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Research Article

Coagulation performance of magnesium chloride in education institutional waste water

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Abstract: Educational institutions are growing rapidly in our country owing to the increase in demand for higher education. In Tamilnadu itself nearly 2500 higher educational institutions are available which are serving 30 districts. Huge amount of population is using these institutions for their day to day activities, considerable amount of waste water is being generated by each institution. A study conveys that nearly 1 million liters of water is consumed as an average by an University, roughly 80% of its turning to be waste water. Not many institutions are adopting proper treatment methodologies for purifying this waste generated and also not many studies had focussed this area. 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 sulphate, as chemical coagulant to treat the waste water of educational institution. Similarly, 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

INTRODUCTION

Educational institutions are growing rapidly in our country owing to the increase in demand for higher education. In Tamilnadu itself nearly 2500 higher educational institutions are available which are serving 30 districts. Huge amount of population is using these institutions for their day to day activities, considerable amount of waste water is being generated by each institution. 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. Not many institutions are adopting proper treatment methodologies for purifying this waste generated and also not many studies had focussed this area. 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 chloride as 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 chloride proved that it can be use for the treatment of turbidity and transmittance in educational institution waste water.

Turbidity and colour removal is one of 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[5-8].

METHODOLOGY

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 its 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. Most of the small level domestic water treatment plants involve the units like screening, grit removal, coagulation with sedimentation, filtration or aeration with biological treatment process. In this propose treatment plant also coagulation with sedimentation is planned, this study aims to make the coagulation process cheaper and effective in long run by introducing natural coagulation techniques.

Table 1: Initial waste water characteristics

Sl.no	Parameter	Value	PCD norms
1	pH	6-6.5	5.5-9.0
2	TDS	1890 ppm	600 ppm
3	Conductivity	2.5 ms/cm	-
4	Turbidity	240-245 NTU	Clear water
5	Transmittance	28% in colorimetry	-
6	Odour	Objectionable level	Unobjectionable
7	Colour	Greyish to dark greyish	Unobjectionable

Sampling

Sampling of waste water is done at the main outlet and the waste water storage sump using grab sampling method, the sampling bottles are of 10 litre capacity which are cleaned three times with tap water, then with distilled water and rinsed fully with 5N HNO_3 for removal of any sign of pathogens or odour. 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 water samples were maintained in a pH of 4 otherwise it will significantly affect the reactions. 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.

Effect of magnesium chloride and poly electrolyte coagulant in waste water

Boon Hai Tan et al[1] 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 dose of 4 g MgCl2/l of dye solution. MgCl2 is shown to be more effective in removing reactive dye than alum and PAC in terms of settling time and amount of alkalinity required. Optimal operating conditions 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 aqueous solution in bench scale.

Akshaya Kumar Verma et al[2] says that Magnesium chloride, though cost wise roughly same as of ferrous sulphate, is less commonly used coagulant in comparison to the ferrous sulphate for the treatment of wastewater. They also concluded that, decolorization and COD reduction efficiency of coagulants significantly depends upon the pH of wastewater. Magnesium based salt appeared to be the efficient coagulant over iron based salt.

Bao Yu Gao et al[3] says that, the color removal by $MgCl_2$ when treating synthetic waste containing pure dyes was studied. The color removal efficiency of $MgCl_2$/Ca $(OH)_2$ was compared with that of $Al_2(SO_4)_3$, poly aluminum chloride (PAC) and $FeSO_4$/$Ca(OH)_2$. The mechanism of $MgCl_2$ was also investigated. The experimental results show that the color removal efficiency of $MgCl_2$ is related to the type of dye and depends on the pH of the waste and the dosage of the coagulants used. Treatment of waste containing reactive dye or dispersed dye with $MgCl_2$ yielded an optimum color removal ratio when the pH of the solution was equal to or above 12.0. For both the

reactive and dispersed dye waste, $MgCl_2$/Ca $(OH)_2$ was shown to be superior to $MgCl_2$/NaOH, $Al_2(SO_4)_3$, PAC and $FeSO_4$/$Ca(OH)_2$ for color removal. A magnesium hydroxide precipitate formed at pH values greater than 12.0, which provided a large adsorptive surface area and a positive electrostatic surface charge, enabling it to remove the dyes through charge neutralization and an adsorptive coagulating mechanism. So, the $MgCl_2$/Ca $(OH)_2$ system is a viable alternative to some of the more conventional forms of chemical treatment, especially for treating actual textile waste with high natural pH.[4]

Solution preparation

In this study an effort is made to identify the effect of magnesium chloride 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 magnesium chloride kept constant, 1g per each 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.

RESULTS AND DISCUSSION

The table shows that by increasing the value of pH, all the parameters of water is achieving a satisfactory range. From the results it is clear that the transmittance value is reaching its maximum level only at higher pH. So here by we can conclude that, magnesium chloride and poly electrolyte will react only in higher pH. In the Table 1, the values entered are obtained by adding 1ml of poly electrolyte per sample and by adding 1g of magnesium chloride. The magnesium chloride and poly electrolyte reacts properly in the higher pH level. So to achieve these fluctuations in the readings first we varied the pH value of sample from 4pH to 12pH.

Table 1: Various parameters of waste water after coagulation by adding 1ml of poly electrolyte

Sl.No:	pH		transmittance	conductivity	turbidity	absorbance	TDS
	initial	final					
1	4	4.6	21%	36.5	244	0.67	13220
2	5	5	21%	11.3	234	0.64	4540
3	6	6	34%	6	143	0.45	2330
4	7	6.7	41%	7	118	0.38	2220
5	8	7.2	61%	4.5	38	0.21	1920
6	9	7.2	61%	7	32	0.21	2650
7	10	8	70%	7	30	0.16	2150
8	11	9.1	90%	7.3	4	0.04	3100
9	12	9.6	84%	7.5	10	0.07	3030

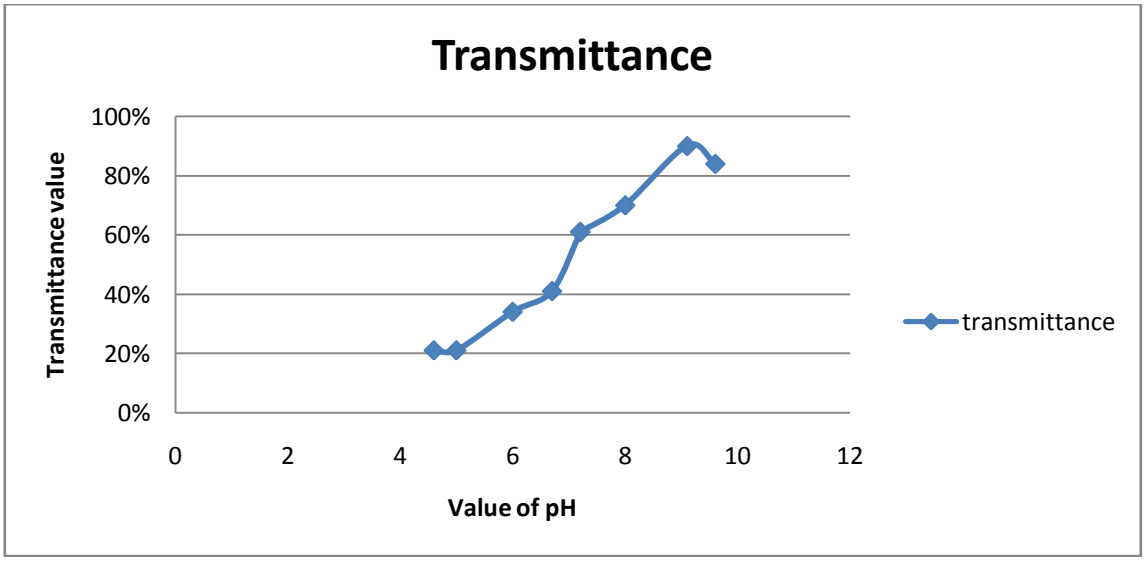

Figure 1: Fluctuations in transmittance while varying pH

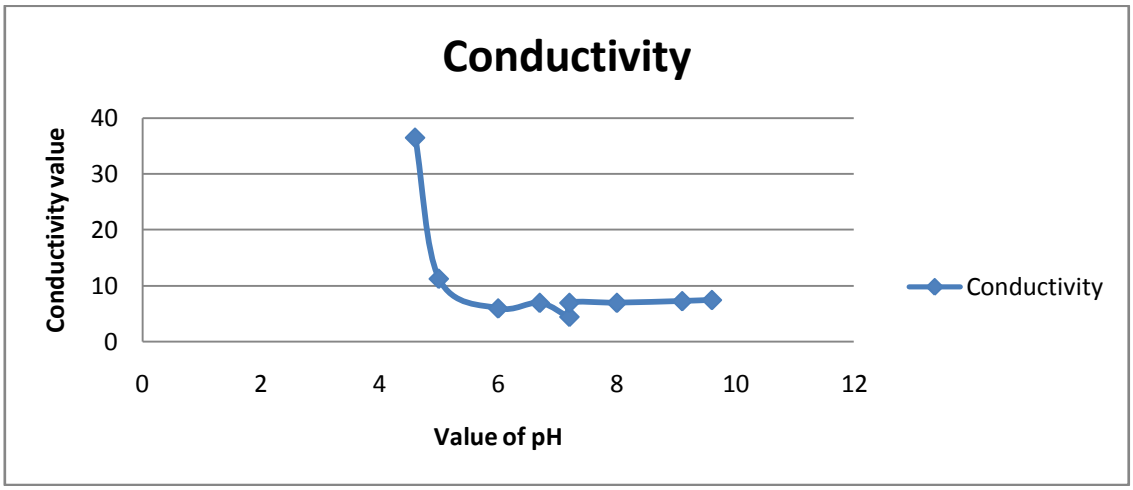

Figure 2: Fluctuations in conductivity while varying pH

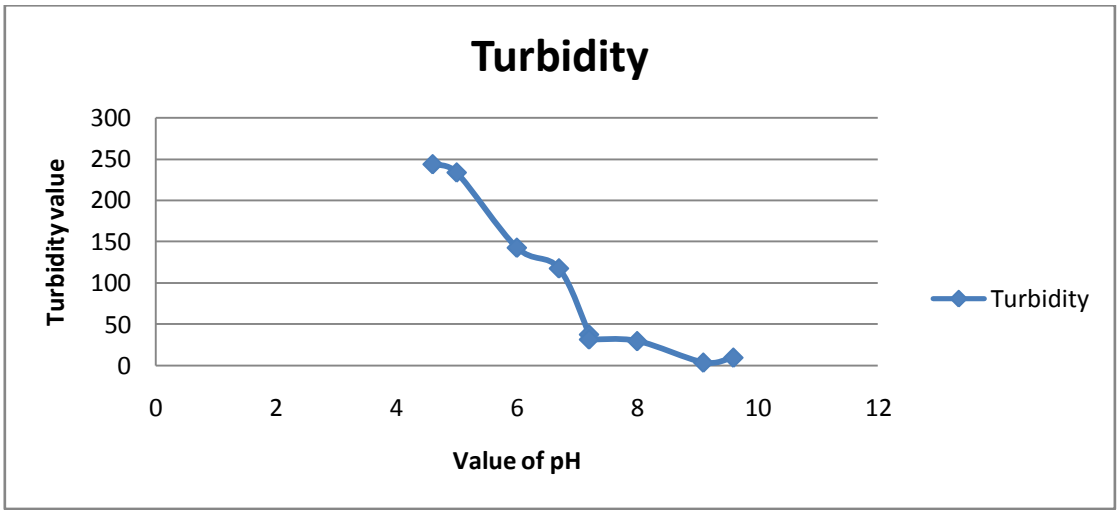

Figure 3: Fluctuations in Turbidity while varying pH

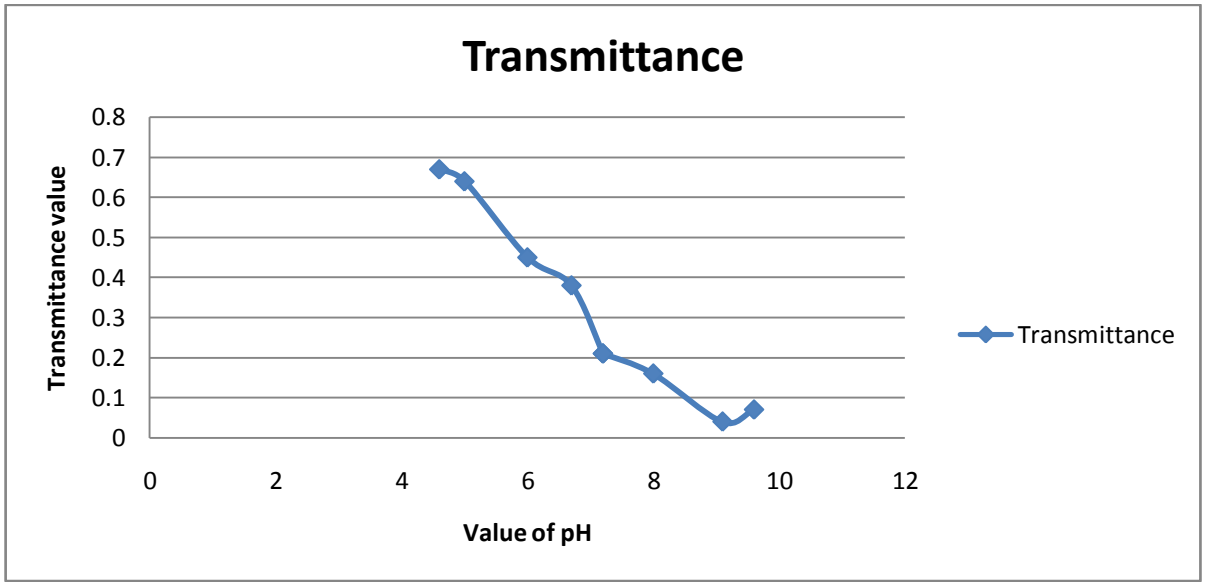

Figure 4: Fluctuations in Absorbance while varying pH

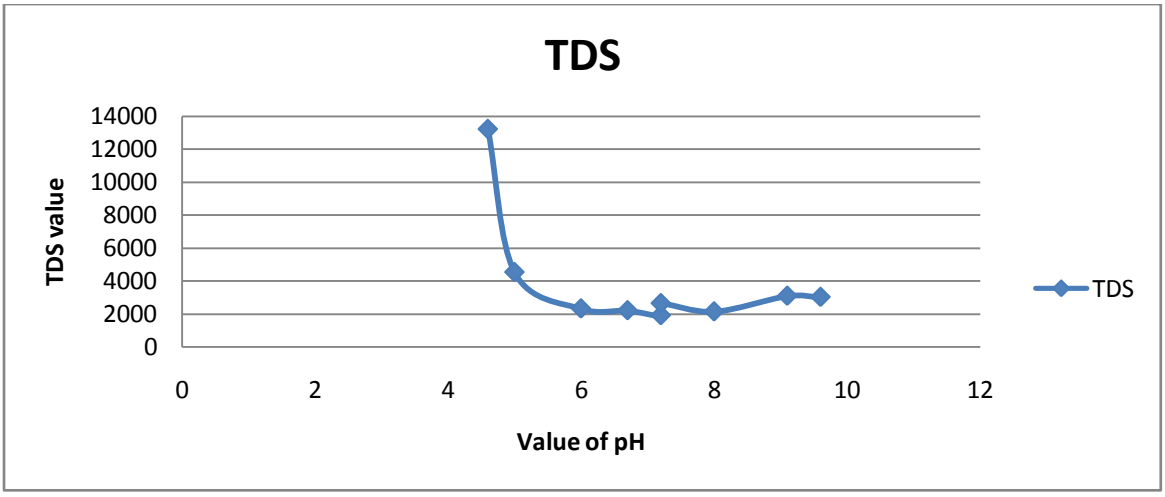

Figure 5: Fluctuations in Turbidity while varying pH

The table 2 shows the reading while adding 1g of magnesium chloride along with 2ml of poly electrolyte solution. In this combination, the maximum values obtained for all the parameters which we had tested. Transmittance value attained 100% and the absorbance became 0.00 as that of pure water at pH of 11.

Table 2: Various parameters of waste water after coagulation by adding 2ml of poly electrolyte

Sl.No:	pH		transmittance	conductivity	turbidity	absorbance	TDS
	initial	final					
1	4	4.6	36%	30.8	149	.44	19200
2	5	5.2	46%	9.6	122	.34	3820
3	6	6.2	52%	9.1	120	.26	2760
4	7	7	57%	6.7	63	.23	2910
5	8	7.7	58%	6.7	56	.20	2800
6	9	8	72%	7.6	32	.13	1330
7	10	9	80%	7.6	10	.09	1300
8	11	9	100%	7.6	3	0.00	3170
9	12	10	72%	7.3	3	.19	2900

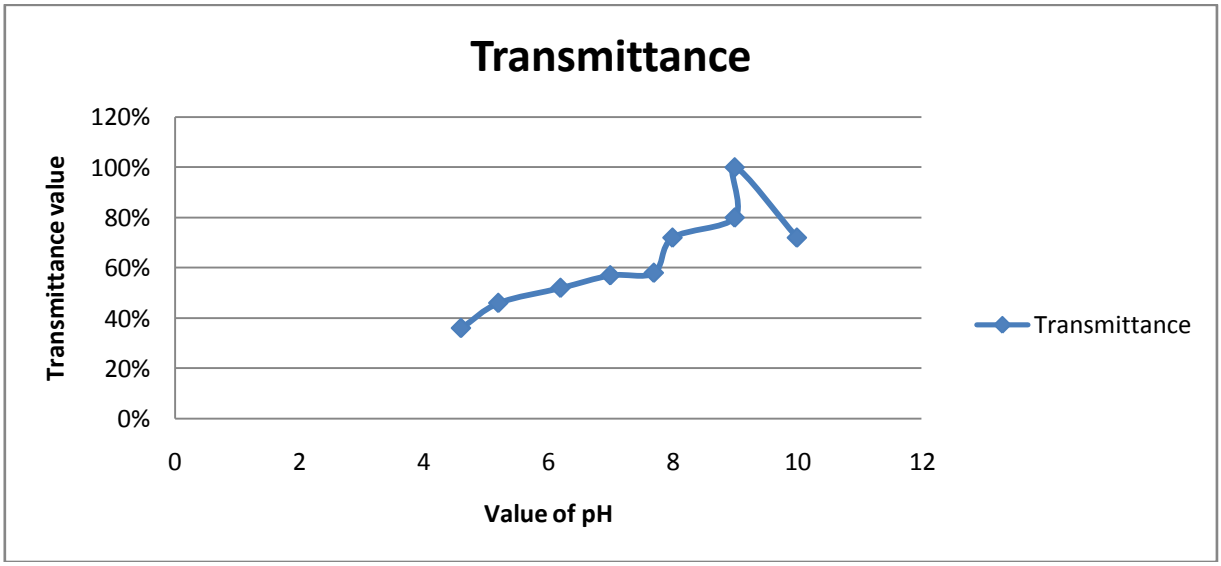

Figure 6: Fluctuations in Transmittance while varying pH

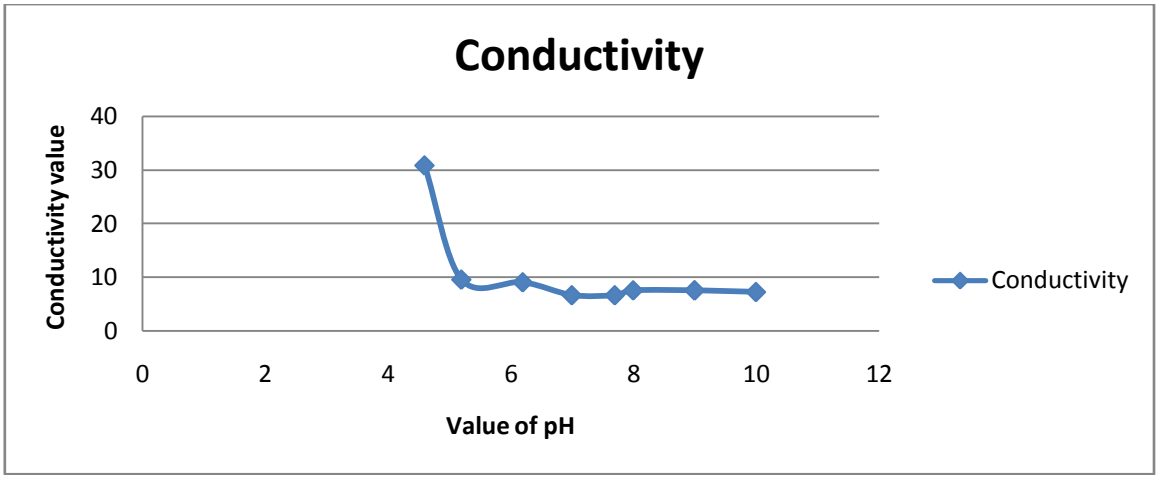

Figure 7: Fluctuations in Turbidity while varying pH

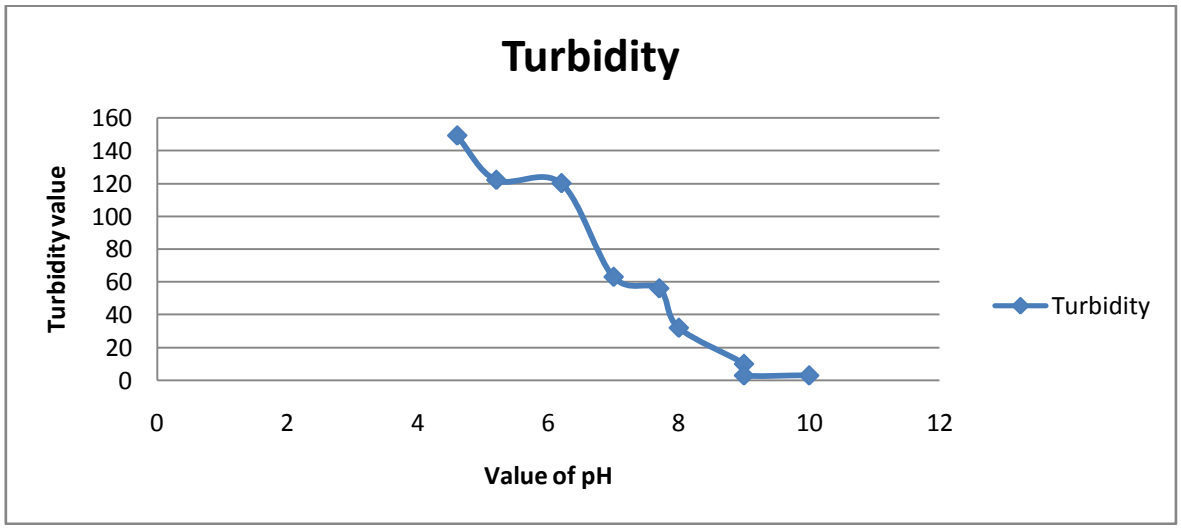

Figure 8: Fluctuations in Turbidity while varying pH

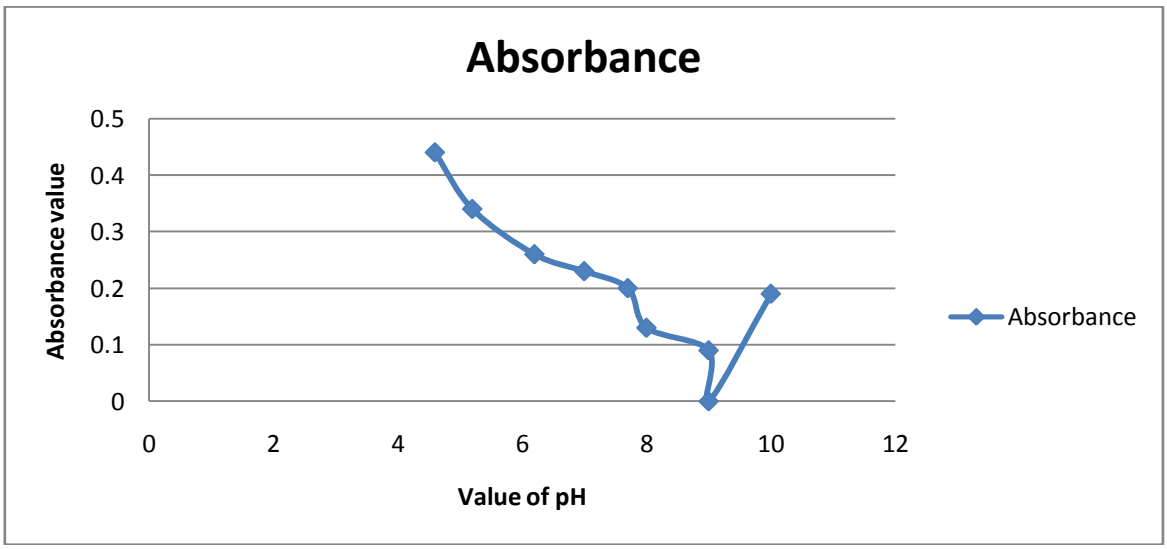

Figure 9: Fluctuations in Absorbance while varying pH

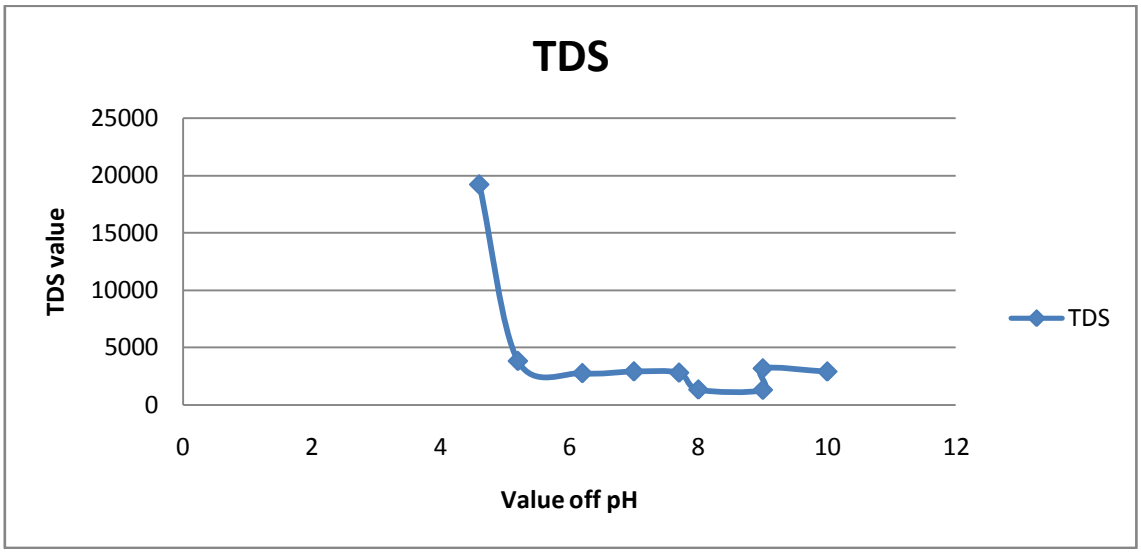

Figure 10: Fluctuations in TDS while varying pH

Table 3: Various parameters of waste water after coagulation by adding 3ml of poly electrolyte

Sl.No:	pH		transmittance	conductivity	turbidity	absorbance	TDS
	initial	final					
1	4	5	36%	48	294	.76	18160
2	5	5.5	40%	8.5	257	.68	3650
3	6	6.2	41%	6	193	.41	2500
4	7	7	56%	6.5	102	.21	2820
5	8	7.8	60%	7	123	.21	3030
6	9	9	78%	7.4	27	.15	3650
7	10	9	83%	7.2	16	.09	3600
8	11	10	87%	7.1	16	.07	3040
9	12	10.5	96%	7	14	.02	3320

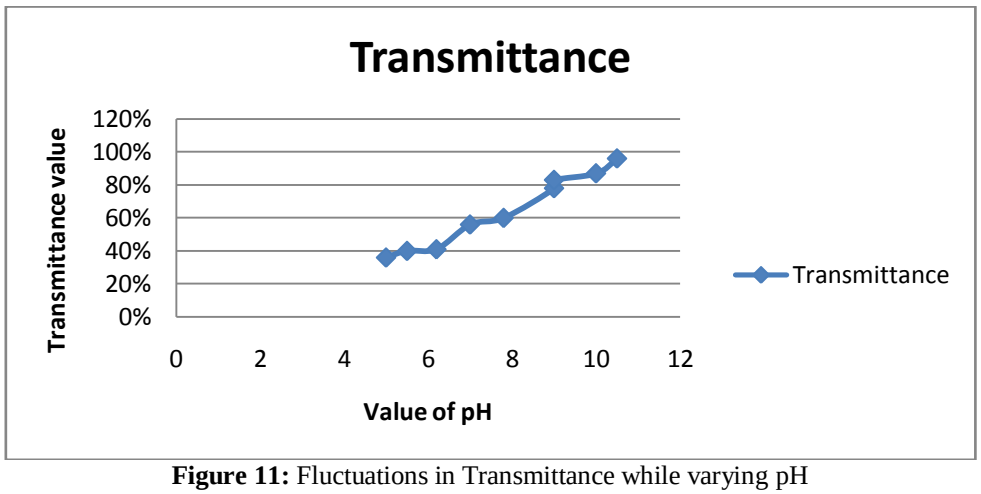

Figure 11: Fluctuations in Transmittance while varying pH

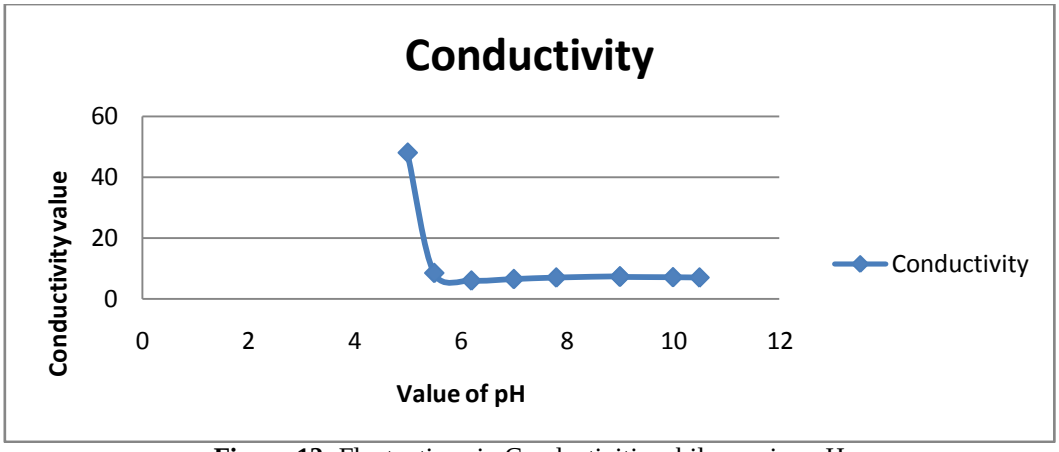

Figure 12: Fluctuations in Conductivitiy while varying pH

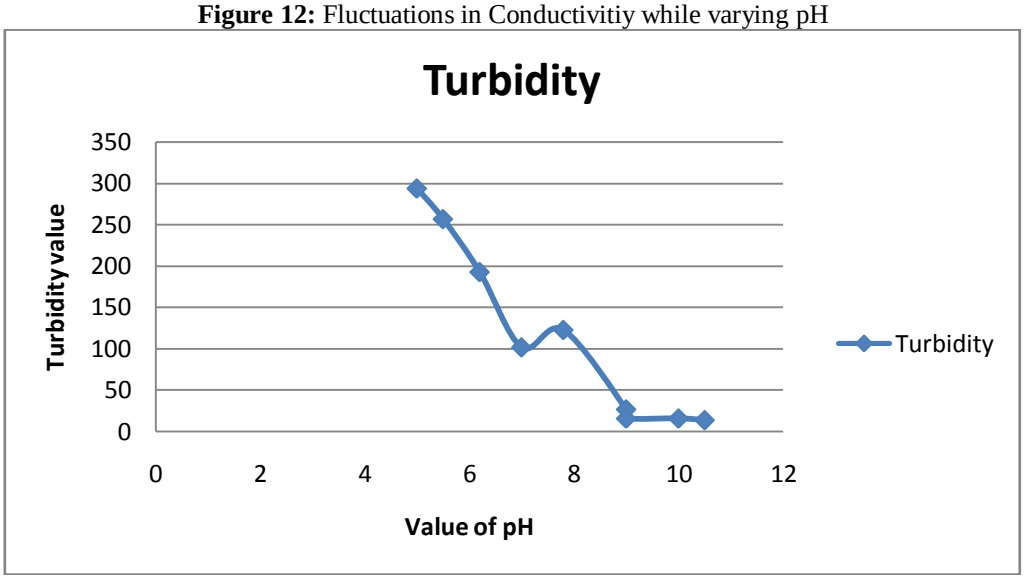

Figure 13: Fluctuations in Turbidity while varying pH

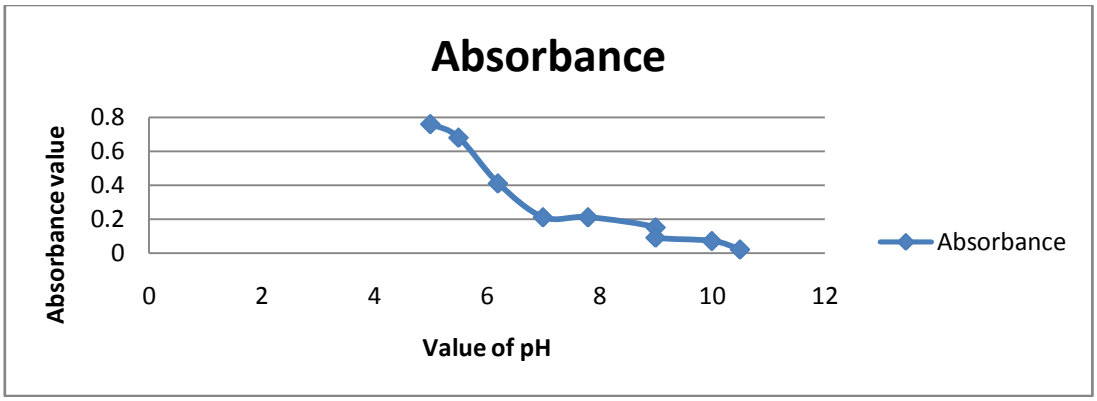

Figure 14: Fluctuations in absorbance while varying pH

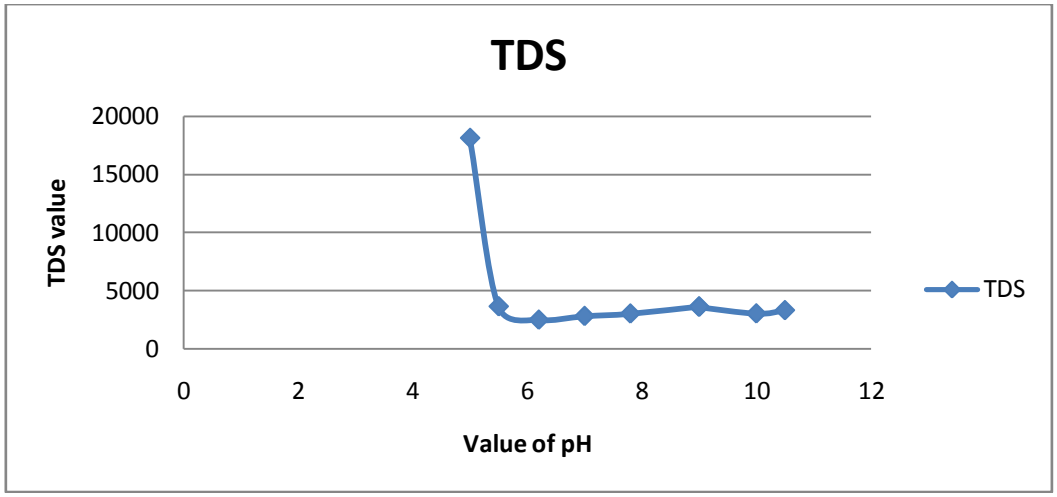

Figure 15: Fluctuations in TDS while varying pH

CONCLUSION

Combination of poly electrolyte solution and magnesium chloride, is satisfactory new agents for water treatment. In this work we obtained that while adding the Magnesium chloride along with poly electrolyte, the result is becoming more acceptable. That is, by increasing the dosage of Magnesium chloride, the value of turbidity is decreasing (3 NTU) and became approximately equal to that of water. The transmittance value is increasing and came to a range of 100%. This indicates that the effect of Magnesium chloride is satisfactorily working in the education institutional waste water treatment. In this study it is proved that the odour is completely removed by this simple coagulation process and it become unobjectionable. While adding the poly electrolyte in a range of 2ml, at pH 11 the transmittance value becomes 100%, and in the same condition the absorbance value became 0.00.So here by it is clear that the effectiveness of poly electrolyte is achieving at a pH of 11 and by adding 1g of magnesium chloride.

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References

1. Tan B H, Teng T T, Omar A K M, Removal of dyes and industrial dye wastes by magnesium chloride, Water research 2000; 34(2):597- 601
2. Akshaya Kumar Verma, Puspendu Bhunia, Rajesh Roshan Dash, Supermacy of magnesium chloride for decolourisation of textile water acomparitive study on the use of different coagulants, international journal of environmental science and development, 2012 ;(3):118-123
3. Maryam Hasani Zonoozi, Mohammad Reza Alavi Moghaddam, Mokhtar Arami, Removal of acid red dye from aqueous solutions by coagulation flocculation process, Environmental engineering and management journal, 2008;(7):695-699
4. G.R. Nabi Bidhendi, A. Torabian, H.Ehsani, N.Razmkhah, Evaluation of industrial waste water treatment with coagulants and poly electrolyte as a coagulant aid, Iran journal of environmental health science environment, 2007;(4):29-36
5. S.F Kang, M.C. Chen.Coagulation of textile secondary effluents with fentons reagent, Water science and technology, 1997;(36):215- 222
6. Leentvaar J, Rebhum M. Effect of magnesium and calcium presipitation on coagulation-flocculation with lime, Water research, 1982;(16):655-663
7. L Semerjian, G.M Ayoub, High pH magnesium coagulation flocculation in waste water treatment, Advanced environmental research, 2003;l(7):389-403
8. S J Allen, B. Koumanova, Decolourisation of water/waste water using adsorption, Journal of the university of chemical technology and metallurgy, 2005 ;(40):175-192