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COMPARISON OF ELECTROCOAGULATION AND CHEMICAL COAGULATION FOR MUNICIPAL WASTEWATER TREATMENT

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Abstract: Municipal wastewater can include many pollutants which effect on the environment so that the treatment is very necessary before discharge into water bodies and for further recycle in recreation and agriculture. So that in this present study considers the treatment of municipal wastewater through electrocoagulation (EC) and chemical coagulation (CC) with comparison of both processes. For EC aluminium electrode and iron electrode was used with different voltage and time. For the CC aluminium sulfate and ferric chloride was used with coagulant dosage and contact time. After treating the municipal wastewater for the electrocoagulation maximum removal efficiency of COD, TOC, TDS and BOD in is 85%, 87%, 82% and 81% for aluminium electrode. 92%, 92%, 84% and 88% for iron electrode respectively. For the chemical coagulation maximum removal efficiency of COD, TOC, TDS and BOD is 81.66%, 80.09%, 84.67% and 77.08% for aluminum sulfate as coagulant and 86%, 83.90%, 87.73%, 81.8% for ferric chloride as coagulant. Here this study performance was achieved that the electrocoagulation was better than the chemical coagulation. And Fe is very promising electrode compare to Al.

Index Terms **– Electrocoagulation, Chemical Coagulation, Municipal Wastewater, Removal Efficiency**

I. INTRODUCTION

Currently, the biggest problem of water to supply ever growing population in twenty first century. Because of this the maintenance and management of water resource are necessary task of humankind, target on water discharge in environment or recycle. The advance treatment technology investigated by water resource management, because to require removal of pollutants from inadequate treated effluent by the treatment plants [9]. The municipal wastewater is one of the most important environmental pollutant which comprised of liquid wastes emanating from residential, commercial or institutional building which consists of latrines, urinals, bathrooms, kitchen sinks, washbasins, etc and having contaminates like heavy metals, total suspended solids, BOD, COD, etc.. The effluents from industrials are having high concentration of contaminant pollutant which directly discharges in to river get up biggest problems to makes serious damage to environment. Aim of wastewater for treatment is to remove the contaminants in useful way, concerning technical and economical view [8]. Treatment of municipal wastewater by electrocoagulation is cost effective technique for treatment of effluent with no addition of chemicals. It also decreases the amount of sludge. Electrocoagulation process may be reflecting as an advance oxidation process and used in wastewater treatment [9]. It situates causation of coagulants by electro dissolution of sacrificial anodes, generally aluminum and iron electrode. And treatment by chemical coagulation it is also cost effective and eco-friendly technique for this treatment addition of coagulant like aluminum sulphate and ferric chloride is require the negative charge of suspended particles over neutralization, the suspended particles stick with each other to form larger particles for efficient coagulation rapid mixing is more effective [10].

In this Present work a comparative study of electrocoagulation and chemical coagulation is represented as treatment process for municipal wastewater discharges from municipal treatment plant. This comparison converse about chemical oxygen demand (COD), biological oxygen demand (BOD), total dissolved solids (TDS) and total organic carbon (TOC)

Objectives of this paper is to study the batch electrocoagulation using aluminum and iron electrodes for removal of pollutants such as COD, TOC, TDS and BOD, to study the batch chemical coagulation using aluminum sulphate and ferric chloride as coagulant for removal of COD, TOC, TDS and BOD, to compare both electrocoagulation and chemical coagulation by removal efficiency of pollutant

II. EXPERIMENTAL

2.1 Materials

Municipal wastewater was collected from sewage treatment plant at Navanagar in Bagalkote For Electrocoagulation: Acrylic glass sheet reactor has dimension of 15cm×15cm×15cm, four aluminium and iron electrode with monopolar parallel connection has dimension of 10cm×10cm×0.1cm and distance between each electrodes are 10cm, DC power supply of applied current was 5v to 20v with different time interval of 15min to 60min, magnetic stirrer with 200rpm.

For Chemical coagulation: Alum jar test apparatus with 6 beakers, stirring paddle of 200 rpm aluminium sulfate $Al_2(SO_4)_3$, and Ferric chloride ($FeCl_3$) with coagulant dosage of 3ml/L to 15ml/L, weighing balance.

2.2. Electrocoagulation Process

An electrocoagulation experiment is carried out as batch reactor was designed and fabricated to treat the municipal wastewater. The batch reactor was made up of acrylic glass sheet and has dimension of 15cm×15cm×15mm with 5mm thickness and has volume of 2L capacity. Then 2L of wastewater was poured into reactor with magnetic stirring bar and kept on magnetic stirrer, four Aluminium electrode was immersed in wastewater with monopolar parallel connection and electrodes has dimension of 10cm×10cm×1mm with 1cm thickness. Magnetic stirrer was use intended for homogeneous mixing solution with magnetic string bar. Connect the electrode to DC power supply then set the voltages of 5v, 10v 15v and 20v and different time interval of 15min, 30min, 45min and 60min with 200 RPM. After the treatment the COD, BOD, TDS and TOC was determined. Then the same procedure did with four iron electrode with same dimension.

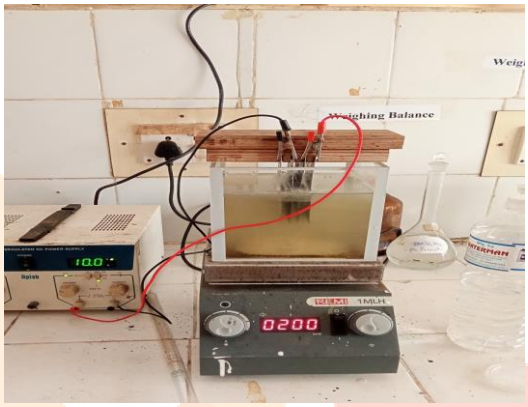


Fig 1: Electrocoagulation Setup

The main reaction of chemicals appearing on electrodes at the time of electrolysis it engage the disintegration of metal cat ions at anode with generation of ions of hydroxyl and H_2 gas at cathode is as follow

At anode: $M_s \rightarrow M_{(aq)}^{n+} + ne^-$

$2H_2O_{(l)} \rightarrow 4H_{(aq)}^{+} + O_{2\,(g)} + 4e^-$

At cathode: $M_{(aq)}^{n+} + ne^- \rightarrow M_s$

$2H_2O_{(l)} + 2e^- \rightarrow H_{2\,(g)} + 2OH^-$

In case that aluminum or iron electrodes are conduct, the developed $Al_{(aq)}^{3+}$ or $Fe_{(aq)}^{3+}$ ions will rapidly have another reactions to create interrelated hydroxides. For example, ions of Al^{3+} taking place hydrolysis possibly will make $Al(H_2O)_6^{3+}$, $Al(H_2O)_5OH^{2+}$, $Al(H_2O_4)(OH)^{2+}$, a lot of monomeric and polymeric group formed by hydrolysis products such as $Al(OH)^{2+}$, $Al_2(OH)_2^{4+}$, $Al(OH)_4^-$ $Al_6(OH)_{15}^{3+}$, $Al_7(OH)_{17}^{4+}$, $Al_8(OH)_{20}^{4+}$, $Al_{13}O_4(OH)_{24}^{7+}$, $Al_{13}(OH)_{34}^{5+}$ in wide range of pH. correspondingly, ferric ions caused through electrochemical decomposition of monomeric ions formed by iron electrode, $Fe(OH)_3$ and hydroxyl compound, such as $Fe(H_2O)_6^{3+}$, $Fe(H_2O)_5(OH)_2^+$, $Fe(H_2O)_4(OH)^{2+}$, $Fe_2(H_2O)_8(OH)_2^{4+}$ and $Fe_2(H_2O)_6(OH)_4^{4+}$. The arrangement of these compounds depends fully on the solution of pH.

2.3. Chemical Coagulation Process

As shown in below figure this process has three stages, in the first stage represents the coagulation. Here in this stage wastewater treated with addition of coagulants like ferric chloride and aluminum sulphate with rapid mixing then customizing the wastewater of negative charge particles to positive charge particles, in this way the particles tend to form larger aggregates. In the second stage slow stirring process is carried out, here based on the aggregation of colloidal particles flocculation occurs which destabilized in the first stage the forming large colloidal particles to allow the sedimentation. Due to addition of polyelectrolyte the flocks are formed. Between the particles the polymeric organic molecules are ionized due to flocculation phenomenon with large size of particles settle able. In the final stage collecting of flocks formed in settling unit and separates it from the treated wastewater for process of sludge in the process of this method

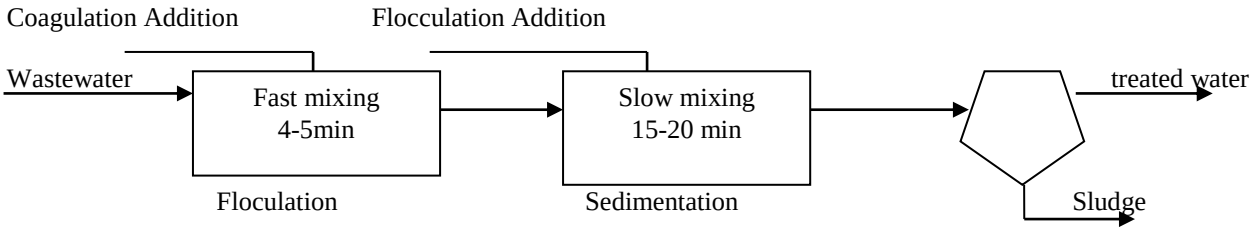


Fig 2: Step by step of coagulation

A chemical coagulation experiment was carried out by jar test apparatus. Jar test apparatus has 5 beakers with volume of 1 litter capacity and has stirring device which mix the solution homogeneously. Measure the municipal wastewater of 1L sample in all beakers fix the wastewater sample jar to the stirring devices by moving the paddles in the right upward manner at the same heights. Add the coagulant of alum with dosage of 3ml, 6ml, 9ml, 12ml and 15ml with different time interval of 15min-60min with automatically operated paddle at 200rpm. Take out the jar as of the stirring tool after stirring is finished and stands for 30 min to allow the floc development and their settlement. Collect the sample without disturbing the sediment and determine the COD, BOD, TDS and TOC of the sample. Same procedure was done with ferric chloride. Then compare the both treatment of electrocoagulation and chemical coagulation with removal efficiency of COD, BOD, TDS, and TOC

Fig 3: Chemical Coagulation Setup

III. RESULTS AND DISSCUSION

3.1 Wastewater treated by electrocoagulation with aluminium electrodes

Electrocoagulation of municipal wastewater was carried out using electrode in a batch reactor with monopolar parallel connection.

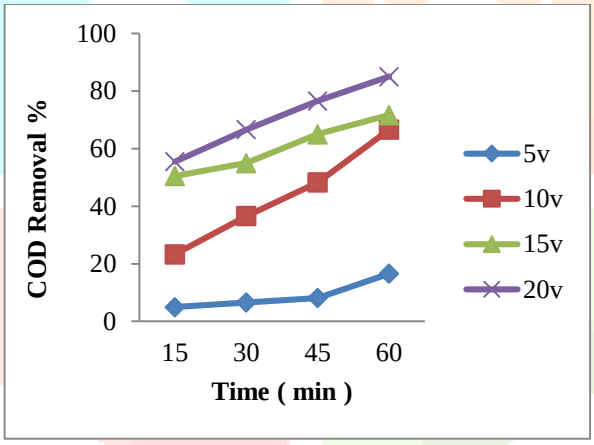
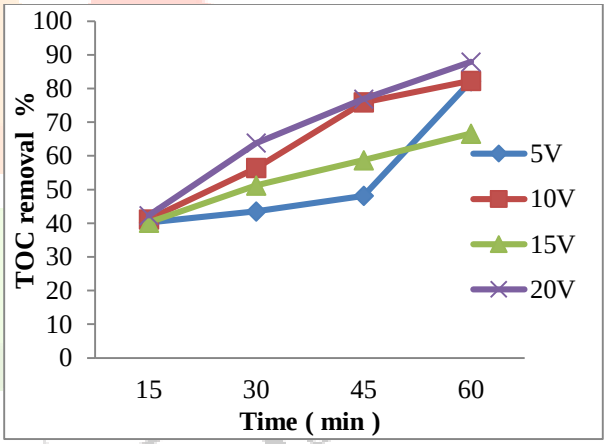


Fig: a



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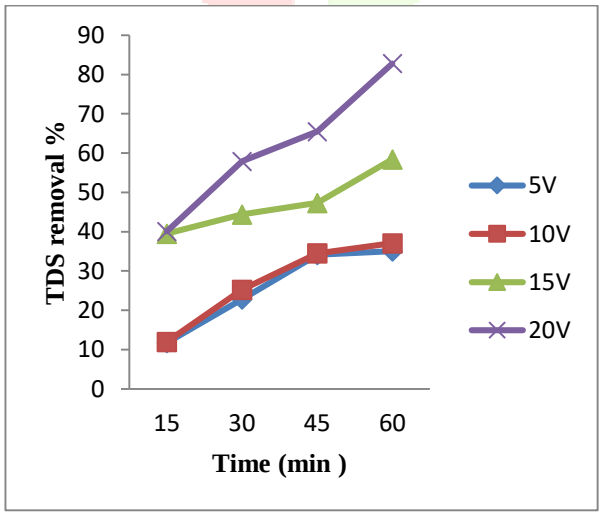


Fig: c

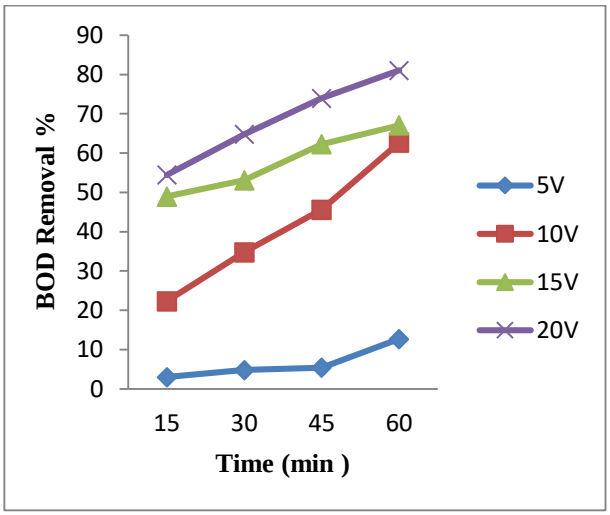
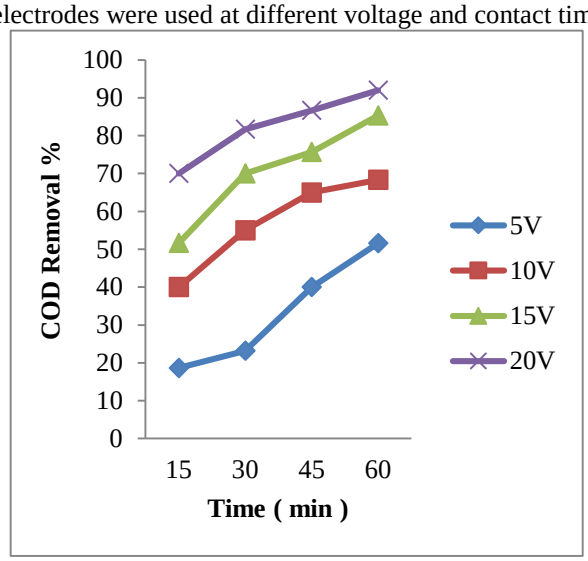


Fig: d

Fig 4: a, b, c, d shows that COD, TOC, TDS, BOD removal efficiency with different voltages and contact time

3.2 Wastewater treated by electrocoagulation with iron electrode

Municipal wastewater treatment by electrocoagulation was carried out by batch reactor with monopolar parallel connection of four iron electrodes were used at different voltage and contact time number of experiment carried out.



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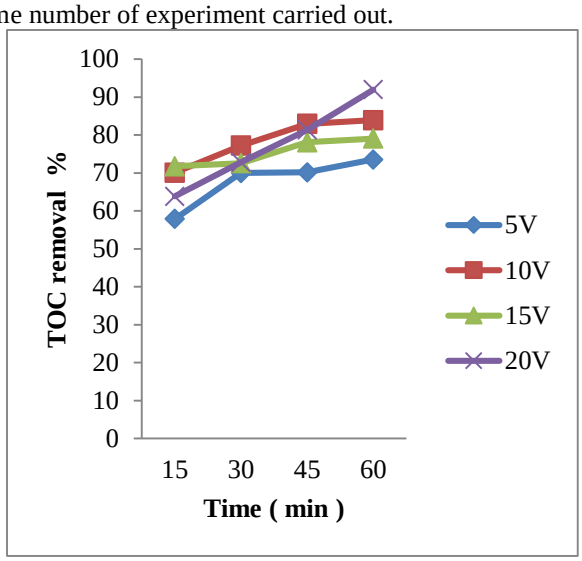

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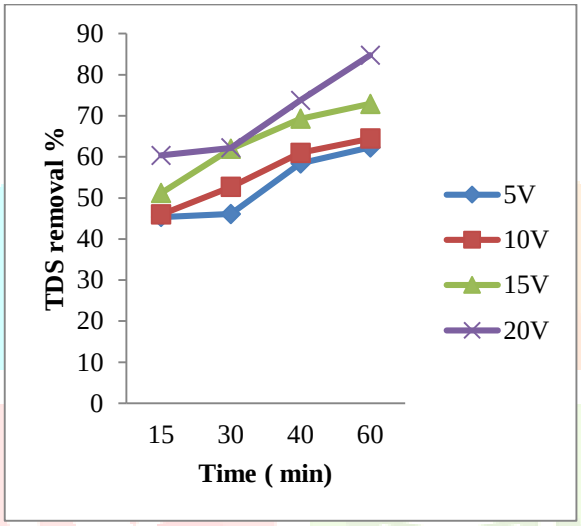


Fig: c

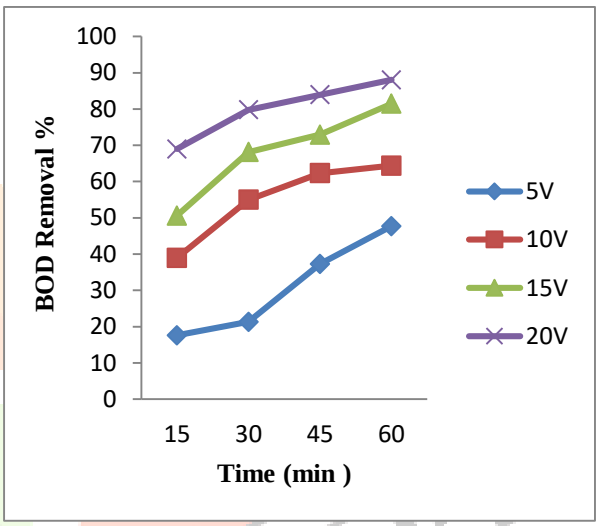
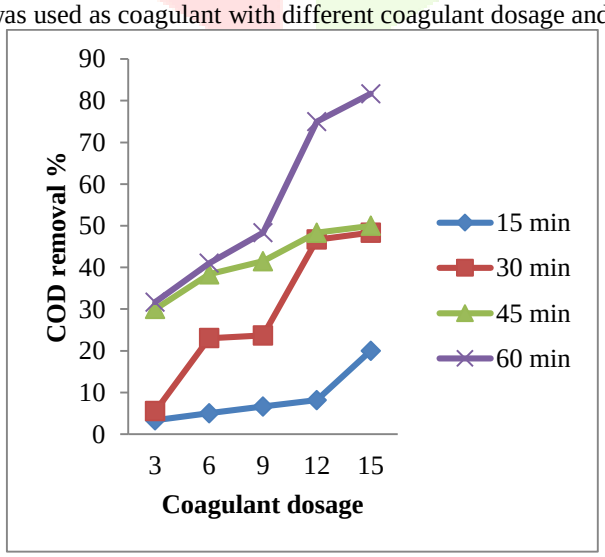


Fig: d

Fig 5: a, b, c, d shows that COD, TOC, TDS, BOD removal efficiency with different voltages and contact time

3.3 Wastewater treatment by chemical coagulation with aluminum sulfate as coagulant

Municipal wastewater treatment by chemical coagulation was prescribed by using jar test device with aluminum sulfate ($Al_2(SO_4)_3$) was used as coagulant with different coagulant dosage and contact time



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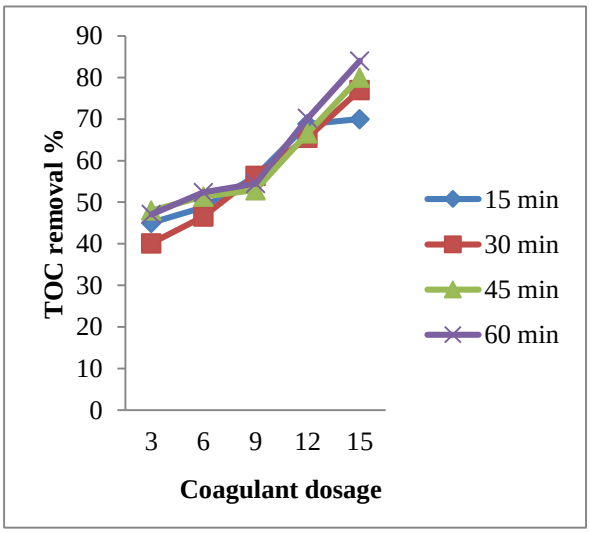

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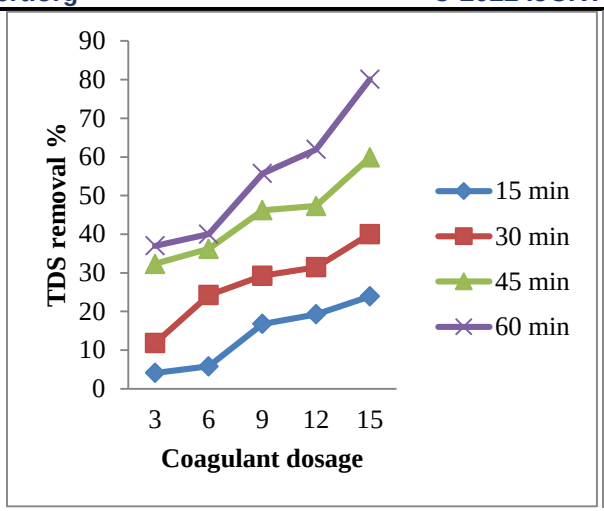

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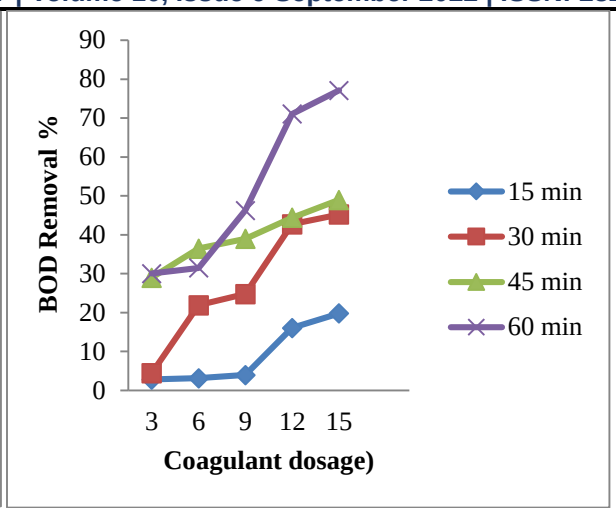


Fig: d

Fig 6: a, b, c, d shows that COD, TOC, TDS, BOD removal efficiency with different coagulant dosage and contact time

3.4 Wastewater treatment by chemical coagulation with ferric chloride as coagulant

Treatment of municipal wastewater by chemical coagulation was carried out through using jar test equipment with ferric chloride ($FeCl_3$) was used as coagulant with different coagulant dosage and contact time.

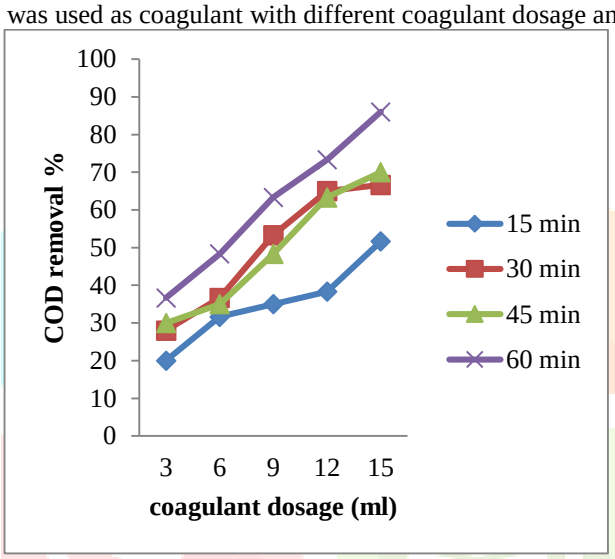
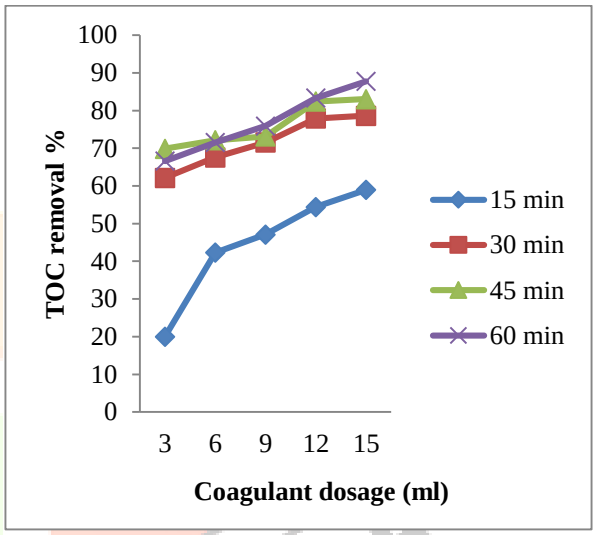


Fig: a



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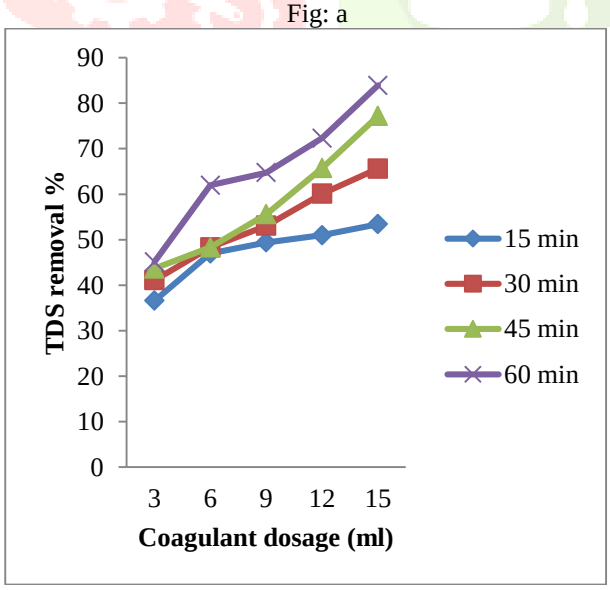

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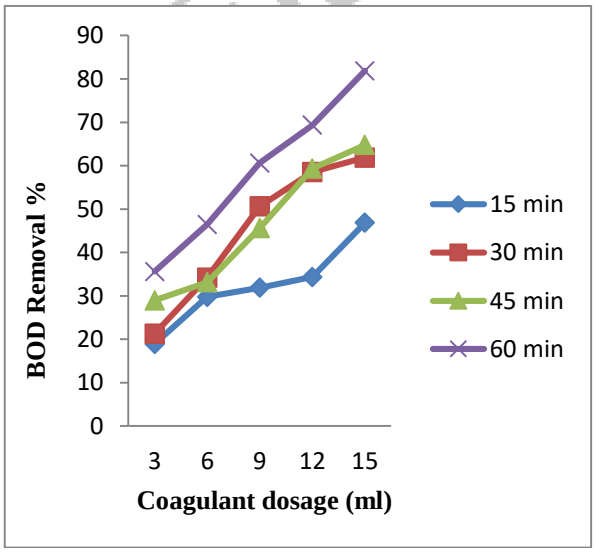


Fig: d

Fig 7: a, b, c, d shows that COD, TOC, TDS, BOD removal efficiency with different coagulant dosage and contact time

3.5 Comparison of Electrocoagulation and Chemical Coagulation

After conducting experiment of electrocoagulation and chemical coagulation with Al and Fe the results of COD, TOC, TDS and BOD was determined.

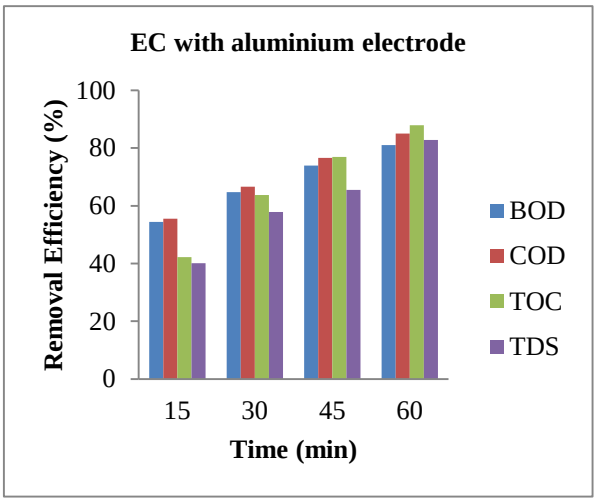
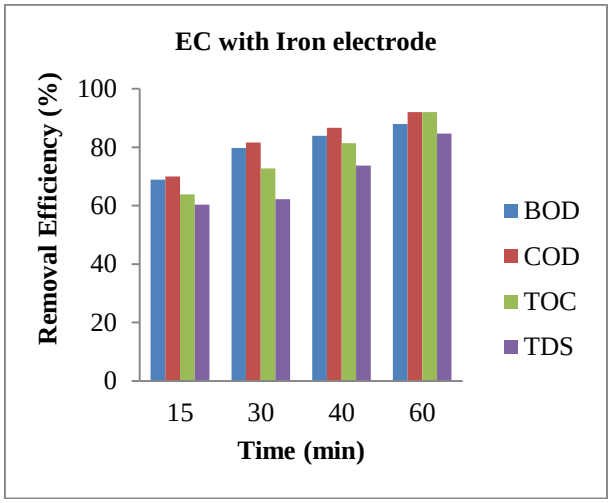


Fig: a



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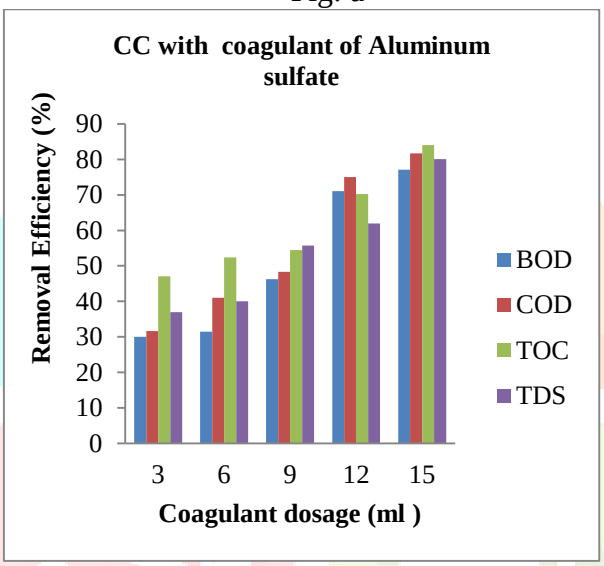

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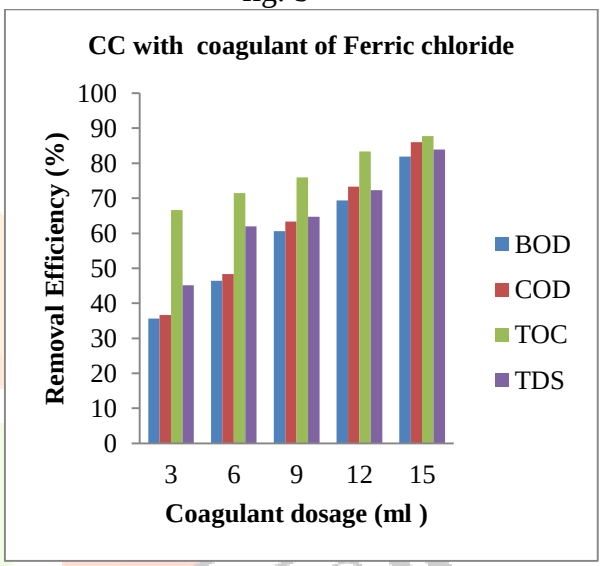

Fig: d

Fig 8: a, b, c, d shows that comparison of electrocoagulation and chemical coagulation of COD, TOC, TDS, BOD removal efficiency.

CONCLUSION

According to finding the investigation increasing electrical current and coagulant dosage the maximum removal efficiency of COD, TOC, TDS and BOD. For the electrocoagulation maximum removal efficiency of COD, TOC, TDS and BOD in is 85%, 87%, 82% and 81% for aluminium electrode. 92%, 92%, 84% and 88% for iron electrode respectively. For the chemical coagulation maximum removal efficiency of COD, TOC, TDS and BOD is 81.66%, 80.09%, 84.67% and 77.08% for aluminum sulfate as coagulant and 86%, 83.90%, 87.73%, 81.8% for ferric chloride as coagulant. Comparison of EC and CC by Al & Fe the Fe has maximum removal efficiency compared to Al. And relationship of EC and CC with removal efficiency of COD, TOC, TDS and BOD, electrocoagulation was achieved maximum removal efficiency so that electrocoagulation best technology for wastewater treatment compared to chemical coagulation.

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