency of the PFC system as the K -value is 0.3048 and the T_R value of 0.9046. Optimization analysis was carried out by using STATISTICA software. In order to obtain the optimum conditions for PFC parameters, the experiments were performed using two variables, which are initial concentration and operation time. Central Composite Design (CCD) was used in this RSM study to clarify the connection of the process variables and to predict the optimum condition for the optimum results of the PFC process. The regression model generated by RSM was a good fit since the R^2 obtained were 0.81767 for K and 0.87622 for T_R . From ANOVA analysis, the optimum initial concentration and operation time to obtain the lowest K value at 0.1316 can be achieved at the value 93.2 ppm and 83min respectively. As for T_R value, it can be summed up that the optimum T_R of 76.53 could be achieved at initial concentration of 51.4 ppm and operation time of 60.5 min. From the verification experiment of the PFC process using the optimum condition predicted by the ANOVA model, the value of 0.3541 for K and 74.04 for T_R were obtained. It was calculated that the percentage error for the K is 169.073% and 3.2144% for T_R . The high percentage of error may be due to the regression model was not fit to the real life situation of the PFC process.

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CHAPTER ONE

INTRODUCTION

1.1 Background Study

2, 4, 6-Trichlorophenol has been used primarily in various pesticide formulations and as a wood preservative. It has been used as a fungicide, glue preservative, insecticide, bactericide, defoliant, herbicide, and anti-mildew agent for textiles (National Toxicology Program, 2009). Increasing of public concerns about environmental problems especially the water resources pollution has highlighted the treatment process of wastewater (Ali et al., 2013). The C-Cl bond and the position of chlorine atoms relative to the hydroxyl group are responsible for their toxicity, carcinogenic properties, structural stabilization and persistence in the environment, making the removal of 2, 4, 6-TCP from the environment very crucial. (Aifei et al., 2015).

Chlorinated phenols or chlorophenol, widely used in industries, are of growing concern owing to their high toxicity, carcinogenicity and wide distribution in industrial wastes (Lin et al., 2008). 2,4,6-TCP has been classified as one of the primary pollutants as enacted by the Department of Environment (DOE), Malaysia in Environmental Quality Act 1979 (Sewage and Industrial Effluent) which should be treated to be less than 1 ppm for inland water discharge (Krishnaiah et al., 2013). The stable carbon chlorine bond and the position of chlorine atoms relative to the hydroxyl group are responsible for their toxicity, carcinogenic properties, structural stabilization and persistence in the environment, making the removal of 2, 4, 6-TCP from the environment very crucial. Thus, the process of removing the TCP in water may in fact be a bit tedious and without proper removal it will destroy the natural habitat and ecosystem of the river alongside any organism that live in the river or near the river. A proper waste management is needed as it will a necessity for a sustainable environment (Crane et al., 2011).

To properly separate the pure water and the contaminant inside the effluent, several methods can be used. Reverse osmosis, freeze concentration and evaporation is the most common method used in separation process (Mazura Jusoh, 2010). Although evaporation and reverse osmosis is a very well-developed method, both methods have major drawbacks. The major drawback of evaporation is that it require a lot of energy