Universal Journal of Environmental Research and Technology
 eISSN 2249 0256
Available Online at: **www.environmentaljournal.org**
2013 Volume 3, Issue 4: 458-464

Open Access **Research Article**

Studies on the Efficiency of Polyelectrolyte as Coagulant Aid

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Abstract:

Thousands of educational institutions are developing in our country every year, in the recent decade there are institutions mushrooming all over the country, also they are generating huge amount of solid and liquid wastes that are to be managed effectively if not will be an environmental nuisance. Not many institutions are adopting proper treatment methodologies for purifying this waste generated and also not many studies had focussed this type of waste which are complex and does not follow the same properties of domestic waste water. Mostly the waste water arising from the educational institutions are matching the domestic waste condition but with varying combinations. Treatment of this kind of wastes are to be done as per the procedures of the domestic waste, coagulation plays a key role in the treatment of this wastes. Many coagulants were tried by researchers across the globe some in turn pollute including aluminium sulphate (alum). In this research an attempt is made at finding the efficiencies of magnesium chloride, as chemical coagulant to treat the waste water of educational institution which is not only cost effective but also does not harms the health. $MgCl_2$ is added as coagulant with and without coagulant aid (polyelectrolyte) and the efficiency of mixture of magnesium chloride with poly electrolyte was tested. The result obtained by adding magnesium chloride proved that it can be use for the treatment of turbidity and transmittance in educational institution waste water. The results obtained when magnesium chloride combined with poly electrolyte were much better. It is found that nearly 97% removal of turbidity is achieved during this study and also 95% transmittance level is achieved, also complete odour removal is obtained by the coagulation process. Hence magnesium chloride can be effectively used as a coagulant aid with any chemical coagulant like polyelectrolyte and alum for treatment of waste water from educational institutions.

Keywords: Adsorption, Coagulation, Magnesium chloride, poly electrolyte, educational institution waste water, turbidity, transmittance.

1. Introduction

The increasing growth of educational institutions is leading to a high environmental issue because of improper discharge of the waste water generated from the institutions. The newly constructing institutions are only aiming for satisfying their needs. Not many of them are having proper waste water treatment or discharging system. A study conveys that nearly 1 million litres of water is consumed as an average by a University, roughly 80% of its turning to be waste water (Gobinathand Nagendarn, 2010). Not many institutions are adopting proper treatment methodologies for purifying this waste generated and also not many studies had focussed this area water including some modern Universities(Gobinath and Nagendarn, 2010). Mostly the waste water arising out of educational institutions are matching the domestic waste condition, in this research an attempt is made at finding the efficiencies of magnesium chlorideas chemical to treat the waste water of educational institution. Similarly, the efficiency of mixture of each of magnesium chloride with poly electrolyte was tested. The result obtained by adding Magnesium chlorideproved that it can be use for the treatment of turbidity and transmittance in educational institution waste water.

Turbidity and colour removal are the most important steps in water treatment process, which is generally achieved using coagulants. Many coagulants are widely used in conventional water treatment processes, based on their chemical characteristics. These coagulants are classified into inorganic, synthetic organic polymers, and natural coagulants. One example of these coagulants is magnesium chloride with excellent activity and coagulating properties and also highly cost effective compared with other equivalent coagulants.

1.1 Study area

In this study the waste water is collected from an educational institution situated in Tirupur district which is an engineering college accommodating 2100 students out of which 30 % students are staying in hostels and remaining are day scholars. The college consumes around 0.6 million litres of water a day for its day to day usage, in that around 40% is used in lavatories, cleaning, and 20% for hostel cooking, 10% for laboratories, 25% for drinking purpose and other 15% goes as wastage.In these water input around 75-80% is converted into wastage which is send to drainage system of public sewer without treatment, the initial characteristics of the waste water is given in table 1 which shows that the values obtained above the discharge norms of pollution control board standards. Also it is evident that this water should be treated before letting it into sewers, a small level of treatment plant is planned to reuse the waste water for gardening purpose which is under construction. This study aims to introduce newer technologies in that treatment plant to make the treatment process efficient.

Table 1: Initial waste water characteristics

Sr.No	Parameter	Value
1	pH	6-6.5
2	TDS	1890 ppm
3	Conductivity	2.5 ms/cm
4	Turbidity	240-245 NTU
5	Transmittance	28% in colorimetric
6	Odour	Objectionable level
7	Colour	Greyish to dark greyish
8	Absorbance	0.4
9	BOD	500mg/l
10	COD	450mg/l
11	Standard plate count/ml	80
12	Fecal coliform/100ml	160
13	MPN(Total coliform)	14

2. Sampling

The waste water is collected in 20 litre poly cans. Which are first washed thoroughly in distilled water and then it is rinsed with 6N Nitric acid. After that washed it in distilled water. Then the sampling is done. As the waste water used in this study is an organic waste, it is essential to wash the can in nitric acid so as to keep the sample without any organic changes. All the chemicals used in this work are analytical grade MERK and Rankem chemicals. The equipments which we used in this work are high quality Hanna instruments and Elico instruments. The transmittance is studied in Elico SL 159 UV VIS spectrophotometer. Samples are collected are used immediately for the study, storage of the waste water in done at 15^0C to avoid any bio-degradation of waste. Before conducting any study initial characteristics of the waste water is noted.The raw water is characterized in terms of some physical and chemical parameters before treatment. The evaluated parameters were color turbidity, pH, transmittance etc. The coagulant magnesium chloride is added to the waste sample directly. The coagulation sedimentation process was conducted by using jar test apparatus. The efficiency of the process is evaluated by measuring the turbidity and transmittance by using Turbidity meter and calorimeter.

3. Materials and methods:

3.1 Effect of magnesium chloride coagulant in waste water

Boon Hai Tan et al says that magnesium chloride, as compared to alum and poly aluminium chloride (PAC) is a less commonly used coagulant in the field of wastewater treatment, with a cost in between alum and PAC. It has been used in this study as a coagulant to investigate the effectiveness in the chemical precipitation method for the removal of colouring matters. The colour concentration of dye solutions was measured by visible spectrophotometry. Parameters such as the effect of pH, the effect of coagulant and coagulant aid dosages and the effect of different coagulants have been studied. The results show that MgCl2 is capable of removing more than 90% of the colouring material at a pH of 11 and a doseof 4 g MgCl2/l of dye solution. MgCl2 is shown to be more effective in removing reactive dye thanalum and PAC in terms of settling time and amount of alkalinity required. Optimal operatingconditions such as pH value, coagulant dose and effect of polyelectrolyte have been determined.Wastewaters of a dyeing and printing mill on different days have been treated by MgCl2 aqueoussolution in bench scale.

3.2 Solution preparation

In this study an effort is made to identify the effect of magnesium chloride and poly electrolyte coagulant in educational institution waste water treatment. The magnesium chloride coagulant which we used is of laboratory grade. Since Magnesium chloride cannot act properly alone in the waste water, an additional catalyst like poly electrolyte (industrial grade-50% pure) is added in various dosages as a coagulant aid. Poly electrolyte solution is prepared by adding 50 grams per 1000 ml of de ionized water and stirred for 20 min using magnetic stirrer, the solution is preserved for dosing. The dosage of this solution is increased from 3 ml to 30 ml keeping the coagulant aid as 3 ml per sample. This solution is prepared in a 500 ml beaker and the jar test is conducted as per the procedure with rapid mixing for 10 minutes and slow mixing for 15 minutes. The mixed solution is allowed to settle for 60 minutes and the final readings were taken.

4. Results and discussion

The table shows that while increasing the amount of magnesium chloride by keeping the content of poly electrolyte constant (3ml). Table 2 shows that the result obtained while adding 1 g of magnesium chloride with 3ml of poly electrolyte. From this combination, the transmittance value reached 86% at the higher pH. In these results the most satisfactory result obtained at a pH of 10.

Table 2: Parameters of waste water sample while adding 1g of magnesium chloride

Sr.No:	pH		Transmittance (%)	Conductivity(ms/cm)	Turbidity(NTU)	Absorbance	TDS(ppm)
	initial	final					
1	4	4.1	56%	30	293	0.24	18700
2	5	4.4	51%	16.8	220	0.34	5620
3	6	6.1	44%	3.6	120	0.36	1790
4	7	6.5	65%	3.2	116	0.32	1620
5	8	6.5	74%	3.6	113	0.13	1420
6	9	9	74%	4.7	30	0.09	2050
7	10	10	81%	4.9	20	0.06	2150
8	11	11	82%	9.6	24	0.11	4100
9	12	12	86%	11.6	26	0.12	5000

Table 3 shows the results obtained by adding 2 g of magnesium chloride with 3 ml of poly electrolyte.

Table 3: Parameters of waste water sample while adding 2 g of magnesium chloride

Sr. No.	pH		Transmittance (%)	Conductivity (ms/cm)	Turbidity (NTU)	Absorbance	TDS (ppm)
	Initial	Final					
1	4	4.56	56%	50	171	.48	17360
2	5	4.8	54%	11	170	.43	5020
3	6	5.8	52%	5.8	95	.20	2120
4	7	6.2	65%	4.1	90	.36	2300
5	8	6.6	74%	3.8	80	.46	1900
6	9	6.7	74%	5	57	.46	1330
7	10	7.5	81%	6.4	36	.26	2800
8	11	9.1	82%	6.8	20	.16	3650
9	12	10	87%	10	12	.15	5600

In the table 4 the results shown are achieved by adding 3 g of magnesium chloride with 3 ml of poly electrolyte. In this the transmittance value became 94% which was highly satisfactory.

Table 4: Parameters of waste water sample while adding 3 g of magnesium chloride

Sr. No.	pH		Transmittance (%)	Conductivity (ms/cm)	Turbidity(NTU)	Absorbance	TDS (ppm)
	initial	final					
1	4	4.6	55%	31	271	.48	17360
2	5	5.2	53%	9	214	.43	5020
3	6	5.7	52%	7.1	100	.20	2120
4	7	6.5	65%	7.1	49	.36	2300
5	8	7	75%	8.3	40	.46	1900
6	9	7.2	77%	8.3	38	.46	1330
7	10	7.6	87%	7.1	36	.26	2800
8	11	8.2	94%	7.1	37	.16	3650
9	12	9	94%	7	18	.15	5600

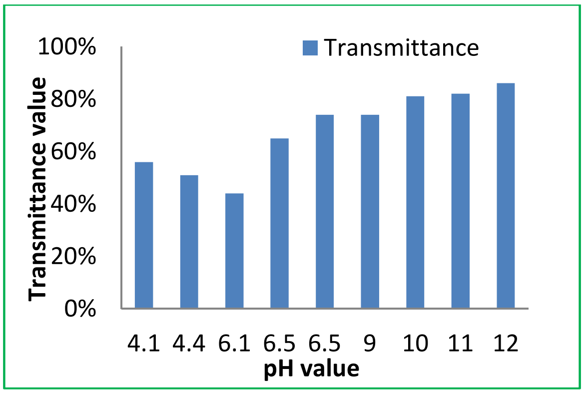

Figure 1: Fluctuations in transmittance while varying pH

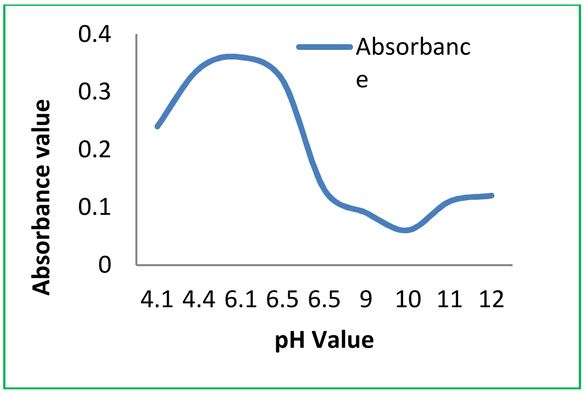

Figure 4: Fluctuations in absorbance while varying pH

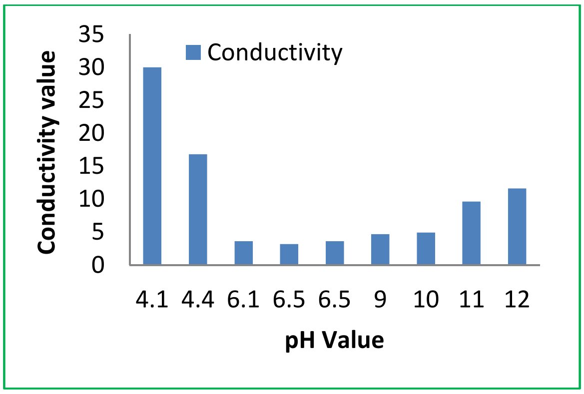

Figure 2: Fluctuations in conductivity while varying pH

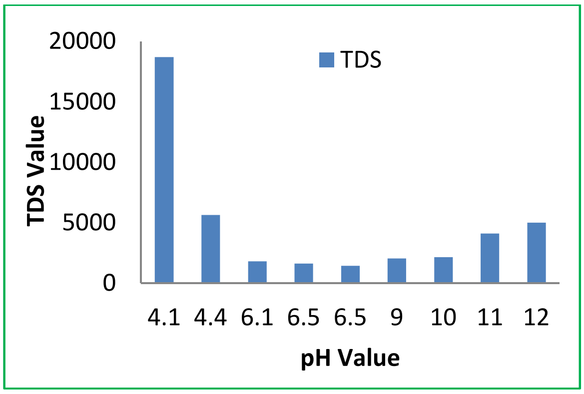

Figure 5: Fluctuations in TDS while varying pH

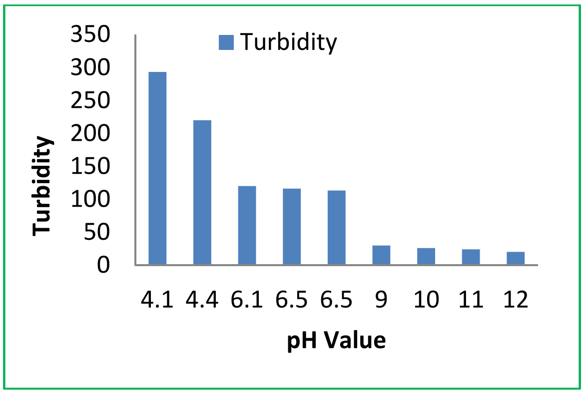

Figure 3: Fluctuations in turbidity while varying pH

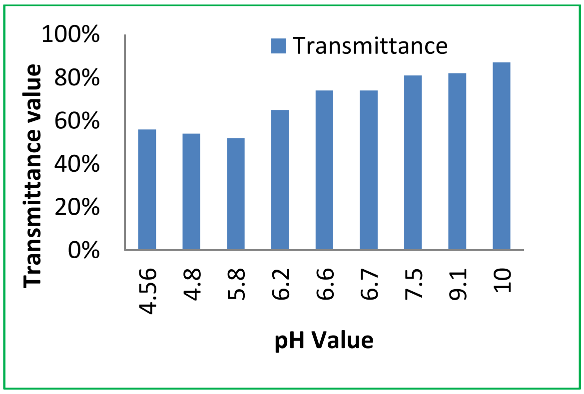

Figure 6: Fluctuations in transmittance while varying pH

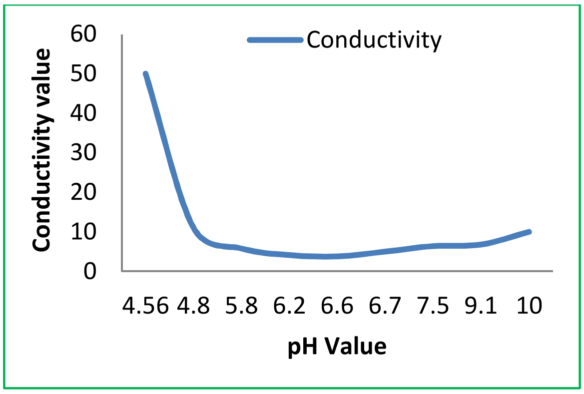

Figure 7: Fluctuations in conductivity while varying pH

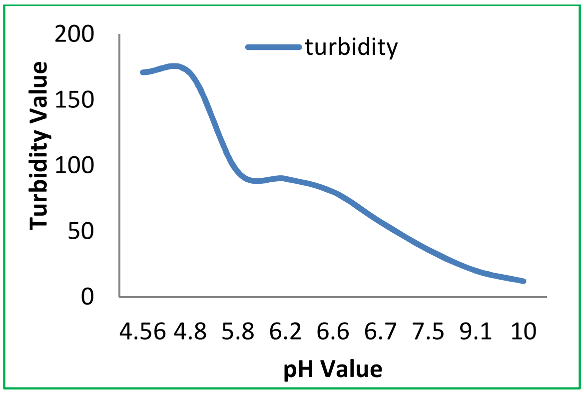

Figure 8: Fluctuations in turbidity while varying pH

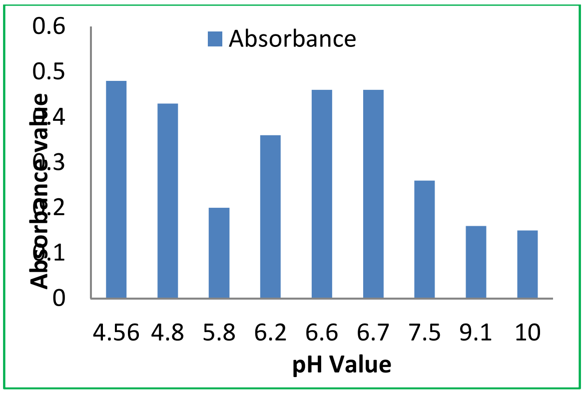

Figure 9: Fluctuations in absorbance while varying pH

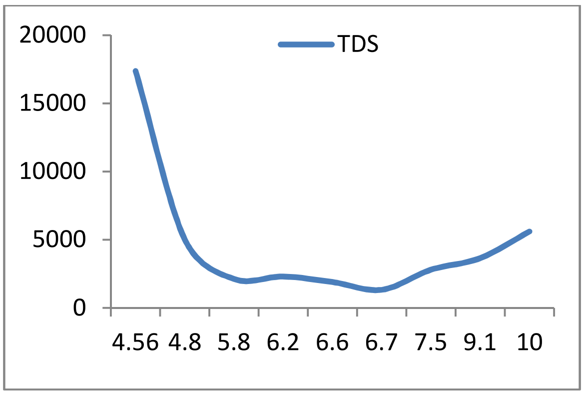

Figure 10: Fluctuations in TDS while varying pH

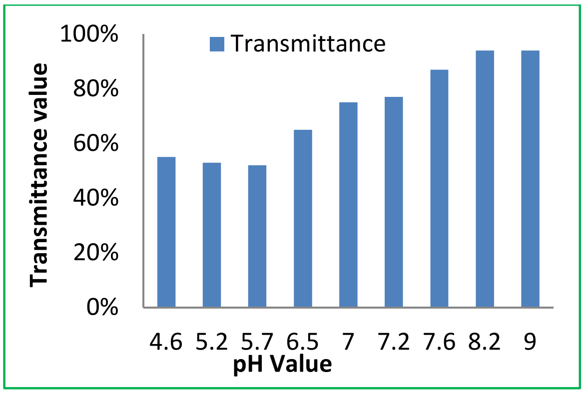

Figure 11: Fluctuations in transmittance while varying pH

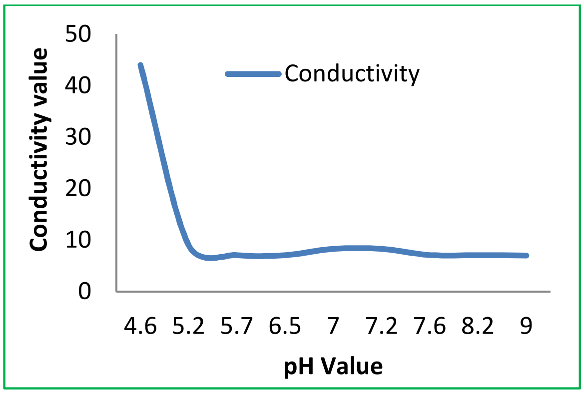

Figure 12: Fluctuations in conductivity while varying pH

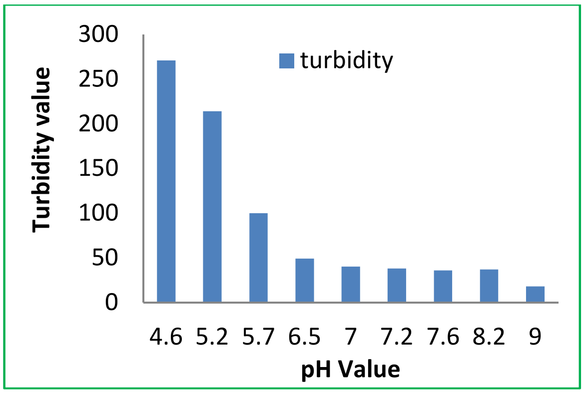

Figure 13: Fluctuations in turbidity while varying pH

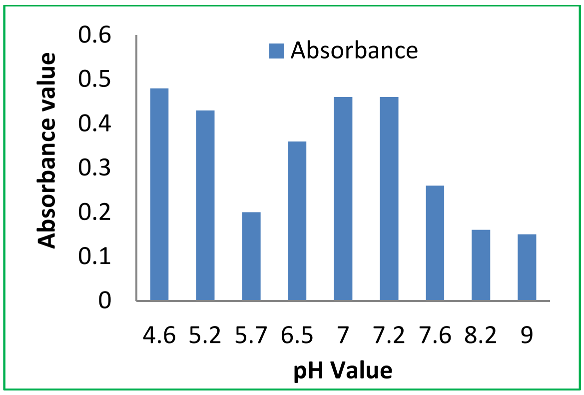

Figure 14: Fluctuations in absorbance while varying pH

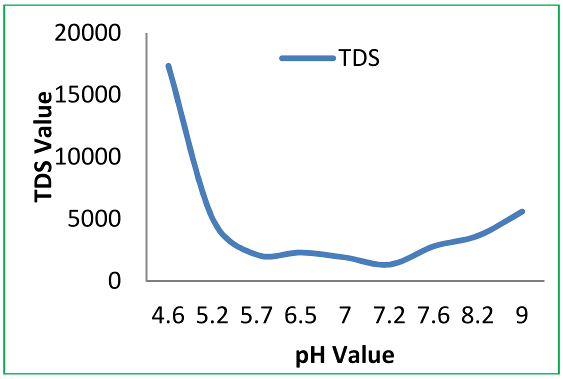

Figure 15: Fluctuations in TDS while varying pH

5. Conclusion:

From the results obtained, we are concluding that the magnesium chloride coagulant is a satisfactory new agent for water treatment. In this work we obtained that while adding the magnesium chloride along with poly electrolyte, the results are more acceptable. That is by keeping the poly electrolyte dosage constant in all pH and varying the magnesium chloride content (From 1g to 3g). The transmittance value reached 97% in the higher pH. Showing that $MgCl_2$works finely in higher pH range. The obtained results were acceptable and in this the odour gets completely removed.

The study clearly indicates the effectiveness of magnesium chloride in waste water treatment. The results obtained from this study show more clarity towards this judgement. The waste water after the coagulation treatment shows more similarity as that of the ordinary drinking water. The odour and colour of the waste water become more acceptable. The odour became unobjectionable. So by using the magnesium chloride the results are favourable and there is no risk in the usage of magnesium chloride for water treatment.

So by using this there is no side effects as in the aluminium and iron salts, and the results obtained are more acceptable.

6.0 Acknowledgement:

Authors sincerely acknowledge the Shri. Thangaraj, Chairman of Jay Shriram Group of Insititutions Shri. Govindasamy, Treasure of Jay Shriram Group of Institutions, Shri T.Karupannasamy, Vice Chairman of Jay Shriram Group of Institutions for providing the necessary facility and also for supporting morally for performing this project. We also acknowledge the support rendered by Prof.Dr.C.Rameshkumar, Principal of Jay Shriram Group of Institutions for all the technical support rendered during this work without which this work may not be materialized.

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