MODELING AND PERFORMANCE ANALYSIS OF ELECTROCOAGULATION REACTOR

A

PROJECT REPORT

Submitted in partial fulfilment of the requirements for the award of the degree

Of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision

Of

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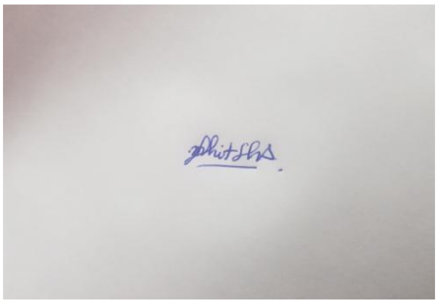
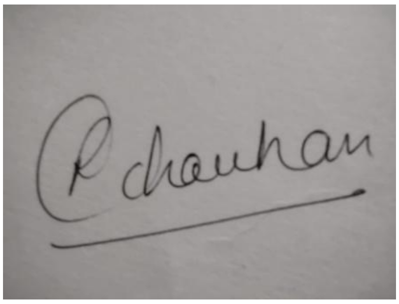
MAY - 2021

STUDENT'S DECLARATION

I therefore pronounce that the work introduced in the Project report named "**(Modeling and performance analysis of Electro-coagulation reactor**)" submitted for fractional satisfaction of the prerequisites for the level of Bachelor of Technology in Civil Engineering at **Jaypee University of Information Technology, Waknaghat** is a bona fide record of my work completed under the oversight of (**Mr. Anirban Dhulia**) . This work has not been submitted somewhere else for the compensation of some other degree/confirmation. I'm completely answerable for the substance of my venture report.





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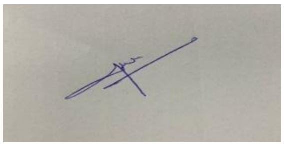
This is to ensure that the work which is being introduced in the undertaking report named " Modelling and performance analysis of Electro-coagulation reactor " in incomplete satisfaction of the necessity for the honor of the level of lone wolf of Technology in Civil Engineering submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is a bona fide record of the work completed by **Mohit Sharma** (171654) and **Rishabh Chauhan** (171621) during a period from August, 2018 to May, 2019 under the oversight of **Mr. Anirban Dhulia** Department of Civil Engineering, **Jaypee University of Information Technology, Waknaghat**.The above statement made is correct to the best of our knowledge.

Date: ... 16th May 2021



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ABSTRACT

In this report we attempt to offer the general outline of the Electro-Coagulation measure . Electro-coagulation is one among the physical-compound technique in favour of nurse dirtied waterwaste whereby conciliatory electrodes erode in order to deliver dynamic coagulant forerunners (normally Fe-Fe or Al-Al cathodes) into agreement. Going with the responces of electrolytic advance gas (generally as H_2 rises) at the cathode.

EC measure has potential in eliminating different contaminations like substance oxygen interest (COD), turbidity, toxins, substantial metals, suspended solids , and so on,

Anyway electro-coagulation has never gotten accredited as a paradigm waterwast handling modernization , in view of deficiency for a logical way to contract with electro-coagulation reactor plan/activity, along these lines the problem of anode untiring quality (in particular pasivation of cathodes for a while) have restricted its execution .

Anyway late specialized enhancements joined with a budding necessity for limited scope decentralized waterwast conduct offices have impelled a revaluation for electro-coagulation

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LIST OF ACRONYMS & ABBREVIATIONS

EC	Electro Coagulation
EF	Electro Floatation
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
DC	Direct Current
ACE	Electrocoagulation using Alternating Current
AC	Alternating Current
MPP	Monoopolar Electrodes In equivalent Connections
MPS	Monoopolar Electrode In sequence Connections
BPS	Bipolar Electrode In sequence Connections
A/V	Area to Volume Ratio
CFD	Computational Fluid Dynamics

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CHAPTER - 1
INTRODUCTION OF ELECTROCOAGULATION PROCESS

1.1 INTRODUCTION

In this day and age anticipation of water assets is one among the main issues since it's to confront different issues like ,populace development, fast urbanization , industrialisation , warming , and climatic changes the whole way across the planet . Safe drink during this time is confined and is also declining quickly . squander water truly sway environments of oceanic life and subsequently the accessibility of safe freshwater. High poison in water cause unpredictable and exceptionally differed issues, in regards to every specific circumstance. Additionally the release of natural and inorganic toxins in water bodies isn't uniform , and may prompts the poisonous end results like: intricacy for sea-going biological systems which makes stresses for the populace . Hefty metals and unsafe poisons are frequently effectively consumed by fishes and vegetables in view of their high solvency inside the amphibian conditions and ought to enter inside the human's once they burn-through them . So these poisonous weighty metals and toxins ought to be distant from the wastewater to monitor individuals and hence the biome . The EC interaction are wont to treat wastewater, water start of ventures or materials businesses . Electro-coagulation is a physical-synthetic methodology, which utilizes a voltage ,electrical momentum to encourage block poisons from squander water . Electro-coagulation framework is significantly successful in eliminating suspended solids, broken up metals, BOD, COD, oils and colors. In EC measure we essentially give voltage or charge to the wastewater test, that kills the charged particles by framing hydroxide edifices, that aides in restricting and reinforcing of flocs for sedimentation.

Since twentieth century (EC) Electro-coagulation has become well known on account of its capacity of eliminating contaminations that are for the most part harder to dispose of by filtration or substance treatment framework, similar to weighty metals , suspended solids ,..and so on .

1.2 DESCRIPTION OF EC – PROCESS

Electro-coagulation (EC) is convenient and very straightforward technique that has been utilized for the treatment of the such wastewaters . EC when utilized with other treatment procedures shows more evacuation productivity w.r.t defiles and poisons. EC is an effective procedure in light of the fact that as contrast with customary strategies like synthetic coagulation , slop creation in EC is incredibly less, that diminished removal of muck in biological system and save operational expense .

At the point when floc is made in EC , it's more steady as contrast with the floc shaped by substance coagulation , so it are regularly effectively eliminated by filtration measure . As no compound are included this interaction, it diminishes the probability of development of optional toxins. It needs low current and voltage accordingly, are frequently worked by green cycles, for example, sun based, windmills and energy components . EC is eco-accommodating procedure . EC limit the slop age to an astounding degree and in the long run dispose of hurtful synthetic substances utilized as coagulants inside the ordinary gushing treatment techniques. EC measure kills the little colloidal particles and creates lower amount of ooze contrasted with different cycles.

1.3 ADVANTAGES OF EC - PROCESS

• EC needs basic gear to work and Waterwast treated by EC accord lovely, satisfactory, lucid, vapid as well as scentless water.

• Flocs that are framed in EC measure are more steady the are shaped in compound coagulation , in this manner they will be effortlessly eliminated by filtration strategies

• EC as contrast with substance coagulation is low ooze creation method , thusly puts less weight to climate during removal of profluent .

• EC as contrast with substance treatment measures eliminates TDS, COD, BOD, hefty metals , oils , and so on in bigger amount.

• The EC interaction enjoys the benefit of eliminating the tiniest colloidal particles, as contrast with compound coagulation . Employments of synthetic compounds in EC measure is discredited and since of that there's no issue of killing abundance synthetic compounds .

• In EC measure probability of arrangement if optional toxins are almost zero because of no utilization of synthetics .

• EC cell unit require less upkeep .

• During electrolysis , toxins gets stay with the gas air pockets and goes to the most elevated of the appropriate response where they get aggregated , and might be effortlessly encouraged out

• In rustic territories having less power, EC measure are frequently utilized when its cell units are joined with sun based boards .

• EC requires less treatment time as contrast with standard procedures .

1.4 LIMITATION OF EC - PROCESS

• Passivation of cathode as for time occur

• Use of power might be expensive relying on here and there .

• High conductivity of water is needed for EC measure.

• Metals plates should be supplanted consistently .

Table 1.1 Disadvantages and Advantages of EC process

Advantages	Disadvantages
• Indifferent method • Reduced need for chemical reagents • cheap functional fee • abridged jeopardy of resulting toxic waste • squat formation of sludge • little power needs	• necessitate for repairs • high-conductivity water is required • Electrode passivation over time • Lack of systematic reactor design

1.5 OBJECTIVE OF THE STUDY :

Important objectives of our study are

- To model the electro-coagulation unit by the help of Kinetic/ Reaction modelling .

- To display EC reactor by taking the impact of different boundaries like pH, bury distance or separating between cathode , blend of anode , and so on, during EC demonstrating .

CHAPTER - 2

BACKGROUND ON EC PROCESS

2.1 BACKGROUND :

EC measure is that the possibility to broadly dispose of the downsides of the traditional treatment strategies so on accomplish a reasonable and monetary treatment of sullied squander water. From the time of start of 19^{th} era, EC have been utilized in squander waterwast curing furthermore loads of study went on the way to utilize the strategy in support of a couple of issues. Commonly, more seasoned investigations were done and in this manner the examinations showed fruitful curing of waterwast , notwithstanding, they supply petite knowledge addicted to principal substance along with actual techniques. Consequently, the techniques included are as yet not unmistakably comprehended. In any case, these physicochemical components should be perceived to streamline and control the technique , to allow displaying of the strategy and to upgrade the arranging of the framework. Electro-coagulation utilizes different instruments i.e electrochemical (disintegrates metals and wastwater decrease, poison electrooxidation or electrodecrease…), compound (corrosive/ base harmony with adjust in pH, hydroxide precipitation, redox response inside a mass…) in addition to physicle (actual adsorption, coaglation, buoyancy…). They are frequently successive or potentially equal.

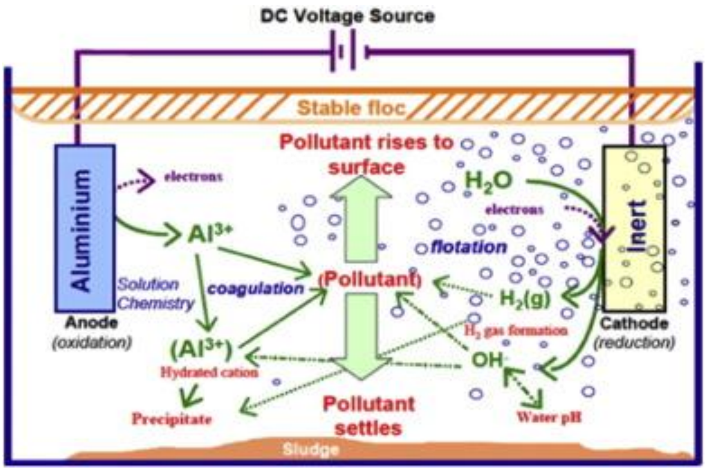

Figure 2.1 Interactions happening inside EC reactor

2.2 EC – MECHANISM

Inside EC chamber, coagulant group are created insitu utilizing a electro disintegration for a conciliatory positive electrode, generally Fe or Al electrodes, by supplying curent to the metal terminal Moreover, synchronous cathodic response permits toxin expulsion besides by testimony on cathod otherwise by buoyancy (advancement of H_2 at negative electrode). The anode and consequently the cathode are normally produced using an identical metal, despite the fact that electro disintegration ought to happen just at the anode. EC are regularly led as a clump or consistent interaction. Along these lines, Electro-coagulation measure embrace the age of cogulant insitu by passivation of any Al or Fe ions from Al or Fe terminals, separately. during this interaction, the metal particles age happens by the side of positive elctrode plus H_2 gas is delivered by side of negative electrode. The H_2 gas paticles convey the toxin towards the most noteworthy appropriate response from where they are regularly more handily focused, gathered along with eliminated.

2.2.1 MECHANISMS OF SOLUBLE POLLUTION

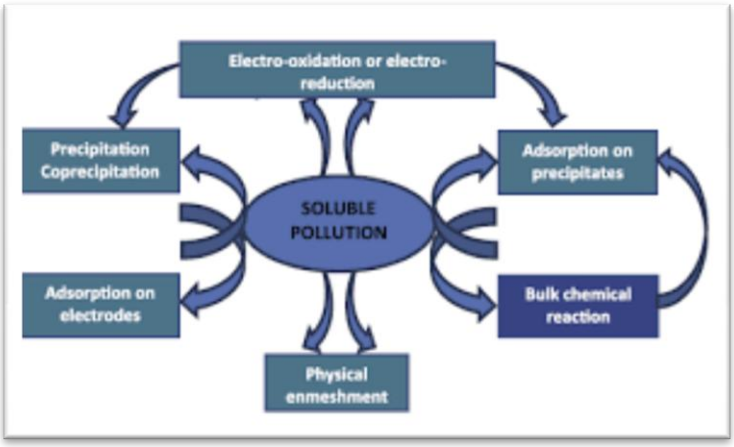

Figure 2.2 Machanism of soluble pollution

The components for dissolvable toxins are summed up in above figure 2.2. There is normally an overarching system for every toxin which is a component of the idea of this contamination.

2.2.2 MECHANISMS OF INSOLUBLE COLLOIDAL POLLUTION

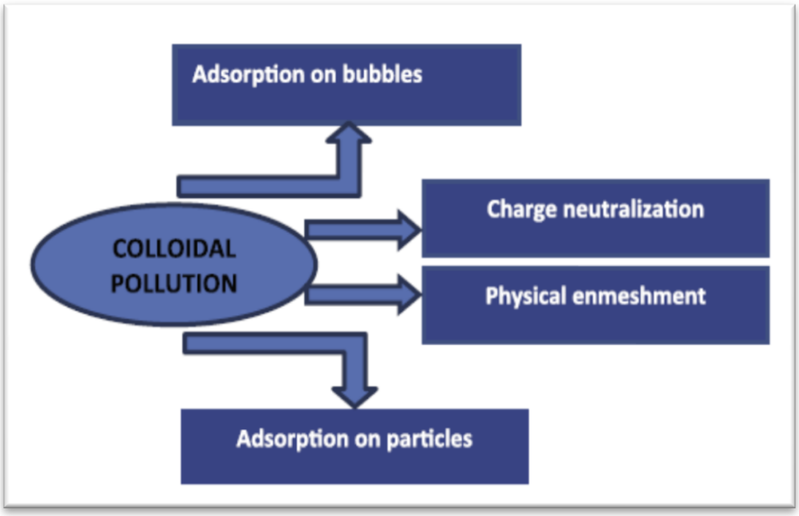

Figure 2.3 Primary instruments of insoluble colloidal contamination reduction utilizing EC

Colloidal suspension and emulsions likewise be eliminated via constant cogulant measurement by electrochemical disintegration even while synthetic cogulation. As propensity of ions to cogulate or to linger isolated and scattered outcomes as of web between ions power can is anticipated by the amount of restricting powers amid the shocking powers and consequently the alluring van der Waals powers of the electrical twofold layer.

The destabilization systems are summed up as:

• The pressure of the twofold sheet of a colloidal molecule is brought about via communications among the dissolvable charged groups created as of electrochemical disintegration based on conciliatory terminals. Therefore influencing electriical electric budding amid the molecule shell along with consequently a mass arrangement as well as prompts lessening unpleasant powers amid ions .

• Charge balance is carry out by ionic metal group/hydronium cations/hydroxyl anion to facilitate are adsorption otherwise via sudden of charged hydroxide accelerates against the outside of exciting colloid ions dispense in waterwast.

2.3 SPECIFICITIES OF Al ELECTRODES

Different responses occur in the electro-coagulation measure, where aluminum is utilized as the terminals are:

By side of positive electrde -

$Al \rightarrow Al^{3+}(aq) + 3e$ (1)

By side of negative electrode -

$3H_2O + 3e \rightarrow 3/2H_2 + 3OH^-$ (2)

Negative electrode might likewise be synthetically assaulted by hydroxide ions created all through H_2 advancement on lofty pH value:

$2Al + 6H_2O + 2OH^- \rightarrow 2Al(OH)_4^- + 3H_2$ (3)

Al^{3+} (aq) and OH^- particles produced via cathode responses respond towards shape different monomeric species like $Al(OH)^{2+}$, $Al(OH)_2^+$, $Al_2(OH)_2^{4+}$, $Al(OH)_4^-$, along with polimeric kinds like $Al_6(OH)_{15}^{3+}$, $Al_7(OH)_{17}^{4+}$, $Al_8(OH)_{20}^{4+}$, $Al_{13}O_4(OH)_{24}^{7+}$, $Al_{13}(OH)_{34}^{5+}$, which change at last into $Al(OH)_3$ as per multifaceted precipitation energy . Newly shaped undefined $Al(OH)_3$ has enormous shell territories that is valuable in favour of quick sorption of dissolvable natural mixtures and catching of colloidal ions. Those flocs polymerise as :

$nAl(OH)_3 \rightarrow Al_n(OH)_{3n}$ (4)

These be effortlessly eliminated since watery climate via sedimentition and H_2 buoyancy. Auxiliary anodic responses happen additionally during electro-coagulation measure for instance, in unbiased plus acid chloride arrangements, local along with fre chloride plus hypochlorite are shaped be solid oxydants. Then again, the Al hydroxide floc typically go about as adsorbents and additionally snares towards contaminations. In this manner, they would dispose of them from the arrangement. A vital issue in EC measure is the pasivation of electrode since it builds cell power and power utilization. The pasivate instrument mayhap kept away from a streamlining of the power inversion recurrence otherwise by sodim chloride expansion towards advance pit erosion among a compound response between chloride soak up on Al oxide layer by means of Al^{3+} ions in oxide cross section. A pace for synthetic erosion for dissolvable aluminum electrode relies basically upon components like :

• Configuration as well as develop towards aloof aluminum oxide film .

• resulting fractional annihilation of the film during pit.

Pitting erosion relies emphatically upon the underlying range in pH, character and the grouping towards partisan electrolite along with current thickness. Beneficial outcome of electrode on uninvolved Al oxide film during dropping request is: Cl^-, Br^-, I^-, F^-, $ClO_4{}^-$, OH^-, SO4 2-. Piting erosion be able to a great extent influence the general disintegration of conciliatory aluminum anode.

2.4 SPECIFICITY OF Fe ELECTRODE

The principle responses happening at the iron anodes are:

Fe (s) ↔ Fe+3 (aq) + 3e-(anode) (5)

3H2O + 3e-↔ 3/2 H2g + 3OH-(aq) (cathode) (6)

Fe^{3+} and OH^- particles produced on cathode area respond within the mass waterwast in order to shape ferric hydroxide :

Fe^{3+} + 3OH-(aq) ↔ $Fe(OH)_3$ (7)

Hanging Al as well Fe hydroxide be able to eliminate toxins by appropriate response through soption, coprecipitation or electrostatic fascination, trailed through cogulation. To a precise charge flow into a phone , the mass of Al as well Fe hypothetically broke up by the conciliatory electrode is measured by Faraday law :

w = [I tM/ZF] (8)

where (w) is that measure of electrode disintegrated, i is that the current density, t electrolysis time is t, M is exact relative atomic mass of terminal, (Z) is that the quantity of electrons and (F) is that the Faraday consistent. Mass of developed hydrogen which of shaped hydroxyl particles are frequently determined respectively. quantity of coagulant dosed interested in appropriate response are regularly expanded by expanding the present and in this way the reaction time , But expanding the current thickness brings about a diminished current proficiency.

2.5 DIVERSE OPERATING FACTORS AFFECTING EC PROCESS -

proficiency toward EC cycle relies upon numerous operational boundaries , and boundaries influencing EC adequacy are with respect to the working conditions like ebb and flow otherwise electrical energy plus activity period, towards waterwaste highlights like range of pH, alkalinity with conductivity plus to calculation for EC reactordesign along with the EC cathodes (anode shell, terminal dispersing). A few boundaries like tumult speed, electrolysis time, beginning contamination fixation, maintenance time and passivation of the anode, conductivity of the appropriate response , kind of force supply likewise influence electro-coagulation measure .

2.5.1 CONDUCTIVITY –

Conductivety toward appropriate response be critical boundary of electrolysis in light of the fact that the expulsion effectiveness of the poison and working cost are straightforwardly in regards to arrangement conductivity . Conductivity for electrode arrangement be crucial assets. During electro-chemical cycle, conductivety decides a phone opposition whereas the property of dissolvable along with electrode decide the connection with the electric dynamic group moreover impacts cathode responses. Appropriate response should include several base conductivity for stream of a electrical flow. The conductivity for squat conductive waterwaste is changed via totalling adequate measure of saline like basic salt otherwise sodium sulfate . there's an ascent in curent density among an ascent within conductance of the appropriate response on consistent cell energy or decrease in cell energy at steady curent thickness. The power utilization be diminished with elite arrangement. The energy utilization is diminished with high conductivity arrangement. the current thickness productivity relies unequivocally upon ionic toughness as well conductance of waterwast . the curent thickness effectiveness increments through the expanding electric conductivity in view of decline in electric obstruction for waterwaste . Conductivety additionally diminishes the handling occasion needed towards prevail in the specified expulsion yield. Thusly, the energy utilization is decreased. Sodeum chloride is typically wont in building electrolytic conductivity. Chloride ion takes an interest additionally as inside the diminish of unfriendly impact of diverse ions for staying away from precipetation for carbonate in water so as to shape a defensive film on the external electrodes . To exceptionally lofty ebb and flow thickness, chloride ions likewise be capable oxidising the dynamic chloriine structures, similar to hypochlorite anions, which will oxidise natural mixtures and ferrous particles or add towards waterwaste sterilization. to certify a customary activity of EC in waterwaste treatment, it's suggested that 20% of ions present ought to be Cl^- . The metal hydroxide particles go about as coagulant and remove contaminations from arrangement by sedimentation. Numerous investigations that are accounted for inside the writing have utilized (DC) inside the EC cycle. the usage of DC brings about the erosion arrangement on anode in light of oxiddation. An oxiddation film structures on cathodic , decreasing the progression of curent amid anode and cathode plus accordingly bringing down contamination evacuation productivity. These limits of DC electro-coagulation measure are diminished somewhat by expansion of equal plate conciliatory terminals inside the cell arrangement. In any case, many have liked to utilize the AC electro-coagulation (ACE) innovation. it's accepted that the AC cyclic stimulation impedes the customary instruments of terminal assault that are knowledgeable about DC electro-coagulation framework, and thus, and guarantee sensible anode life. furthermore thereto , seeing as AC electric fields in the ACE seprator don't root electro phoretic carry of the exciting ions owing to regular difference in extremity, be able to initiate diipole–diipole associations during framework containing non-circular electric type. Subsequently, the AC electricifiields can likewise disturb relentlessness towards adjusted diipolar constructions active in framework. This is, be that as it may, incomprehensible in DC electro-coagulation separator utilizing DC electric fields.

2.5.2 EC DESIGN & CELL ARRANGEMENT–

EC gadget be primarily prepared of anodes plus cathod . Anode be masterminded within a walled in area i.e a non conductive chamber wherein the handling of waterwaste happens.

2.5.2.1 ELECTRODE ARRANGEMENT : The cathode material and the association method of the terminals assumes a critical part in cost examination of the EC **.**

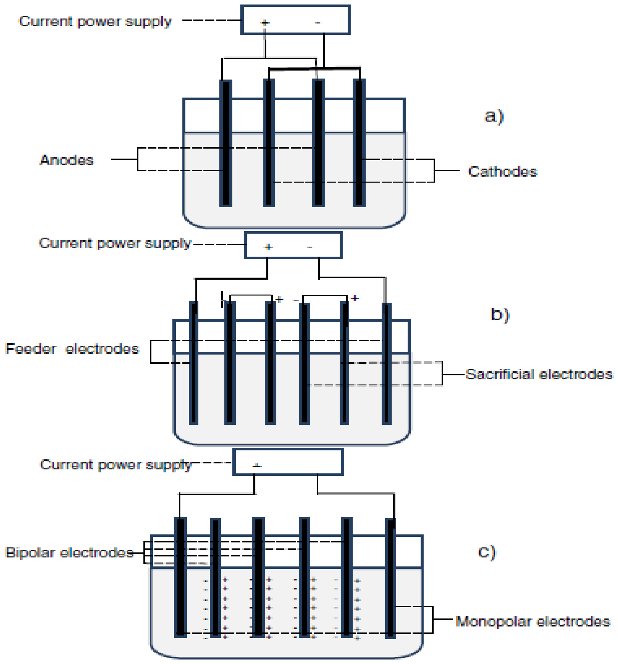

Figure 2.5 Monoopolar terminal 1. equal associations 2. At arrangement 3. biipolar cathode at arrangement associations

The intricate cathodes plan are regularly arranged in monoopolar and bipolar anodes :

• Monoopolar anodes at equal association (MPP) are portrayed at above figure a) section. It relates to a terminal course of action that comprises of cathodes and anodes set then again at a comparable anodic or cathodic potential, separately. The anodes and cathodes are associated in equal in light of which the present is parted between every one of the terminals to the opposition for single cells. and equal association desires a inferior electric potensial contrasted and sequential associations . Every couple of anode as well cathod compares towards alittle chamber during that time power is that the equivalent. The chamber comprises, along these lines, of unit in equal. Thus, presents of every chamber is added substance.

• Monoopolar anodes sequential associations (MP-S) are depicted in above figure (b) part. inside the monopolar setup, each pair of conciliatory terminals is inside associated among apiece . The expansion of the cell voltages brings about superior electric budding towards flow, i.e each pair of inner conciliatory anodes is inside associated among apiece , plus have denial interconnections among contrary external cathodes. during this case, the electrical flow going during every one of terminals be that the equivalent, while a overall electrical energy is that the amount of power in every single unit .

• Bipoolar terminal sequential associations (BP-S) involves two external cathodes associated with electrical force supply and thusly the conciliatory anodes set between the 2 external anodes as demonstrated in above figure c) part. the type of the terminals influences the toxin evacuation proficiency inside the interaction. it's normal that the punched holed type cathodes should end in higher evacuation proficiency contrasted with the plane anodes. a couple of studies are accounted for inside the writing portraying the impact of cathode shape on the exhibition of the electrostatic precipitator. Other than the supported rectangular cathodes, there are other mathematical shapes like round, round and hollow.

Generally, monoopolar cathodes require an espresso power and a superior curentdensity as contrasting towards bipoolar terminals so as to work beneath a lofty power plus inferior curentdensity . basically its hard towards close a terminals course of action.e is best than the inverse considering just EC yield as long as it's been demonstrated that similarly BPS might show a lofty EC effectiveness .

2.5.2.2 DISTANCE BETWEEN ELECTRODES –

Between anode separating might be an indispensable boundary inside the reactor plan for expulsion of poison from profluent. The between anode dispersing and powerful space of cathodes are significant erratic while an operational expense streamlining towards unit chamber is required. For diminishing the power utilization inside the handling of profluent through a similarly lofty conductivety, bigger separating ought to be utilized between terminals. For effluents with low conductivity, energy utilization are frequently limited by diminishing the space between the terminals. The between terminal distance assumes a major part inside the EC on the grounds that the electric field relies upon coldness amid the positive elctrode and in this manner the cathode. A most extreme toxin evacuation productivity is gotten by keeping an ideal distance between the anodes .At the base between terminal distance, the poison expulsion effectiveness is low. this is regularly a result of the very reality to facilitate the created metal hydroxides that go about the same as floc plus eliminates toxin through sediimentation gets debased via crash through apiece in light of the great electrostatic fascination. The contamination expulsion proficiency increments with an ascent inside the between anode distance from least till the ideal distance between the cathodes. this is regularly a result of the reasoning i.e further expanding the space between the cathodes, there's a reduction inside the electrostatic impacts prompting a more slow development of the produced particles. It gives longer to produced metal hydroxide for agglomerate to build a floc prompting a ascent inside a expulsion productivity of toxin inside the arrangement. On additional expanding the cathode distance a remarkable ideal terminal distance, there's decrease inside the poison evacuation productivity. this is regularly a result of the very actuality that time-frame of the particles increments with an ascent inside the distance between the terminals. This outcomes in a reduction in electrostatic fascination prompting less arrangement of flocs expected to coagulate the poison. The toxin evacuation effectiveness is low at the base bury terminal distance .

2.5.2.3 DESIGN OF EC UNIT –

EC unit chamber configuration be critical while it influences as the whole exhibitions through out EC cycle during its impact happening on working boundaries to be specific, stream system, flocs arrangement, expulsion yield and buoyancy/settling attributes. EC reactor configuration are regularly ordered on the possibility of three significant differentiations reliable with writing review :

the essential one be anyhow a unit chamber to be arranged like a cluster otherwise interminable outline, for paradigm feed mode. In perpetual framework, reactors are persistently taken care of within waterwaste as well as work, whereas activity be controlled through rigid wastewater volume for each handling set during clump interaction .

So subsequent qualification be that, technique wont to isolate the amassed poisons .

In the event that current inversion be functional, the balance of the anode cathode terminals diminishes upkeep, especially when contrasted with tube shaped EC cells. Portrayed in light of the fact that the most flexible plan as far as stream , blending is regularly the most shortcoming of this cell math .

Adjacent to anodes course of action and cathodes dispersing, EC reactor configuration influences EC during the unit operational capacity to intercedes the characterize terminal region/voluume proportion plus during EC math. Cathode proportion be that a solitary input upgrade boundary within place plan which grants creating EC full scale hardware by lab tests maintening a identical between terminal distance when utilizing anode plates. the standard scope of cathode (A/V) proportion differs between (15 – 45) m^2/m^3 . an ascent of the area by volume proportion prompts an abatement of mutually handling period along with consequently a ideal current thickness. At the point when the cathode region is sufficiently high, the principle boundary is that the current fixation curent/volume. This boundary joins a curent density plus thusly a cathode (A/V) proportion and permits characterizing the centralization for coaguulants delivered within water by a particular handling period utilizing beneath cluster surroundings. beneath constant framework, a unit chamber capacity permits characterizing a span used for a thought about progression towards waterwaste as well as in this mannera delivered coaguulant amount are regularly found.

$$C = M/ZF\ (I/V).t \quad (9)$$

here C plus V be the hypothetical centralization of metallic cations (g/m3) and accordingly a functioning capacity of EC gadget, individually.

Standard unit chamber calculation, while round and hollow, cubiic plus rectangular paralelepiped, includes minor impact happening at EC execution, besides since a non ordinary formed EC unit chamber alluded towards a electrochemically determined transport unit.

2.5.3 EFFECT OF CURRENT DENSITY –

Current density is extremely It is a critical consideration in the EC since curent regulates a coaguulant quantity tempo, fizz formation tempo, floc mass plus development, all haveing an effect on the EC's efficiency. With a rise within the curent density, a positive electrode sides dissolution rate hightens. Resulting in a ascent inside a quantity of metal hydrooxide floc prompting the ascent at poison evacuation effectiveness. a transcend the ideal current thickness doesn't end in an ascent inside the toxin evacuation productivity as adequate quantities of metal hydrooxide floc be accessible for the sedimentation of the contamination .

EC are frequently determined either under the galvano-static or potentio-static type. In a galvano-static type, EC method is administered with regolating otherwise shifting a present functional during electrioodes though a potentio-static type, functional cell power regulates or pied like a funcction of quantity of coaguulant required to get unrestricted in EC unit. The potentio-static mode is never used for EC and sometimes used for other electrochemical methods like electro-oxidation and electro-reduction when sacrificial electrodes aren't used . Depending on the parameters and therefore the quantity of pollutants to be far removed from water/ wastewater, the current density range can range from (0.01 – 880) A•m-^{2}.Ideal current thickness ought to be resolved thinking about other working boundaries.

2.5.4 EFFECT OF WATER PH –

Range of pH be a chief factor to consider that sway the recital of electrochemical process. utmost noxious waste deletion effectiveness be secure by a finest clarification pH for an exact toxin. Precipiitation of toxin starts by an exact pH range. Impurity deletion effectiveness diminish via eitheer mounting otherwise declining a pH value of the answer by the finest pH value. Taking under consideration the superficial charge, behaviour amid a pH dependent coaguulant group plus their sarounding toxin might get diminish by electrostatic interactions. The pH distorted throughout batch EF, it development trusted the preliminary pH range. EF method depict various buffering capacity due to a stability amid assembly plus consequently the OH utilization . pH includes critical effect happening on coaguulant ions framed through coaguulation measures. pH has footprint on shallow charrge of the Al hydroxide encourages (brought about through a adsoorption of ion). Through overall period of coaguulation , pH alter within a contrary approach along with swaying altogether to coaguulant ions shaped, plus subsequently towards effectiveness got within evacuation for poisons. We can not say that one cycle is best than the contrary to every squanders. Beneath a comparable liquid unique conditions, portions of Al , pH range, effectiveness acquired via coaguulation plus EC be comparative.

2.5.5 ELECTROLYSIS TIME –

The poison evacuation productivity is also an element of the electrolysis time. The contamination evacuation effectiveness increments with an ascent inside the electrolysis time. However, past the ideal electrolysis time, the contamination evacuation productivity gets steady and doesn't increment with an ascent inside the electrolysis time. The metal hydroxides are shaped via the disintegration of electrodes . To a curent desity, a measure towards created metal hydroxide increments through a ascent inside electrolytic moment. To an all-inclusive electrolytic era, we have ascent inside age of floc prompting a ascent inside toxin expulsion productivity. To a electrolytic era past to ideal electrolytic time, toxin expulsion productivity doesn't increment as adequate quantities of floc be accessible to evacuation in contamination .

Bazrafishan et al. confirmed to Cr^{+6} decrease as of manufactured chromium arrangement might be beneath legitimate cutoff points as long as treatment was among 20 and hour .

CHAPTER - 3

EC MODELING

Essentially, in electro-coagulation there are two primary kinds of displaying , Statistical demonstrating and demonstrating upheld information .Statistical displaying is that the one that spotlights on ideal working the conditions/boundaries during which EC evacuation effectiveness is improved. Where as displaying upheld information has given a few models that consider EC together cycle and a couple of others shows that depict the given physical or regular marvel happening during the technique . beside these two demonstrating

computational liquid elements (CFD) displaying, are applied to survey hydrodynamics (i.e stream contemplates), liquid stream, mass exchange.

3.1 STATISTICAL MODELLING

In electro-coagulation measure for wastewater treatment , fundamentally what we do is that we just shifts one factor and each one different components are kept fixed at specific arrangement of conditions . so by this routine method of performing EC measure , we've to attempt to numerous exploratory runs and it eventually upset the improvement .

Presently to disentangle this issue and to upgrade the advancement of electro-coagulation measure , reaction surface philosophy (RSM) as a device has been utilized in a few works fields to show the results of significant cycle boundaries and their collaborations. RSM has numerous structures to be specific the entire or halfway factorial plan (FD), focal composite plan (CCD), D-ideal plan (DOP) , plus Box Behnken plan (BBD), amid rests . FD be utilized towards work out chief impacts within free factors as well as coooperations whereas CCD, DOP plus BBD be wont towards appraise ideal working surroundings plus in the direction of getting a observational form addressed with a 2nd -request polynomial relapse form given beneath:

$$Y = b_0 + \sum_{i=1}^{k} b_i X_i + \sum_{i=1}^{k} b_{ii} X_i^2 + \sum_{i=1}^{k}\sum_{i=1}^{k} b_{ij} X_i X_j$$

here Xi and Xj expressions are the elements which impact on anticipated reaction Y, b0 be normal trial reaction, bi, bii and bij be relapse coefficients for straight, quadratic and connection stretch, separately. [1]

In electro-coagulation measure for wastewater treatment , fundamentally what we do is that we just fluctuates one factor and each one different components are kept fixed at specific arrangement of conditions . so by this ongoing method of performing EC measure , we've to attempt to numerous trial runs and it at last prevent the advancement .

Presently to disentangle this issue and to upgrade the advancement of electro-coagulation measure , reaction surface technique (RSM) as a device has been utilized in a few works fields to show the outcomes of significant cycle boundaries and their collaborations. RSM has numerous structures specifically the entire or halfway factorial plan (FD), focal composite plan (CCD), D-ideal plan (DOP) , and Box Behniken plan (BBD) , amid rests . FD be utilized towards work out chief impacts within free factors as well as coooperations whereas CCD, DOP plus BBD be wont towards appraise ideal working surroundings plus in the direction of getting a observational form addressed with a 2nd -request polynomial relapse form given beneath:

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here Xi and Xj expressions are the elements which impact on anticipated reaction Y, b0 be normal trial reaction, bi, bii and bij be relapse coefficients for straight, quadratic and connection stretch, separately. [1]

3.2 MODELLING IN EC

3.2.1 MODELLING ON PHENOMENOLOGY

Uniformly, a deletion in toxics , like sulphates and heavy metals by the means of electro-coagulation clothed to follow n^{th} order in reaction/ kinetic form :

$$\frac{dC}{dt} = KC^n$$

Here , dc by dt is rate of change of concentration , K is reaction rate constant and n is order following the reaction .

3.2.2. DISPLAYING DETAILED MECHANISMS

3.2.2.1. ELECTRO CHEMICAL HAPPENING

Joined by electro-synthetic compounds, thermodynamics, and information on anodes interface electrochemistry is an unpredictable science .

Electro-science helps in assessment of coagulant species delivered and power input .

Ohmic likely drop of arrangement is given by:

$$U = E_{eq} + \eta_{a,a} + \eta_{a,c} + \eta_{c,a} + \eta_{c,c} + \eta_{c,p} + d/ki$$

Here $\eta_{a,a}$, $\eta_{a,c}$ and $\eta_{a,p}$ be anode enactment overpotential, fixation overpotential and pasivation overpotential respectively. $\eta_{c,a}$, $\eta_{c,c}$ and $\eta_{c,p}$ be cathode actuation overpootential focus overpotential [1], and pasivation overpotential, & final stretch describe IR drop of agreement, while Eeq is the harmony latent contrast determined flanked by electrodes , separately, utilizing the Nerrnst condition with suspicion of ideality given underneath:

$$E = - \Delta Go/ZF + RT/ZF \sum v_i \ln(C_i/(c^o))$$

Here ΔGo signifies benchmark Gibbs free energy, C is fixations, T sand for temperature as well as R is universal gas consistent [1]. Utilization of exciting flow be resulted by electrolitic responses.

Tafel condition:

$$\eta = \alpha + \beta \ln I$$

3.2.2.2. VOK MODEL AND ADSORPTION

Adsorption model is straightforward along with flexible (isotherms) similarity among conservative adsoorption plus are widely utilized in better understanding of electro-coagulation mechanisms. Adsorption phenomenon helps in modeling of pollution abatement . Generally adsorption isotherms is looked uped for EC modeling amid idea of thermodynemic constant are namely, Langmuir plus Freundlich isotherms ,therefore the Langmuir Freundlich form that mixes the 2 prior types .

Langmuuir isotherm: $q_e = K_iC_e/(1+K_{if}C_e^n)q_{max}$

Freundlich isotherm: $q_e = K_FC_e^{(1/p)}$

Langmuir-Freundlich: $q_e - q_{max}K_{if}C_e/(1+K_{if}C_e^n)$

Here q_e be quantity molecules / absorbent , C_e be absorbate dose in water, q_{max} be capacity of molecules / metal caations , K_L be Langmuuir constant, K_F plus pare Freuundlich limit plus K_{LF} along with n are Langmuir Freundlich limit.[1]

3.2.2.3 MODELING OF FLOCCULATION

Flocculation in the electro-coagulation can be described as the process where crash ions hold or stick mutually to appear as floc .

Tempo of winning crash amid molecules i plus j is depicted beneath :

rfloculation = αβ (i,j)n inj

Here α is the crashing effectiveness , β (i,j) is the crashing incidence amid molecules of dimension i plus j, furthermore ni and nj be molecules of dimension i plus j respectively [1].

3.3 CFD MODELLING

CFD is sort of costly , because it requires fast and powerful computers to try to to numerical simulation of the info to be analysis.
In electro-coagulation cell , water sample can have either streamline flow pattern or flow pattern. within the multifaceted diamentions , speed pitch embrace a haphazard unstable section, that engender the jet stream as well as chaotic whirlpool . Generally instability form are often wont to suggest precisely a flow outline. Central equation to incompressible stream be often settled like trail. Mass equilibrium in organize framework be specified :

∂ρ/∂t+ρ∂ui/∂xi=0

Here ρ be liquid thickness plus u be average establish in middle value of speed vector [1].

CHAPTER - 4
LITERATURE REVIEW

4.1 REVIEW OF LITERATURE –

A Literature survey is essentially an academic paper that gives us thought and information on considerable discoveries as hypothetical and methodological commitment to a specific theme . So fundamentally its a proposition and information of the guardians who have all prepared dealt with a specific task.

Literature review are very significant in our project works of our guidance .

Table 4.1 Summary of Studies associated to Electro-coagulation studies

S. No	Authors and year of publications	Title	Journal Name	Critical Observation
1.	Jeian Nepio Hakiizimana, Bochaib Gouirich, Mohamed Chafi, Youssef Stiriba, Christophe Vial, Patrick Droogui, Jamal Naja, Bouuchaib Gourich, Mohammed Chefi, Youssef Stiriba, Christophe Vial, Patrick Droigui, Jamal Nae, Bouchaib Gourich, Mohammed Chafi, Youssef Stiriba, Christophe Vial (2017)	Electro-coagulation Process in water Treatment : An audit of electro-coagulation demonstrating approach	Desalination	Despite the many benefits of the EC process, its industrial use has yet to be considered due to deficient in of methodical model for reactor increase. By and large, this diary uncovers that there is an absence of a precise way to deal with EC reactor plan.
2.	Weiping Xiong, Peiipei Sog, Qiaihqian Sog, Zhaohuii Yang, Guanrgming Zeg, Hakiyin Xu, Xin Li, Peipei Song, Qianqian Song (2018)	Numerical model & examination of Electro-coagulation procedure for arsenic and antimony removal : Electric field , Flow Field , & Mass transfer studies	Journal of Environmental Management	To boost up the accuracy of EC model , the influence of flow rate , mass transfer, temperature , etc. Must be taken in account while doing

				numerical Simulations . At the point when bury cathode distance was kept in cm , better anode current effectiveness were gotten .
3.	N S M Zin and L W M Zailani (2018)	Utilization of Electro-coagulation in different Wastewater And Leachate Treatment – A Review	IOP Conference Series : Earth and Environment Science	Precision of the model of EC reactor relies on a few variables like : Operation time, Spacing b/w anodes , pH factor , Current thickness and so on, Distinctive cathode materials gives Different % expulsion of COD, BOD, turbidity TSS and so on
4.	Peter KG. Holt , Geoffraey J. Barton , Cynthuia A Mitchell (2005)	The Future towaeds Electro-Coagulation as a limited waterwaste handling innovation	Chemosphere	This diary shows EC astounding absence of acknowledgment as primary alternative for wastewater treatment . This Journal gives Conceptual system that objective bury – connection b/w Coagulation , buoyancy and electro science .

5.	Amir Hossein Mahvi, Edris Bazrafshan, Leili Mohammdi, Alireza Ansari-Moghaddam (2015)	Heavy metals deletion from aqueous atmosphere through electro-coagulation process– a methodical review.	Diary of Environmental Health Science and Engineering	Customary natural treatment strategy and Chemical Coagulation are exorbitant as well as sluggish and create bigger measure of slime . EC measure is fit for getting evacuation productivity of COD , BOD, Turbidity and so on, and is quick and less expensive than conventional strategies . However, Continuous examination must be done in EC measure for discovering better demonstrating strategies .of COD , BOD, Turbidity and so on, and is quick and less expensive than conventional techniques . Be that as it may, Continuous examination must be done in EC measure for discovering better displaying techniques.of COD , BOD, Turbidity

				and so forth, and is quick and less expensive than conventional strategies . Yet, Continuous exploration must be done in EC measure for discovering better displaying procedures .
6.	Mohammad M. Emamjomeh , Muttucumaru. Sivakumar (2009)	Review of toxins eliminated by electro-coagulation and electro-coagulation/buoyancy measures.	Diary of Environmental Management	In this Journal trial results shows that Aluminum anodes are more proficient than iron terminals . It likewise shows that EC cycle is more successful and effective than Coagulation measure for consumable water treatment .
7.	O. Tunnay, I. Kabdiasli, I. Arislan-Alaton, T.Olimez-Haci, and I. Kabdasli (2012)	Electro-coagulation application for mechanical wastewaters :	a basic audit Environmental Technology Reviews	Inborn benefit of EC is that it doesn't need expansion of any Coagulant species to treat wastewater. This Journal mirror that till now , strategy is just exactly enhanced consequently it require more central information on its system for better designing plan .

8.	Yousuf A. Mollah , Robert Schiennach , Jose R. Pariga , David L. Cocke (2000)	Electro-coagulation (EC)- Science plus Application	Journal of Hazardous Materials	This Journal shows that more key data is needed on the Chemistry in question. Response under motor control must be set up . Displaying of the response must be never really consistent state and balance status . carried out in order to establish steady-state and equilibrium conditions.
9.	Xueming Chin , Guiohua Chen , Po Lock Yae (1999)	severance of poisons by café waterwaste by Electro-coagulation	division and Purification Technology	For eatery wastewater , that have high oil and oil content , COD , BOD and SS focus Electro-coagulation can be an achievable cycle . Influent boundaries like pH, conductivity , current thickness doesn't influence toxin expulsion effectiveness fundamentally . The ideal charge stacking and current thickness were 1.67-9.95 F/m3 and 30-80 A/m2 .

				evacuation effectiveness of oil and oil is more than 94 % for all the wastewater tried ..
10.	Mehomet Kobya , Orhain Taner Can@ , Mahmut Bayriamoglu . (2003)	Treatmentate for material waterwaste by Electro-coagulation utilizing Iron and Al electrodes	Journal of Hazardous Materials	Using cathode material as Aluminum and Iron in the treatment of material wastewater by EC has been discovered to rely on pH .

CHAPTER - 5

MATHODS AND APPROACH

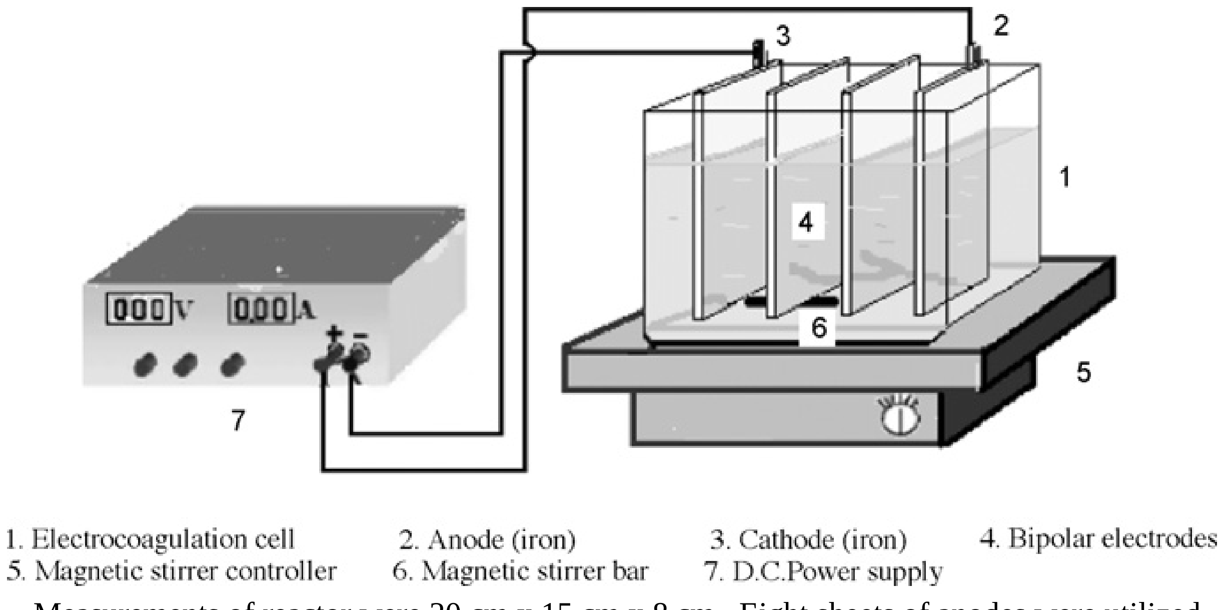
Electro-coagulation unit chamber is utilized to handling of waterwaste along with the standards at Electro-coagulation be utilized to cure the waste water . As we probably are aware in EC measure various terminals bring about various effectiveness , So Aluminum and Iron were chosen to be utilized as regarded anode and cathode .

Motor/Reaction displaying was done , which is a sort of demonstrating dependent on information . K (response rate consistent), n (request of response), and R square qualities were finded for COD , Turbidity , BOD , and TSS focus Vs time for anode Al and Fe , continuing to space of terminal as 0.5 cm and 1cm .

5.1 EXPERIMENTAL SETUP

5.1.1 REACTOR DESIGN

For the analysis Rectangular molded reactor was utilized , with the net limit of 2 liters .



Measurements of reactor were 20 cm x 15 cm x 8 cm . Eight sheets of anodes were utilized having estimation as 9 cm x 5 cm x 0.3 cm . Two sort of anode material were utilized i.e Aluminum and Iron . Separating between two anodes were kept as 0.5 cm for first time and 1 cm for sometime later . The Electro-coagulation structure was associated Powered by a DC Source of breaking point 0-10 An and 0-30V.

Fig 5.1 Diagram of EC reactor

5.2 ANALYTICAL TECHNIQUES

Parameters chosen for investigation were COD concentration (mg/l) , Turbidity (NTU) , BOD concentration (mg/l) , and TSS concentration (mg/l) .

Standard Methods were used to remove COD , TSS , Turbidity , and BOD concentration . pH was computed with pH paper , Turbidity was computed by using Turbidity Meter (LABTRONICS MODEL NO. 33) , and conductivity was computed by Conductivity Meter .

Table 5.1 Analytical Techniques

Parameters	Instruments
pH	pH Meter
COD	COD Digester
TSS	Filter paper
Turbidity	Turbidity Meter
Conductivity	Conductivity Meter

CHAPTER - 6

RESULTS & DISCUSSION

6.1 CHARACTERISTICS OF WASTEWATER

The waterwaste to every trial was assembled . Outcome showed that waterwast must be delicacy preceding to its released to the atmosphere . Attributes of waterwaste test be appeared in table 6.1.

Table 6.1 : Composition of waste water test

Composition	Value/ Range
pH	3.5
COD	20160 mg/l
BOD	5423 mg/l
Turbidity	156 NTU
TSS	650 mg/l
Cl content	587.33 mg/l
TS	2900 mg/l
Conductivity	1.072 – 1.212 (m.mho/cm)

6.2 MODELLING EQUATION USED

1) First Modeling Equation utilized is a Kinetic Modeling :

This demonstrating is a kind of Modeling dependent on information , and the fundamental condition utilized is :

dc/dt=Kc^n

Where dc/dt represent Rate of progress of fixation , K is response rate consistent and n is the request for response . This is a non direct condition .

To demonstrate this condition first we need to coordinate it structure limit state of C0 to Ct .

Subsequent to coordinating this above condition , we get last condition in term of Ct (Corrected focus) as :

$C_t^{(1-n)}=C_0^{(1-n)}- Kt(1-n)$

Presently we have model this condition in Excel programming , to get Ct (Corrected fixation) for COD, Turbidity , BOD and TSS focus .

2) Second Modeling Equation utilized is :

$t_N= 1/K \ \ln(C_0/C_1)$

Where t_N is time expected to arrive at definite fixation , C0 is beginning focus and Ct is Corrected fixation .

In the wake of composing this condition in term of Ct , we get

$C_t=C_0\times e^{(- Kt)}$

Likewise we have model this condition in Excel programming , to get Ct (Corrected fixation) for COD, Turbidity , BOD and TSS focus .

6.3 EFFECT OF ELECTRODE SPACING AND MATERIAL

The outcome from the tests exhibited that for a 0.5 cm dividing between two cathode we improve COD , Turbidity, BOD and TSS eliminated fixation when contrasted with 1 cm separating of anodes . Likewise when Al-Al (Aluminum is utilized as both anode and cathode) is utilized and dispersing is kept as 0.5 cm we improve COD , Turbidity , BOD and TSS eliminated focus , than Al-Al anode at 1 cm separating . So by the chart shown it tends to be led that Aluminum is preferable terminal material over Iron .

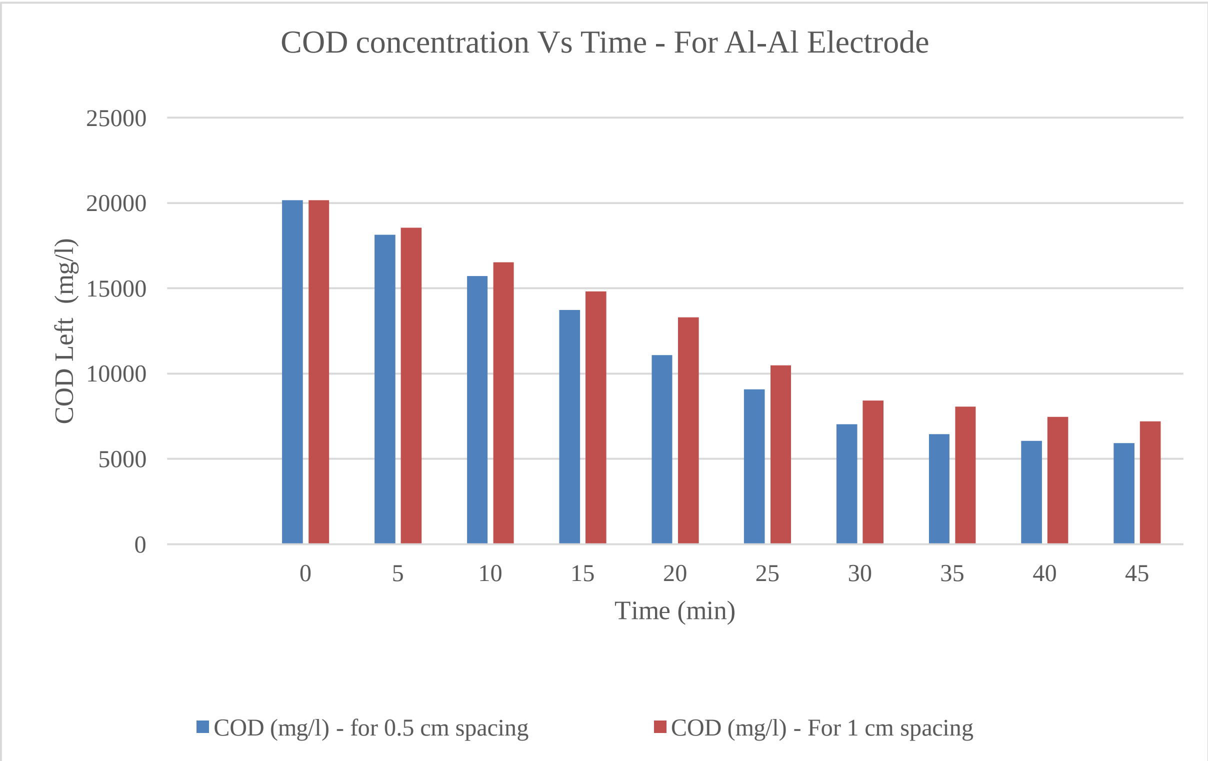


Fig 6.1 COD concentration Vs Time – for Al-Al electrode , Spacing of 0.5cm and 1 cm

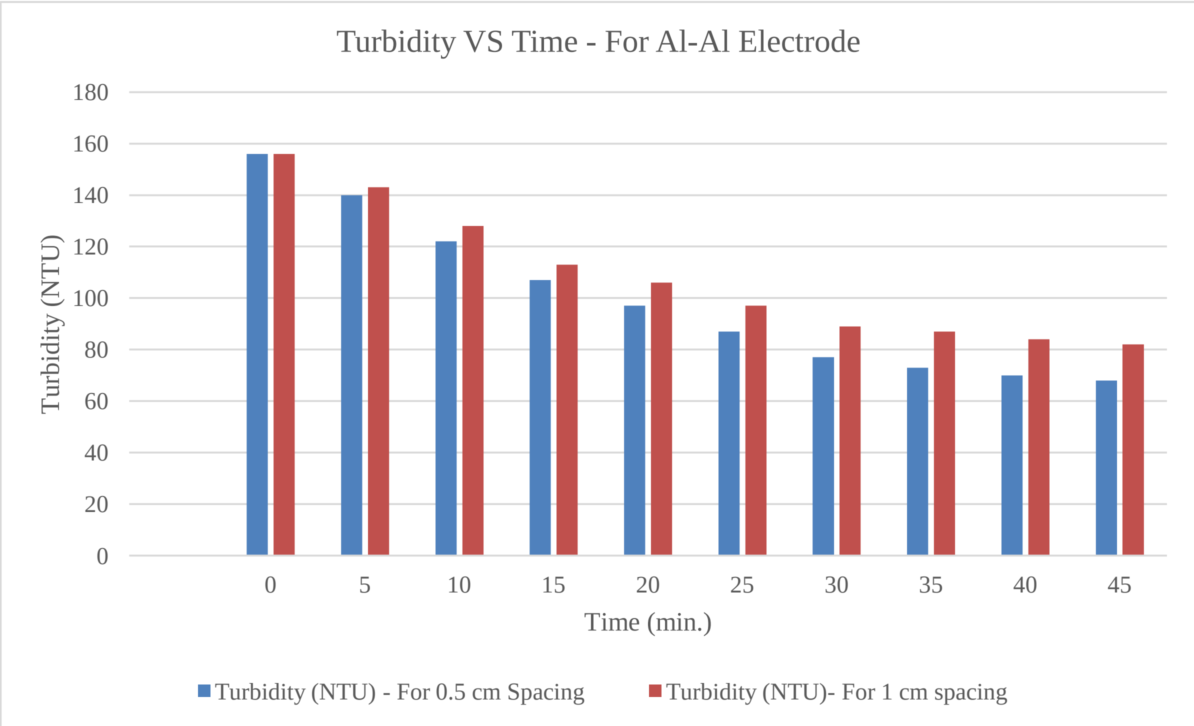


Fig 6.2 Turbidity Vs Time – For Al-Al electrode , Spacing of 0.5 cm and 1 cm

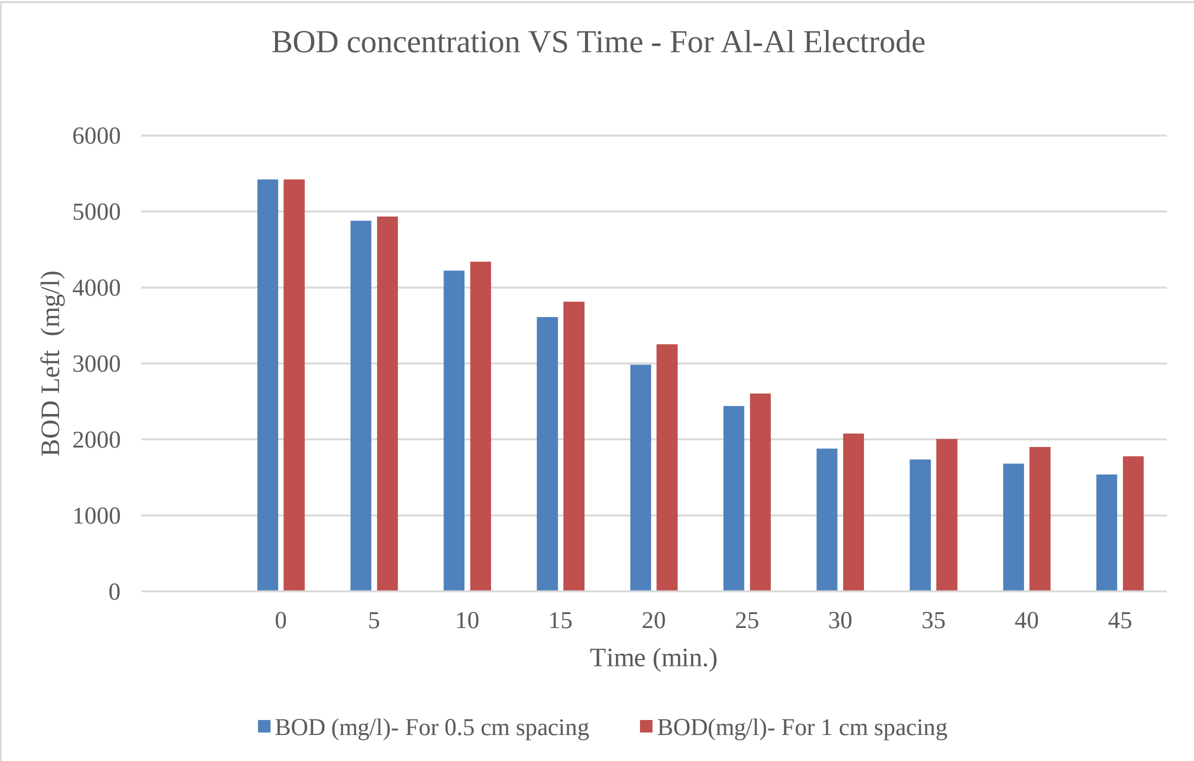


Fig. 6.3 Body focus Vs Time – For Al – Al anode , separating of 0.5 cm and 1 cm

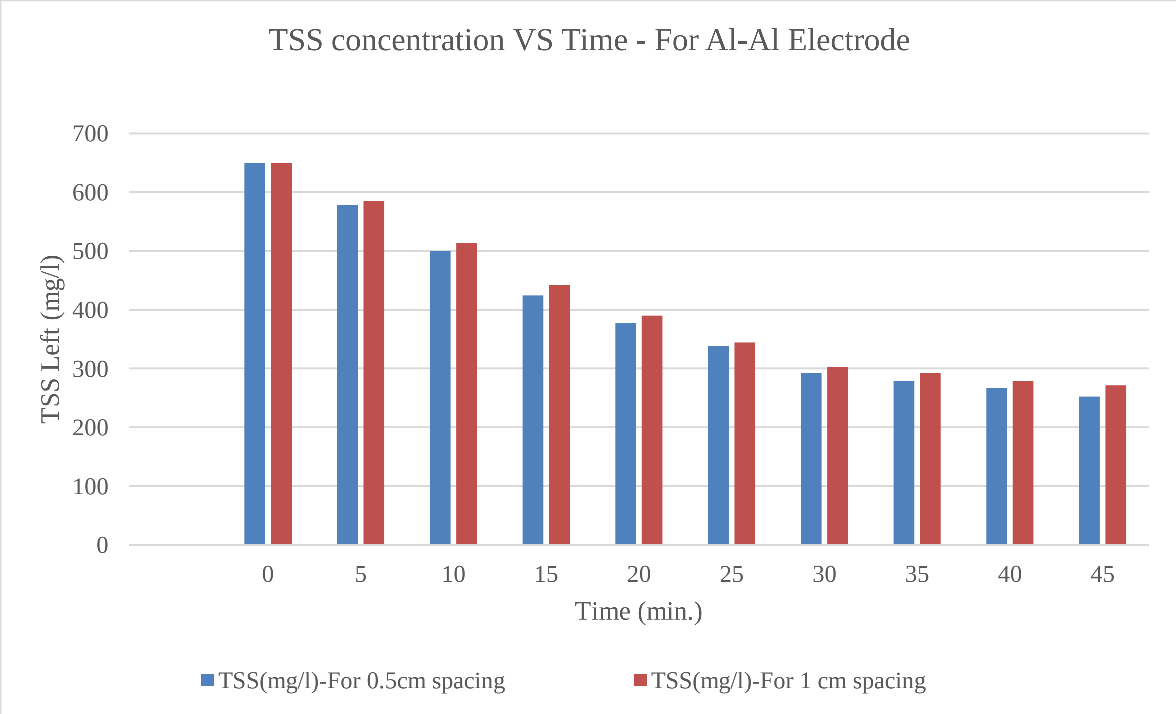


Fig. 6.4 TSS fixation Vs Time – For Al-Al cathode , of dividing 0.5 cm and 1 cm

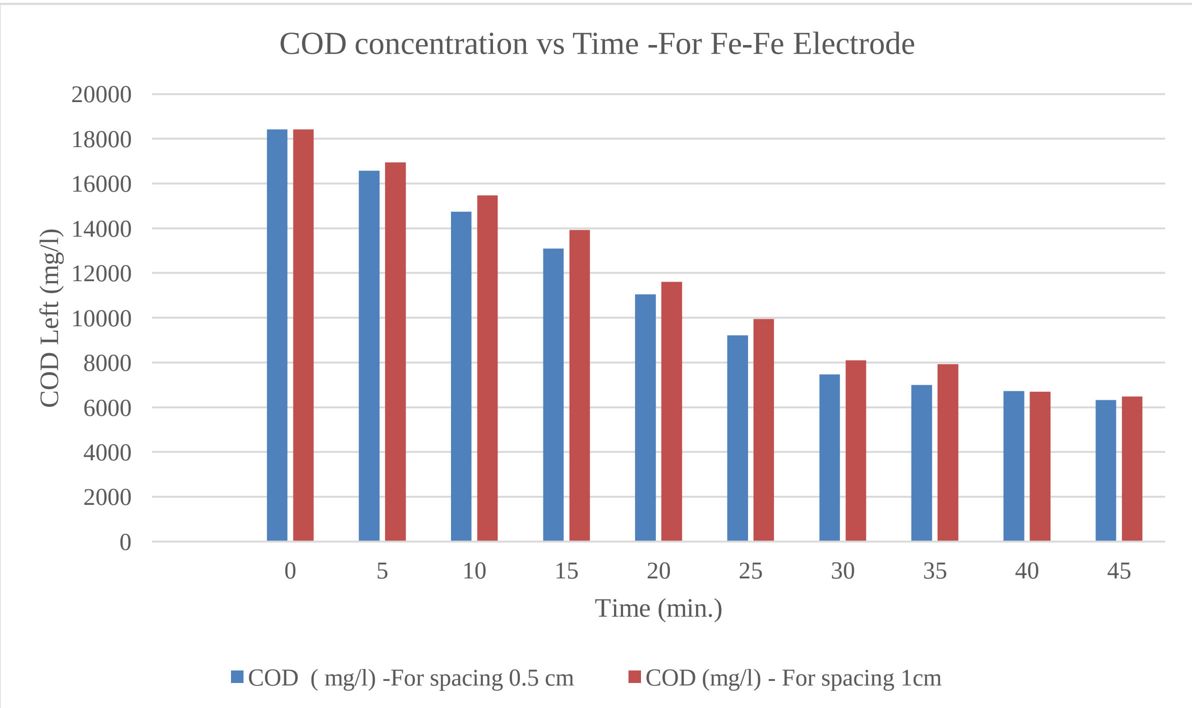


Fig. 6.5 COD fixation Vs Time-For Fe-Fe cathode , separating of 0.5 cm and 1 cm

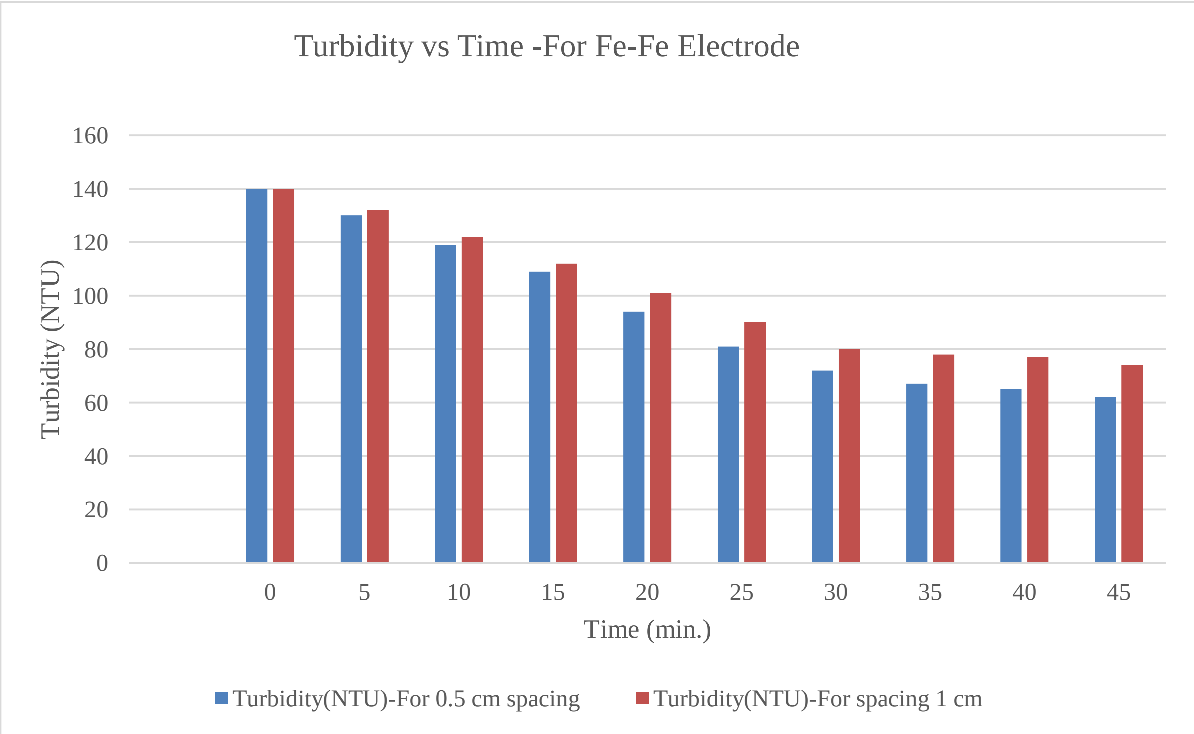


Fig 6.6 Turbidity Vs Time – For Fe-Fe anode, dividing of 0.5 cm and 1 cm

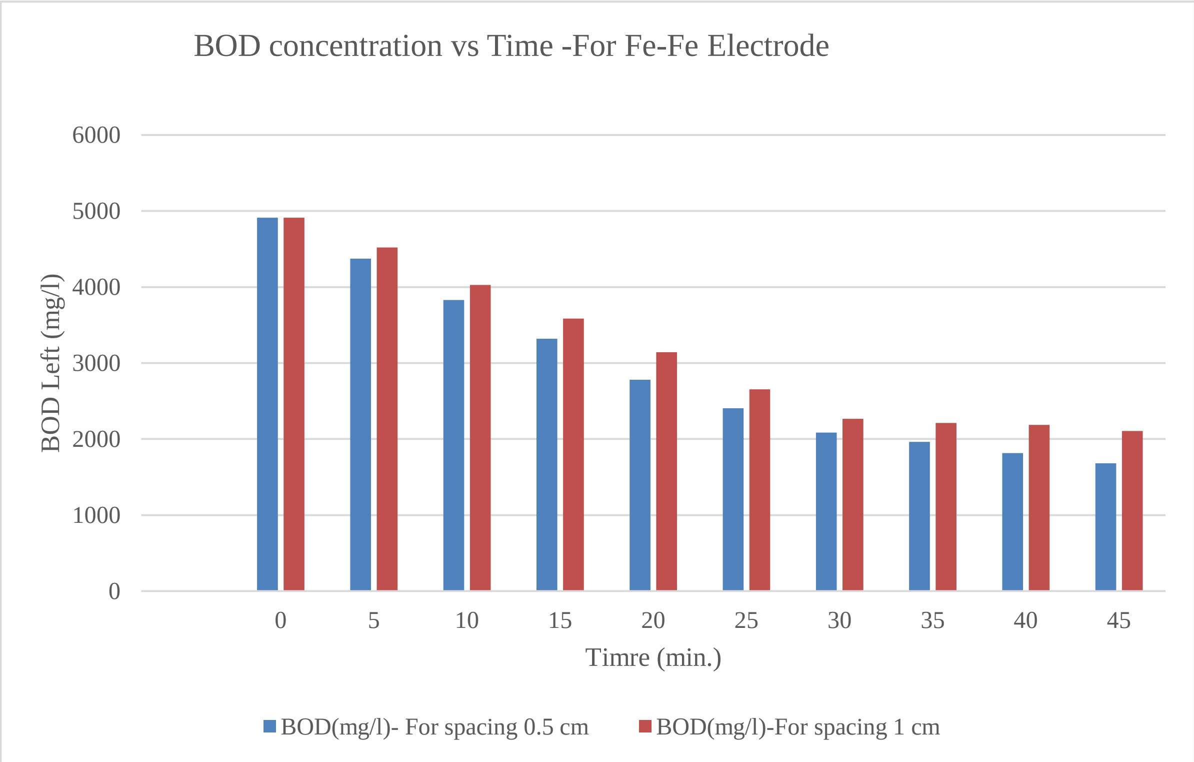


Fig. 6.7 Body fixation Vs Time – For Fe-Fe anode , dispersing of 0.5 cm and 1 cm

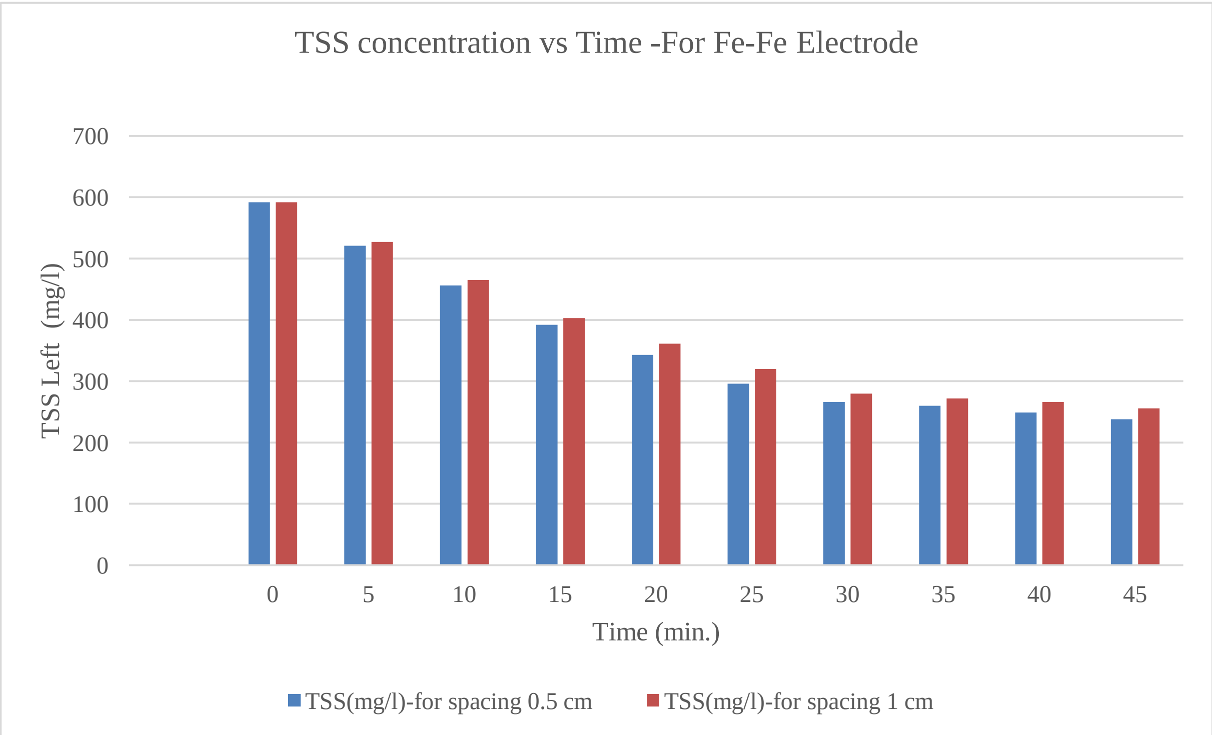


Fig. 6.8 TSS fixation Vs Time-Fe-Fe anode , dispersing of 0.5 cm and 1 cm

6.4 RESULTS FROM – MODELLING OF KINETIC EQUATION

$$\frac{dc}{dt} = Kc^n$$

Modelling of above kinetic equation was done on excel software for different parameters like COD , Turbidity, BOD and TSS concentration , at spacing between electrode as 0.5 cm and 1 cm , for Al-Al electrode and Fe-Fe electrode , to generate following plots :

6.4.1 SPACING 0.5 CM & 1 CM FOR AL-Al ELECTRODE:

CASE I : COD Concentration Vs Time (Al-Al ,Spacing - 0.5 cm)					
X (Independent)	Y (Dependent)				
Time (min)	COD Concentration (mg/l)	COD Corrected Concentration (mg/l)	Squared error	Constant	
0	20160	20160	0	K	0.2
5	18144	17531.75827	0.001138623	n	0.8
10	15725	15185.06913	0.001178949	R square	0.984630182
15	13727	13096.68012	0.002108486		
20	11088	11244.65576	0.000199612		
25	9072	9608.339187	0.003495208		
30	7023	8168.313719	0.02659522		
35	6451	6906.364475	0.004982694		
40	6048	5805.439971	0.001608477		
45	5916	4849.613719	0.032491725		
		Sum of squared error	0.073798993		
		Normalized STD deviation	9.055323374		

Fig. 6.9 Data set for COD Vs Time

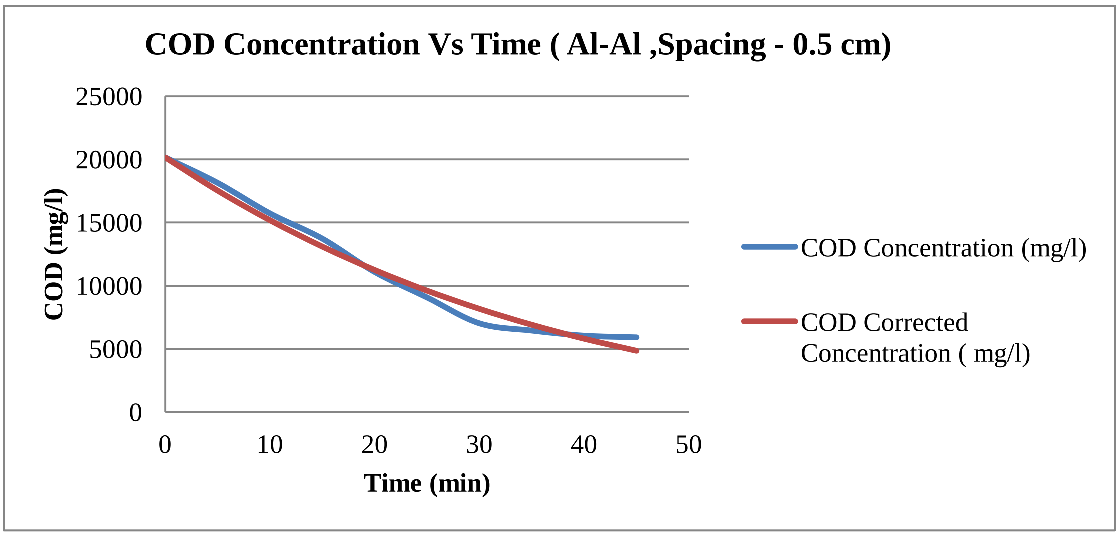


Fig.6.9.1 COD concentration Vs Time

Case 2 :Turbidity Vs Time (Al-Al ,Spacing - 0.5 cm)					
X (Independent)	Y (Dependent)				
Time (min)	Turbidity (NTU)	Turbidity Corrected (NTU)	Squared error	Constants	
0	156	156	0	K	0.000319816
5	140	135.6701359	0.000956517	n	1.897626821
10	122	119.8408213	0.000313226	R square	0.994323753
15	107	107.1836848	2.94699E-06		
20	97	96.84346189	2.60433E-06		
25	87	88.24523764	0.000204864		
30	77	80.98864821	0.002683305		
35	73	74.78653371	0.000598931		
40	70	69.42770933	6.68401E-05		
45	68	64.75348897	0.002279376		
		Sum of square error	0.007108609		
		Normalized STD deviation	2.810419008		

Fig.6.9.2 Data set for Turbidity Vs Time

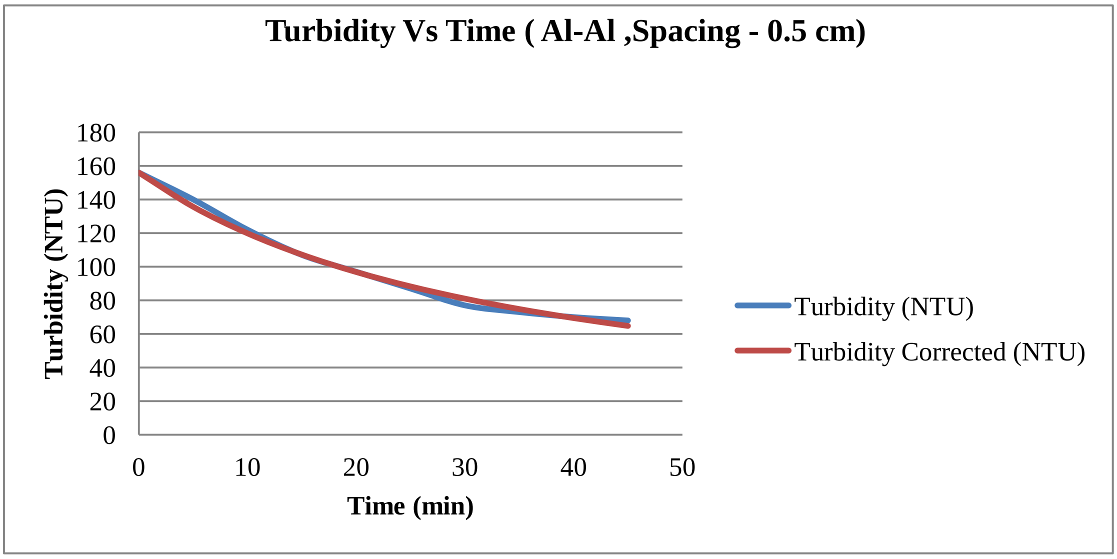


Fig 6.9.3 Turbidity Vs Time

Case 3 : BOD Concentration Vs Time (Al-Al ,Spacing - 0.5 cm)					
X (Independent)	Y (Dependent)				
Time (min)	BOD Concentration (mg/l)	BOD Corrected Concentration (mg/l)	Squared error	Constants	
0	5423	5423	0	K	0.1
5	4880	4378.749697	0.010550418	n	0.9
10	4223	3519.08986	0.027783841	R Square	0.984842985
15	3610	2814.424323	0.048567818		
20	2983	2239.395575	0.062140884		
25	2440	1772.353359	0.074871009		
30	1877	1394.87999	0.06597536		
35	1735	1091.367459	0.137618566		
40	1681	848.6416811	0.245180102		
45	1538	655.6295988	0.329146463		
		Sum of square error	1.001834459		
		Normalized STD deviation	33.36389364		

Fig 6.9.4 Data set for BOD concentration Vs Time

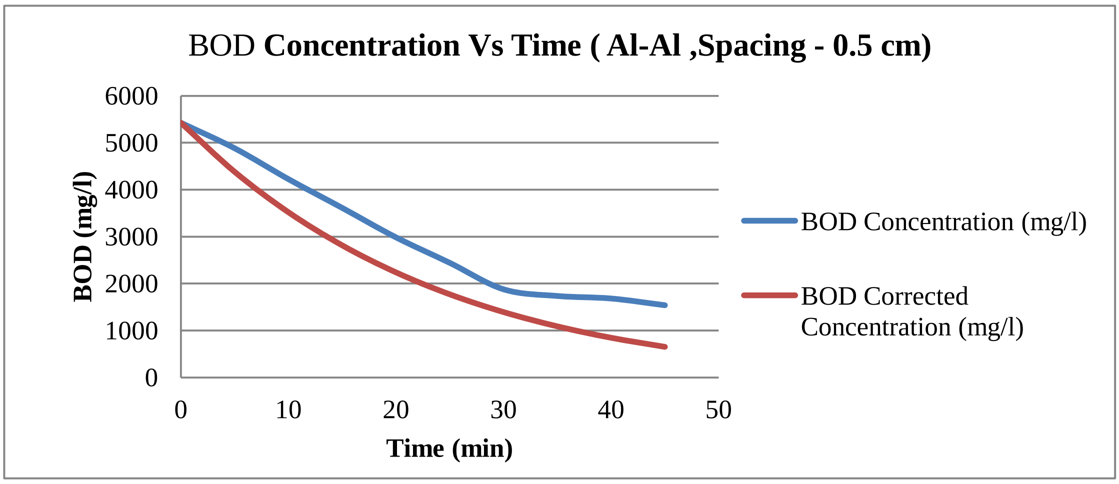


Fig.6.9.5 BOD concentration VS Time

Case 4 : TSS Concentration Vs Time (Al-Al ,Spacing - 0.5 cm)					
X (Independent)	Y (Dependent)				
Time (min)	TSS Concentration (mg/l)	TSS Corrected Concentration (mg/l)	Squared error	Constants	
0	650	650	0	K	0.1
5	578	565.7591721	0.000448504	n	0.8
10	500	490.4881078	0.000361904	R Square	0.983188145
15	424	423.4506332	1.67878E-06		
20	377	363.9520041	0.001197857		
25	338	311.3377051	0.006222453		
30	292	264.9922503	0.008554824		
35	279	224.3379831	0.03838512		
40	266	188.8338758	0.084156972		
45	252	157.9743303	0.139216846		
		Sum of square error	0.278546159		
		Normalized STD deviation	17.59249078		

Fig.6.9.6 Data set for TSS vs Time

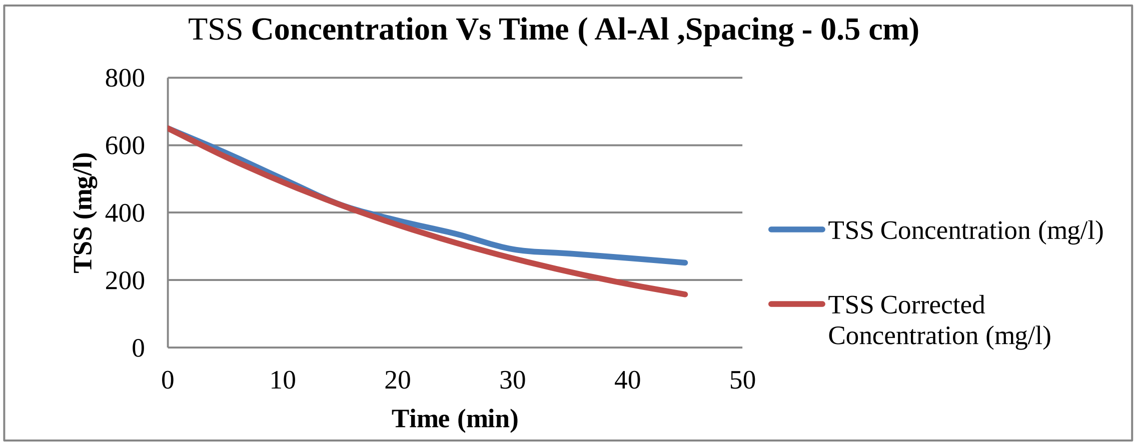


Fig 6.9.7 TSS concentration Vs Time

Case 5 : COD Concentration Vs Time (Al-Al ,Spacing - 1cm)					
X (Independent)	Y (Dependent)				
Time (min)	COD Concentration (mg/l)	COD Corrected Concentration (mg/l)	Squared error	Constant	
0	20160	20160	0	K	0.2
5	18547	17531.75827	0.002996343	n	0.8
10	16531	15185.06913	0.006628988	R square	0.981580264
15	14816	13096.68012	0.013466398		
20	13306	11244.65576	0.023999711		
25	10483	9608.339187	0.006961586		
30	8412	8168.313719	0.000839196		
35	8064	6906.364475	0.020608323		
40	7459	5805.439971	0.04914493		
45	7194	4849.613719	0.106198278		
		Sum of squared error	0.230843753		
		Normalized STD deviation	16.01540068		

Fig 6.9.8 Data set for COD Vs Time

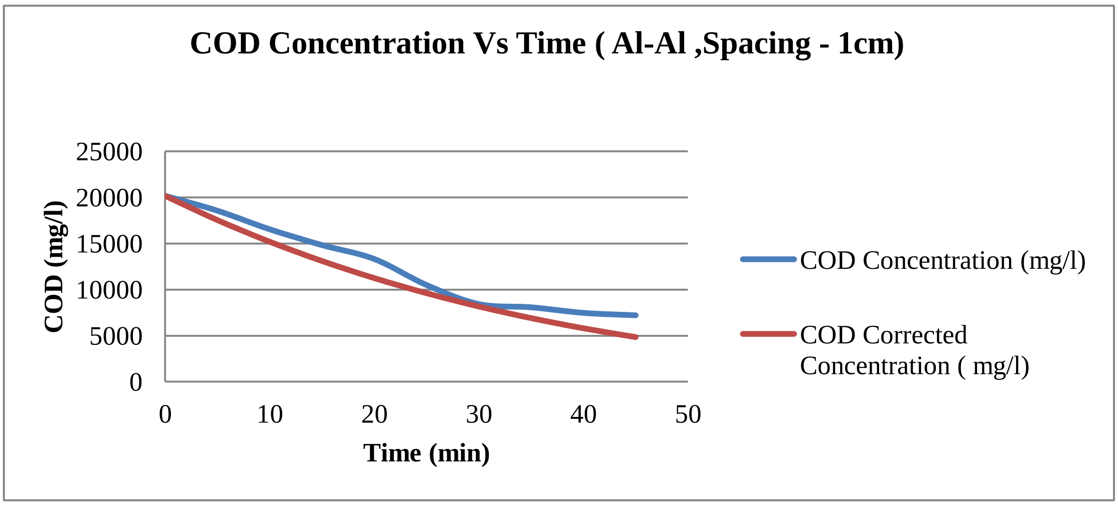


Fig. 6.9.9 COD concentration Vs Time

Case 6 : Turbidity Vs Time (Al-Al ,Spacing - 1 cm)					
X (Independent)	Y (Dependent)				
Time (min)	Turbidity (NTU)	Turbidity Corrected (NTU)	Squared error	Constants	
0	156	156	0	K	1.77344E-05
5	143	138.6492895	0.000925653	n	2.441407385
10	128	125.3609823	0.000425074	R square	0.991118248
15	113	114.8055892	0.000255318		
20	106	106.1857631	3.07119E-06		
25	97	98.99204369	0.000421749		
30	89	92.88251159	0.001903029		
35	87	87.61848746	5.05386E-05		
40	84	83.02790835	0.000133923		
45	82	78.98335827	0.00135338		
		Sum of square error	0.005471737		
		Normalized STD deviation	2.465706285		

Fig.6.9.10 Data Set for Turbidity Vs Time

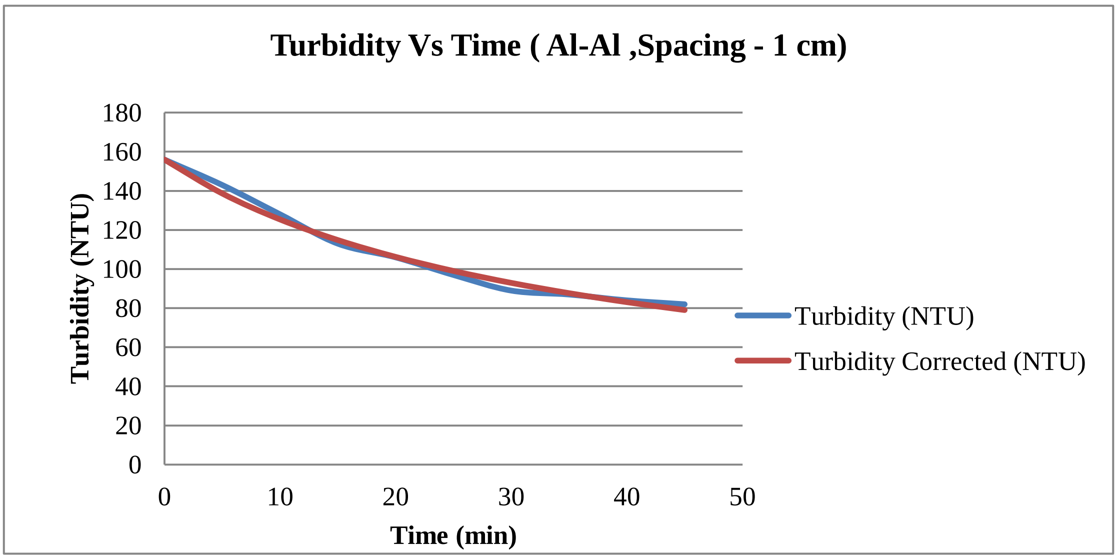


Fig.6.9.11 Turbidity Vs Time

Case 7 : BOD Concentration Vs Time (Al-Al ,Spacing -1 cm)					
X (Independent)	Y (Dependent)				
Time (min)	BOD Concentration (mg/l)	BOD Corrected Concentration (mg/l)	Squared error	Constants	
0	5423	5423	0	K	0.1
5	4935	4718.729133	0.001920533	n	0.85
10	4338	4093.765305	0.003169827	R Square	0.984096368
15	3812	3540.602765	0.005068799		
20	3254	3052.305611	0.003841957		
25	2603	2622.475648	5.59803E-05		
30	2076	2245.221407	0.006644402		
35	2006	1915.128308	0.002052085		
40	1898	1627.229936	0.020352084		
45	1779	1376.980439	0.05106725		
		Sum of square error	0.094172918		
		Normalized STD deviation	10.22920209		

Fig 6.9.12 Data set for BOD Vs Time

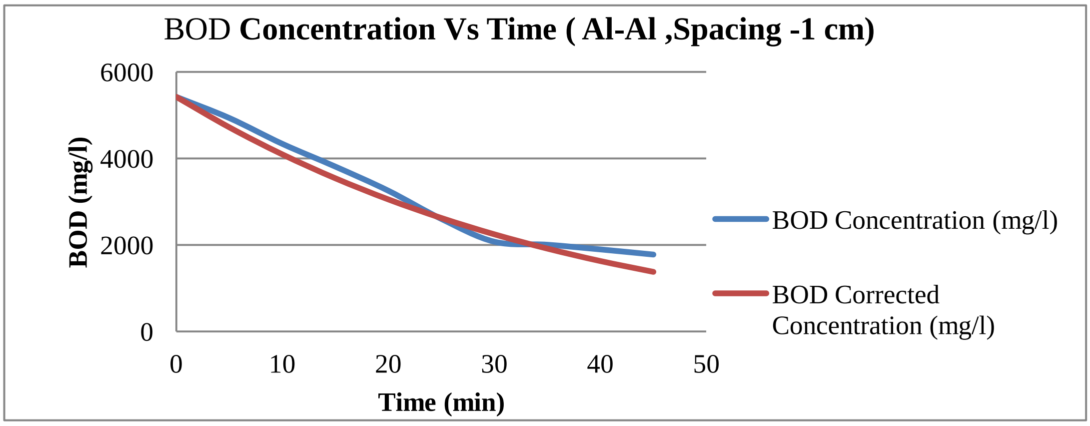


Fig 6.9.13 BOD concentration vs Time

Case 8 : TSS Concentration Vs Time (Al-Al ,Spacing - 1cm)					
X (Independent)	Y (Dependent)				
Time (min)	TSS Concentration (mg/l)	TSS Corrected Concentration (mg/l)	Squared error	Constants	
0	650	650	0	K	0.1
5	585	565.7591721	0.001081772	n	0.8
10	513	490.4881078	0.001925703	R Square	0.982053328
15	442	423.4506332	0.00176122		
20	390	363.9520041	0.004460868		
25	344	311.3377051	0.009015224		
30	302	264.9922503	0.015016595		
35	292	224.3379831	0.053693804		
40	279	188.8338758	0.104442774		
45	271	157.9743303	0.17394646		
		Sum of square error	0.365344421		
		Normalized STD deviation	20.1479092		

Fig 6.9.14 Data set for TSS concentration vs time

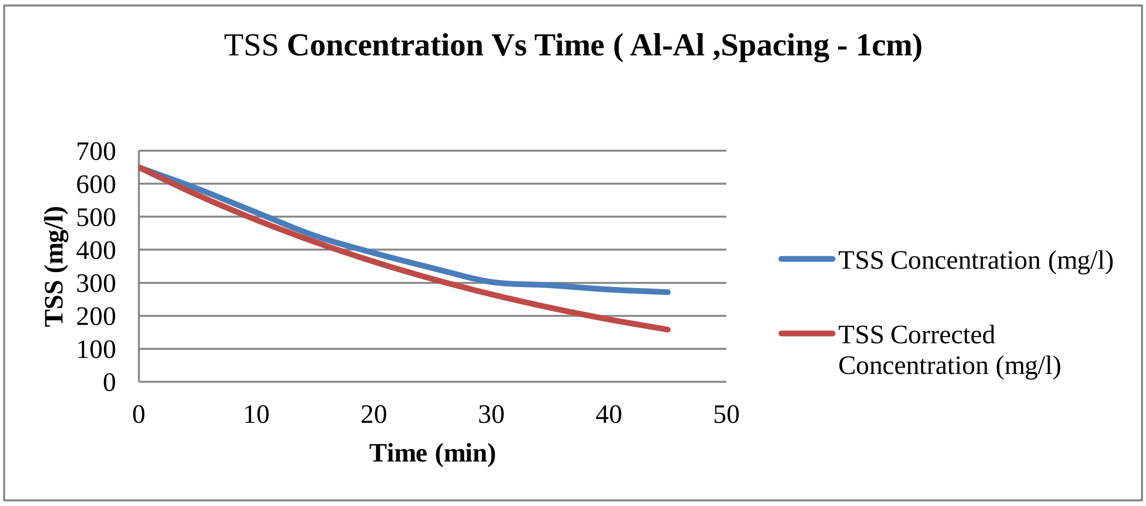


Fig 6.9.15 TSS Concentration Vs Time

6.4.2 SPACING 0.5 CM & 1 CM FOR Fe-Fe ELECTRODE

Case 9 : COD Concentration Vs Time (Fe-Fe,Spacing - 0.5 cm)					
X (Independent)	Y (Dependent)				
Time (min)	COD Concentration (mg/l)	COD Corrected Concentration (mg/l)	Squared error	Constant	
0	18420	18420	0	K	0.2
5	16578	15977.30732	0.001312926	n	0.8
10	14736	13800.91577	0.004026635	R square	0.987328092
15	13096	11868.43246	0.00878645		
20	11052	10158.75659	0.006532176		
25	9210	8652.041012	0.003670163		
30	7468	7329.653835	0.000343183		
35	6997	6174.140031	0.013830189		
40	6723	5169.18303	0.053416263		
45	6321	4299.566326	0.102269801		
		Sum of squared error	0.194187786		
		Normalized STD deviation	14.68891442		

Fig 6.9.16 Data set for COD Concentration Vs Time

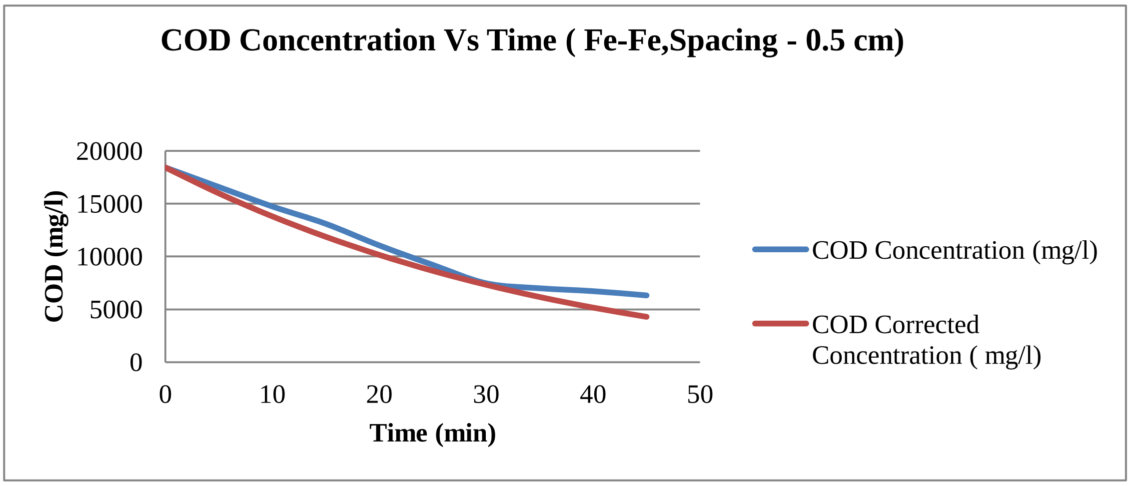


Fig 6.9.17 COD concentration Vs Time

Case 10 : Turbidity Vs Time (Fe-Fe,Spacing - 0.5 cm)					
X (Independent)	Y (Dependent)				
Time (min)	Turbidity (NTU)	Turbidity Corrected (NTU)	Squared error	Constants	
0	140	140	0	K	0.005201552
5	130	125.649465	0.00111995	n	1.291583076
10	119	113.1433784	0.002422146	R square	0.984114006
15	109	102.199397	0.003892619		
20	94	92.58494726	0.000226615		
25	81	84.1073596	0.001471679		
30	72	76.6061637	0.004092736		
35	67	69.94702864	0.001934724		
40	65	64.01696495	0.000228724		
45	62	58.72050163	0.002797895		
		Sum of square error	0.018187089		
		Normalized STD deviation	4.495317161		

Fig 6.9.18 Data set for Turbidity Vs Time

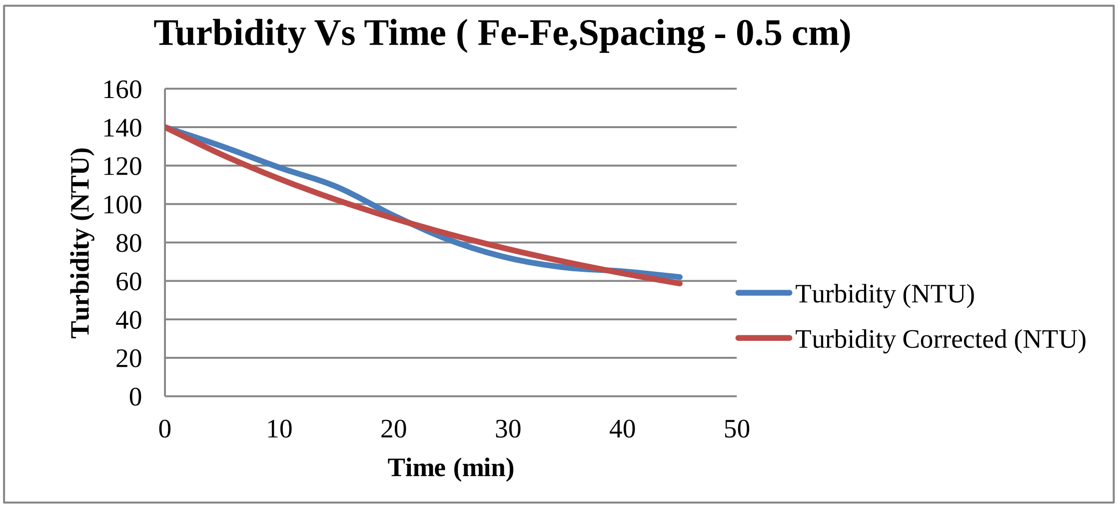


Fig 6.9.19 Turbidity Vs Time

Case 11 :BOD Concentration Vs Time (Fe-Fe,Spacing - 0.5 cm)					
X (Independent)	Y (Dependent)				
Time (min)	BOD Concentration (mg/l)	BOD Corrected Concentration (mg/l)	Squared error	Constants	
0	4912	4912	0	K	0.1
5	4372	4265.113661	0.000597701	n	0.85
10	3831	3692.118756	0.001314204	R Square	0.991318858
15	3321	3185.919501	0.001654427		
20	2780	2739.966905	0.000207371		
25	2407	2348.227462	0.000596207		
30	2087	2005.152982	0.001538016		
35	1965	1705.651556	0.017419761		
40	1817	1445.05963	0.041902196		
45	1679	1219.115173	0.075023405		
		Sum of square error	0.140253287		
		Normalized STD deviation	12.4834685		

Fig 6.9.19 Data set for BOD concentration Vs Time

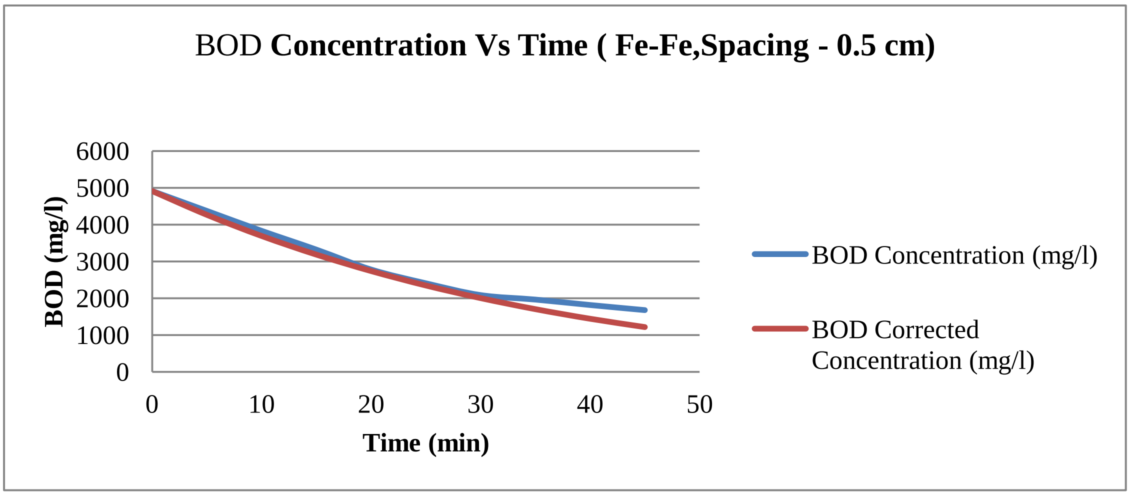


Fig 6.9.20 BOD concentration vs Time

Case 12 : TSS Concentration Vs Time (Fe-Fe,Spacing - 0.5 cm)					
X (Independent)	Y (Dependent)				
Time (min)	TSS Concentration (mg/l)	TSS Corrected Concentration (mg/l)	Squared error	Constants	
0	592	592	0	K	0.1
5	521	513.9090408	0.00018524	n	0.8
10	456	444.2852955	0.000659983	R Square	0.977295936
15	392	382.4207449	0.000597161		
20	343	327.6479876	0.002003283		
25	296	279.3390395	0.00316823		
30	266	236.9041343	0.011964631		
35	260	199.790523	0.05362694		
40	249	167.4812744	0.107180572		
45	238	139.4940745	0.171305299		
		Sum of square error	0.350691338		
		Normalized STD deviation	19.73973258		

Fig 6.9.21 Data set for TSS concentration Vs Time

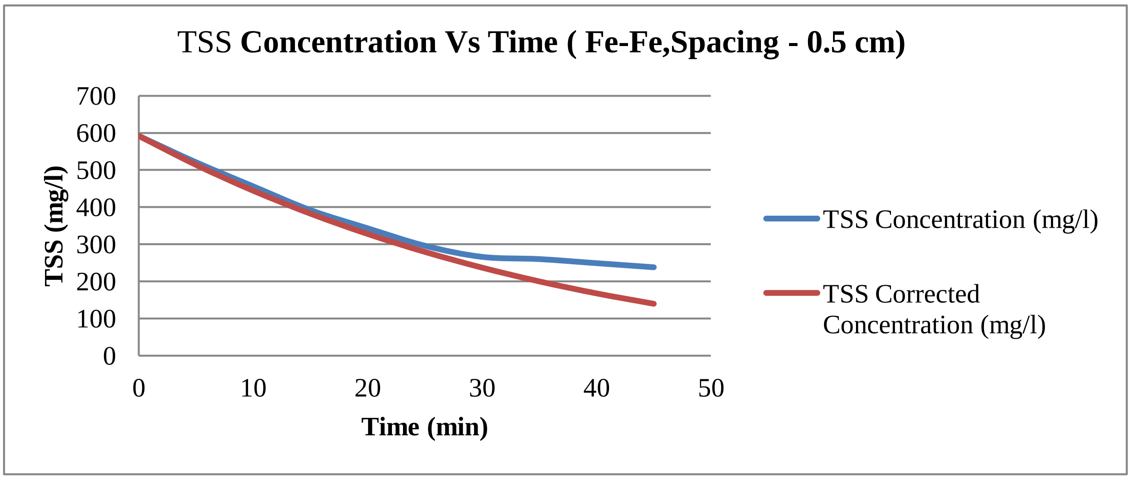


Fig 6.9.22 TSS concentration Vs Time

Case 13 :COD Concentration Vs Time (Fe-Fe,Spacing - 1cm)					
X (Independent)	Y (Dependent)				
Time (min)	COD Concentration (mg/l)	COD Corrected Concentration (mg/l)	Squared error	Constant	
0	18420	18420	0	K	0.2
5	16946	16390.5023	0.001074559	n	0.78
10	15473	14539.80258	0.003637458	R square	0.987020829
15	13922	12856.30003	0.005859582		
20	11605	11328.86292	0.000566186		
25	9947	9946.821761	3.21085E-10		
30	8096	8699.962279	0.005565173		
35	7921	7578.518416	0.001869452		
40	6700	6573.16516	0.000358367		
45	6484	5675.011302	0.015566784		
		Sum of squared error	0.034497561		
		Normalized STD deviation	6.191173001		

Fig 6.9.23 Data set for COD concentration Vs Time

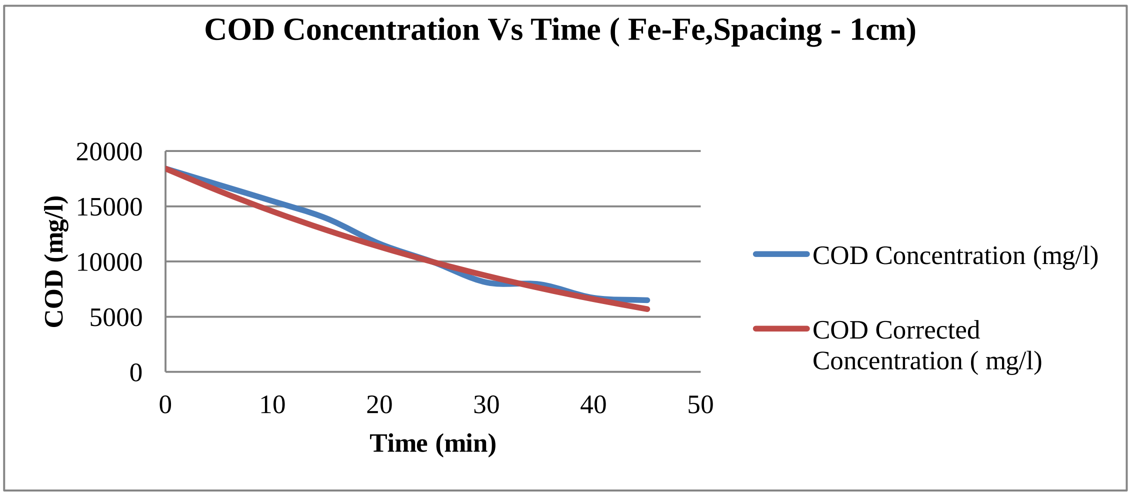


Fig 6.9.24 COD Concentration vs Time

Case 14 :Turbidity Vs Time (Fe-Fe,Spacing - 1cm					
X (Independent)	Y (Dependent)				
Time (min)	Turbidity (NTU)	Turbidity Corrected (NTU)	Squared error	Constants	
0	140	140	0	K	0.003427931
5	132	128.4372639	0.000728483	n	1.329757477
10	122	118.110601	0.001016355	R square	0.980081915
15	112	108.8593823	0.000786311		
20	101	100.5473677	2.00839E-05		
25	90	93.05849607	0.001154864		
30	80	86.29348451	0.006188742		
35	78	80.16706733	0.00077189		
40	77	74.60574192	0.000966853		
45	74	69.54591935	0.00362287		
		Sum of square error	0.015256451		
		Normalized STD deviation	4.117233581		

Fig 6.9.25 Data set for Turbidity Vs Time

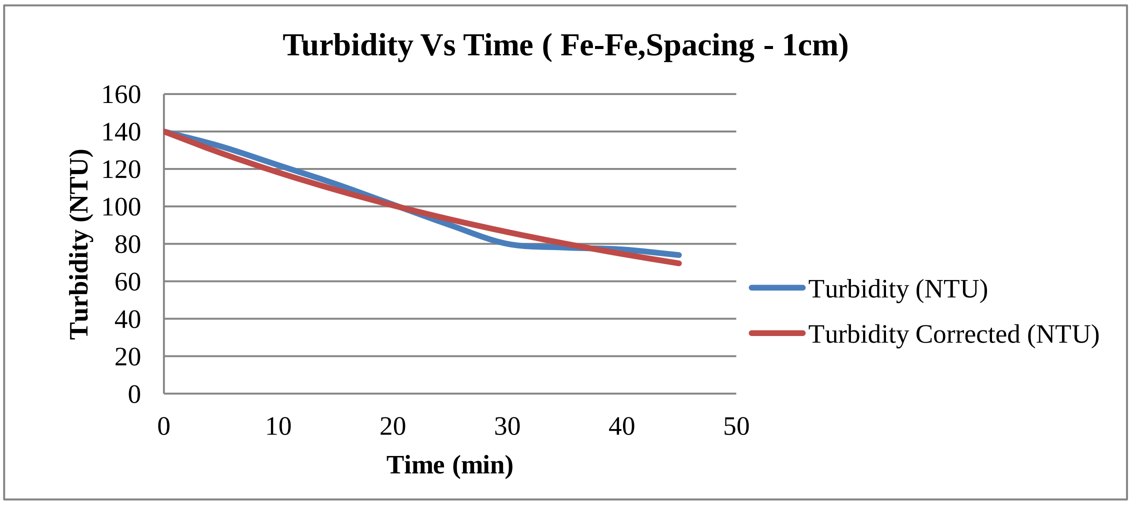


Fig 6.9.26 Turbidity Vs Time

Case 15 :BOD Concentration Vs Time (Fe-Fe,Spacing - 0.5 cm					
X (Independent)	Y (Dependent)				
Time (min)	BOD Concentration (mg/l)	BOD Corrected Concentration (mg/l)	Squared error	Constants	
0	4912	4912	0	K	0.1
5	4519	4314.593769	0.00204599	n	0.84
10	4028	3779.445961	0.0038077	R Square	0.978285706
15	3587	3301.196495	0.006348518		
20	3144	2874.84557	0.007328886		
25	2652	2495.736541	0.003471905		
30	2266	2159.539255	0.002207289		
35	2210	1862.233852	0.024762248		
40	2186	1600.095017	0.071837973		
45	2105	1369.67669	0.122026026		
		Sum of square error	0.243836535		
		Normalized STD deviation	16.45993569		

Fig 6.9.27 Data set for BOD Vs Time

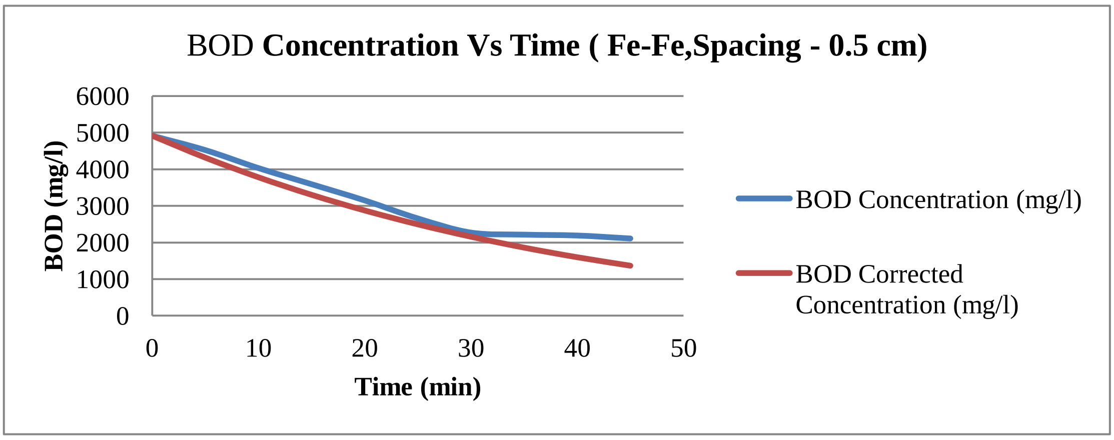


Fig 6.9.28 BOD concentration Vs Time

Case 16 : TSS Concentration Vs Time (Fe-Fe,Spacing - 1 cm)					
X (Independent)	Y (Dependent)				
Time (min)	TSS Concentration (mg/l)	TSS Corrected Concentration (mg/l)	Squared error	Constants	
0	592	592	0	K	0.1
5	527	518.4390786	0.000263888	n	0.79
10	465	452.2952269	0.000746497	R Square	0.977747837
15	403	393.0040598	0.00061523		
20	361	340.0293752	0.003374491		
25	320	292.8625282	0.00719182		
30	280	251.0217992	0.01071092		
35	272	214.0517589	0.045388174		
40	266	181.522627	0.100859666		
45	256	153.0296273	0.161787379		
		Sum of square error	0.330938065		
		Normalized STD deviation	19.17573886		

Fig 6.9.29 Data set for TSS Concentration Vs Time

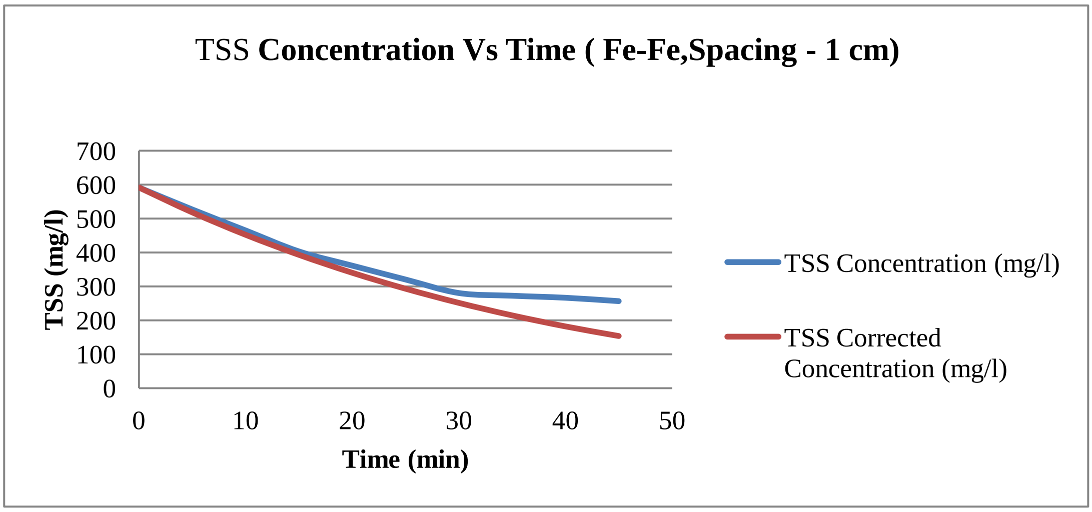


Fig 6.9.30 TSS Concentration Vs Time

6.5 RESULT FROM – MODELLING OF SECOND EQUATION

$$t_N = \frac{1}{K} \ln\left(\frac{C_0}{C_t}\right)$$

Modelling of the above equation was done on excel software for different parameters like COD, Turbidity, BOD and TSS Concentration , at spacing between electrode as 0.5 cm and 1 cm , for Al-Al electrode and Fe-Fe electrode , to generate following plots :

6.5.1 FOR Al-Al – SPACING 0.5 CM & 1 CM

Case 1 :COD Concentration Vs Time (Al-Al ,Spacing - 0.5 cm					
X (Independent)	Y (Dependent)				
Time (min)	COD Concentration (mg/l)	COD Corrected Concentration (mg/l)	Squared error	Constant	
0	20160	20160	0	K	0.03
5	18144	17351.8728	0.001906004	R Square	0.985397
10	15725	14934.89533	0.002524573		
15	13727	12854.58354	0.00403921		
20	11088	11064.04258	4.66846E-06		
25	9072	9522.909703	0.002470433		
30	7023	8196.44434	0.027917701		
35	6451	7054.745022	0.00875897		
40	6048	6072.075312	1.5846E-05		
45	5916	5226.283655	0.013592042		
		Sum of squared error	0.061229448		
		Normalized STD deviation	8.248194923		

Fig 6.9.31 Data set for COD concentration Vs Time

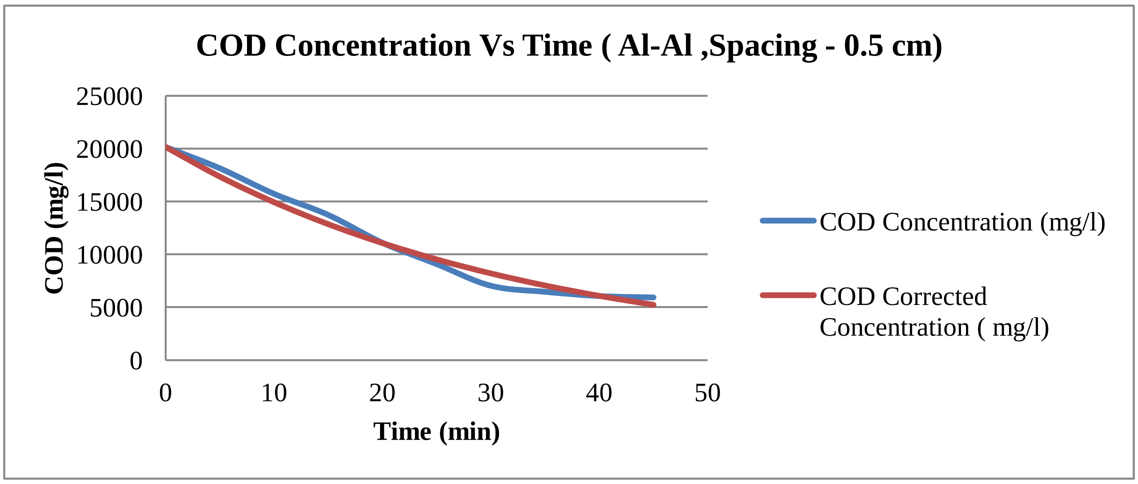


Fig 6.9.32 COD concentration Vs Time

Case 2 :Turbidity Vs Time (Al-Al ,Spacing - 0.5 cm					
X (Independent)	Y (Dependent)				
Time (min)	Turbidity (NTU)	Turbidity Corrected (NTU)	Squared error	Constant	
0	156	156	0	K	0.021274
5	140	140.2583399	3.40508E-06	R Square	0.980963
10	122	126.1051405	0.001132235		
15	107	113.3801132	0.003555406		
20	97	101.9391439	0.002592746		
25	87	91.65266091	0.002859989		
30	77	82.4041671	0.004925792		
35	73	74.08892102	0.000222509		
40	70	66.61275044	0.002341522		
45	68	59.89098586	0.014220612		
		Sum of squared error	0.031854215		
		Normalized STD deviation	5.94924974		

Fig 6.9.33 Data set for Turbidity Vs Time

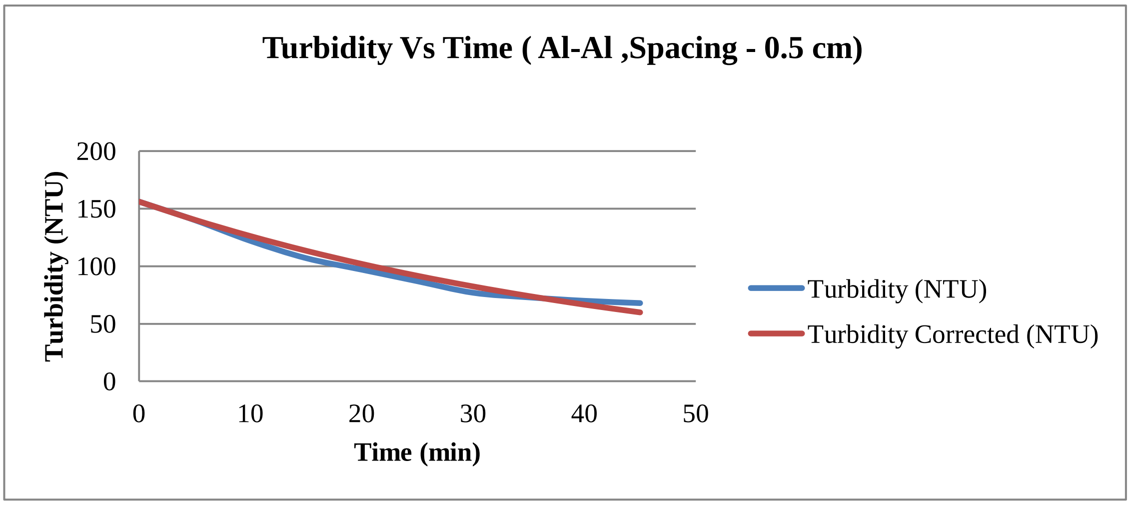


Fig 6.9.34 Turbidity Vs Time

Case 3 :BOD Concentration Vs Time (Al-Al ,Spacing - 0.5 cm					
X (Independent)	Y (Dependent)				
Time (min)	BOD Concentration (mg/l)	BOD Corrected Concentration (mg/l)	Squared error	Constant	
0	5423	5423	0	K	0.03071
5	4880	4651.07243	0.002200678	R Square	0.987363
10	4223	3989.023557	0.003069744		
15	3610	3421.212888	0.00273483		
20	2983	2934.226247	0.000267341		
25	2440	2516.558879	0.00098449		
30	1877	2158.343651	0.022467032		
35	1735	1851.117952	0.004479193		
40	1681	1587.623764	0.003085584		
45	1538	1361.636201	0.013149409		
		Sum of squared error	0.0524383		
		Normalized STD deviation	7.633136804		

Fig 6.9.35 Data set for BOD Vs Time

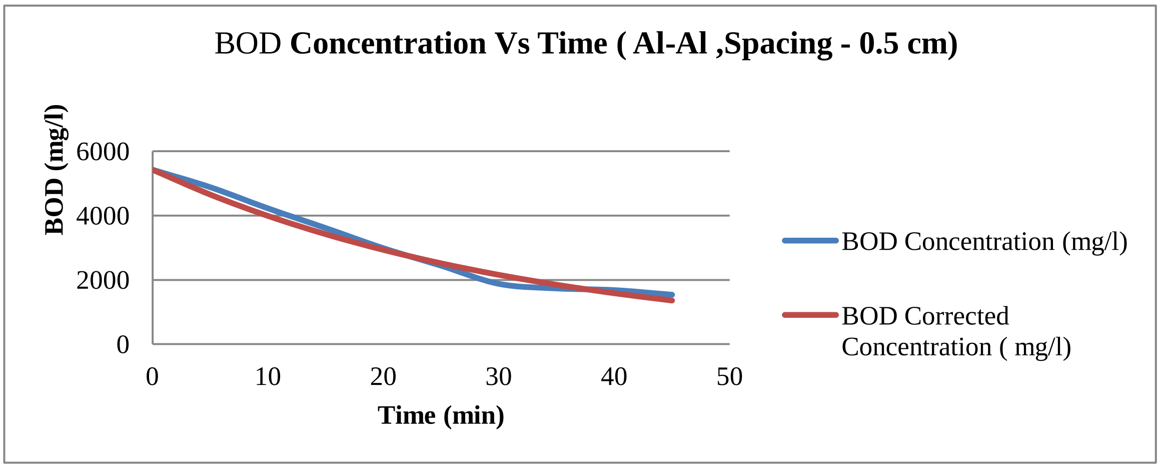


Fig 6.9.36 BOD Vs Time

Case 4 :TSS Concentration Vs Time (Al-Al ,Spacing - 0.5 cm)					
X (Independent)	Y (Dependent)				
Time (min)	TSS Concentration (mg/l)	TSS Corrected Concentration (mg/l)	Squared error	Constant	
0	650	650	0	K	0.023976
5	578	576.5665493	6.15049E-06	R Square	0.981869
10	500	511.4292088	0.000522507		
15	424	453.6507294	0.00489034		
20	377	402.3997472	0.004539166		
25	338	356.938821	0.003139587		
30	292	316.613822	0.007105463		
35	279	280.8445213	4.37078E-05		
40	266	249.1162408	0.004028794		
45	252	220.9724482	0.015159816		
		Sum of squared error	0.039435532		
		Normalized STD deviation	6.619460517		

Fig 6.9.37 Data set for TSS Concentration Vs Time

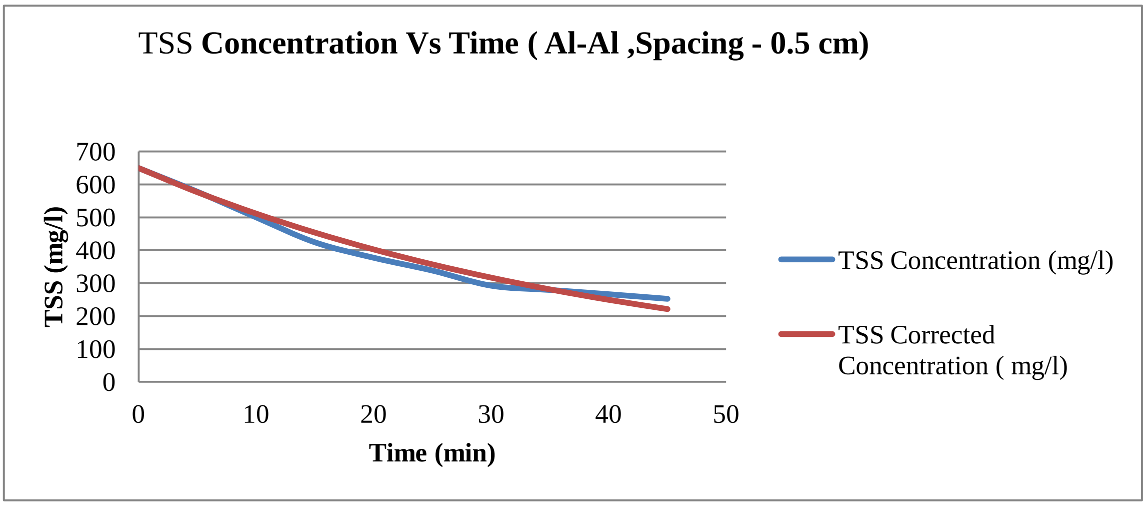


Fig 6.9.38 TSS concentration Vs Time

Case 5 :COD Concentration Vs Time (Al-Al ,Spacing - 1cm)					
X (Independent)	Y (Dependent)				
Time (min)	COD Concentration (mg/l)	COD Corrected Concentration (mg/l)	Squared error	Constant	
0	20160	20160	0	K	0.02497
5	18547	17793.82714	0.001649081	R Square	0.980709
10	16531	15705.37124	0.00249443		
15	14816	13862.03676	0.004145733		
20	13306	12235.05386	0.006477989		
25	10483	10799.02944	0.000908833		
30	8412	9531.550748	0.017712874		
35	8064	8412.835634	0.001871288		
40	7459	7425.42376	2.0263E-05		
45	7194	6553.904108	0.007916792		
		Sum of squared error	0.043197283		
		Normalized STD deviation	6.927985368		

Fig 6.9.39 Data set for COD Vs Time

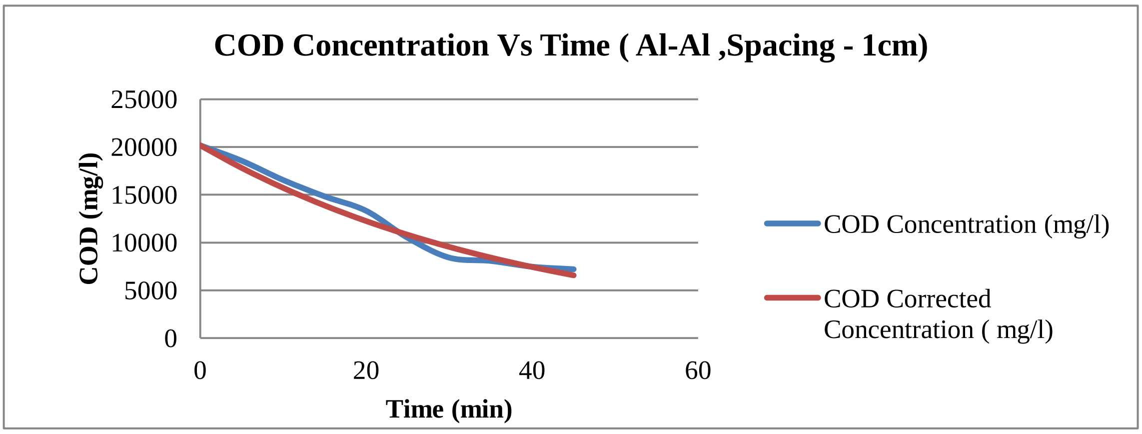


Fig 6.9.40 COD concentration Vs Time

Case 6 :Turbidity Vs Time (Al-Al ,Spacing - 1 cm					
X (Independent)	Y (Dependent)				
Time (min)	Turbidity (NTU)	Turbidity Corrected (NTU)	Squared error	Constant	
0	156	156	0	K	0.02
5	143	141.1546372	0.00016653	R Square	0.973422
10	128	127.7219975	4.71713E-06		
15	113	115.5676424	0.000516312		
20	106	104.5699272	0.000182014		
25	97	94.61878292	0.000602635		
30	89	85.61461523	0.001446892		
35	87	77.46730739	0.012005843		
40	84	70.0953184	0.027400818		
45	82	63.42486692	0.051314035		
		Sum of squared error	0.093639795		
		Normalized STD deviation	10.20020672		

Fig 6.9.41 Data set for Turbidity Vs Time

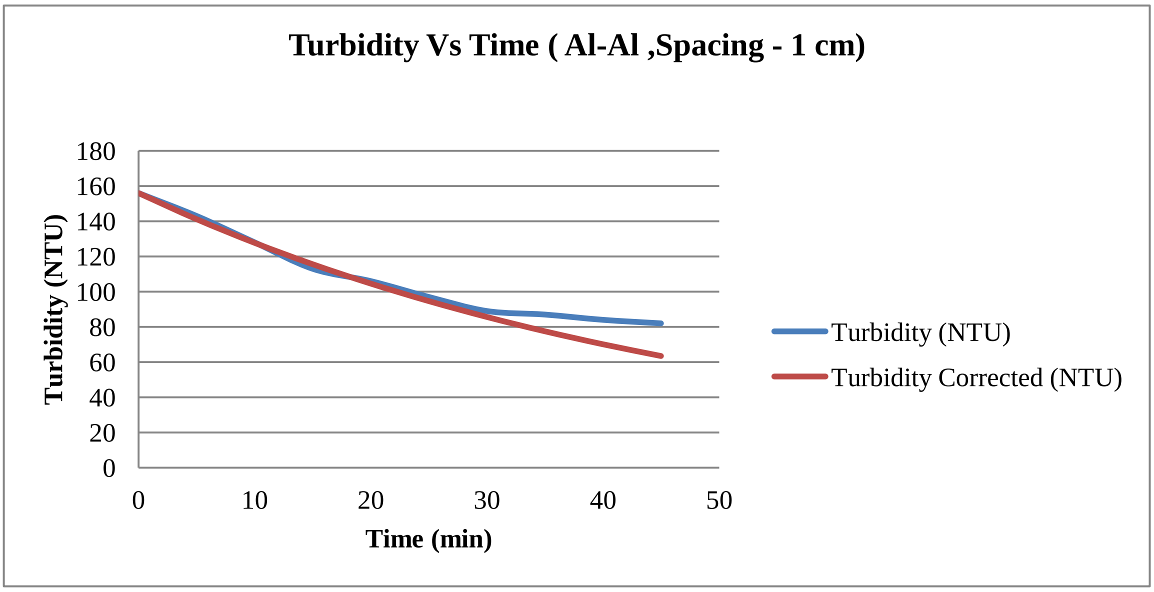


Fig 6.9.42_ Turbidity Vs Time

Case 7 :BOD Concentration Vs Time (Al-Al ,Spacing -1 cm					
X (Independent)	Y (Dependent)				
Time (min)	BOD Concentration (mg/l)	BOD Corrected Concentration (mg/l)	Squared error	Constant	
0	5423	5423	0	K	0.03
5	4935	4667.619356	0.002935524	R Square	0.983976
10	4338	4017.457211	0.005460004		
15	3812	3457.857466	0.008630787		
20	3254	2976.205503	0.007288064		
25	2603	2561.643816	0.000252425		
30	2076	2204.827265	0.003850888		
35	2006	1897.712413	0.00291404		
40	1898	1633.376211	0.019438616		
45	1779	1405.859933	0.04399384		
		Sum of squared error	0.094764188		
		Normalized STD deviation	10.26126416		

Fig 6.9.43 Data set for BOD concentration Vs Time

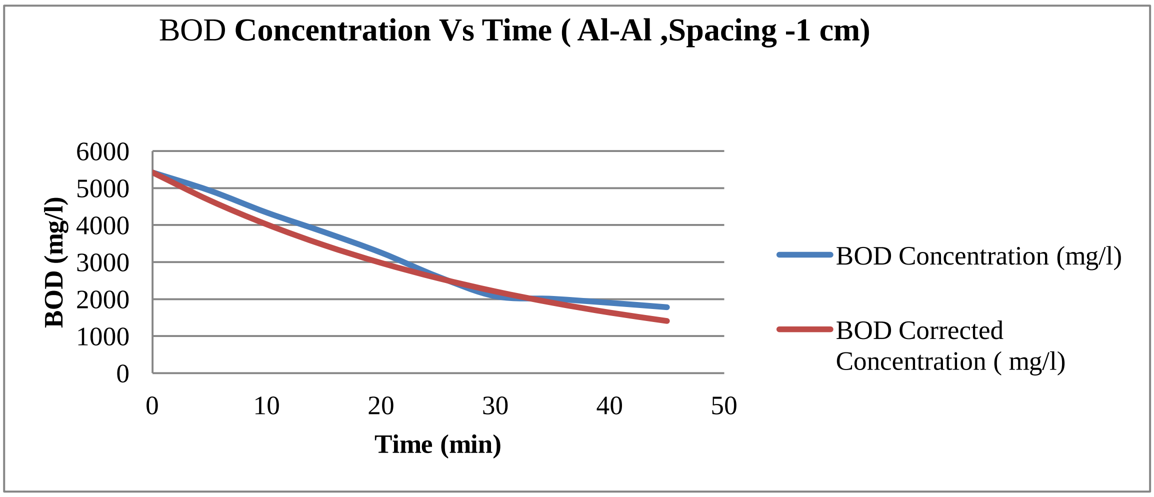


Fig 6.9.44 BOD Concentration Vs Time

Case 8 :TSS Concentration Vs Time (Al-Al ,Spacing - 1cm)					
X (Independent)	Y (Dependent)				
Time (min)	TSS Concentration (mg/l)	TSS Corrected Concentration (mg/l)	Squared error	Constant	
0	650	650	0	K	0.024
5	585	576.4982839	0.000211204	R Square	0.98061
10	513	511.3081097	1.0877E-05		
15	442	453.4896119	0.000675719		
20	390	402.2092047	0.000980044		
25	344	356.7275635	0.001368906		
30	302	316.3889664	0.002270102		
35	292	280.6118402	0.001521043		
40	279	248.8803759	0.011654421		
45	271	220.7370917	0.034399858		
		Sum of squared error	0.053092173		
		Normalized STD deviation	7.680579588		

Fig 6.9.45 Data set for TSS Concentration Vs Time

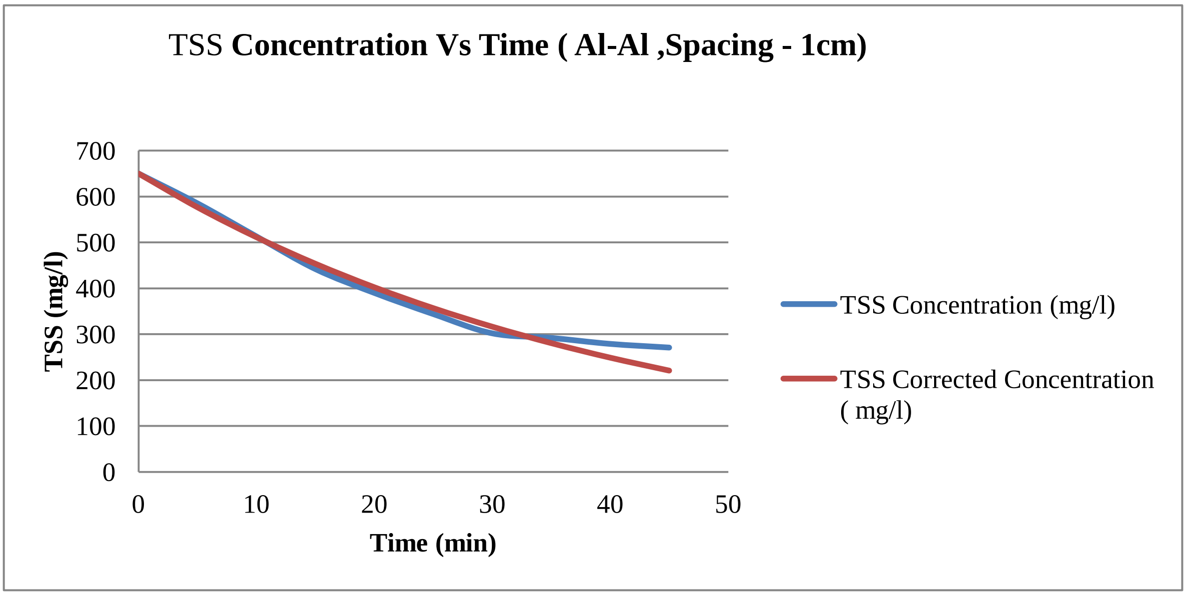


Fig 6.9.46 TSS Concentration Vs Time

6.5.2 FOR Fe-Fe ELECTRODE – SPACING 0.5 CM & 1 CM

Case 9 :COD Concentration Vs Time (Fe-Fe,Spacing - 0.5 cm)					
X (Independent)	Y (Dependent)				
Time (min)	COD Concentration (mg/l)	COD Corrected Concentration (mg/l)	Squared error	Constant	
0	18420	18420	0	K	0.026
5	16578	16174.51784	0.000592358	R Square	0.98672
10	14736	14202.77021	0.001309392		
15	13096	12471.38763	0.002274803		
20	11052	10951.06849	8.34011E-05		
25	9210	9616.083208	0.001944065		
30	7468	8443.838728	0.01707448		
35	6997	7414.496207	0.003560257		
40	6723	6510.635242	0.000997789		
45	6321	5716.959058	0.009131901		
		Sum of squared error	0.036968445		
		Normalized STD deviation	6.409060019		

Fig 6.9.47 Data set for COD concentration Vs Time

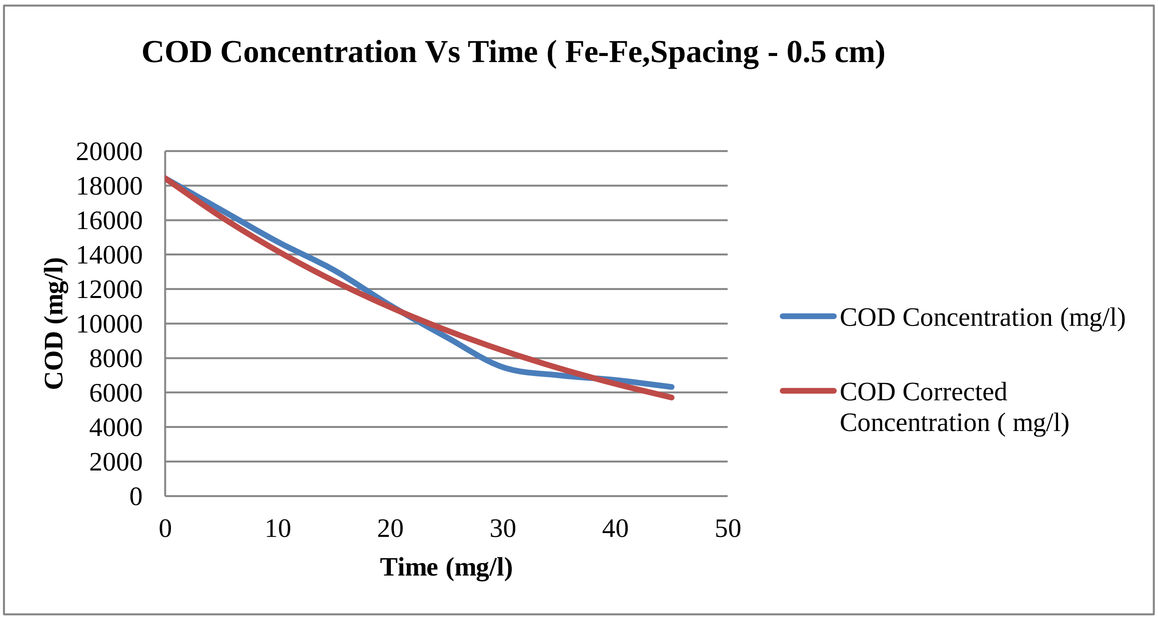


Fig 6.9.48 COD concentration Vs Time

Case 10 :Turbidity Vs Time (Fe-Fe,Spacing - 0.5 cm)					
X (Independent)	Y (Dependent)				
Time (min)	Turbidity (NTU)	Turbidity Corrected (NTU)	Squared error	Constant	
0	140	140	0	K	0.02
5	130	126.6772385	0.000653298	R Square	0.983981
10	119	114.6223054	0.001353309		
15	109	103.7145509	0.002351315		
20	94	93.84480644	2.72579E-06		
25	81	84.91429236	0.002335267		
30	72	76.83362905	0.004506939		
35	67	69.52194253	0.00141684		
40	65	62.90605498	0.001037777		
45	62	56.91975236	0.006714078		
		Sum of squared error	0.020371548		
		Normalized STD deviation	4.757631055		

Fig 6.9.49 Data set for Turbidity Vs Time

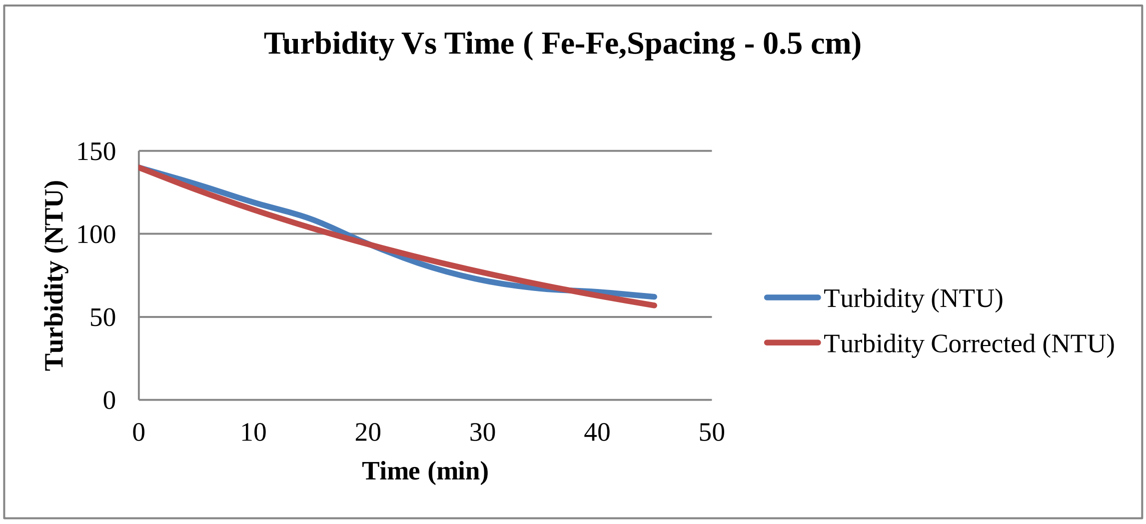


Fig 6.9.50 Turbidity Vs Time

Case 11 :BOD Concentration Vs Time (Fe-Fe,Spacing - 0.5 cm)					
X (Independent)	Y (Dependent)				
Time (min)	BOD Concentration (mg/l)	BOD Corrected Concentration (mg/l)	Squared error	Constant	
0	4912	4912	0	K	0.025
5	4372	4334.824785	7.23014E-05	R Square	0.990194
10	3831	3825.469446	2.08407E-06		
15	3321	3375.964937	0.000273926		
20	2780	2979.278601	0.005138445		
25	2407	2629.204137	0.008522207		
30	2087	2320.264507	0.012492588		
35	1965	2047.626241	0.001768117		
40	1817	1807.023815	3.01453E-05		
45	1679	1594.69292	0.002521313		
		Sum of squared error	0.030821127		
		Normalized STD deviation	5.851982304		

Fig 6.9.51 Data set for BOD concentration Vs Time

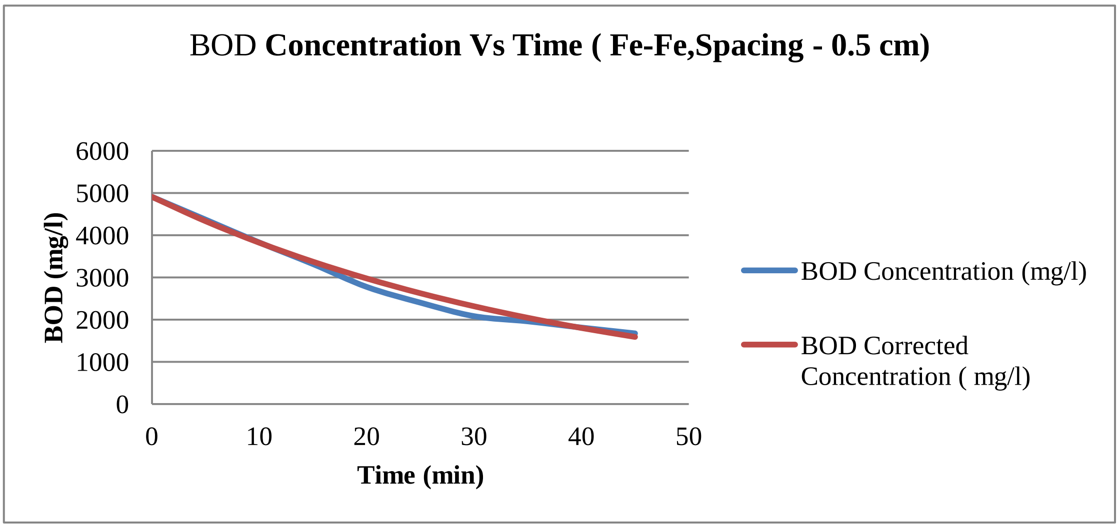


Fig 6.9.52 BOD Concentration Vs Time

Case 12 :TSS Concentration Vs Time (Fe-Fe,Spacing - 0.5 cm)					
X (Independent)	Y (Dependent)				
Time (min)	TSS Concentration (mg/l)	TSS Corrected Concentration (mg/l)	Squared error	Constant	
0	592	592	0	K	0.02372
5	521	525.7928806	8.46287E-05	R Square	0.974367
10	456	466.9901238	0.000580865		
15	392	414.7636527	0.003372188		
20	343	368.3779995	0.005474274		
25	296	327.1799485	0.011096023		
30	266	290.5893371	0.00854536		
35	260	258.0908862	5.39159E-05		
40	249	229.2269434	0.006305927		
45	238	203.5910387	0.020902066		
		Sum of squared error	0.056415248		
		Normalized STD deviation	7.917298084		

Fig 6.9.53 Data set for TSS Concentration Vs Time

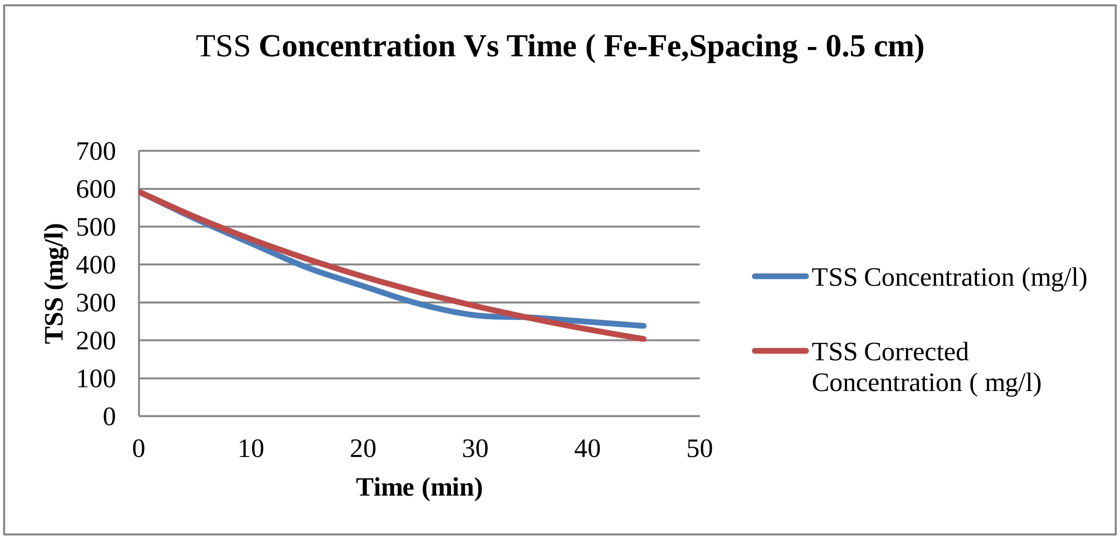


Fig 6.9.54 TSS Concentation Vs Time

Case 13 :COD Concentration Vs Time (Fe-Fe,Spacing - 1cm)					
X (Independent)	Y (Dependent)				
Time (min)	COD Concentration (mg/l)	COD Corrected Concentration (mg/l)	Squared error	Constant	
0	18420	18420	0	K	0.024
5	16946	16337.07444	0.001291201	R Square	0.985751
10	15473	14489.6852	0.004038649		
15	13922	12851.19793	0.005915823		
20	11605	11397.99008	0.000318194		
25	9947	10109.11034	0.000265606		
30	8096	8965.976555	0.011547131		
35	7921	7952.107842	1.54234E-05		
40	6700	7052.88696	0.002774097		
45	6484	6255.349582	0.001243535		
		Sum of squared error	0.027409659		
		Normalized STD deviation	5.518620894		

Fig 6.9.55 Data set for COD Concentration Vs Time

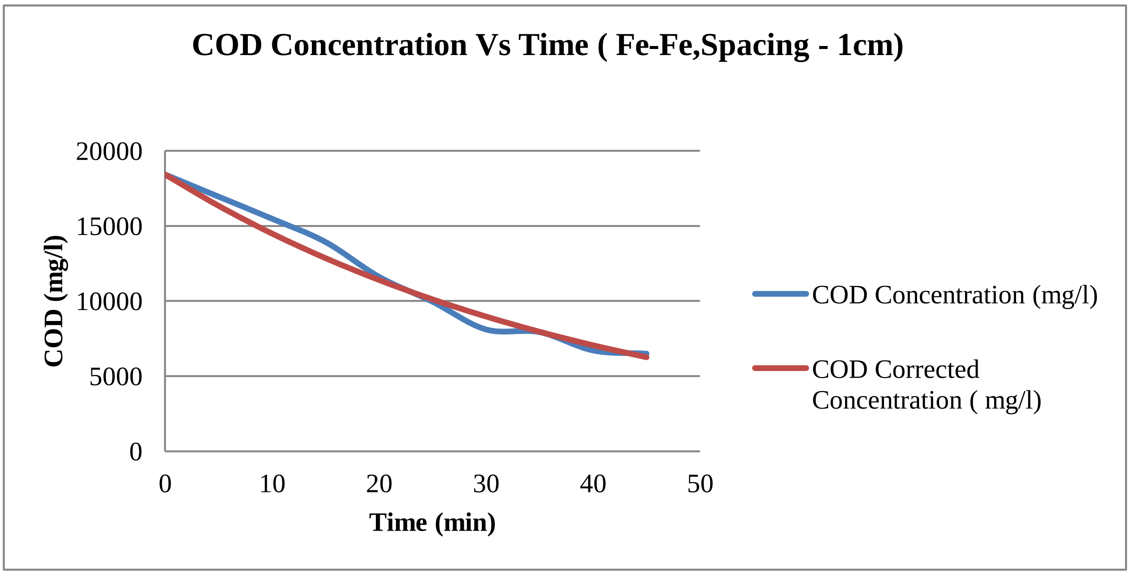


Fig 6.9.56 COD concentration Vs Time

Case 14 :Turbidity Vs Time (Fe-Fe,Spacing - 1cm					
X (Independent)	Y (Dependent)				
Time (min)	Turbidity (NTU)	Turbidity Corrected (NTU)	Squared error	Constant	
0	140	140	0	K	0.016
5	132	129.2362885	0.000438367	R Square	0.977088
10	122	119.3001305	0.00048974		
15	112	110.1279005	0.000279397		
20	101	101.6608652	4.28137E-05		
25	90	93.84480644	0.001825005		
30	80	86.62967485	0.006867592		
35	78	79.96926894	0.000637413		
40	77	73.82093937	0.001704575		
45	74	68.14531583	0.006259556		
		Sum of squared error	0.018544458		
		Normalized STD deviation	4.53926794		

Fig 6.9.57 Data set for Turbidity Vs Time

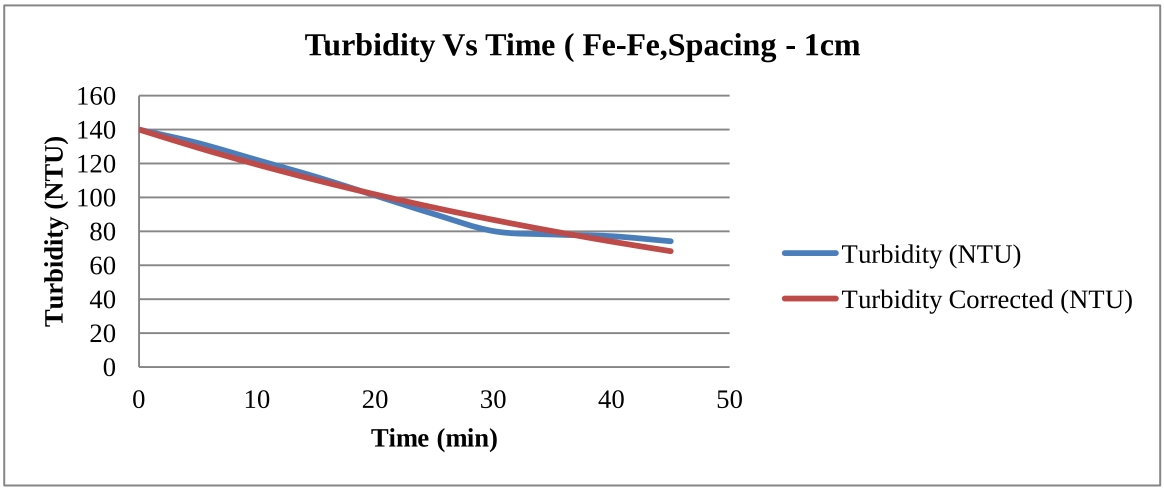


Fig 6.9.58 Turbidity Vs Time

Case 15 :BOD Concentration Vs Time (Fe-Fe,Spacing - 0.5 cm)					
X (Independent)	Y (Dependent)				
Time (min)	BOD Concentration (mg/l)	BOD Corrected Concentration (mg/l)	Squared error	Constant	
0	4912	4912	0	K	0.022
5	4519	4400.337273	0.000689515	R Square	0.97623
10	4028	3941.972336	0.000456139		
15	3587	3531.353379	0.000240666		
20	3144	3163.5069	3.84956E-05		
25	2652	2833.977469	0.004708561		
30	2266	2538.773755	0.014490566		
35	2210	2274.320192	0.000847052		
40	2186	2037.413662	0.004620165		
45	2105	1825.184706	0.017670087		
		Sum of squared error	0.043761247		
		Normalized STD deviation	6.973063034		

Fig 6.9.59 Data set fof BOD Concentration Vs Time

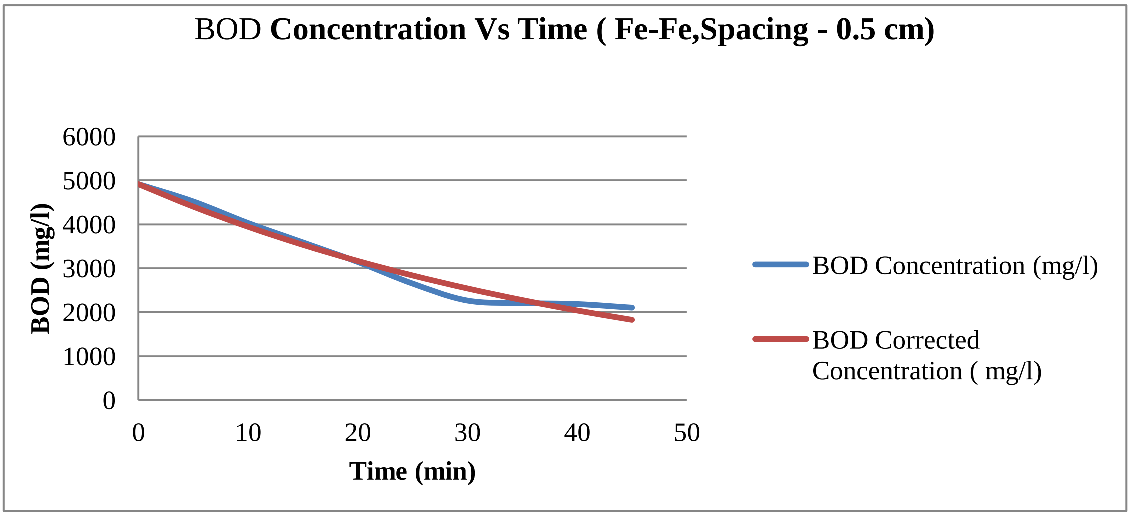


Fig 6.9.60 BOD Concentration Vs Time

Case 16 :TSS Concentration Vs Time (Fe-Fe,Spacing - 1 cm)					
X (Independent)	Y (Dependent)				
Time (min)	TSS Concentration (mg/l)	TSS Corrected Concentration (mg/l)	Squared error	Constant	
0	592	592	0	K	0.022
5	527	530.3338081	4.00184E-05	R Square	0.975126
10	465	475.0911284	0.000470949		
15	403	425.6028502	0.003145693		
20	361	381.2695613	0.003152639		
25	320	341.5542877	0.004536986		
30	280	305.97599	0.008606531		
35	272	274.1037364	5.98198E-05		
40	266	245.5514837	0.005909631		
45	256	219.9734011	0.019804624		
		Sum of squared error	0.04572689		
		Normalized STD deviation	7.127948934		

Fig 6.9.61 Data set for TSS concentration Vs Time

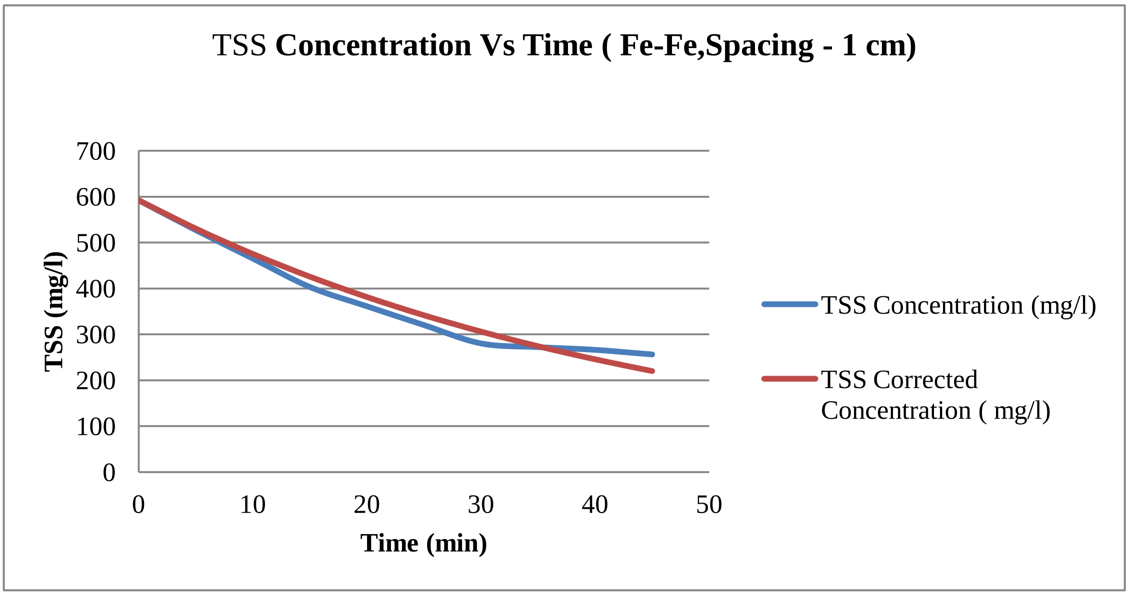


Fig 6.9.62 TSS concentration Vs Time

CHAPTER - 7

CONCLUSIONS

7.1 CONCLUSION

Electro-coagulation is an actual synthetic treatment technique as a therapy for wastewater that contain high convergence of substantial metals, oils , oil , COD, BOD, Turbidity, and TSS. We have perform motor demonstrating in Electro-coagulation measure and have ascertain K (active rate consistent), n (request of response), and R square incentive for various boundaries like COD, Turbidity, BOD, and TSS, for both Al-Al anode and Fe-Fe terminal, and for separating 0.5 cm and 1 cm .

Aluminum anode was seen to be more effective than Iron cathode in eliminating pollutants . Plots for different tests exhibit that internal cathode distance or dispersing between electrons assume a vital part in demonstrating. From the displaying , ideal benefit of dividing was seen to be 0.5 cm .

7.2 SUGGESTIONS FOR FUTURE STUDY

- Yes EC process is fast than other conventional treatment methods of wastewater , but still it is not used on a large scale .
- Though little quantity of sludge is formed in EC process , it might dissolve metals and demand extra attention.

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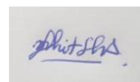

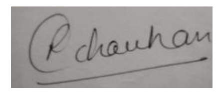

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