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OPTIMIZATION OF POLY ALUMINIUM CHLORIDE PRODUCED FROM USED BEVERAGE CANS FOR TREATING DYE INDUSTRY WASTE WATER, DOMESTIC WASTE WATER AND SURFACE WASTE WATER

Gayathri Mohan[1], K G Harshan[2]

[1]M.Tech student, Department of Civil Engineering, MDIT Engineering College, Kerala, India
[2]Associate Professor, Department of Mechanical Engineering, MDIT Engineering College, Kerala, India

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Abstract – *Aluminium is the second most commonly used metal and the expenditure and manufacture of aluminium is increasing day by day. The scrap produced by used beverage cans contributes a portion in polluting the environment so it can be recycled productively. In this project the productive recycling of aluminium cans is done and for this purpose 60 aluminium cans were collected and after removing the lid portion and paint, they were filed into fine powder. This aluminium powder is used to produce aluminium chloride and then it is used to produce the coagulant poly aluminium chloride. The investigation of effect of parameters like coagulant dosage , pH, contact time and revolution per minute is carried out and using the predominant optimal conditions the coagulation flocculation of dye industry waste water , domestic waste water and surface waste water is carried out and water quality parameters like pH, turbidity , chemical oxygen demand , biochemical oxygen demand , dissolved oxygen , ammonia nitrogen and nitrate is tested before and after the treatment and the removal efficiency is calculated.*

1.INTRODUCTION

In the present situation there is a constantly increasing worldwide concern for developing sustainable waste water treatment and reuse technologies. It is very important to treat the waste water in order to reuse it so that we can avoid environmental degradation and promote conservation of water resources. If not treated the water may harm human health , fishes , wild life population , cause oxygen depletion and may cause other restrictions on recreational water use .Used beverage cans are largest component of processed aluminium scrap so there is a need to recycle it in a productive way. Aluminium cans can be used to synthesis aluminium based coagulants like alum, poly aluminium chloride etc. Poly aluminium chloride have good coagulant performance, large alum particles, fast settling, low dosage, high efficiency and wide application range. Treatment of water using poly aluminium chloride is very efficient and it have a wide range of pH adaptation and does not have any side effects so it is used for treating of dye industry waste water, domestic waste water and surface waste water. This process newly proposed will help to recycle waste resources and protect environment,

2. OBJECTIVE OF THE STUDY

The overall aim of this project work is to synthesis and analyse the properties of an efficient flocculant, poly aluminium chloride, from used beverage cans. This was achieved by the following objectives:

- To prepare Poly Aluminium Chloride from used beverage cans.
- To characterise the effluents collected. This include pH, turbidity, chemical oxygen demand, biochemical oxygen demand ,dissolved oxygen , nitrate and ammonia.
- To determine the effect of pH , flocculant dosage , revolution per minute and contact time on flocculation using PAC and thereby determine optimum conditions.
- To treat dye industry waste water, domestic waste water and surface waste water using PAC produced.

3. EFFECT OF PARAMETERS ON FLOCCULATION

3.1 Effect of flocculant dosage

Concentrations of 250 mg/L,500 mg/L, 1000 mg/L, 1500 mg/L and 2000 mg/L Poly aluminium chloride will be spiked respectively to 200 ml of the sample . One tube will be taken as zero flocculant control . . Samples will be mixed thoroughly by a magnetic stirrer at 150 rpm, 5 mins contact time and 30 mins settling time. Then the following parameters were analyzed for different samples .

3.2 Effect of pH

0.1M HCl and 0.1M NaoH is used to adjust the pH value 2 to 10 . for obtaining the optimum value constant dose of poly aluminium chloride will be added and flocculation will be carried out at different pH value. The pH value at which maximum removal takes place is choosed .

3.3 Effect of contact time

In the case of a rapid mixing chamber the contact time is 1 to 3 minutes.. The contact time is varied to obtain an optimum value.

3.4 Effect of revolution per minute

The experiments will be done at constant pH with optimum flocculant dosage and constant mixing time . Speed will be varied from 40 to 200rpm with an increment of 40rpm.

4. MATERIALS AND METHODOLOGY

4.1 Materials

Materials collected are the back bone of every scientific research so every research need a wide array of products. In this project 60 aluminium cans were collected from Mini industrial estate Velliyamparamba , Kannur and cleaned and then dried . The lids of the cans were removed and after removing the paint it was filed into fine powder by mechanical filing .

Aluminium consist about 8% of the earth's crust and And aluminium is the most abundant metallic element. Aluminium occurs naturally in environment as silicates, oxides, and hydroxides, combined with other elements, such as sodium and fluoride, and as complexes with organic matter. Aluminium metal is used as structural material in construction, automotive, and aircraft industries, in the production pf metal alloys, in the electric industries, in cooking utensils, and in food packaging. Aluminium compounds are used as antacids, antiperspirants, and food additives. Aluminium salts are also widely used in water treatment as coagulants to reduce organic matter, colour, turbidity, and microorganism levels. The process usually consists of addition of an aluminium salt at optimum pH and dosage, followed by flocculation, sedimentation, and filtration.

4.2 Preparation of poly aluminium chloride (PAC)

Initially, 60 used beverage cans were taken. The lid portion was cut off and paints on the cans were removed. Then, they were crushed into fine powder by filing. The powder was collected. Then 30g of can powder will be taken for Extraction of aluminium chloride from used beverage cans. Aluminium solution will be prepared by dissolving 30g of can powder in 105 ml of commercial Hydrochloric acid (35%). Granular Al will be added in small portions to pure HCl solution, in a 500 ml flask under continuous magnetic stirring. The following reaction will take place:

$$2Al + 6HCl \rightarrow 2AlCl_3 + 3H$$

Firstly 100ml of 0.25M aluminium chloride solution will be placed in 500ml glass beaker.Then, the solution will be heated to 85°C in a water bath.Within 20 minutes, 240ml of 0.25M sodium hydroxide solution (2.4g)will be added slowly under continuous stirring and accurate temperature control 70°C.This will yield the required flocculant, poly aluminium chloride. This poly aluminium chloride is then collected and then it is oven dried into powder form.

4.3 Selection of sample points

The sample points selected are Mananthala Kadavu in the Kozhikode district, Kannur weavers Co-operative society, Mini industrial estate Velliyamparamba , Kannur and domestic water is collected from the domestic waste water drains .

The river water was collected from Mananthala Kadavu. Mananthala Kadavu is apart of Chaliyar river located in Calicut district . The banks of the river is polluted by various domestic activities..Its tributaries flow through Malappuram and Calicut and there is higher chance of pollution in this river The collected waste water was polluted so there was a need to analyse the water quality parameters before the treatment .

The dye industry waste water was collected from Kannur weavers Co-operative society. The collected water was dark brown in colour .

The waste water from the domestic waste water drains was collected for this purpose and the initial parameters were analysed before the treatment of this domestic waste water . The domestic waste water collected was contaminated to the degree that it is no longer beneficial, and therefore must be treated before it can be used or released back into the environment.

4.4 Characterization of industrial effluent

For the characterization of the industrial effluent ,the physical ,chemical and biological characteristics of industrial effluent like pH, tubidity ,ammonianitrogen ,Biochemical oxygen demand ,Chemical oxygen demand , Dissolved Oxygen and Nitrates will be calculated. The effluents collected are river water , domestic waste water and surface waste water .These parameters will be tested before and after the treatment.pH is measured using pH meter and turbidity is measured using turbidity meter. Ammonia Nitrogen is measured using Spectophotometer and chemical oxygen demand is measured using reflux method .Biochemical oxygen demand and dissolved oxygen is measured using Winklers method and nitrate is measured using the spectrophotometer . Magnetic stirring process is used and different dosage of poly aluminium chloride is added and process take place in the magnetic stirrer. Then the values are calculated and then the removal efficiency is calculated . Then the break through curve is plotted for the further analysis . All the methods for the characterization of industrial effluent will be performed according to Standard Method for The Examination of water and Wastewater.

5. RESULTS AND DISCUSSION

5.1 River water initial characteristics

The collected river water is tested from NABL accredited Water lab, Kozhikode. The tests are conducted as per the procedure given above.

Table -1: Initial characteristics of River water

SL No	PARAMETER	UNIT	VALUES OBTAINED
1	pH	-	7.38
2	Turbidity	NTU	18
3	Ammonia-n	mg/L	1.5
4	Cod	mg/L	72
5	Bod	mg/L	42
6	Dissolved oxygen	mg/L	5.9
7	Nitrate	mg/L	14

5.2 Domestic waste water initial characteristics

The collected domestic waste water is tested from NABL accredited Water lab Kozhikode .

Table -2: Initial characteristics of domestic waste water

SL No	PARAMETER	UNIT	VALUES OBTAINED
1	pH	-	7.13
2	Turbidity	NTU	65
3	Ammonia-n	mg/L	6.9
4	Cod	mg/L	315
5	Bod	mg/L	195
6	Dissolved oxygen	mg/L	3.3
7	Nitrate	mg/L	24.9

5.3 Dye industry waste water initial characteristics

The collected dye industry waste water is tested from NABL accredited Water lab Kozhikode .

Table -3: Initial characteristics of dye industry waste water

SL No	PARAMETER	UNIT	VALUES OBTAINED
1	pH	-	11.2
2	Turbidity	NTU	1500
3	Ammonia-n	mg/L	23
4	Cod	mg/L	11380
5	Bod	mg/L	BDL
6	Dissolved oxygen	mg/L	BDL
7	Nitrate	mg/L	58

5.3 Stock preparation of PAC

$$\frac{\text{Required concentration} \times \text{Required volume}}{\text{Available concentration}}$$

Stock: Dried PAC to 10000g/L ,Concentrations from Stock using waste water is 250 mg/L, 500 mg/L , 1000 mg/L, 1500 mg/L, 2000 mg/L ,Satisfactory working range of PAC is 5.5 – 8.5

5.6 Effluent characteristics

The river waste water, domestic waste water and dye industry waste water is treated with Poly Aluminium Chloride using the magnetic stirrer and the parameters of effluent is then tested in the laboratory after treatment. The test results are given in the tables.Contact time is 5 minutes and RPM is 150,settling Time is 30 minutes.

Table -4: River water effluent characteristics after treatment

PARAMETER	250mg/l	500mg/l	1000 mg/l	1500 mg/l	2000 mg/l
Ph	7.31	7.11	6.52	6.10	5.80
Turbidity	7.5	3.1	<1	18	18
Ammonia-n	0.9	0.42	Bdl	Bdl	Bdl
Cod	43	28	19	11.1	Bdl
Bod	12.3	7.7	5.3	Bdl	Bdl
Dissolved oxygen	4.8	5.6	5.1	5.3	5.9
Nitrate	11.5	7.3	4.8	1.9	Bdl

There is a fluctuation in the values of parameters of river water when there is change in dosage . Some of the values are obtained below detection limit . The table below shows the effluent characteristics of domestic waste water after treatment.

Table -5: Domestic waste water effluent characteristics after treatment

PARAMETER	250mg/l	500mg/l	1000mg/l	1500mg/l	2000mg/l
pH	7.05	6.69	6.36	5.90	5.40
Turbidity	42	29	21	9.2	2.8
Ammonia -n	5.4	3.11	1.2	BDL	BDL
Cod	269	194	148	102	47.4
Bod	73	53	41	29.8	13.3
Dissolved oxygen	4.1	4.4	4.8	4.3	5.1
Nitrate	18.9	13.2	9.3	4.4	2.6

Table -6: Dye industry waste water effluent characteristics after treatment

PARAMETER	250mg/l	500mg/l	1000mg/l	1500mg/l	2000mg/l
pH	11.2	10.8	10.3	9.5	8.9
Turbidity	1300	1200	900	750	390
Ammonia -n	21.6	19.1	17.3	17.1	17.1
Cod	10593	10.8	9890	9778	9719
Bod	BDL	1200	BDL	BDL	BDL
Dissolved oxygen	BDL	10223	BDL	BDL	BDL
NItrate	56.3	BDL	48.3	45.9	47.1

5.7 Removal efficiency

The removal efficiency of poly aluminium chloride is calculated in the case of river water,domestic waste water and dye industry waste water . The percentage removal of different water quality parameters is calculated .

$$\text{Removal Efficiency} = \frac{(\text{Value before} - \text{value of after})}{\text{Value before}} \times 100$$

Table -7: Removal efficiency of PAC in river water

PARAMETER	REMOVAL EFFICIENCY (%)				
	250 mg/l	500 mg/l	1000mg/l	1500 mg/l	2000 mg/l
Turbidity	58.33	82.77	97.22	0	0
Ammonia-n	40	72	83.33	83.33	83.33
Cod	40.27	61.11	73.61	84.58	98.61
Bod	70.71	81.66	87.38	88.09	88.09
Nitrate	17.85	47.85	33.57	86.42	92.85

In the case of river water the optimum dosage of PAC is 1000mg/L . After that dosage removal efficiency of PAC starts decreasing in the case of removal of turbidity . pH and dissolved oxygen is minimum as per CPCB so it is not applicable .

The table below shows the removal efficiency of domestic waste water . In the case of domestic waste water 2000mg/L is the optimum dosage . All the values are within the limits in the case of the dosage 2000mg/L .

Table -8: Removal efficiency of PAC in domestic waste water

PARAMETER	REMOVAL EFFICIENCY (%)				
	250 mg/l	500 mg/l	1000mg/l	1500 mg/l	2000 mg/l
Turbidity	35.38	55.3	67.69	85.8	95.69
Ammonia-n	21.73	54.92	82.6	96.3	96.3
Cod	14.6	38.4	53.01	67.6	84.9
Bod	62.5	72.8	78.7	84.7	93.1
Nitrate	27.7	54.9	82.6	96.37	96.37

Table -9: Removal efficiency of PAC in dye industry waste water

PARAMETER	REMOVAL EFFICIENCY (%)				
	250 mg/l	500 mg/l	1000mg/l	1500 mg/l	2000 mg/l
Turbidity	13.33	20	40	50	74
Ammonia-n	13.6	23.6	30.8	31.6	31.6
Cod	6.91	10.16	13.09	14.07	14.59
Bod	BDL	BDL	BDL	BDL	BDL
Nitrate	2.93	10.68	16.7	20.8	18.7

5.8 Break through curve

The break through curve is plotted with PAC dosage in the x axis and removal efficiency in the y axis .

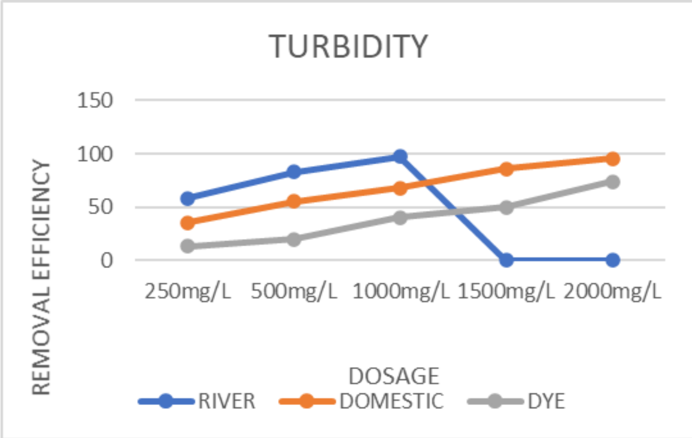

Fig -1: Break through curve of parameter turbidity

The break through curve shown below represents that the removal effiency s in the case of Turbidity . At first dosage in the case of river water the removal efficiency was 58.33% then it decreased to 0 at dosage 2000mg/L . In the case of domestic waste water at first dosage removal efficiency was 35.38% it increased to 95.96% at dosage 2000mg/L. In the case of dye industry waste water the removal efficiency was 13.33% then it increased to 74% at dosage 2000mg/L. In the case of turbidity these is variation in the removal efficiency at various dosages.

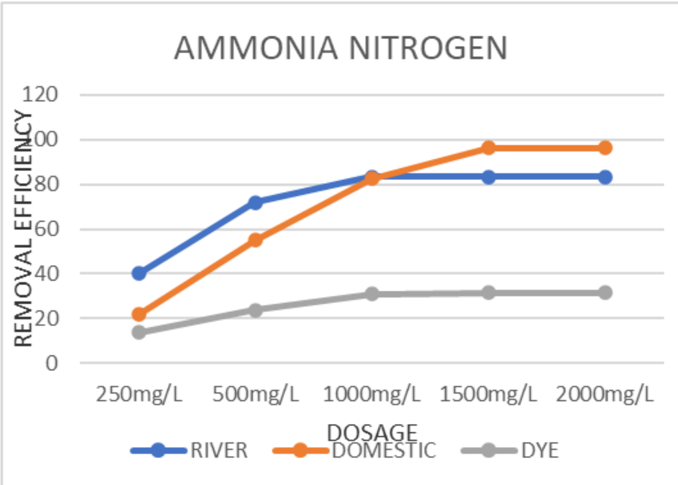

Fig -2: Break through curve of parameter ammonia nitrogen

This break through curve above represents the removal effiency changes in the case of ammonia nitrogen . At first dosage in the case of river water the removal efficiency was 40% then it increased to 83.53% at dosage 2000mg/L . In the case of domestic waste water at first dosage removal efficiency was 21.73% it increased to 96.3% at dosage

2000mg/L. In the case of dye industry waste water the removal efficiency was 13.6% then it increased to 31.6% at dosage 2000mg/L.

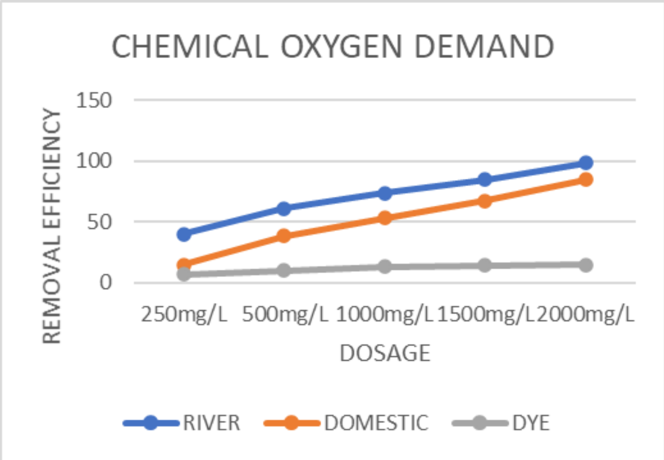

Fig -3: Break through curve of parameter chemical oxygen demand

This break through curve above represents the removal effiency changes in the case of chemical oxygen demand. At first dosage in the case of river water the removal efficiency was 40.27% then it increased to 98.61% at dosage 2000mg/L . In the case of domestic waste water at first dosage removal efficiency was 14.6% it increased to 84.9% at dosage 2000mg/L. In the case of dye industry waste water the removal efficiency was 6.91% then it increased to 14.59% at dosage 2000mg/L.

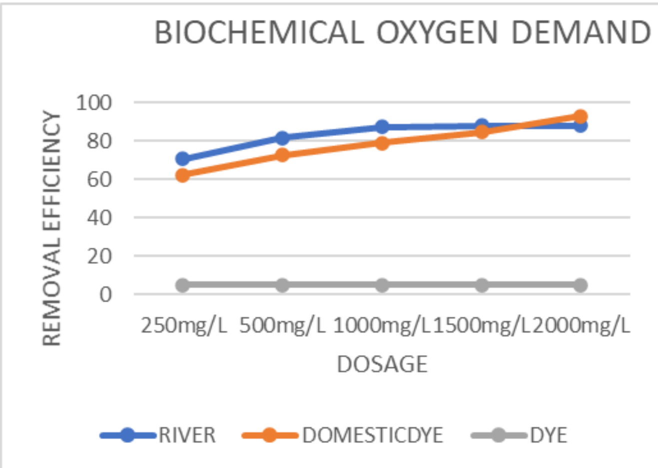

Fig -4: Break through curve of parameter bio chemical oxygen demand

This break through curve above represents the removal effiency changes in the case of biochemical oxygen demand . At first dosage in the case of river water the removal efficiency was 70.71% then it increased to 88.09% at dosage 2000mg/L . In the case of domestic waste water at first dosage removal efficiency was 62.5% it increased to 93.1% at dosage 2000mg/L. In the case of dye industry waste water the removal efficiency was below detention limit .

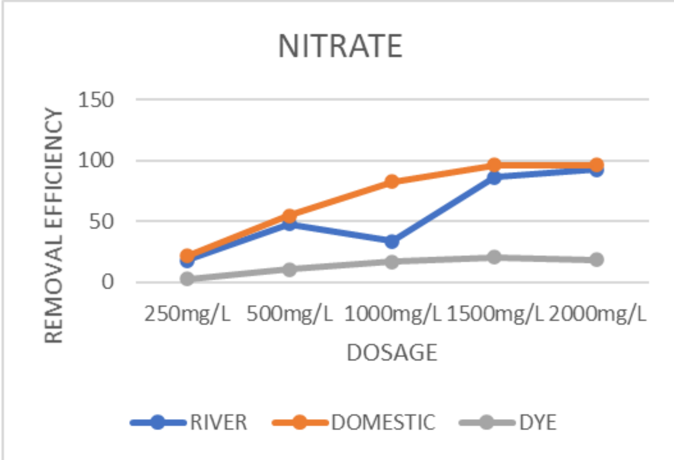

Fig -5: Break through curve of parameter nitrate

This break through curve above represents the removal effiency changes in the case of nitrate . At first dosage in the case of river water the removal efficiency was 17.8% then it increased to 92.85% at dosage 2000mg/L . In the case of domestic waste water at first dosage removal efficiency was 21.73% it increased to 96.37% at dosage 2000mg/L. In the case of dye industry waste water the removal efficiency was 2.93% then it increased to 18.7% at dosage 2000mg/L.

6. CONCLUSIONS

Removal of turbidity from water is an important step in treatment of waste water effluent. This is achieved by coagulation – flocculation using some chemicals like alum salts and polymers. In this project PAC was produced by using the waste aluminium beverage cans. The recycling of aluminium cans for production of PAC will lower the cost of PAC production and helps in cleaning and protecting the environment. This technique of treating waste water is beneficial in lowering environmental pollution and thus can be studied upon further to be considered as an effective method of waste water treatment. In this project the application of PAC on various parameters like pH, turbidity , ammonia nitrogen , COD,BOD,DO, nitrate is tested for river water , domestic waste water and dye industry waste water at various dosages and removal efficiency is calculated . The optimum dosage for river water is obtained 1000mg/L and that of domestic and dye industry waste water is obtained 2000mg/L. This river water after treatment can be used for drinking purpose.

From the analysis it is inferred that PAC is very effective in its desired working range. Removal of COD, ammonia is maximum obtained at 2000 mg/L. So coagulation technique using PAC is preferred in many industries depending upon the nature of pollutants present.

REFERENCES

[1] Aziz, N, Effendy N, & Basuki K. T (2017). Comparison of poly aluminium chloride (pac) and aluminium sulphate coagulants efficiency in waste water treatment plant. Journal Inovasi Teknik Kimia, 2(1).

[2] Bin Ahmed S, Ayoub G, Al-Hindi M, & Azizi F (2015). The effect of fast mixing conditions on the coagulation–flocculation process of highly turbid suspensions using liquid bittern coagulant. Desalination and Water Treatment, 53(12), 3388-3396.

[3] Choi Y. I, Jung B. G, Son H. J, & Jung Y. J (2010). Determination of Optimum Coagulants (Ferric Chloride and Alum) for Arsenic and Turbidity Removal by Coagulation. Journal of Environmental Science International, 19(8), 931-940.

[4] Deng S, Zhou Q, Yu G, Huang J , & Fan Q (2011). Removal of perfluorooctanoate from surface water by polyaluminium chlor Kipngetich, T. E., Hillary, M., & Anthoney Swamy, T. (2013). Determination of levels of phosphates and sulphates in domestic water from three selected springs in Nandi County, Kenya. International Journal of Pharmacy & Life Sciences, 4(7).

[5] Kushwaha J. P, Srivastava V. C, & Mall I. D. (2011). An overview of various technologies for the treatment of dairy wastewaters. Critical reviews in food science and nutrition, 51(5), 442-452.