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OPTIMISATION OF PALM KERNEL SHELL ACTIVATED CARBON FOR METHYLENE BLUE ADSORPTION: TAGUCHI APPROACH AND ISOTHERM STUDY

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***Abstract*-**Activated carbon was used for methylene blue or dye adsorption in liquid solution analysis. Taguchi orthogonal array design was employed to optimize the process parameters for preparation of activated carbon. The influence of process parameters; impregnation ratio, activation temperature and activation time were studied. Based on the S/N ratio analysis, the optimized conditions are the impregnation ratio of 0.6, the activation temperature of 750°C and the activation time of 90 min considering the condition larger is the better approach. Analysis of Variance (ANOVA) is applied and proved that the most influential factor on the methylene blue adsorption is impregnation ratio. From the result, the linear regression model was developed and the value of R^2 is 0.9625. This shows that, the regression was 96.25 % reliable to the experimental value. As for isotherm study, it is shown that the optimum condition of the methylene blue adsorption on activated carbon follows the Langmuir model. It is because the value of regression coefficient, R^2 for Langmuir model is the highest among all models (R^2=0.9987), where the Freundlich model is R^2=0.9834 and the Temkin model is R^2=0.9957.

***Keywords*:** Taguchi Orthogonal Array Design, Activated Carbon, Methylene Blue or Dye Adsorption

Table of Contents

1. Introduction

Water pollution due to dyes from industry and the abundance of palm kernel shell from plantation site is becoming more worrisome but these problems can be solved. Textile industry is one of the major industrial producers of wastewater with high colour to the environment. Dyes that commonly used in many industries is methylene blue. The function of dye is to impact color in pulp and paper, leather, textile and in many industries such as cosmetic industries. However, there are many disadvantages of using dyes to environment and water because dyes are generally non-degradable and constitute a problematic group of pollutants. Furthermore, dyes can also damage flora and fauna and it also inhibit solar radiation into the water sources. Thus, it will reduce the extent of photosynthesis.

Removal of these dyes has been extensively studied, with the processes used including precipitation, ionic exchange, membrane filtration, and adsorption. Among these processes, adsorption shown more desired results comparatively with other treatment methods due to the convenience of many adsorbents, simplicity of design, high efficiency, and ability to treat dyes in a more concentrated form. This experiment is about to choose the best parameters of preparation activated carbon for methylene blue or dyes adsorption. The abundance of palm kernel shell from palm plantation can be used to produce activated carbon that can treat wastewater that were polluted with dyes. The activated carbon can be prepared from palm kernel shell. The activated carbon is derived from material with carbon content such as char that were pyrolyzed. Next, the substances such as oxygen, Sulphur and others will be separated from the char and only leaves the char enriches with carbon. This will form lots of tiny pores and the pore will increase the surface area of activated carbon. In addition, it will increase the place for molecule to bond through adsorption process. There are many factors that can be considered in preparing the activated carbon such as impregnated ratio, time and temperature.

In this experiment, the best parameters will be selected based on the resources used, time and cost of production of the preparation of activated carbon. In order to find the best parameters, the Taguchi method will be use. The Taguchi method of quality control is a method to engineering that highlights the roles of research and development (R&D), product design and development in reducing the rate of defects and failures in manufactured goods. Also, the Taguchi method allows for the analysis of many different parameters without an excessively high amount of experimentation. For example, a process with 8 variables, each with 3 states, usually would require 27 experiments but with the aid and application of Taguchi statistical analysis, only 9 experiments would be require to test all the variables with the same results.

The Taguchi method has standardized the methods for each of these ANOVA application steps. Thus, ANOVA using Taguchi approach has become a much more attractive tool to practicing engineers and scientists. There were limitations when conventional experimental design techniques were applied to industrial experimentation. The Taguchi method, also known as orthogonal array design, adds a new dimension to conventional experimental design. Taguchi

method is a broadly accepted method of ANOVA, which has proven in producing high-quality products at subsequently low cost.

Taguchi method can be a tool to offer a systematic way to optimize design of performance and quality of product through "orthogonal array design". It also systematizes parameters and the level affecting the process with respect to all control factors with minimum amount of experimentation. Meanwhile, the conventional methods which use only mean value of response to determine the optimum level without showing the variability of data set, but the Taguchi method takes into account both mean value and the variance. An important aspect that needs to be considered is the signal-to-noise (S/N) ratio. S/N ratio is an analytical medium used to determine the best levels which contribute to optimum response value. The Taguchi method can ensure less experiment are needed that mean less spending on energy, time, material, cost on the experiment while producing high-quality and low-cost production process.

2. Materials and Methods

2.1 Optimization Method

The data was extracted from experiment that has been done on the methylene blue adsorption using palm kernel shell as precursor of activated carbon.

2.2 Taguchi Experimental Design

In this research, three controlled factors including impregnation ratio, activation temperature and activation time were designed in three levels as shown in Table 1. A standard L_9 orthogonal array design was used to determine the optimum experimental conditions for maximum removal of methylene blue dye and the design experimental runs are given in Table 2. The signal/noise (S/N) ratio considered conditions are smaller the better, nominal the best and larger the better. Since the aim of this study is to obtain the high methane adsorption, the larger the better of S/N ratio is used.

Table 1. Control factors and their levels.

Control factors	Level 1	Level 2	Level 3
Impregnation ratio	0.2	0.4	0.6
Activation temperature	550	650	750
Activation time	30	60	90