Magnesium oxide Nanoparticle as Adsorbent for Removal of Synthetic Dyes

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***Abstract*—Increase in population and industrialization in recent decades is the main cause for excessive pollution of water resources. Among various types of pollutants causing water contaminant, pollution from dyes inducing industries has created more problem. Almost all the industries like textile, paper, leather sloughter house, coametics, food processing industries produces coloured wastewaterto water bodies causing harm full effect to human life and also aquatic life. Thus in this present study attempt has been made to determine the efficiency of Magnesium oxide nanoparticle in removing Direct red 23 and Reactive black 8 from synthetic coloured wastewater (batch studies), by considering various parameters like Adsorbent dosage, initial colour concentration, varied pH and for different contact time.**

***Key Words*—Magnesium oxide nanoparticle, Reactive dyes, Direct dye, Batch studies**

1. INTRODUCTION

Due to growth in industrialization and increase in discharge of large quantity of coloured wastewater in to water bodies wastewater treatment became one of the main priority in preserving aquatic ecosystem. Among numerous industries producing wastewater like food, pharmaceutical, leather, paper especially textile industry discharges coloured wastewater in high volume and should be treated specifically before discharging in to water bodies [1]. Dyes are chemicals, which up on binding with any material induces colour to them. Nowadays more synthetic dyes with various different colours has been prepared, textile is one of those industry which uses more and more dyes and pigments that gives colour to the textile products [2]. More than ten thousand dyes are commercially available in today's life, the dyes creates degradation problem due to its complex structure. Maximum dyes are lethal for mammals causes variety of disorders to skin, lung and respiratory issues. Even a small quantity of dyes can create photosynthetic problem and is harmful to aquatic life [3]. The present study has been carried out to determine the efficiency of Magnesium oxide nanoparticle in removing Reactive black 8 and Direct red 23 by conducting batch studies.

2. MATERIALS AND METHODOLOGY

2.1 ADSORBENT USED AND ITS PREPARATION:

Preparation of Magnesium oxide Nanoparticles MgO NPs: (Chemical Method)

1. In a beaker 6 g of $MgCl_2$ and 2 g of Sodium dodecyl sulphate (SDS) were mixed in 100 ml of distilled water.
2. To this mixture 0.4 N NaOH solution was added by stirring constantly with magnetic stirrer for about 2 hours to maintain pH 11.
3. A white precipitate of $Mg(OH)_2$ precipitated was then washed thoroughly with distilled water.
4. Washed $Mg(OH)_2$ precipitate was dried at 120^0C for 2 hours and calcined at 800 ^{0}C for 5 hours in an muffle furnace.
5. It was then permitted to cooled to arrive at room temperature to obtain granular Nano MgO NPs [2]

Picturious view of synthesized Magnesium nanoparticle is presented in Plate 2.1

Plate 2.1: Synthesized Magnesium oxide Nanoparticle

2.2 SELECTION OF COLOR AND PREPARATION OF SAMPLES

For the color removal process in this present study the selected dyes were

- Direct Red 23
- Reactive black 8.

Color Stock solution (1000 mg/L) produced by dissolving a measured quantity of Reactive black-8 and Direct red-23 in distilled water. All working solutions prepared by diluting required quantity of stock solution in 1000 ml of distilled water (10 mg/ L,20 mg/ L, 30 mg/ L,40 mg/ L.) To adjust pH of the solutions Sodium hydroxide (NaOH) and Hydro chloric acid (HCL) of 2N solution were added. Picturious views of Adsorbate used are given in Plates 2.2 and 2.3.

Plate 2.2: Pictorial view of Direct Red 23

Plate 2.3: Pictorial view of Reactive black 8

2.3 EXPERIMENTATION

To carryout adsorption study batch experimentation was performed. The initial absorbance of the prepared synthetic wastewater sample was taken in U.V. Spectrometer. The different amount of wastewater samples containing colour (with pH adjusted to 5, 7 and 9) was taken in a beaker. The experimentation was carried out for different adsorbent dosages of 200, 300 and 400 mg. Then the contact time of 20, 40, 60 and 80 minutes were given with agitation speed of 100 rpm, after giving the particular contact time the solutions were collected for measuring the final absorbance in U.V Spectrophotometer by adjusting wavelength to respective colours (Reactive Black 8 - 400 nm and Direct red 500 nm)

3. RESULTS AND DISCUSSIONS

Results on evaluating the performance of Bench scale studies in removing Reactive black 8 and Direct red 23 by adsorbent magnesium oxide nanoparticle are presented in table 3.1 and 3.2 and Figure 3.1 to 3.6. Based on the results obtained and observed, the discussions were made and thereby inferences were drawn.

Table 3.1: Removal Potential of Reactive Black 8 by MgO NPs at Stated Experimental Conditions (pH 9)

Adsorbent Dosage, mg	Contact Time, min	Effluent Colour Concentration at Stated Initial Colour Concentration, mg/L			
		10	20	30	40
200	20	3.46	8.36	13.98	21.08
	40	2.87	6.72	11.91	17.76
	60	2.26	5.36	9.48	14.44
	80	1.65	4.26	8.37	12.08
300	20	2.67	7.18	12.72	19.12
	40	2.08	5.48	10.44	16.28
	60	1.57	4.28	7.62	13.04
	80	1.07	2.94	6.21	10.32
400	20	2.07	5.78	10.86	16.72
	40	1.55	4.66	9.21	14.68
	60	1.08	3.56	7.53	12.68
	80	0.57	2.34	4.98	9.8

Table 3.2: Removal Potential of Direct Red 23 by MgO NPs at Stated Experimental Conditions (pH 5)

Adsorbent Dosage, mg	Contact Time, min	Effluent Colour Concentration at Stated Initial Colour Concentration, mg/L			
		10	20	30	40
200	20	3.94	8.92	15.24	22.36
	40	3.26	7.76	13.08	19.88
	60	2.53	6.04	11.25	16.96
	80	1.98	4.97	9.78	15.32
300	20	3.16	7.5	12.99	19.88
	40	2.54	6.14	10.98	17.12
	60	1.85	4.96	9.51	15.40

	80	1.23	3.52	7.05	12.16
400	20	2.47	6.12	11.34	17.08
	40	1.95	5.08	9.53	14.60
	60	1.38	3.66	7.35	11.76
	80	0.74	2.36	5.31	9.44

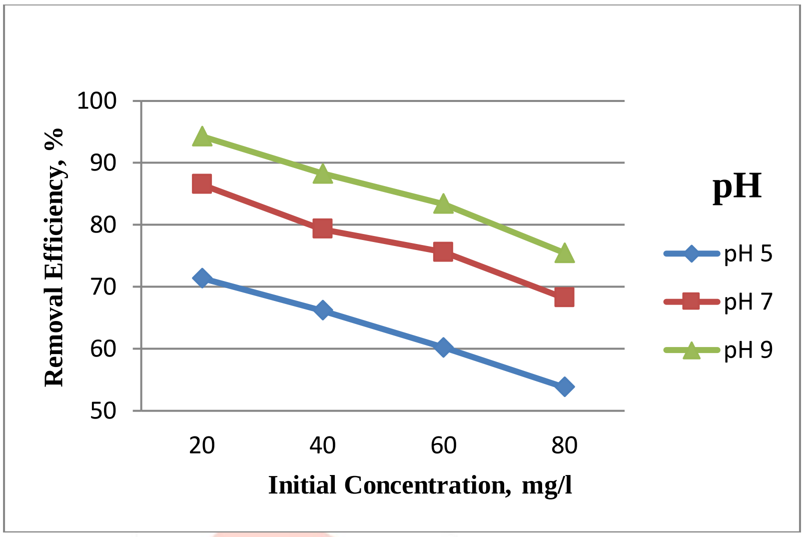

Figure 3.1 Effect of Initial Concentration of RB 8 with Mgo NPs (Dosage 400 mg, t = 80 min)

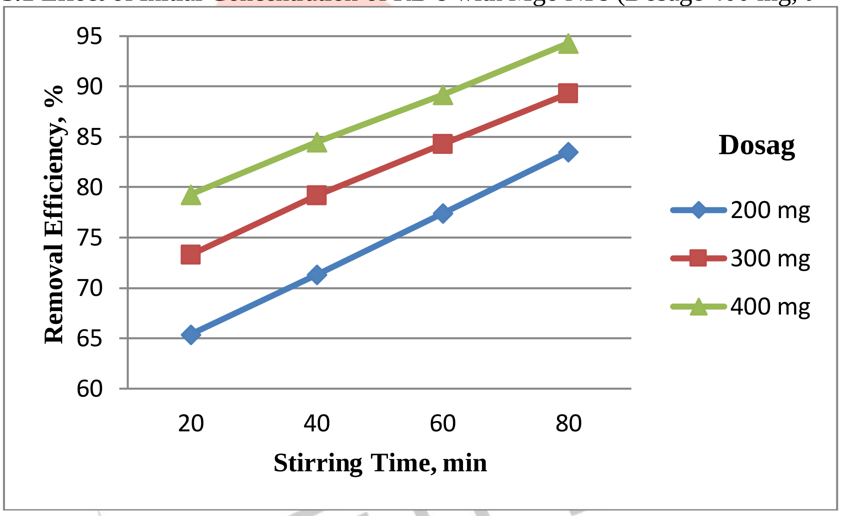

Figure 3.2 Effect of Contact time on RB 8 at pH 9 (Co 10 mg/L, MgO NPs)

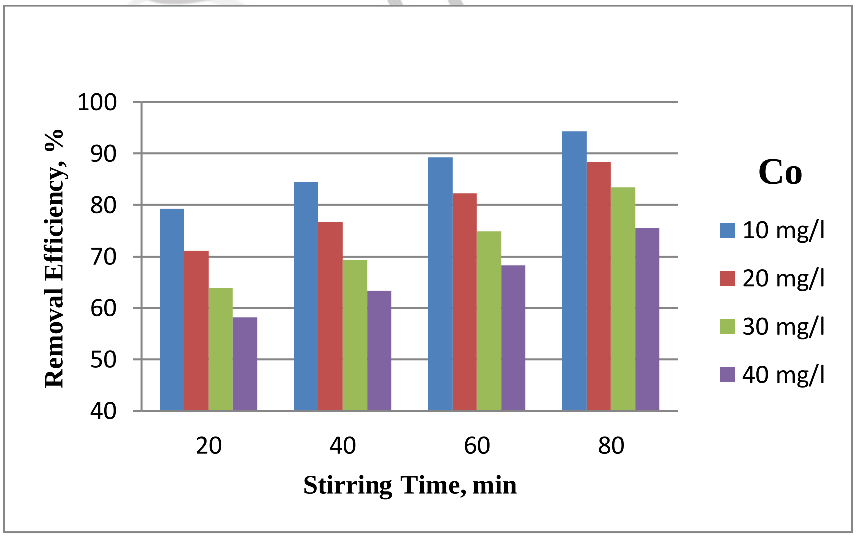

Figure 3.3 Effect of MgO NPs on removal of RB 8 at pH 9 (Dosage 400 mg)

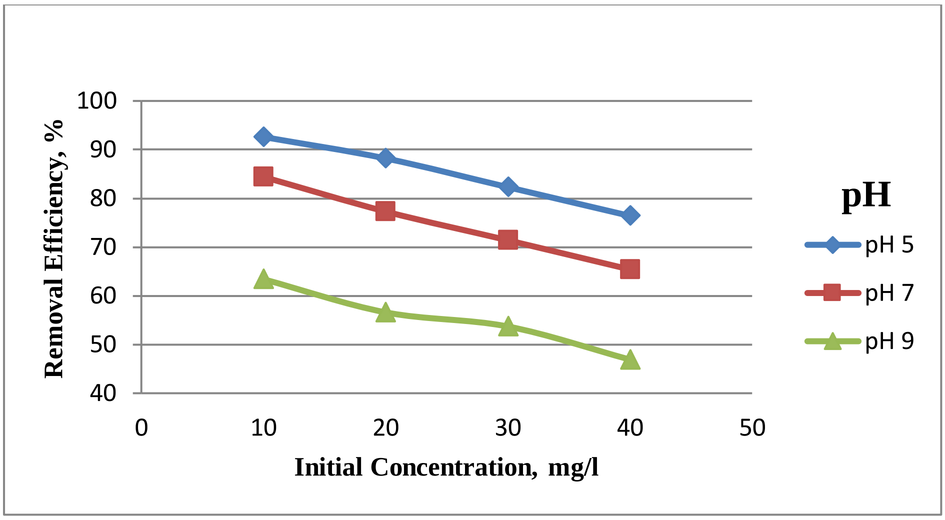

Figure 3.4 Effect of Initial Concentration of DR 23 with Mgo NPs (Dosage 400 mg, t = 80 min)

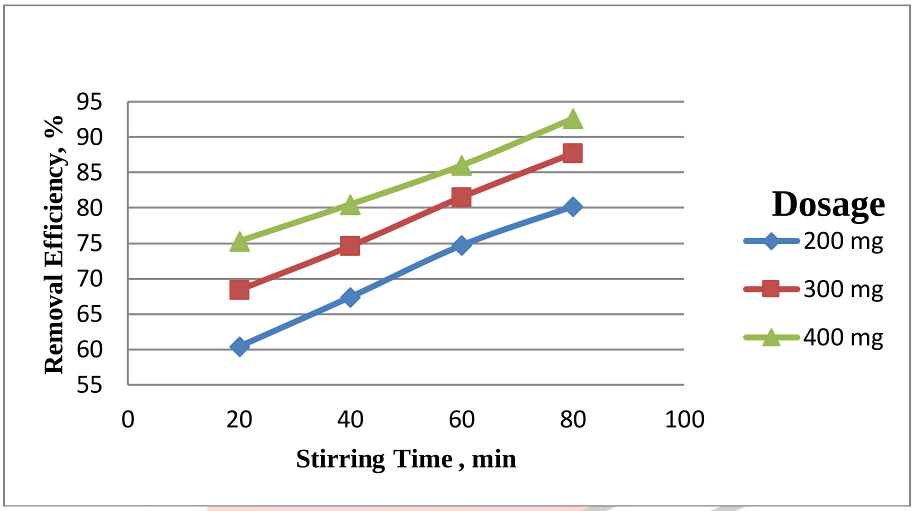

Figure 3.5 Effect of Contact time on DR 23 at pH 5 (Co 10 mg/L, MgO NPs)

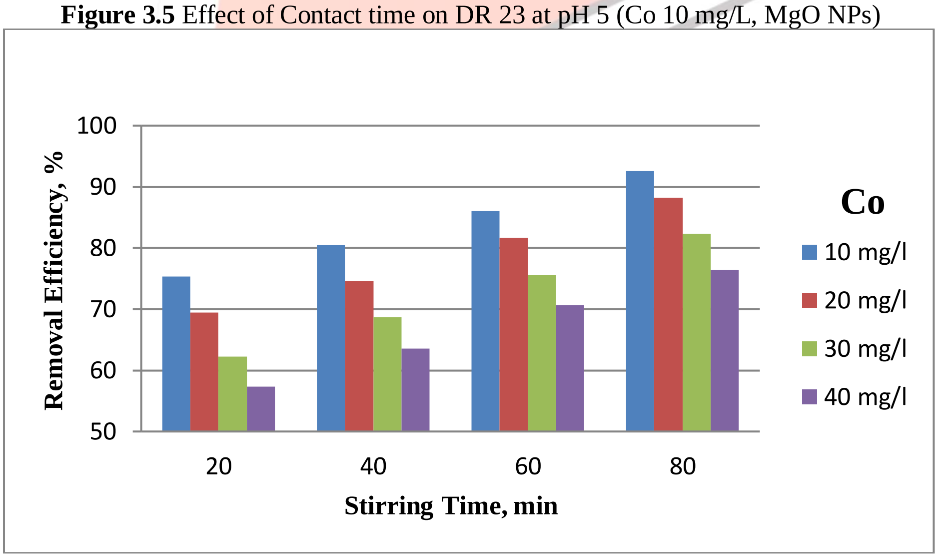

Figure 3.6 Effect of MgO NPs on removal of DR 23 at pH 5 (Dosage 400 mg)

From the results obtained from batch experimentation of colour removal potential of RB 8 and DR 23 from MgO NPs the following inferences were drawn.

The removal efficiency of Reactive black 8 was observed as pH increased from 5 to 9, where as for Direct red 23 it was inverse as pH decreased from 9 to 5 the removal efficiency was increased. Decolorization was observed to be directly proportional to initial colour concentration as initial colour concentration increased from 10 to 40 mg/L colour removal efficiency was decreased. As the Contact time increased from 20 to 80 minutes the colour removal efficiency was found to be increased. Decolorization of both colour increased as adsorbent dosage increased from 200 to 400 mg.

- Thus best results were recorded at optimized pH value of 9, adsorbent dosage of 400 mg, contact time of 80 min, corresponding to initial color concentration of 10 mg/L, the maximum removal efficiency was found to be 94.3 % accordingly lowest removal efficiency recorded was 27.6 % at pH 5, Co= 40 mg/L, t= 20 min and adsorbent dosage being 200mg.
- Corresponding for Direct red 23 Maximum removal efficiency was 92.6 [Adsorbent dosage 400 mg, t= 80 min, pH 5 and initial colour concentration 10 mg/L] and minimum 19.5 % [Adsorbent dosage 200 mg, t= 20 min, pH 9 and initial colour concentration 40 mg/L].

4. CONCLUSIONS

Based on the performance evaluation of the present work, the following conclusions have been drawn.
As there was increased in initial colour concentration of both the colours decolorization efficiency was found to be decreased. As the adsorbent dosage increased the colour removal efficiency was also increased for both the colours. The raise in contact time also increased decolorization efficiency of both the colours. Maximum removal of direct red 23 dye was achieved at ph 5 and increase in pH showed decrease in colour removal efficiency ans at pH 9 reactive black 8 colour removal efficiency was high and as ph decreased to 5 the decolorization was also decreased.
Maximum removal of RB 8 and DR 23 by MgO NPs was observed to be 94.3 % and 92.6 % respectively and minimum colour removal efficiency obtained as 27.6 % and 19.5 % respectively.

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