

UNIVERSITI TEKNOLOGI MARA

**PROGRESSIVE FREEZE
CONCENTRATION: EFFECT OF
CIRCULATION FLOWRATE ON
2, 4 ,6- TRICHLOROPHENOL
REMOVAL AND OPTIMIZATION
VIA RESPONSE SURFACE
METHODOLOGY.**

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ABSTRACT

2,4,6- Trichlorophenol (TCP) is a toxic and mutagenic yet carcinogenic compound which is found in the emissions from combustion of fossil fuel, incineration of municipal waste and process of chlorination of water containing phenol or some aromatic acids with hypochlorite and disinfection process of water for domestic used or others. This study attempted to prove that TCP in wastewater can be separated through PFC method; which is simple yet cost effective by freezing the solution which causes a large ice mass to be formed and grown on the surface of cooler. The component in the mother liquor with higher freezing point is frozen first on the cooling surface leaving the other component with lower freezing point, thus separation between the components are easy simply by pouring out the liquid counterpart. The wastewater then can be safely dumped into water-channels after removing TCP from simulated wastewater due to lower concentration of TCP in wastewater thus lowering water pollution aftermath. The objectives of this study are to study the relationship between the circulation flowrate of specimen in separating TCP from simulated wastewater using progressive freeze concentration (PFC) and its effectiveness through effective partition constant, K and TCP reduction efficiency (Eff) and to determine the optimum circulation flowrate of specimen in PFC for optimization of separation process. In this research, a method of experiment was designed to study the effect of circulation flowrate in PFC. This method focused on the effect of solution on the crystallization by freeze concentration of simulated wastewater. Wastewater which was simulated by combining powder TCP with acetone and then diluted with distilled water until 1000 ml of solution were reached, was used in the experiment. The main operating condition studied in this experiment was circulation flowrate which was varied at 500, 600, 700, 800 and 900 rpm throughout the experiment. Simultaneously, for other operating conditions which were initial concentration, temperature of coolant and operating time were kept constant at 100 ppm, -5°C and 30 minutes respectively. The best circulation flowrate found was at 900 rpm which resulted in lowest K value and highest Eff which were 0.5253 and 65.56% respectively. The optimization process was done by using Response Surface Methodology (RSM) via STATISTICA software. The model generated by RSM was found to be a great model as the calculated F value of 17.6662 and 10.1723 for K value and Eff are larger than tabulated which was 6.26. Meanwhile the R^2 value for both models are 0.956 and 0.927 for K value and Eff, respectively which shown the good correlation between circulation flowrate and coolant temperature conditions and K value and Eff parameters. The best responses for K and Eff forecasted by ANOVA were 0.1528 and 84.8% respectively.

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CHAPTER ONE

INTRODUCTION

1.1 Research Background

The growth in technological advancement which started during the First Industrial Revolution together has brought about tremendous achievements in manufacturing processes in order to cater with human population which increases throughout the globe. Such endeavors bring about good things but at the same time carry along bad consequences; due to overexploitation and ineffective waste management, especially towards the ecosystem (Lim Chin et al., 2016).

Chlorophenols are a group of chemicals resulting from addition of chlorines to phenols group. They are regarded as one of many common organic pollutants widely used in industry, agriculture and public health (Gao and Wang, 2007). Some of industrial wastewaters rich in chlorophenols are from pesticide, paint, wood, pharmaceuticals, paper and pulp industries as well as water disinfecting process (Tan et al., 2009). Chlorophenols with at least two chlorines are used in pesticides whereas four chlorines are benefited in antiseptics (Radhika and Palanivelu, 2006). Chlorophenols are hazardous towards living organisms as they can permeate into skin in vitro and promptly absorbed by gastrointestinal tract (Tan et al., 2009a).

2,4,6- Trichlorophenol (TCP) is a toxic and mutagenic yet carcinogenic which is found in the emissions from combustion of fossil fuel, incineration of municipal waste and process of chlorination of water containing phenol or some aromatic acids with hypochlorite and disinfection process of water for domestic used or others (Chaliha and Bhattacharyya, 2008). Aside from that, researches confirmed that TCP also can cause adverse effects on human nervous system as well as respiratory problems, for instance, cough, modified pulmonary function and chronic bronchitis (Hameed, 2007). Such traits of hazards and toxicity to biological environment are due to the stable C-Cl bond in