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Optimization of experimental parameters in the treatment of textile effluents charged by colorant blue Telon the using the experimental design method

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Abstract

In the present paper, a systematic study of the influence of experimental parameters and operating conditions on the effectiveness of the adsorption process using olive active as adsorbent. The influence of the parameters is studied at two levels, fractional factorial designs and a Doehlert uniform shell design to determine the influence of the adsorption conditions. The analysis of the experimental responses (mass adsorbent (Natural Resin) and Temperature and Time and pH, respectively) shows that the parameters which have the greatest influence change depending on the response.

The results concerning the theoretical parameters, allowed us to give better treatment by adsorption (Natural Resin (NR), blue Telon (BT)) in optimal conditions, namely: the temperature in the range (80 °C), mass Natural Resin order (50 mg), the agitation of the order (1000 Torr/min) and the pH of the order (10).

Keywords: Blue Telon, Natural Resin, Adsorption and NemrodW.

1. Introduction

With the increased demand for textile products, the textile industry and its wastewaters have been increasing proportionally, making it one of the main sources of severe pollution problems worldwide [1]. Effluent treatment from dyeing and finishing processes in the textile industry is one of the most significant environmental problems [2, 3]. Since most synthetic dyes have complex aromatic molecular structures which make them inert and biodegradable difficult when discharged into the environment [4, 5]. Through, textile processing employs a variety of chemicals depending on the nature of the raw material and product. Some of these chemicals are enzymes, detergents, dyes, acids, sodas and salts [6, 7]. The high consumption of reactive dyes, mainly in the cotton industry, increases the environmental problems, due to their low degree of exhaustion (60 - 90%) [8, 9]. Dyes removal techniques such as adsorption, electrochemical oxidation, photo-catalytic oxidation, electro-Fenton oxidation appear to face several technical and economic

limitations [10–12] and were found to be inadequate [13] because most textile dyes have complex aromatic molecular structures that resist degradation. The need for more efficient treatment processes has attracted the attention of environmental scientists and engineers.
To determine the parameters affecting the quality of the final product, with the intention to optimise the process during further work, the set of factors influencing the treatment of the effluent was studied. A full factorial matrix was established and processing the results with the Nemrodw software (New Efficient Methodology for Research using Optimal Design) enabled us to quantify the direct effects and interactions of the various factors on the responses chosen and to identify those that will require fine-tuning during the optimisation phase.

2. Materials and methods

2.1. Method of experiment (ME)

It comes up with definitions in few experiences, allowing a full study of the influence of all experimental parameters on given processes and their optimization. This is based on the search for a simple mathematical model giving a good representation of the phenomenon.

2.2. Mathematical model

The answers are described by a polynomial model of the following form:
$Y = b_0 + b_1*X_1 + b_2*X_2 + b_3*X_3 + b_4*X_4 + b_{12}*(X_1*X_2) + b_{13}*(X_1*X_3) + b_{14}*(X_1*X_4) + b_{23}*(X_2*X_3) + b_{24}*(X_2*X_4) + b_{34}*(X_3*X_4)$.
By applying this model, we tested four factors at two levels with the limit values of the parameters defined in Table 1:

Table 1: Areas of variation of the studied factors

factors	Number of Levels	levels
Mass of RN (mg) X_1	2	50
		150
pH X_2	2	2
		10
Temperature (°C) X_3	2	25
		80
Agitation (Torr/min) X_4	2	250
		1000

3. Resultants and discussion

The measured responses Yi (adsorption), which are quantitative and continuous in the experimental area, are represented in the experimental design. We calculated for those answers the direct effects of factors Xi (Mass Natural resin, pH, Temperature and Agitation) and their interaction effects. The obtained results are represented those interactions and in the form of bar charts.

3.1. Study schedules interactions between factors

3.1.1. Study schedules interactions X_1X_2:

In this case study, the following parameters: mass NR (X_1) and the pH (X_2). They are shown in Figure 1:

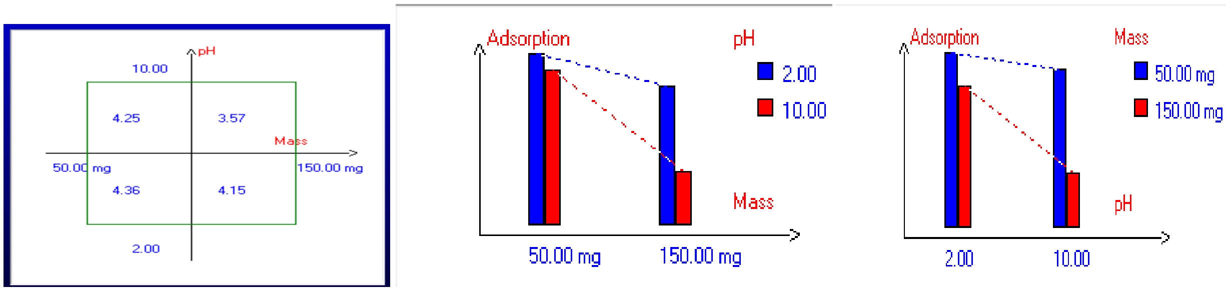

Figure 1. Graphical System of interactions X_1X_2

According to Figure 1, the interactions between the pH values and the mass of the adsorbent NR data have maximum results when working at a pH equal to 2 and a mass of RA A500 equal to 150mg.

3.1.2. Study schedules interactions X_1X_3:

In this case study, the following parameters: the mass of NR (X_1) and the Temperature (X_3). They are shown in Figure 2:

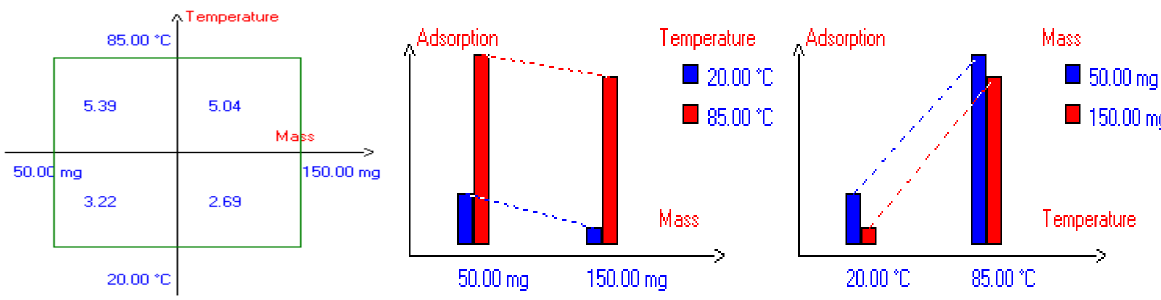

Figure 2. Graphical System of interactions X_1X_3

According to this system of interaction, it emerges that the best adsorption is determined in the case of interaction where X1= 50g (Mass of the NR) and X2 = 85 °C (Temperature).

3.1.3. Study schedules interactions X_1X_3:

In this case study, the following parameters: the mass of NR (X_1) and the Agitation (X_4). They are shown in Figure 3:

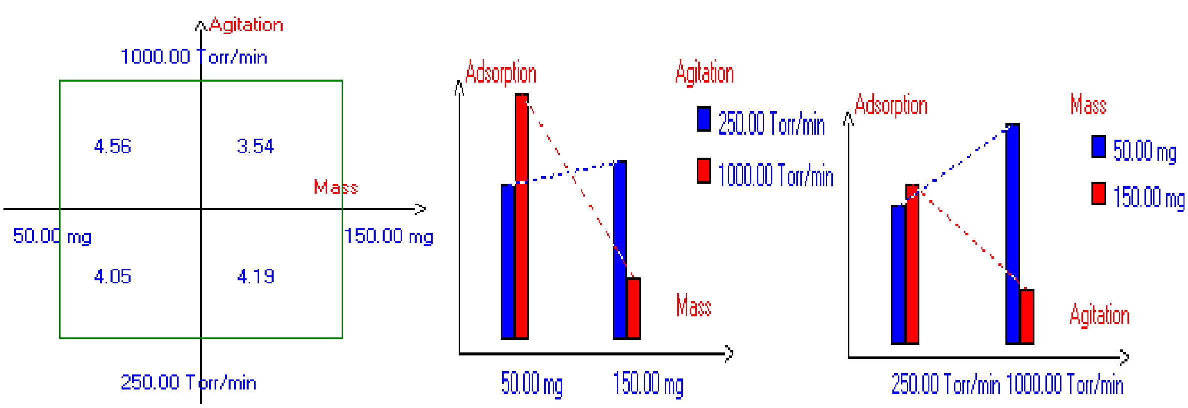

Figure 3. Graphical System of interactions X_1X_4

In figure 3, we see that there is a significant interaction between the mass of the adsorbent NR and agitation in the case of 50 mg values for Natural Resin and 1000 Torr/min for agitation.

3.1.4. Study schedules interactions X_2X_3:

In this case study, the following parameters: the mass of pH (X_2) and the Temperature (X_3). They are shown in Figure 4:

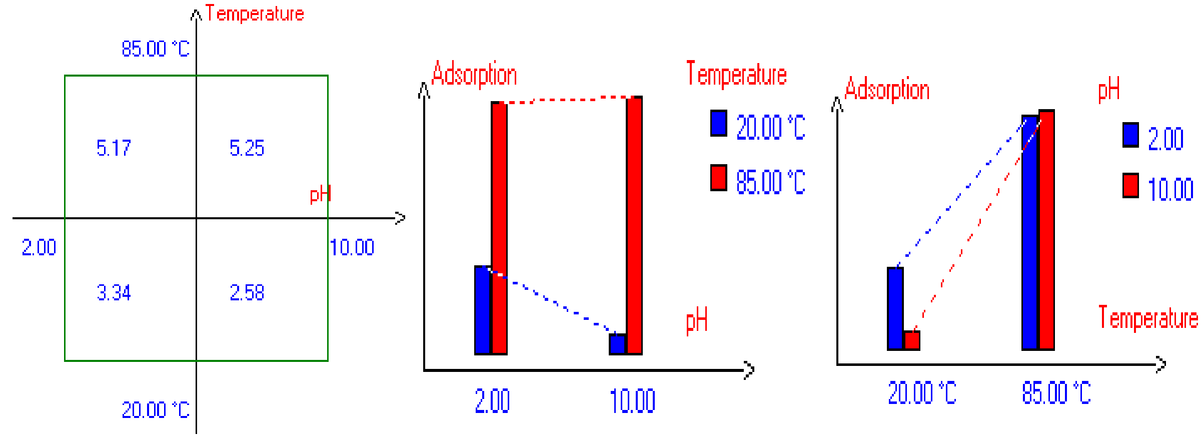

Figure 4. Graphical System of interactions X_2X_3

The optimum interaction between the pH (X_2) and the Temperature (X_3) shows that good adsorption is obtained at a temperature of 10 and 85 °C time.

3.1.5. Study schedules interactions X_2X_4:

In this case study, the following parameters: the mass of pH (X_2) and the Agitation (X_3). They are shown in Figure 5:

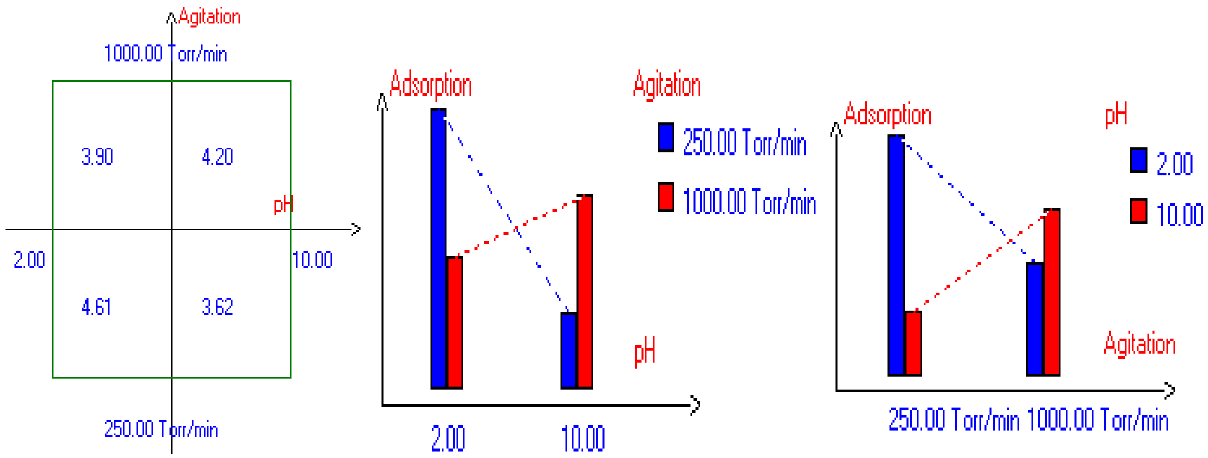

Figure 5. Graphical System of interactions X_2X_4

The interaction between pH and agitation shows that the optimal conditions were registered at the values of pH 2 and 250 Torr/min for agitation. The obtained value of these parameters gives a better adsorption.

3.1.6. Study schedules interactions X_3X_4:

In this case study, the following parameters: the mass of temperature (X_3) and the Agitation (X_4). They are shown in Figure 6:

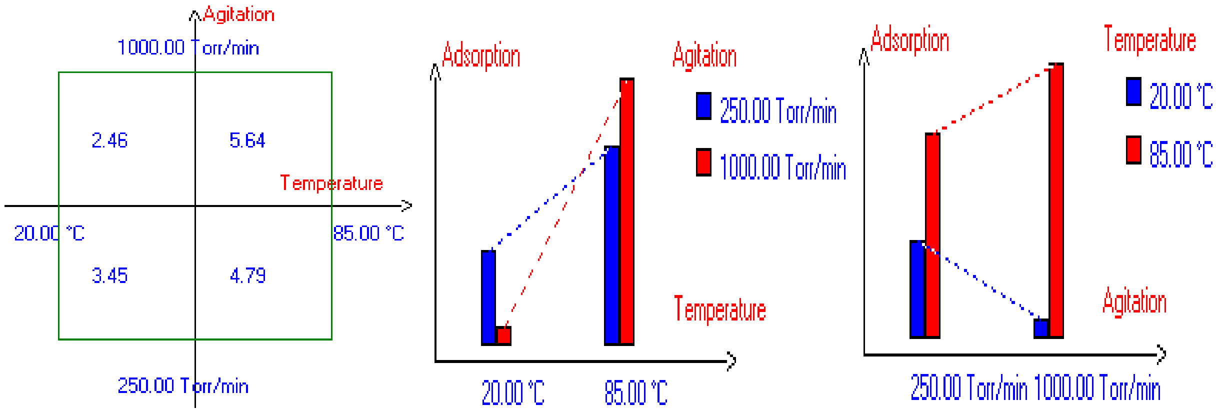

Figure 6. Graphical System of interactions X_3X_4

In Figure 6, we find that the best combination has been given to a temperature of 85 °C and agitation of 1000. The resulting combination showed a maximal response.

3.2. The bar chart of average effects

From the analysis of the chart below, we are shown that the most important effect on the adsorption is those of temperature (b_3) and the interaction between temperature and agitation (b_{34}).

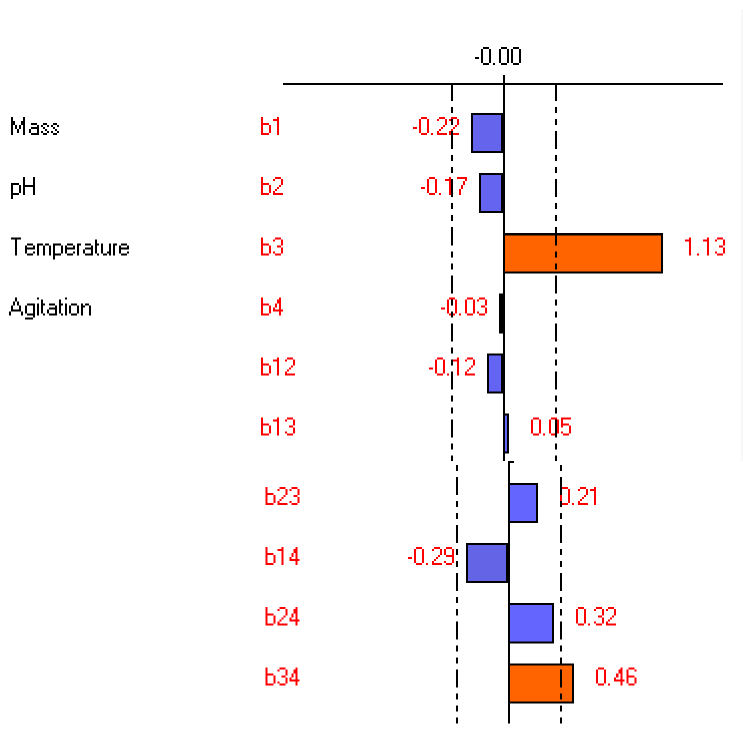

Figure 7: Average effects of parameters on adsorption.

3.3. Screening Study: Treatment of experimental responses

3.3.1. Validation of the model

The treatment of various parameters by the diagrams (bar chart and Pareto chart) allowed us to highlight that the coefficient of regression is in the vicinity of 92.1 % (Table 2) based on the analysis of variance represented as follow:

Table 2. Analysis of variance

Source of the variation	sum of squares means	Degrees of freedom	Mean square	Report	Meaning %
Regression	4.1313	4	1.328	0.4788	75.4
Residue	8.6287	4	2.1578	**	**
total	12.7600	8	***	**	**

In table 2, we are shown that the correlation coefficient R equal to 0.745 [19, 20] is very close to 1. This allowed us to say that there is some correlation between the obtained experimental values and those calculated by the proposed mathematical model.

4. Conclusion

The results of this study showed that the efficiency of adsorption of the blue Telon by Natrual resin depends on several factors and primarily those of the mass of the NR, agitation, pH and temperature. The most influenced effects on the adsorption of blue Telon/ NR are temperature (b3) and the interaction between temperature (b3) and agitation (b4).

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