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Treatment of household domestic wastewater by electrocoagulation process

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Abstract

Electro coagulation is a process that involves dissolution of a metal a node with simultaneous formation of hydroxyl ion sand hydrogen gas at the cathode. This study investigated the influence of operating parameters (current density, detention time, pH, electrolyte concentration, electrodetype, electrode distance) on COD removal using electro coagulation process (EC) with aluminum and iron electrodes in continuous flow model. Till today researchers are mainly focused on use of electro coagulation systemin batch processes. Looking to a large quantity of waste water, continuous flow regime may offer better solution. The operational parameters including current density, detention time and pH will be optimized for study and it is expected for the improved efficiency of COD and turbidity removal.

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Introduction

The rapid increases in population and urbanization have led to the increased generation of solid waste world wide, prompting concern for environmental protection and sustainability. Although approaches such as reuse and recycle are being adopted to reduce the amount of solid waste, land filling remains the dominant method for the disposal of solid waste in many countries. One of the major issues with land fill is the generation of waste water which must be properly managed to prevent environmental pollution (Akyol, 2012). Wastewater poses hazard to the environment since it may contain various pollutants such as persistent organic pollutants (POPs), heavy metal sand other recalcitrant organic pollutants. Thus, waste water treatment is quite challenging due to its complex nature. The characteristics of waste water will depend largely on the composition of the solid waste in the house hold domestic wastewater (Asaithambi et al., 2012). In addition, cover design and operational activities could change the properties of the produced waste water. Since the waste water must be continuously collected and disposed, so proper treatment is necessary before discharging to the environment, the selection of treatment method is mainly based on the composition and properties of the household wastewater. Various treatment methods such as aerobic, anaerobic, flotation, coagulation, flocculation, chemical precipitation, adsorption, and air stripping have been used for waste water treatment. Coagulation is considered an economical way to treat waste water through the use of chemicals such as alum and other compounds with coagulating effects. These chemicals facilitate the

flocculation and coagulation of the particles, leading to easier removal via sedimentation. However, issues such as possible adverse effects of the chemicals, production of secondary pollutants and the cost of chemicals are viewed as drawbacks of chemical coagulation process. Recently, use of electro-assisted coagulation or electrocoagulation (EC) for wastewater treatment has gain popularity. In EC, differences in electric potentials are used to generate coagulants which can remove color, suspended and dissolved particles in wastewater (Zhu et al., 2012). EC has been applied successfully for the treatment of textile dyes, biodiesel wastewater, pharmaceutical wastewater, oil tanning effluent, industrial wastewater, pretreated coke wastewater, and heavy metals.EC has gained significant attention from many researchers owing to its advantages such as reduced sludge production as compared to chemical coagulation, no requirement for external chemical coagulants, ease of operation, short operating time, and low capital and operating costs.

Materials and methods

Based on the various literature study carried out, the following methodology was arrived to treat the household domestic waste water through batch study using electrocoagulation process.

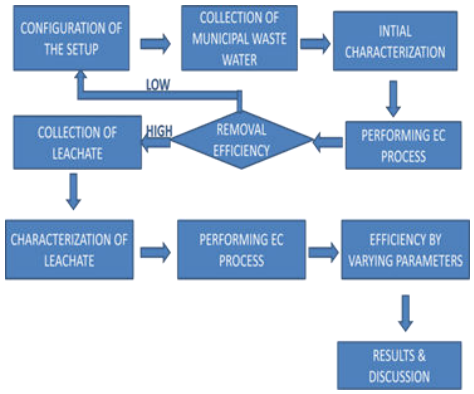

Fig.1: Methodology flowchart

Materials used in the study

As waste water contains high organic and inorganic content, the reactor is started up with domestic waste water (which is less hazardous) for testing the performance of the reactor and to know about the working of electrocoagulation (Mertens, 2011).The domestic wastewater was collected from household domestic waste water treatment plant after the preliminary treatment.

Fig.2: Collection waste water sample

Electrodes used

The dimensions of the two aluminum and two iron electrode were140mm X 100mm X 2mm and the wet area of the electrode is 180 cm^2. The weight of the two aluminium and two iron electrodes were 141.88g, 143.10g and 331.78g, 339.88g respectively.

Fig. 3: Aluminium and iron electrodes

Preparation of natural coagulant

The thethankottai was taken for the experiment of electro coagulation process. It was used as a coagulant for normal coagulation process (Kasmuri and Tarmizi, 2018). Here using to know the efficiency and capacity of electrocoagulation capacity for natural coagulant. The seed was grained well and it was sieved by 4micron sieve. The fine powdered material was used for this process.

Fig.4: Powdered natural coagulant (Thethan kottai)

Preparation of synthetic coagulant

The synthetic coagulant was prepared by Amino Enzyme; it is a bio catalyst which generates the treatment efficiency in wastewater (Madrona et al., 2010). To maintain uniformity the fine powdered material was sieved by 4micron sieve and it was used for coagulation process.

Fig. 5: Amino enzyme as coagulant.

Results and discussion

The characterization studies were conducted for domestic waste water before treatment plant. The chemical parameters such as pH, COD, Conductivity, Alkalinity, Turbidity and TDS were arrived. The initial water characterizations were done to determine the treatment efficiency. The water quality characteristics were checked before and after treatment process.

Water quality characters before treatment process

The water qualities were checked before and after treatment process to analysis the treatment efficiency. The Ph was in the alkaline nature of 8.48 which indicated that it crossed the permissible limit. COD was at 28 mg/L which indicated a higher level of chemical contamination. The conductivity showed the higher concentration of 14.08 (mS/cm). TDS was higher than the permissible limit; it was ranged as 1042 mg/L. The total solid range was about 938 mg/L which denoted that the discharge of solid and liquid waste in the domestic drainage system caused heavier range of TS. The alkalinity was alarming range of1100mg/L as $CaCo_3$.Duethesolidandliquidwastedischargeintothedrain age of urban area created the higher pollution load in the domestic waste water (Kurenkov et al., 2009). This implies in turbidity level which crossed the permissible limit as 580NTU. The main aim of this project was to reduce the turbidity level. It plays a key role in water treatment process.

Coagulation with natural material

In electro coagulation process the major role plays by electrical charges. It activates the suspended particles presented in water to make floc. The naturally available thethan kottai powder was successful coagulant for treating domestic waste water; it was added as a coagulant. The electrical charges were passed in different ranges to know the optimum level of treatment (Kurenkov et al., 2009). The same process was done with synthetic coagulant here the Amino Enzyme was added as coagulant. It acts as a bio catalyst which activates the treatment process. The comparison of treatment process with natural and synthetic material produces the efficient coagulant. The coagulation was preceded with thethan kottai powder. The coagulant was taken in different ranges as 1g in a different current densityof 7V, 14V and 21V. 1gm of natural coagulant produced pH of 7.3, 6.5, 6.5; the COD level was at 26,23 and 21 mg/L, Conductivity was 12.13,9.5 and 8.15 (mS/cm), TDS was about 917,604 and 325 mg/L, the TS about 742,410 and 405 mg/L, Alkalinity was 841,251 and 174 mg/L and Turbidity was 510,347 and 315 NTU. The turbidity level was reduced well but this results concluded that the removal range was nothing here efficient (Kurt et al., 2008).Thes light variation taken place when compared with untreated effluent.

Addition of coagulant 2 g/L

The coagulant was taken in different ranges as 2gm in a different current density of 7V, 14V and 21V.1gm of natural coagulant produced pH of 6.8, 6.6, 6.6; the COD level was at 12, 10 and 10mg/L, Conductivity was 9.1,8.5 and 7.9 (mS/cm), TDS was about 548,437 and 241 mg/L, the TS about 458, 312 and 297 mg/L, Alkalinity was 341, 211 and 131 mg/L and Turbidity was 315, 205 and 75 NTU. The turbidity level was reduced well but these results concluded that the removal range was nothing here efficient. The slight variation taken place when compared with untreated effluent.

Addition of coagulant 3 g/L

The coagulant was taken in different ranges as 3gm in a different current density of 7V, 14V and 21V. 1 g of natural coagulant produced pH of 6.6, 6.5 and 6.5; the COD level was at 11,10 and 9 mg/L, Conductivity was 9,8.4 and 7.5 (mS/cm), TDS was about 514, 453 and 240 mg/L, the TS about 324, 310 and 277 mg/L,

Alkalinity was 286, 210 and 131 mg/L and Turbidity was 241, 135 and 48NTU. The turbidity level was reduced well but these results concluded that the removal range was nothing her efficient. The slight variation taken place when compared with untreated effluent.

Table 1. Water Quality Characteristics before treatment process.

Parameter	Before Treatment
pH	8.48
COD (mg/L)	28
Conductivity (mS/cm)	14.08
TDS (mg/L)	1042
TS (mg/L)	938
Alkalinity (mg/LasCaCo3)	1100
Turbidity (NTU)	580

Table 2. Water Quality Characteristics after treating with natural coagulant Addition of Coagulant 1gm/L.

Current density (V)	Time (min)	Water Quality Parameters	Water Quality
7	15	pH	7.3
		COD(mg/L)	26
		Conductivity(mS/cm)	12.13
		TDS(mg/L)	917
		TS(mg/L)	742
		Alkalinity(mg/Las CaCo3)	841
		Turbidity(NTU)	510
14	30	pH	6.5
		COD(mg/L)	23
		Conductivity(mS/cm)	9.5
		TDS(mg/L)	604
		TS(mg/L)	410
		Alkalinity(mg/Las $CaCo_3$)	253
		Turbidity(NTU)	347
21	45	pH	6.8
		COD(mg/L)	21
		Conductivity(mS/cm)	8.15
		TDS(mg/L)	325
		TS(mg/L)	405
		Alkalinity(mg/Las $CaCo_3$)	174
		Turbidity(NTU)	128

Table 3. Water quality after treating with 2 g of coagulant.

Current density (V)	Time (min)	Water Quality Parameters	Water Quality
7	15	pH	6.8
		COD(mg/L)	12
		Conductivity(mS/cm)	9.1
		TDS(mg/L)	548
		TS(mg/L)	458
		Alkalinity(mg/Las CaCo3)	341
		Turbidity(NTU)	315
14	30	pH	6.6
		COD(mg/L)	9
		Conductivity(mS/cm)	8.6
		TDS(mg/L)	487
		TS(mg/L)	412
		Alkalinity (mg/L as CaCo3)	274
		Turbidity (NTU)	298
21	45	Ph	6.4
		COD (mg/L)	8
		Conductivity(mS/cm)	7.1
		TDS(mg/L)	269
		TS(mg/L)	214
		Alkalinity (mg/L as CaCo3)	164
		Turbidity (NTU)	102

Table 4. Water quality characteristics after treating with 3 g of coagulant.

Current density (V)	Time (min)	Water Quality Parameters	Water Quality
7	15	pH	6.6
		COD (mg/L)	11
		Conductivity (mS/cm)	9.0
		TDS (mg/L)	514
		TS (mg/L)	324
		Alkalinity (mg/Las CaCo3)	286
		Turbidity (NTU)	241
14	30	pH	6.5
		COD (mg/L)	10
		Conductivity(mS/cm)	8.4
		TDS (mg/L)	453
		TS (mg/L)	310
		Alkalinity (mg/L as CaCo3)	210
		Turbidity (NTU)	135
21	45	pH	6.5
		COD (mg/L)	9
		Conductivity (mS/cm)	7.5
		TDS (mg/L)	244
		TS (mg/L)	277
		Alkalinity (mg/L as CaCo3)	131
		Turbidity (NTU)	48

Table 5. Water quality characteristics after treating with natural coagulant addition of coagulant 1 g/L.

Current density (V)	Time (min)	Water Quality Parameters	Water Quality
7	15	pH	6.3
		COD (mg/L)	16
		Conductivity (mS/cm)	10.13
		TDS (mg/L)	647
		TS (mg/L)	745
		Alkalinity (mg/Las CaCo3)	541
		Turbidity(NTU)	310
14	30	pH	6.3
		COD (mg/L)	12
		Conductivity (mS/cm)	9.5
		TDS (mg/L)	410
		TS (mg/L)	506
		Alkalinity (mg/L as CaCo3)	374
		Turbidity (NTU)	108
21	45	pH	6.5
		COD (mg/L)	9
		Conductivity (mS/cm)	8.05
		TDS (mg/L)	328
		TS (mg/L)	394
		Alkalinity (mg/L as CaCo3)	187
		Turbidity (NTU)	65

Table 6. Water quality characteristics after treating with 3g of coagulant.

Current density (V)	Time (min)	Water Quality Parameters	Water Quality
7	15	pH	6.6
		COD(mg/L)	3.7
		Conductivity(mS/cm)	6.4
		TDS(mg/L)	208
		TS(mg/L)	277
		Alkalinity(mg/Las CaCo3)	114
		Turbidity(NTU)	87
14	30	pH	6.5
		COD(mg/L)	3.1
		Conductivity(mS/cm)	4.5
		TDS(mg/L)	198
		TS(mg/L)	212
		Alakalinity (mg/L as CaCo3)	**102**
		Turbidity (NTU)	**22**
		pH	6.6
		COD (mg/L)	1.9
21	45	Conductivity(mS/cm)	4.1
		TDS(mg/L)	134
		TS(mg/L)	187
		Alkalinity (mg/L as CaCo3)	77
		Turbidity (NTU)	14

The natural coagulant added in the electro coagulation was not that much efficient and the reduction level of pollutant was very low and the reaction with coagulation taken places lowly. The main aim of the project was to vary the current flow in the effluent and minimal amount of coagulant adding. In natural coagulant the process taken places lowly and the removal efficiency was low. The variation in current density made some changes in the water quality parameters. The increasing current density made some increase in the removal efficiency of the effluent.

Coagulation by amino enzyme material

Amino enzyme was used as coagulation different ranges of 1 g, 2 g and 3 g. The treatment efficiency was compared with the efficiency of natural coagulant. 1 g of coagulant was taken in a different density of voltage like 7V, 14V and 21V. The pH of 6.3, 6.3, 6.5; the COD level was at 16, 12 and 9 mg/L, Conductivity was 10.13, 9.5 and 8.05 (mS/cm), TDS was about 647, 410 and 328 mg/L, the TS about 745, 506 and 328 mg/L, Alkalinity was 541, 374 and 187 mg/L and Turbidity was 310, 108 and 65 NTU. The turbidity level was reduced well.

Addition of coagulant 3 g/L

The coagulant was taken in different ranges as 3gm in a different current density of 7V, 14V and 21V. One gram of natural coagulant produced pH of 6.6, 6.5 and 6.6; the COD level was at 3.7,3.1 and 1.9 mg/L (Beltrán-Heredia et al., 2011), Conductivity was 6.4, 4.5 and 4.1 (mS/cm), TDS was about 208, 198 and 134 mg/L, the TS about 277, 212 and 187 mg/L, Alkalinity was 114, 102 and 77 mg/L and Turbidity was 87, 22 and 14 NTU. The turbidity level was reduced well and it came near to the permissible limit. The whole parameter produced higher changes in the water quality.

Amino Enzyme used for treating the effluent. It was used as coagulant and the enzyme activated the suspended and dissolved particles present in effluent. This enzyme generated the particles and made floc and got deposited. This detailed study reported that the reaction time and binding capacity of the natural particles was lesser than Amino Enzyme.

Conclusions

This study facilitated to determine the treatment efficiency of natural and synthetic coagulant. The waste water collected from the treatment plant and the basic water quality parameters was checked. Thethan kottai was taken for this study the different concentration of coagulant was taken and the electrical charges introduced in the different volt. The both coagulant and electrical charges reacted with suspended and dissolved particles present in effluent. The Amino Enzyme was

taken as synthetic coagulant. This coagulant also added in a different concentration to determine the treatment efficiency. Treatment efficiency of these two coagulants was compared. The turbidity and COD removal showed the treatment efficiency. The natural coagulant started reaction with suspended and dissolved solid in the effluent slowly. When increasing the coagulant range it produced positivity in reaction range.

The higher concentration of 3 g produced the removal range of COD in 9 mg/L and 48NTU of turbidity. The synthetic coagulant started quick reaction with suspended and dissolved particles present in the effluent. The higher removal efficiency was observed the better removal. The higher concentration of 3gmproduced the removal range in COD as 4.1 mg/L and 14 NTU of turbidity, it showed that the higher pollutant level was reduced nearby permissible limit of water quality, It because of chemical reaction. When compared with the natural coagulant the reaction range was higher with synthetic coagulant. The synthetic coagulant got dissolved and it react also with dissolved particles present in sample which produced the better performance compared with natural coagulant.

Conflict of interest statement

Authors declare that they have no conflict of interest.

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References

Akyol, A., 2012. Treatment of paint manufacturing wastewater by electrocoagulation. Desalination 285, 91–99. https://doi.org/10.1016/j.desal.2011.09.039

Asaithambi, P., Susree, M., Saravanathamizhan, R., Matheswaran, M., 2012. Ozone assisted electrocoagulation for the treatment of distillery effluent. Desalination 297, 1–7. https://doi.org/10.1016/j.desal.2012.04.011

Beltrán-Heredia, J., Sánchez-Martín, J., Rodríguez-Sánchez, M.T., 2011. Textile wastewater purification through natural coagulants. Appl. Water Sci. 1, 25–33. https://doi.org/10.1007/s13201-011-0005-2

Kasmuri, N., Tarmizi, N.A.A., 2018. The treatment of landfill leachate by electrocoagulation to reduce heavy metals and ammonia-nitrogen. Int. J. Eng. Technol. 7, 109–112.

Kurenkov, V.F., Nadezhdin, I.N., Hartan, H.-G., Lobanov, F.I., 2009. Clarification of a dilute suspension of calcium carbonate in the presence of Praestol flocculants and aluminum sulfate coagulant. Russ. J. Appl. Chem. 82, 328–332. https://doi.org/10.1134/S107042720902030X

Kurt, U., Gonullu, M.T., Ilhan, F., Varinca, K., 2008. Treatment of Domestic Wastewater by Electrocoagulation in a Cell with Fe–Fe Electrodes. Environ. Eng. Sci. 25, 153–162. https://doi.org/10.1089/ees.2006.0132

Madrona, G.S., Serpelloni, G.B., Salcedo Vieira, A.M., Nishi, L., Cardoso, K.C., Bergamasco, R., 2010. Study of the Effect of Saline Solution on the Extraction of the Moringa oleifera Seed's Active Component for Water Treatment. Water, Air, Soil Pollut. 211, 409–415. https://doi.org/10.1007/s11270-009-0309-0

Mertens, J., 2011. Al nanoclusters in coagulants and granulates: application in arsenic removal from water. Rev. Environ. Sci. Bio/Technology 10, 111–117. https://doi.org/10.1007/s11157-011-9239-6

Zhu, G., Zheng, H., Chen, W., Fan, W., Zhang, P., Tshukudu, T., 2012. Preparation of a composite coagulant: Polymeric aluminum ferric sulfate (PAFS) for wastewater treatment. Desalination 285, 315–323. https://doi.org/10.1016/j.desal.2011.10.019.

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