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REMOVAL OF METHYL ORANGE DYES FROM WASTEWATER USING ION EXCHANGE METHOD

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ABSTRACT:
Effluent coming out from textile industry consist of major proportion of organic dyes which shows reluctant behavior towards the conventional wastewater treatment. The environmental food chain is the soft target for such toxic pollutant coming out as untreated from industry. The present study gives an overview on the common organic dye methyl orange (MO) in the wastewater. The scalability and sustainability of ion exchange process has overcome major setbacks of the conventional processes. The tertiary treatment adopted for the various types of wastewater treatment. Ion exchange process better for the high color, dyes, toxic compounds, organic matter removal of the effluent as comparing to other processes. As the time of treatment increase the absorbance decreases that means the concentration of solution decrease. For 50, 100 and 150 ppm concentration solution absorbance calculated for various contact time 10, 20 and 30 min. The % reduction of methyl orange dyes for various conc. of solution 50, 100 and 150 ppm at contact time 10, 20 and 30 min. For 50 ppm % reduction of methyl orange observed to be varied from 90 % to 97.5 % at 10-, 20- and 30-min treatment time. For 100 ppm solution after treatment with ion exchange process % reduction of methyl orange dyes at 10-, 20- and 30-min treatment time is 82.22, 91.11 and 95.5 % respectively. For 150 ppm solution after treatment with ion exchange process % reduction of methyl orange dyes at 10-, 20- and 30-min treatment time was 83.63, 87.27 and 90.90 % respectively. Rate of reduction increase with increase in contact time rate of reduction decrease with increase in concentration of solution. The rate of reduction of dyes depends on the parameters like contact time, pH, conc. of dyes.
KEYWORDS: Ion exchange, Cation and anion, methyl orange, contact time, concentration of dye.

INTRODUCTION

Dyes appear to be colored because they absorb some wavelengths of light more than others. There are many treatment processes available for removal of dyes from wastewater. Rapid growth is environmental disorder with a big pollution problem. Removal of dyes from adsorption is found to be the most competitive one because it does not need a high operating temperature and several coloring materials can be removed simultaneously. This process is suitable for the high color, dyes, toxic compounds, organic matter and COD removal of the effluent as comparing to other processes. Ion exchange treatment process use for different types of industrial waste water treatments with low cost. Ion exchange process gives the effective results for removal of various types of pollutants from wastewater. Due to the rapid growth of textiles industries the lot of waste water generated from the various processes. The various types of dyes are most widely used in textiles processing. These dyes are very toxic and dangerous for the human as well as animals. The treatment of such types of dyes are very necessary for environment. Now day's lots of wastewater treatment methods are available but choose of the correct method from these is important thing. Ion exchange methods has less time-consuming, low-cost method, and easy to operate.

Raw Materials and Chemicals

1. Methyl orange solution
2. Distilled Water
3. Anion and Cation Resins
4. 1 N NaOH or H2SO4 Solution for pH Maintain
5. HCl and NaOH for regeneration of bed.

Apparatus

1. Ion Exchange Apparatus/Setup
2. Colorimeter
3. Measuring Cylinder and Sample Bottles
4. Beaker and glass rod

Experimental Setup

Figure 1. Experimental Setup

Experimental Process

1. First we make the synthetic wastewater of 50, 100 and 150 ppm by adding 50, 100 and 150 mg of methyl orange dyes in 1liter solution each resp.
2. Then measure the absorbance of synthetic wastewater with help colorimeter we get absorbance 50, 100 and 150 ppm solution 0.40, 0.45 and 0.55 resp.
3. The overall cation and anion exchange bed wash with clear water.
4. The regeneration of anion bed with NaOH solution 40 gm/liter water and anion cation bed with HCl solution 40 gm/liter water.
5. Feed tank fill with 50 ppm synthetic wastewater and start the equipment.
6. The synthetic waste water first pass-through cation and then anion bed of equipment.
7. Withdraw sample 10, 20 and 30 min and measure the absorbance.
8. The similar process follow the various concentration solution and take sample then measures the absorbance of each.

Table 1. Initial Absorbance for Various Concentration Solutions

Sr. No.	Concentration of Solution	Initial Absorbance
01	50 ppm	0.40
02	100 ppm	0.45
03	150 ppm	0.55

Table 1 shows the initial absorbance for various concentrations solution. The absorbance of solution varies with concentrations. The % reduction of dyes can be calculated by using,

% Reduction of Dyes = [(Initial Absorbance-Final Absorbance)/Initial Absorbance] * 100

Table 2. Absorbance for Various Concentration Solutions after Treatment

Time in Min	50 ppm Solution	100 ppm Solution	150 ppm Solution
10	0.04	0.08	0.11
20	0.03	0.04	0.07
30	0.01	0.02	0.05

Table 2 shows the absorbance for various concentrations solution after treatment. As the time of treatment increase the absorbance decreases that means the concentration of solution decrease. For 50, 100 and 150 ppm conc. solution absorbance calculated for various contact time 10, 20 and 30 min.

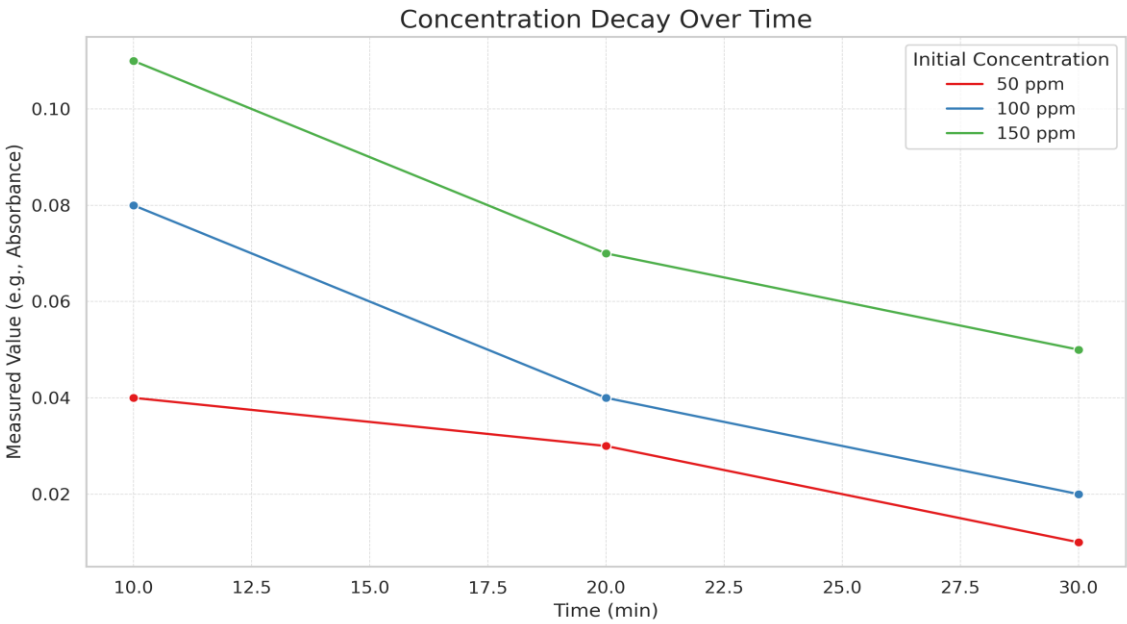

Figure 1. Absorbance of Methyl Orange Dye at Various Concentrations.

% Reduction of Methyl Orange Dyes
% Reduction of Dyes = [(Initial Absorbance-Final Absorbance)/Initial Absorbance] * 100
For 50 ppm Solution
% Reduction of Dyes = [(Initial Absorbance-Final Absorbance)/Initial Absorbance] * 100
Initial absorbance= 0.40
1. % Reduction of Dyes = [(0.40-0.04)/0.4] *100 = 90
2. % Reduction of Dyes = [(0.40-0.03)/0.4] *100 = 92.5
3. % Reduction of Dyes = [(0.40-0.01)/0.4] *100 = 97.5

For 100 ppm Solution
% Reduction of Dyes = [(Initial Absorbance-Final Absorbance)/Initial Absorbance] * 100
Initial absorbance= 0.45
1. % Reduction of Dyes = [(0.45-0.08)/0.45] *100 = 82.22
2. % Reduction of Dyes = [(0.45-0.04)/0.45] *100 = 91.11
3. % Reduction of Dyes = [(0.45-0.02)/0.45] *100 = 95.55

For 150 ppm Solution
% Reduction of Dyes = [(Initial Absorbance-Final Absorbance)/Initial Absorbance] * 100
Initial absorbance= 0.55
1. % Reduction of Dyes = [(0.55-0.11)/0.55] *100 = 80
2. % Reduction of Dyes = [(0.55-0.07)/0.55] *100 = 87.27
3. % Reduction of Dyes = [(0.55-0.05)/0.55] *100 = 90.90

Table 3. % Reduction of Methyl Orange Dyes at Various concentration.

Time in Min	50 ppm Solution	100 ppm Solution	150 ppm Solution
10	90	82.22	83.63
20	92.5	91.11	87.27
30	97.5	95.55	90.90

Table 3 shows the % reduction of methyl orange dyes for various conc. of solution 50, 100 and 150 ppm at contact time 10, 20 and 30 min. For 50 ppm % reduction of methyl orange dyes at 10-, 20- and 30-min treatment time is 90, 92.5 and 97.5 % resp. For 100 ppm % reduction of methyl orange dyes at 10-, 20- and 30-min treatment time is 82.22, 91.11 and 95.5 % resp. For 150 ppm % reduction of methyl orange dyes at 10-, 20- and 30-min treatment time is 83.63, 87.27 and 90.90 % resp. Rate of reduction increase with increase in contact time rate of reduction decrease with increase in concentration of solution.

Graphical Representation of % Reduction of Methyl Orange Dyes
Graph shows the % reduction of methyl orange dyes for various conc. of solution 50, 100 and 150 ppm at contact time 10-, 20- and 30-min. As per fig. rate of reduction increase with increase in contact time rate of reduction decrease with increase in concentration of solution.

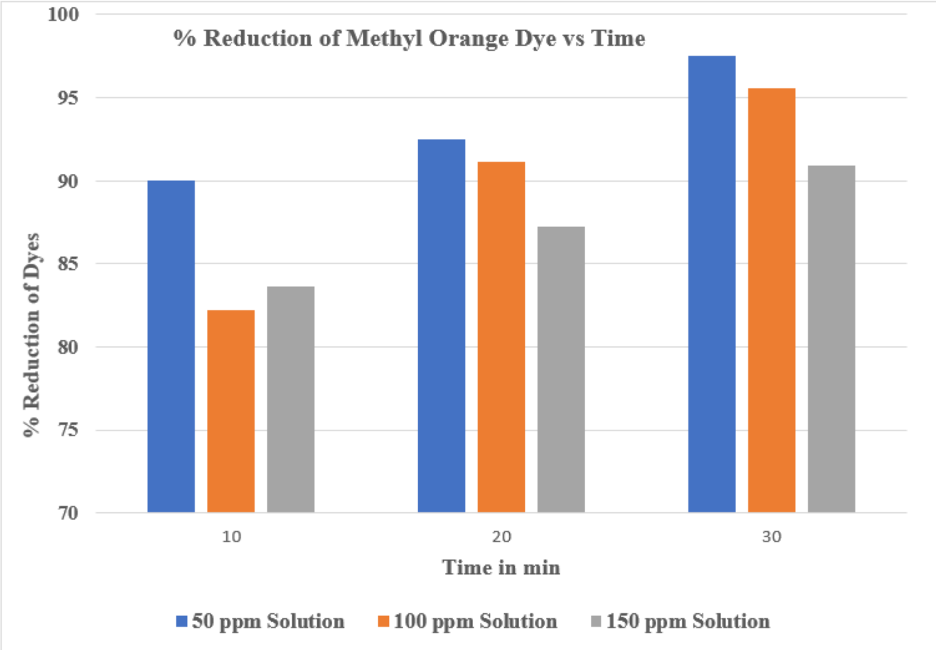

Figure 2. Graphical Representation of % Reduction of Methyl Orange Dyes for various time

Table 4. Absorbance for Various pH after Treatment

pH of Solution	50 ppm Solution	100 ppm Solution	150 ppm Solution
3	0.01	0.02	0.04
6	0.02	0.04	0.06
8	0.05	0.08	0.12

Table 4 shows the absorbance for various pH solution after treatment. The absorbance of solution decreases with pH of solution. As the pH of treatment increase the absorbance decreases that means the concentration of solution decrease. For 50, 100 and 150 ppm conc. solution absorbance calculated for various pH of solution.

% Reduction of Methyl Orange Dyes

% Reduction of Dyes = [(Initial Absorbance-Final Absorbance)/Initial Absorbance] * 100

For 50 ppm Solution

% Reduction of Dyes = [(Initial Absorbance-Final Absorbance)/Initial Absorbance] * 100

Initial absorbance= 0.40

1. % Reduction of Dyes = [(0.40-0.01)/0.4] *100 = 97.5
2. % Reduction of Dyes = [(0.40-0.02)/0.4] *100 = 95
3. % Reduction of Dyes = [(0.40-0.05)/0.4] *100 = 87.5

For 100 ppm Solution

% Reduction of Dyes = [(Initial Absorbance-Final Absorbance)/Initial Absorbance] * 100

Initial absorbance= 0.45

1. % Reduction of Dyes = [(0.45-0.02)/0.45] *100 = 95.55
2. % Reduction of Dyes = [(0.45-0.04)/0.45] *100 = 91.11
3. % Reduction of Dyes = [(0.45-0.08)/0.45] *100 = 82.22

For 150 ppm Solution

% Reduction of Dyes = [(Initial Absorbance-Final Absorbance)/Initial Absorbance] * 100

Initial absorbance= 0.55

1. % Reduction of Dyes = [(0.55-0.04)/0.55] *100 = 92.72
2. % Reduction of Dyes = [(0.55-0.06)/0.55] *100 = 89
3. % Reduction of Dyes = [(0.55-0.12)/0.55] *100 = 78.18

Table 5. % Reduction of Methyl Orange Dyes at Various pH.

pH of Solution	50 ppm Solution	100 ppm Solution	150 ppm Solution
3	97.5	95.55	92.72
6	95	91.11	89
8	87.5	82.22	78.18

As per experimental analysis reduction of methyl orange dyes from the wastewater pH of dyes in wastewater is another most important factor. As per experiment analysis the maximum reduction at pH value 3-4. For our case the optimum value for pH is 3-4 in which reduction is more than 97%.

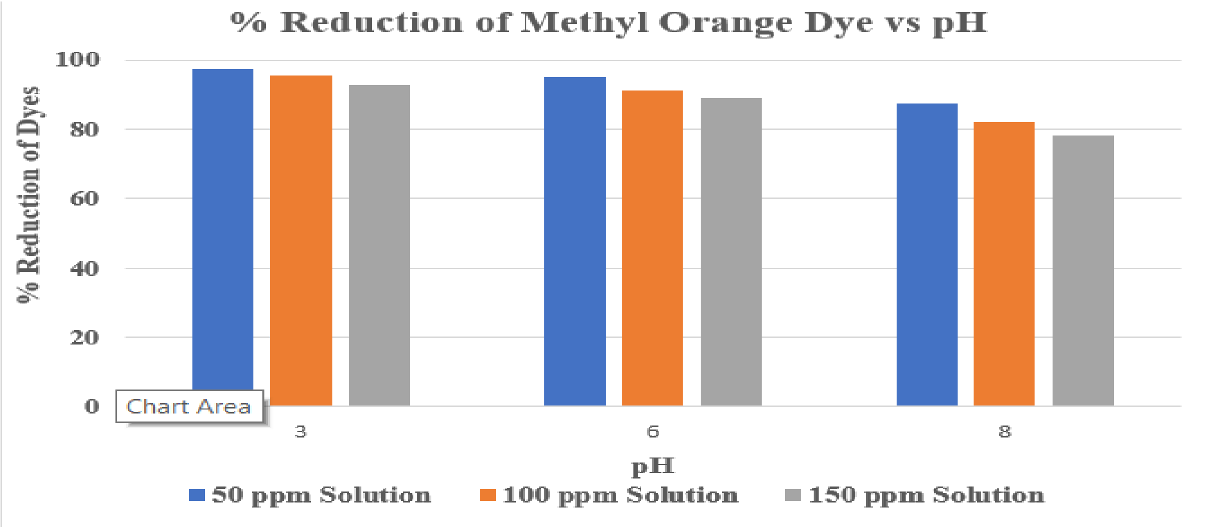

Figure 3. Graphical Representation of % Reduction of Methyl Orange Dyes for various pH

Parameters Affected on Ion Exchange Process

1. Contact Time

As per experimental analysis reduction of methyl orange dyes from the wastewater contact time for both anion and cation exchange bed to be 30-60 min.

2. Concentration

As per experimental analysis reduction of methyl orange dyes from the wastewater concentration of dyes in wastewater is another most important factor. Experiment carried out for various conc. 50, 100 and 150 ppm. For our case the optimum value for conc. is 50 ppm in which reduction is more than 97%.

3. pH

As per experimental analysis reduction of methyl orange dyes from the wastewater pH of dyes in wastewater is another most important factor. As per experiment analysis the maximum reduction at pH value less than 6. For our case the optimum value for pH is 3-4 in which reduction is more than 97%. For acidic pH reduction of methyl orange dyes is more than the basic pH values.

Conclusion

Ion exchange is basically a reversible chemical process wherein an ion from solution is exchanged for a similarly charged ion attached to an immobile solid particle. The absorbance of solution varies with concentrations of solution. The variable initial concentration from 50 ppm to150 ppm ware shows the maximum reduction for 30-minute equilibrium time is 97%. Rate of reduction increase with increase in contact time rate of reduction decrease with increase in concentration of solution. As per experimental analysis reduction of methyl orange dyes from the wastewater contact time for both anion and cation exchange bed to be 30-60 min. As per experimental analysis reduction of methyl orange dyes from the wastewater concentration of dyes in wastewater is another most important factor. The absorbance of solution decreases with pH of solution. As the pH of treatment increase the absorbance decreases that means the concentration of solution decrease. For 50, 100 and 150 ppm conc. solution absorbance calculated for various pH of solution. As per experimental analysis reduction of methyl orange dyes from the wastewater pH of dyes in wastewater is another most important factor. From experimental study and various literatures ion exchange process is most economical, less time consuming and highly effective process for dyes removal from wastewater. Ion exchange method can be useful for the various types of wastewater. Ion exchange method has requires the regeneration of cation and anion beds which can be done by using alkali and acid wash. Ion exchange method is ecofriendly and ecological for treatment of various types of wastewater.

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