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Effect of different parameters on removal of suspended solids of UMK lake using electrocoagulation process

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DECLARATION

I declare that this thesis entitled "Effect of different parameters on removal of suspended solids of UMK lake using electrocoagulation process" is the result of my own research except as cited in the references.

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Effect of different parameters on removal of suspended solids of UMK lake using electrocoagulation process

ABSTRACT

Water quality and ecological balance are paramount in natural water, which is why the removal of suspended solids (SS) from it remains crucial. The efficiency of the Electrocoagulation (EC) process in terms of reducing suspended solids from UMK Lake was investigated in this study. Different parameters from current density, electrode material to pH and treatment time were observed during the examination of removal efficiency of suspended solids. In this experiment, three set experiments run in the lab were conducted using an electrocoagulation system made specifically for these purposes with aluminum electrodes. In order to determine the proper operating condition, water samples were taken from UMK Lake and treated under different conditions. The efficiency of removal efficacy of the suspended solids was then calculated by comparing turbidity and total suspension concentration before treatment to that after purification. The Observations show that electrocoagulation is more effective in removing suspended solids from UMK Lake water, using aluminum electrodes that use different distances and times to show the removal efficiency. In general, the findings of this study have shown that electrocoagulation is a promising technology ameliorating suspended solids in natural water bodies including UMK Lake. The results provide important information concerning the factors governing SS removal efficiency in electrocoagulation processes and design recommendations for improving treatment protocols under actual conditions.

Keywords: Treatment for wastewater using electrocoagulation

Kesan parameter yang berbeza terhadap penyingkiran pepejal terampai tasik UMK menggunakan proses elektrokoagulasi

ABSTRAK

Kualiti air dan keseimbangan ekologi adalah terpenting dalam air semula jadi, itulah sebabnya penyingkiran pepejal terampai (SS) daripadanya kekal penting. Kecekapan proses Electrocoagulation (EC) dari segi mengurangkan pepejal terampai dari Tasik UMK telah dikaji dalam kajian ini. Parameter yang berbeza daripada ketumpatan arus, bahan elektrod kepada pH dan masa rawatan diperhatikan semasa pemeriksaan kecekapan penyingkiran pepejal terampai. Dalam eksperimen ini, tiga set eksperimen yang dijalankan di makmal telah dijalankan menggunakan sistem elektrokoagulasi yang dibuat khusus untuk tujuan ini dengan elektrod aluminium. Untuk menentukan keadaan operasi yang betul, sampel air telah diambil dari Tasik UMK dan dirawat di bawah keadaan yang berbeza. Kecekapan keberkesanan penyingkiran pepejal terampai kemudiannya dikira dengan membandingkan kekeruhan dan jumlah kepekatan ampaian sebelum rawatan dengan selepas penulenan. Pemerhatian menunjukkan bahawa elektrokoagulasi adalah lebih berkesan dalam mengeluarkan pepejal terampai dari air Tasik UMK, menggunakan elektrod aluminium yang menggunakan jarak dan masa yang berbeza untuk menunjukkan kecekapan penyingkiran. Secara amnya, dapatan kajian ini telah menunjukkan bahawa elektrokoagulasi adalah teknologi yang menjanjikan memulihkan pepejal terampai dalam badan air semula jadi termasuk Tasik UMK. Hasilnya memberikan maklumat penting mengenai faktor yang mengawal kecekapan penyingkiran SS dalam proses elektrokoagulasi dan cadangan reka bentuk untuk menambah baik protokol rawatan di bawah keadaan sebenar.

Kata kunci: Rawatan untuk air sisa menggunakan electrocoagulation

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND STUDY

In place of costly chemical reagents, electrocoagulation (EC) is an electrochemical method for treating polluted water. It has been used to treat soluble or colloidal contaminants in a variety of industrial effluents, including those from the food industry, tanning plants, and mechanical workshops. Heavy metals, suspended solids, emulsified organics, and numerous other pollutants are present in the wastewater from the (soluble oil) polymerization production and textile industries (Erick Butler et al. 2011).

When compared to traditional flocculation-coagulation, electrocoagulation has the advantage of being able to remove the smallest colloidal particles. This is because charged particles are more likely to be coagulated and destabilised due to the electric field that propels them into motion. Additionally, electrocoagulation-flotation can decrease the amount of waste generated during the treatment of wastewater and the amount of time needed (Nazih et al., 2010). The technology of electrocoagulation has been used for a long time to purify water and remove a variety of impurities. The idea of electrochemical treatment (EC) was originally put forth in London by Vik et al. in 1889, where a sewage treatment facility had been constructed and EC was applied by combining domestic wastewater with saline (sea)water (I. Kabdasl et al. 2012). In order to treat ship bilge water, A. E. Dietrich originally patented the electrocoagulation technique in 1906. J.T. Harries was given a patent in the US in 1909 for electrolysis-based wastewater treatment employing sacrificial aluminium and iron anodes.

After that, numerous water and wastewater uses under various circumstances followed. Electrocoagulation has re-emerged as a viable technique at a time when environmental restrictions are being put enormous pressure on businesses to come up with novel ways to comply. Applications for electrocoagulation in industrial wastewater processing were discussed in this research. With particular emphasis on the various sections, a review of the literature published from 2010 to 2013 on electrocoagulation treatment of wastewater has been presented. For example, sacrificial electrode materials and electrical energy requirements, as well as optimisation, modelling, different wastewater treatment processes, analytical, instrumentation, and comparison with other treatment methods.

1.2 PROBLEM STATEMENT

The use of electrocoagulation technology, pollutants can be treated and flocculated without the need of coagulants. According to Shammas et al., coagulation happens when current is applied and is capable of eliminating small particles because direct current applied causes them to move. Additionally, electrocoagulation may reduce waste production residue. Water contamination is becoming a major impediment to any society's long-term growth. Many transition economies have weak economies. Water quality management is one of the most significant responsibilities in other developing countries. Part of the problem is that big, flawless, but impossible programmes are often postponed. Worse, realistic step-by-step solutions were ignored, resulting in the failure of even achievable undertakings. Construction of waste water treatment plants (WWTP) is only one (and often not the most expensive) component of the complex measures that must be implemented as part of water pollution management planning. Stormwater drainage, sewer rehabilitation, sludge disposal, and recipient section regulation are frequently significantly more involved and, of course, more expensive. For a variety of reasons, electrocoagulation is a viable alternative to traditional chemical coagulation. Due to the coagulant being provided by the electrodes, electrocoagulation can reduce the requirement for chemicals. However, many people continue to use chemical coagulants in an effort to improve treatment. Alum, iron chloride, or ferrous sulphate are typically used in chemical coagulation, which can be highly expensive based on the amount of water treated. When the coagulant is used, it serves a similar purpose to that of the electrodes by neutralising the electrical charge of the particles, allowing them to clump together and sink to the bottom of the tank. Additionally, electrocoagulation-flotation can decrease the amount of waste generated during the treatment of wastewater and the amount of time required

1.3 Expected outcome

In wastewater treatment, considering and addressing the factors that affect the removal efficiencies of suspended solids can lead to several expected outcomes to Improved Effluent Quality By optimizing the removal of suspended solids, the effluent quality of the wastewater treatment plant is enhanced. This means a reduction in the concentration of solids in the treated wastewater, resulting in clearer and cleaner effluent. Enhanced Treatment Process Performance Understanding and optimizing the factors that affect the removal efficiencies of suspended solids can lead to improved performance of the treatment processes. This includes more effective coagulation, flocculation, sedimentation, and filtration, resulting in higher removal efficiencies and improved overall treatment performance.

1.4 Objective

i. To study the effect of different electrode arrangements on suspended solid removal of UMK lake sample

ii. To study the effect of different electrode materials on suspended solid removal of UMK lake sample

iii. To characterize the UMK lake before and after electrocoagulation process using YSI multiparameter

1.5 Scope of study

The removal of suspended particles from UMK lake was explored within the scope of this study. The electrochemical approach, which employs the electrocoagulation process, was used to complete the task of eliminating suspended in the UMK lake. The Lake water collected for this investigation was acquired from the UMK Campus Jeli Lake. In order to determine the initial inductively coupled plasma (ICP) test was performed on a UMK lake sample to determine the quantity of suspended particles. The electrodes utilised in this study were made from aluminium, stainless steel, and mild steel. This investigation was carried out to determine the elements that contributed to the removal rate in the total volume of suspended particles extracted from water samples and to generate a more in-depth understanding of the current research topic that is the focus of the study.

Some of these factors include the configuration of the electrodes and the materials utilised to produce them. During the electrocoagulation procedure, an ICP reading was taken every 10 minutes for thirty minutes to assess the rate at which suspended particles were eliminated.

1.6 Significant study

The significance of this study stems from the fact that it will identify whether or not the amounts of suspended particles present in UMK lake are under the Malaysian Authority's allowed standard. This range was determined by earlier study undertaken by the Malaysian Authority. The purpose for ensuring that heavy metal ion concentrations are below the allowable threshold is so that any water from the fishpond that is released into the river does not contaminate it and cause the river water to become polluted. A high concentration of heavy metals can cause the water to become poisonous, which is dangerous not only to the aquatic life in the fishpond but also to the people who will consume the fish. The rationale for ensuring that suspended solids concentrations are below the allowable level is to ensure that any water released into the river from the UMK lake does not contaminate it and cause the river water to become polluted. The presence of a high concentration of suspended particles can lead the water to become increasingly poisonous, which is damaging not only to the aquatic life that lives in UMK lake, but also to the people who eat the fish. In this study, the water sample was electrocoagulation to remove the presence of suspended particulates. This is a common approach for wastewater treatment in the western hemisphere. On the other hand, it is not a very common wastewater treatment procedure in Malaysia. The results of this study will indicate whether or not the electrocoagulation method of treating wastewater can eventually be deployed as a viable alternative to current treatment methods.

LITERATURE REVIEW

2.1 Suspended solids in water body

Total suspended solids, or TSS for short, are waterborne particles larger than 2 microns. On the other hand, every particle less than 2 microns is referred to as a total dissolving solid (TDS). Although bacteria and algae can also be included in total suspended solids (TSS), inorganic materials make up the majority of TSS. TSS may include sand, particles, and plankton as well as anything else that floats or suspends in water. The organic particles released into the water when some water sources are polluted by dead plants or animals are typically suspended solids. While some sediment will sink to the bottom of a body of water, other TSS will float to the top or hang suspended somewhere in the middle. TSS has an impact on water clarity, hence the more TSS is present in a water supply, the less clear it will be. The most common suspended solids are bacteria, clay and sand. Well water sources are the most typical places to find bacteria. The two most prevalent species of aquatic bacteria are legionella and coliforms. When consumed, some bacteria represent a danger of illness, while others suggest that your water may contain germs that can cause illness. Once more, colloidal clay is a prevalent well water pollutant. Water may appear particularly hazy when exposed to this kind of TSS. While clay may not be harmful to health when consumed in small amounts, it is notoriously difficult to remove and may alter the taste of water. Wastewater contains natural elements and various types of components introduced as a result of human activities, including especially dangerous chemicals such as fertilizers, pesticides, oil derivatives or heavy metals. It may contain microbiological contamination as well as various organic and inorganic compounds such as ions, sediments, colloids and suspensions. High water quality is obtained through the purification process, aiming to increase its parameters through various purification methods. An inherent element of water use is waste water obtained from a number of processes associated with human activity. Wastewater is very harmful to the natural environment and therefore it is necessary to perform an adequate purification process

2.2 Effect of suspended solids

In the aquatic environment, macrophytes whether they are floating on the surface in the case of free-floating macrophytes, floating below the surface in the case of submerged macrophytes, or both are significant oxygen producers and food producers. The main way that SS can affect macrophytes and algae is by modifying the quantity of light that penetrates the water column. Reduced light penetration via the water column will slow the rate of photosynthesis by periphyton, emergent macrophytes, and submerged macrophytes, which will directly affect primary consumers. It is crucial to note, however, that this process is less significant for planktonic species such surface phytoplankton and floating-leaved or free-floating macrophytes. Additionally, different stream communities have diverse perspectives on the significance of instream primary producers throughout food chains. For instance, the small forested streams in New Zealand that Cowie (1983, 1985) studied get a significant amount of their energy from allochthonous sources such decomposing leaf detritus. Under these conditions, SS entering the waterbody play a significant role in the ecosystem. High levels of SS in transportation by fast flow rates can act to scour these organisms away from streambed substrates as well as being abrasive and damaging to the photosynthetic structures of organisms (Alabaster and Lloyd, 1982; Steinman and McIntire, 1990). Periphyton abundance can also be affected by SS through mechanisms other than reduced light penetration. By functioning as a transporter of nutrients like phosphorus and harmful substances like pesticides and herbicides from the land surface to the waterbody, SS can indirectly alter the quantity of phytoplankton, periphyton, and macrophytes (Kronvang et al., 2003). High levels of total suspended solids in wastewater or water for drinking can have an impact on both the environment and public health. High TSS can affect water quality by lowering naturally occurring dissolved oxygen levels and raising water temperature. This might make it impossible for aquatic creatures, like little fish, to thrive. TSS may also obscure sunlight, which might stop photosynthesis, reduce plant viability, and further reduce oxygen levels in water. Depending on the situation, the total suspended particles in drinking water may also have an impact on people's health. For instance, bacteria and algae may result in gastrointestinal problems, whereas metal pollution may cause catastrophic health impacts or even death. While some common TSS, such as sand and silt, may not be harmful to health, they can have an unsightly effect on home plumbing fixtures, fittings, and water-using appliances.

2.3 Factors that affecting the removal efficiencies of suspended solids

Suspended solids, consisting of fine particles and colloidal matter, are a common impurity found in water and wastewater. The efficient removal of suspended solids is crucial for ensuring water quality and meeting regulatory standards. However, achieving high removal efficiencies can be influenced by various factors. This essay explores the key factors that affect the removal efficiencies of suspended solids in water and wastewater treatment processes.

Coagulation One of the primary factors influencing the removal efficiency of suspended solids is the type and dosage of coagulants or flocculants used in the treatment process. Coagulants facilitate the destabilization of suspended solids by neutralizing their surface charges, while flocculants aid in the formation of larger, settleable flocs. The optimal dosage of these chemicals is crucial for achieving effective aggregation and settling of suspended solids. Insufficient dosing may result in incomplete removal, while excessive dosing can lead to the formation of smaller, non-settleable flocs.

Mixing Intensity is the intensity of mixing during coagulation and flocculation stages plays a significant role in determining the removal efficiency of suspended solids. Proper mixing ensures thorough contact between the suspended solids and the coagulants/flocculants, promoting the formation and growth of flocs. Inadequate mixing can result in poor aggregation, while excessive mixing can disrupt floc formation and hinder settling. Optimizing the mixing intensity is essential to maximize removal efficiencies.

The pH level of the water or wastewater is a critical parameter that affects the removal of suspended solids. The optimum pH range for coagulation and flocculation processes depends on the specific coagulant or flocculant used. pH adjustment may be necessary to enhance removal efficiency by facilitating charge neutralization and precipitation of solids. Deviations from the optimal pH range can hinder the effectiveness of the treatment process and reduce removal efficiencies. Particle Characteristics of suspended solids, including size, shape, density, and surface charge, significantly influence their removal efficiency. Larger particles are generally easier to remove than smaller ones due to their higher settling velocities. Irregularly shaped particles or those with complex surface properties may require additional treatment measures for efficient removal. Understanding the particle characteristics is crucial in selecting the appropriate treatment methods and optimizing removal efficiencies. Hydraulic Retention Time (HRT) the duration of contact between suspended solids and the treatment process, as determined by the hydraulic retention time, affects their removal efficiency.

Longer HRT allows for more extended sedimentation or filtration, promoting the settling or capture of suspended solids. Insufficient HRT may result in incomplete removal, while excessively long HRT can lead to clogging or fouling of the treatment system. Proper adjustment of HRT is necessary to optimize removal efficiencies. Temperature can influence the kinetics of coagulation and flocculation processes, thereby impacting the removal efficiency of suspended solids. Generally, higher temperatures accelerate reaction rates and promote faster floc formation. However, extreme temperatures can destabilize flocs and reduce removal efficiencies. Understanding the temperature sensitivity of the treatment process is crucial for maintaining optimal removal performance. The presence of organic matter, such as dissolved organic compounds or colloidal particles, can significantly affect the removal of suspended solids. Organic matter can interfere with coagulation or flocculation processes by competing for coagulant or flocculant binding sites or contributing to the stability of colloidal suspensions. Additional treatment steps, such as advanced oxidation or biological processes, may be necessary to address the removal of organic matter and enhance overall removal efficiencies. N Herlina and associates' research on the electrocoagulation-based removal of heavy metals included a study in 2021 on lowering iron, copper, and lead concentrates in leachate. It has been found that the amounts of heavy metals in leachate can be significantly reduced by the electrocoagulation method (N Herlina et al., 2021). One technique that can be used to get rid of the organic and heavy metal content in leachate is electrocoagulation. The electrocoagulation technique works on the basis of applying an electric current to an electrode plate in order to produce ions that have the ability to bind contaminants in water, acting as a coagulant. The advantages of electrocoagulation processing method are its very short retention period and small processing land requirements. The goal of this study is to examine how the batch system electrocoagulation method reduces the amounts of heavy metals in landfill leachate. The impact of the variables—contact time and electric voltage—that will be utilised in the partial electrocoagulation process is also examined. measurements.

2.4 Electrocoagulation process in suspended solids removal

Electro-coagulation is a sophisticated process that uses both chemical and physical mechanisms to remove contaminants from wastewater. When reactive electrodes such as iron or aluminium are utilised, Metal ions are formed (in situ), which results in the elimination of suspended particles. The process occurs in three stages: creation of coagulants by metal ion dissolution from the reactive electrode's anode, destabilisation of particulate or colloidal suspension, aggregation of the destabilised suspension, and formation of flocs (Mollah et al., 2004).

Ferrous ions (Fe2+) are discharged into solution by electrolytic oxidation of the anode material in iron electrodes. Depending on the pH of the solution, the generated ferrous ions hydrolyze to form monomeric hydroxide ions and polymeric hydroxide complexes. These polymeric hydroxides, which are strongly charged cations, destabilise negatively charged colloidal particles, allowing them to clump together and form flocs. In addition, depending on the solubility of the metal hydroxide, when the amount of iron added to water exceeds the solubility of the metal hydroxide, amorphous metal hydroxide precipitates occur, generating sweep-floc coagulation (Benefield et al., 1982). The purpose of this research is to look at the potential of the electro-coagulation method using iron electrodes for removing suspended particles, turbidity, and particulate BOD from municipal wastewater. The impacts of applied current and iron generation on the removal efficiency of the studied parameters are examined. Anodes and cathodes are placed in pairings of two electrodes, which are pairs of sheets of metal used in electrocoagulation. Using electrochemical principles, the cathode is oxidised as water content is reduced, improving the treatment of the wastewater. Metal is released into the device when the cathode electrode comes into touch with the wastewater. When this occurs, hydroxide complexes are formed in order to neutralise the particles and create agglomerates. These agglomerates can be removed through filtration and start to form towards the tank's bottom. The particles are going to float to the top of the tank using generated hydrogen bubbles that are produced from the anode when one thinks of an electrocoagulation-flotation setup. From the tank's top, the floated particles can be skimmed off. The inputs that follow or variables must be taken into account in order to determine the efficacy of the electrocoagulation reactor can be wastewater category, pH, current density, kind of metal electrodes, number of the electrodes, size of the electrodes, and configuration of ions. These factors would have an impact on the kinetics, removal efficiency, and overall treatment time. The electrochemical method of electrocoagulation (EC) removes microscopic particles from wastewater by treating it with an electric current instead of adding chemicals. Furthermore, EC was widely used and progressive because it was inexpensive to install and maintain initially, produced little sludge after treatment and required little time to settle, and had a high pollutant removal effectiveness. The EC method uses three different types of electrodes to treat wastewater: iron (Fe), aluminium (Al), and stainless steel (SS). (Das, Sharma, & Purkait, 2022)

2.5 Factor that improves the electrocoagulation efficiency

Electrocoagulation is an electrochemical process that utilizes an electric current to destabilize and aggregate suspended particles and colloidal matter, leading to their removal from water or wastewater. Several factors can improve the efficiency of electrocoagulation. Here are some key factors is Electrode Material. The selection of appropriate electrode materials is crucial for improving the electrocoagulation efficiency. Electrodes made of materials such as iron, aluminium, or graphite are commonly used. Different electrode materials offer varying levels of coagulation efficiency, and their performance can be influenced by factors such as surface area, surface roughness, and chemical reactivity. Choosing electrodes with optimal characteristics can enhance the efficiency of the electrocoagulation process. The configuration and arrangement of electrodes also play a role in improving efficiency. Electrodes can be arranged in parallel, series, or other configurations based on the specific application. The electrode spacing and arrangement should be optimized to ensure uniform current distribution and effective contact with the suspended solids. Proper electrode configuration helps maximize the surface area available for coagulation, leading to improved removal efficiency. Electric Current Density is the electric current density, expressed in A/m^2, is a critical parameter that affects electrocoagulation efficiency. The current density influences the rate of metal dissolution and the production of coagulant species. Higher current densities can lead to more rapid and effective coagulation. However, excessive current densities can result in electrode passivation and reduced efficiency. Optimizing the current density is necessary to achieve the desired removal efficiency without compromising the performance or lifespan of the electrodes. The pH of the water or wastewater undergoing electrocoagulation can significantly impact the removal efficiency. Adjusting the pH to an optimal range can enhance coagulation and flocculation processes. Generally, adjusting the pH to a slightly acidic or alkaline range improves the efficiency of metal dissolution and the generation of coagulant species. The pH adjustment should be performed carefully to ensure the stability of the treated water and to avoid any adverse effects. Water Chemistry is the composition of the water or wastewater, including the presence of ions, organic matter, and other contaminants, can influence the electrocoagulation efficiency. Understanding the water chemistry and its potential impact on the process is essential for optimizing removal efficiency.

Adjustments in coagulant dosage or pH control may be required to account for the specific water chemistry and improve overall efficiency. By considering and optimizing these factors, the electrocoagulation efficiency can be improved, leading to enhanced removal of suspended solids and improved water or wastewater treatment outcomes.

Throughout the whole electrocoagulation procedure, current. The most crucial factor in regulating the reaction rate is density. An increase in current density led to an improvement in the BOD, SS, and COD removal efficiency. For the electrocoagulation process to be successful, it is necessary to pay attention to several different parameters. The primary operating parameter that must be met for the electrocoagulation process to work effectively is a pH value that is between 3 and 7.5, an electric current that is between 0.03 and 0.09 A, an electrolytic concentration that is between 1 and 3 g/L, a distance between electrodes that is between 1 and 2 cm, and an electrolysis time that is between 20 and 60 minutes (M. Ebba, et al. 2021).

In order to find out what influences the electrocoagulation process when removing malachite green dye from a synthetic wastewater solution, Arslan H. and colleagues conducted research. Environmental Science and Technology is the publication where the research was published. The variables that were examined in this study were the dye's initial concentration, the amount of electrolyte, the pace of mixing, the current density, the duration of electrolysis, the pH level, and the distance between electrodes. According to the prior study's findings, the parameters that I will be controlling in this investigation are the electrolysis time and the distance that separates the electrodes. These two parameters regarding the electrocoagulation process were held constant for this study.Electrocoagulation for the efficient treatment of organic contaminants, (EC) and electro-oxidation (EO) have received a lot of attention as an alternative technology. Years, Instalments are popular because of convenience and cheapness especially financially. chemical usage. I especially a very means that EC differs from other technologies. a safe way to discharge impurities from wasters. Recent EC is competent to eliminate groundwater pollution, including TDS, chlorides, sulphates, potassium, calcium, mag Sodium, if not in high concentration, and nesium. Advances in research during recent years has resulted to the portability of EC equipment. Combined with suitable tailoring to the specifications of the industries data acquisition of current and voltage present for monitoring, thus andrate the complexity of humanizing the following sentence efficiency (Sriram Boinpally, Kolla, Jyoti Kainthola, Kodali, & Vemuri, 2023).

MATERIAL AND METHOD

3.1 Material

DC power, Aluminium Iron, Mild steel, Stainless steel, Beaker, Waste water, Cylinder, Stirrer bar for Electrocoagulation process.

3.2 Method

3.2.1 Raw materials preparation

10L of untreated water will be collected from lab Great wastewater. Physico-chemical properties such as pH value, temperature. will be measured before carrying out the electrocoagulation process

3.2.2 Electrocoagulation set up

A DC power supply is required for the electrocoagulation setup to supply electricity to the electrodes during the electrocoagulation process. The next step is to pour 0.5L of waste water into the used container. The waste water must have characteristics such as a high pH, a different color, and a different temperature. The use of electrodes varies according to size in order to establish the level of efficacy of the electrode in the electrocoagulation process. After the material has been prepared, the electrocoagulation process is started by turning on the DC power. Due to the passage of electricity from DC power to electrodes that absorb suspended solids when the electrocoagulation process is carried out, the electrocoagulation process is capable of eliminating suspended solids from waste water.

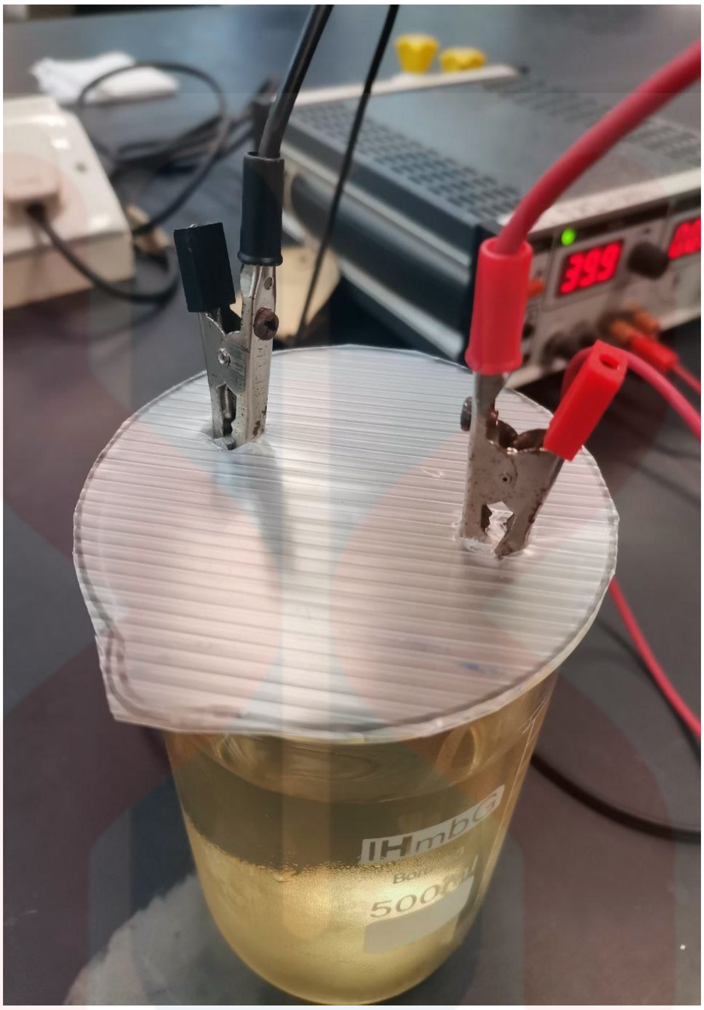


Figure 1: Electrocoagulation process set up for removel suspended solids

Analysis of Untreated and Treated UMK Lake Water

On the same day the sample was collected, in-situ analysis using the YSI Multiparameter device was carried out. In-situ analysis was used to determine the following values water quality parameters: temperature, TDS, pH, DO, and salinity. These values are related to the water quality in the lab Great wastewater**.**

3.3. Process Study

3.3.1 Effects of Electrode Materials

The selection the electrode materials is the main factor influencing the efficiency of the process in electrocoagulation of wastewater. In different electrode materials, unique electrochemical properties govern the generation of coagulant species and thus influence the efficiency of removal for emerging contaminants. Aluminum electrodes release Al(III) ions during electrocoagulation. Aluminum is known for its ability to form stable flocs, aiding in the removal of suspended solids and colloidal particles. The type of aluminum alloy and its composition can influence performance. Stainless steel electrodes are corrosion-resistant and have been explored for electrocoagulation. They can release iron and chromium ions, contributing to coagulation. The effects of different stainless steel grades and surface treatments on treatment efficiency have been studied. Other studies are done later reiterating on electrode materials which being worked on and many are the continued desire to find materials that are high efficiency, stable, and cost effectiveness for different wastewater treatment categories. The applicability of various electrode materials should be determined according to the type of wastewater characteristics and treatment objectives addressed in each study in the process of literature review. Electrode materials play a crucial role in the electrocoagulation process, as they directly influence the generation of coagulant species and their effectiveness in destabilizing and aggregating suspended solids. Here are some common electrode materials used in electrocoagulation. Aluminium electrodes, often in the form of aluminium plates or foils, are commonly used in electrocoagulation. Similar to iron electrodes, aluminium electrodes dissolve during the process, releasing aluminium ions (Al3+) that act as coagulant species. Aluminium electrodes are particularly effective in removing suspended solids, organic matter, and certain anionic pollutants. They are known for their high charge neutralization capacity and ability to form dense and stable flocs. Graphite electrodes are another commonly used electrode material in electrocoagulation. The use of Stainless steel electrodes in wastewater treatment processes can have several positive effects, primarily due to the material's corrosion resistance and durability. Stainless steel is known for its excellent corrosion resistance. In wastewater treatment processes, where the environment can be corrosive due to the presence of chemicals, salt, or acidic substances, stainless steel electrodes can withstand these conditions better than other materials.

This helps in maintaining the structural integrity of the electrodes over time. Using mild steel electrodes in wastewater treatment can have both advantages and disadvantages, and the suitability depends on the specific conditions and requirements of the wastewater treatment process. Mild steel possesses good mechanical strength, which is beneficial in structural applications within a wastewater treatment facility.

3.3.2 Effect of electrode spacing arrangement

Different arrangement of electrode spacing has been used to study its effect on the efficiency of TSS removal. A total of three different types of electrode distance milking were studied which are 2 cm, 4 cm and 6 cm to find the successful depletion of the electrode distance of the suspended solids. In wastewater treatment using electrocoagulation, the arrangement of electrodes plays a crucial role in the effectiveness of the process. Electrocoagulation is an electrochemical technique that utilizes the formation of coagulant species through the electrolysis of sacrificial electrodes to remove contaminants from water or wastewater. The arrangement of electrodes can affect the electrocoagulation process like Electrode spacing. The distance between the electrodes affects the electrical field strength and the distribution of current within the treatment system. A smaller electrode spacing typically leads to a higher electric field intensity, promoting more efficient coagulation and flocculation. However, a smaller spacing may also increase the chance of short-circuiting or electrode fouling, requiring regular cleaning and maintenance.

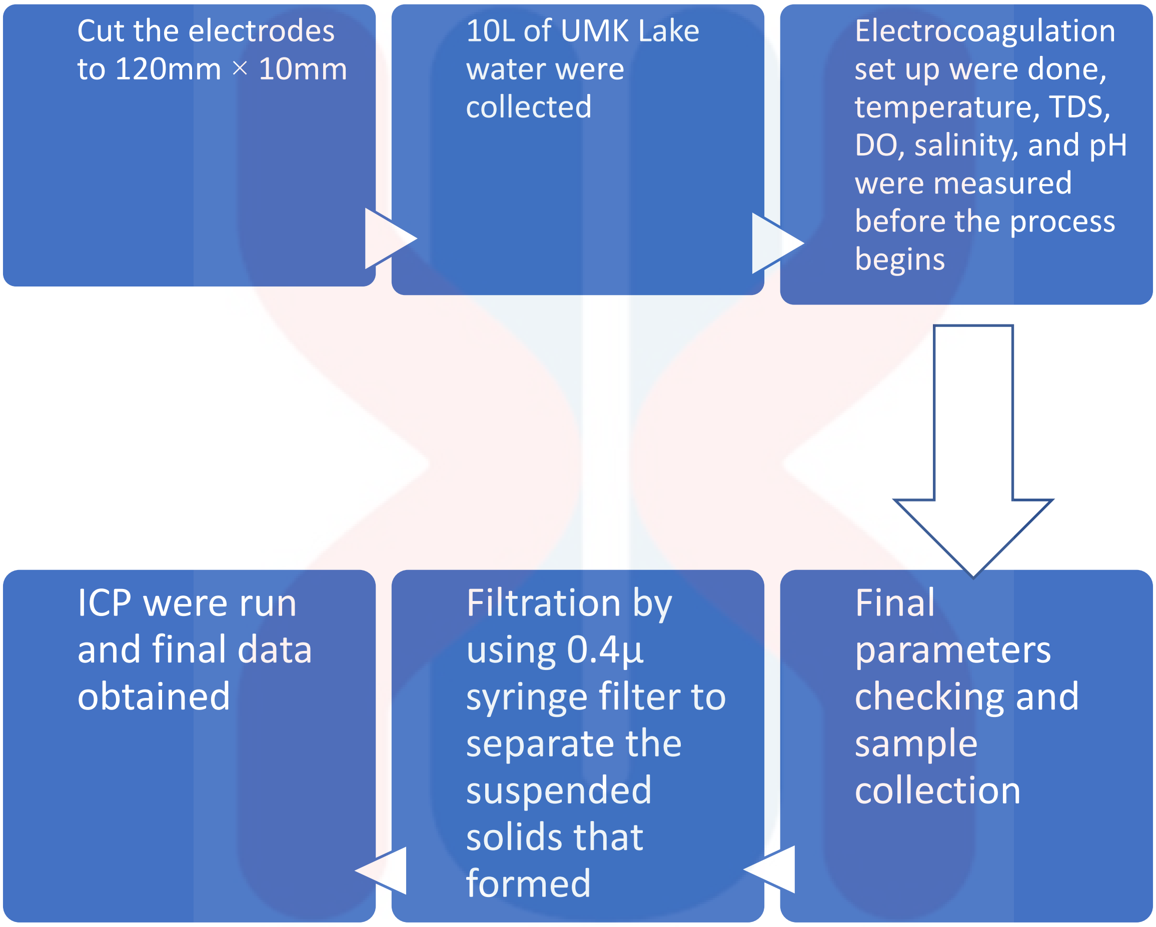
3.3.3 Suspended solids removal rate analysis

Physical settling processes are commonly employed in wastewater treatment. Primary settling tanks have been widely utilised for the removal of suspended solids (SS) by gravity settling that are not eliminated by preliminary treatment, and they are also an essential component of the biological wastewater and sludge treatment process. The removal of SS reduces organic load significantly, which is commonly stated in terms of biochemical oxygen demand (BOD) or chemical oxygen demand (COD). PSTs are one of the regulating variables for overall wastewater treatment plant construction costs and are currently required for wastewater treatment as well as the production of renewable energy in the form of biogas and electrical energy in the wastewater treatment plant (WWTP). PST function and operation have become more sophisticated, particularly when biological nutrient removal is essential and optimal performance is critical.

3.4. Characterization of UMK lake wastewater

Physicochemical analysis is performed after filtering larger pieces before electrocoagulation and again after filtering flocculant using a 0.45m syringe filter. Laboratory feature Large wastewater samples have been investigated. Temperature, pH, DO, and TSS are examples of these properties. This analysis is done before the electrocoagulation process. The water samples that underwent this test were taken from the Great lab water pool where the characteristics of the water pool in the Great lab reached the level as wastewater.

3.5 Flow chart



RESUT

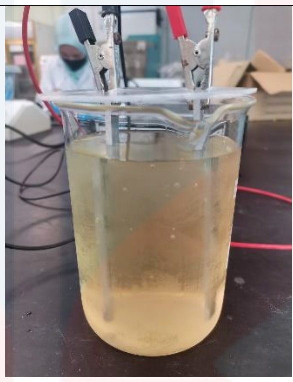
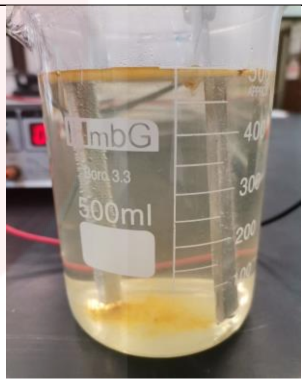
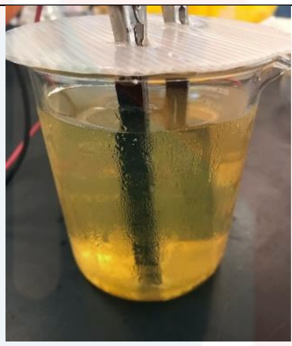
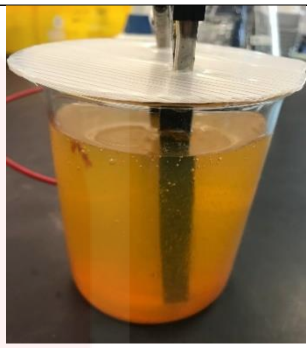
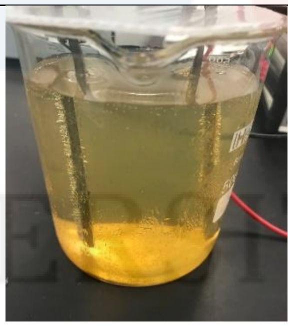
4.1 Physiochemical characteristics of wastewater

Table 4.1 below show the result of the in-situ Analysis of the wastewater

Parameter	Reading
Temperature (℃)	26.1
TDS (mg/L)	147.55
DO (DO mg/L)	8.33
Salinity (sal)	0.11
pH	6.76

YSI Multiparameter Professional Plus devices were used to get the findings of the in-situ analysis, which were then utilised to generate the reading in Table 4.1. The temperature determined by the in-situ analysis was 24.4 °C. Water has a room temperature of 20 to 25 degrees Celsius, a freezing point of 0 degrees Celsius, and a boiling point of 100 degrees Celsius. Tap water is typically around 13 degrees Celsius in temperature. The temperature of the pipes, which depends on the outside temperature as well as the interior temperature of the home, determines the temperature of the tap water. Hot tap water should be about fifty degrees Celsius in temperature. The temperature of cold tap water is approximately 7 degrees Celsius. These are only estimate, and they change with the season and the region. The temperature of tap water is dependent on the local conditions, much like the temperature of a room. On the other hand, the effectiveness of the heavy metal ion removal in the water sample will not be impacted by the rainy season. However, the initial concentration of the heavy metal ions would be impacted by the wet season. This is because contaminants in the air are carried into the water by rains, which also permits pollutants that are located on land to flow into the water. According to Table 4.1, the level of dissolved oxygen measured in the wastewater was 8.33 mg/L, which is within the acceptable range of DO levels for fisheries. This reading indicates that the water quality is adequate for use. Any DO range less than 5 mg/L will put aquatic life under stress, which can be detrimental to fish farming. The pH value of 6.76 obtained from the in-situ water analysis in the fishpond is considered neutral and falls within the permissible pH range.

4.2 Effect of different electrode materials on TSS removal

ELECTRODES	ELECTRODE ARRANGEMENTS	BEFORE	AFTER
Aluminium	**4 CM**		
Mild Steel	**4CM**		
Stainless steel	**4CM**		

This is the difference in results between the electrodes in doing wastewater treatment using electrocoagulation. we can see the difference between the electrode process directly before and after which aluminum can do wastewater treatment very effectively as in the picture above. Aluminum is often used in electrocoagulation (EC) processes for wastewater treatment due to several advantageous properties that make it effective in the removal of contaminants. Electrocoagulation is an electrochemical water treatment process that involves the application of an electric current to metal electrodes (usually aluminum or iron) immersed in the wastewater.

The reasons why aluminum is commonly chosen for electrocoagulation was High Electrochemical Reactivity. Aluminum has a high electrochemical reactivity, which means it can release electrons more readily during the electrocoagulation process. This property allows for the formation of aluminum hydroxide flocs that play a key role in removing suspended particles, colloids, and contaminants from the wastewater. Aluminum also Effective Coagulant Formation. The electrochemical reactions involving aluminum result in the formation of aluminum hydroxide and aluminum oxyhydroxide species. These species act as coagulants that neutralize charged particles and help in the agglomeration of colloidal and suspended matter, facilitating their removal through precipitation or settling. It's important to note that while aluminum is commonly used, the selection of the optimal coagulant in electrocoagulation depends on the specific characteristics of the wastewater to be treated. Factors such as the type of contaminants, their concentration, and the desired treatment outcomes play a role in determining the most effective coagulant for a given application. Additionally, proper system design and operating conditions are crucial for achieving efficient and sustainable electrocoagulation wastewater treatment.

4.3 Effect of different electrode arrangement on TSS removal

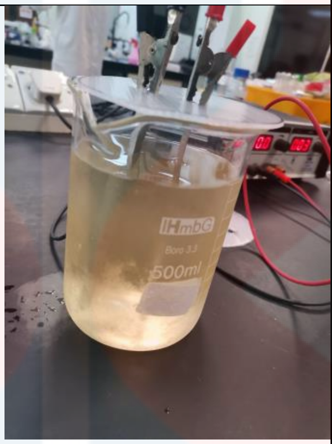
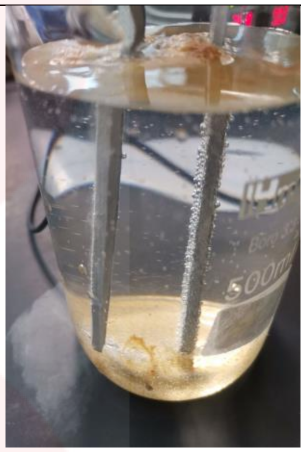
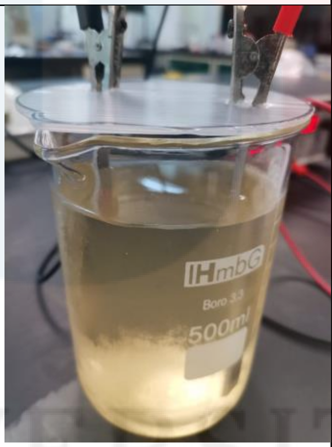
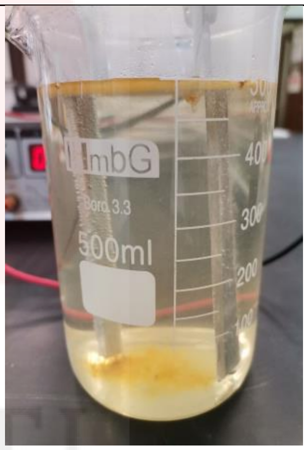
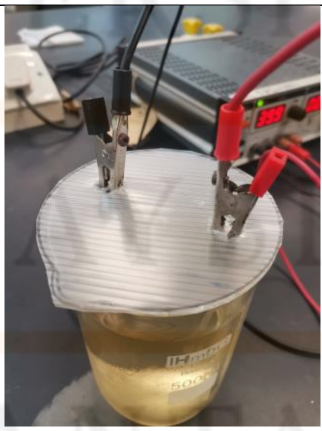
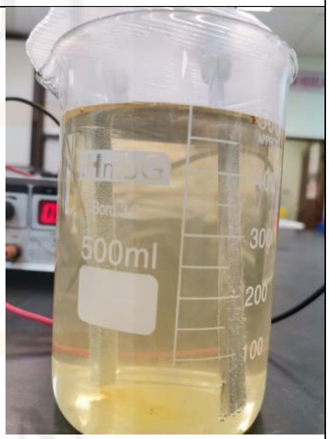
ELECTRODES	ELECTRODE ARRANGEMENTS	BEFORE	AFTER
	2cm		
Aluminium	4cm		
	6cm		

Figure 4.3: Effect of different electrode arrangement on TSS removal

Based on the data recorded in the table above, it can be seen that there is a different removal that occurs to each different electrode distance milk. According to the table above, it can be seen that the electrode depletion distance of 2 cm has a higher removal efficiency compared to the electrode distance of 4 cm and 6 cm. he spacing between electrodes in an electrocoagulation system can have a significant impact on the removal efficiency of Total Suspended Solids (TSS). Narrow electrode spacing, where electrodes are positioned closely together, can create a higher electric field intensity in the treatment zone. This increased electric field strength can enhance the generation of coagulant species and promote efficient coagulation of suspended solids. The close proximity of electrodes facilitates rapid and uniform dispersion of coagulants throughout the treatment volume, ensuring effective contact with suspended solids. This can lead to improved TSS removal efficiency, especially for fine particulate matter.

4.4 Analysis of Turbidity meter

Table 4.2 below show the result of the turbidity meter of the wastewater

Turbidity test	
1	60.4
2	55.2
3	57.5
4	57.0
5	54.4
Average	56.9

A turbidity meter is a device used to measure the turbidity of a liquid, which refers to the cloudiness or haziness caused by suspended particles in the water. Turbidity is an important water quality parameter as it can affect the aesthetics of water, impact light penetration, and serve as an indicator of overall water quality. Elevated turbidity levels can be indicative of pollution, sedimentation, or other environmental changes. Turbidity is commonly expressed in nephelometric turbidity units (NTU). These units quantify the amount of light scattered by the particles in the water. for sample wastewater five times the turbidity meter attempt was taken to get the average to see the NTU level on the wastewater sample.

According to table 4.2 the average level of wastewater taken is 56.9 NTU and slightly polluted compared to the standard level for NTU which is below 10 NTU. For Environmental Water Quality in United states, The EPA provides guidelines for acceptable levels of turbidity in various water bodies. For example, in streams and rivers designated for recreation, a turbidity level of 50 NTU may be considered acceptable. For Environmental Water Quality in European Union, The European Union's Water Framework Directive sets standards for turbidity in surface waters. For instance, in rivers and lakes, the threshold for good ecological status might be set at a turbidity of 10 NTU. high NTU levels are not suitable for Aquatic Life Aquatic organisms, such as fish and invertebrates, rely on dissolved oxygen in water for respiration. Insufficient levels of dissolved oxygen can lead to hypoxia, a condition where oxygen levels are too low to support most forms of marine life. These values are general guidelines, and specific requirements can vary based on factors such as temperature, salinity, and the specific needs of the aquatic organisms present. Additionally, different species of fish and invertebrates may have different tolerance levels for dissolved oxygen. Environmental agencies often establish water quality standards to ensure the protection of aquatic ecosystems. For example, the United States Environmental Protection Agency (EPA) provides water quality criteria, including recommended dissolved oxygen levels, for various water bodies.

It's important to note that extremely low levels of dissolved oxygen (hypoxia) or complete absence of oxygen (anoxia) can be harmful to aquatic life. Monitoring and maintaining appropriate dissolved oxygen levels are key components of water quality management and environmental protection efforts.

4.5 Analysis Inductively Coupled Plasma (ICP)

Table 4.3 below show the result of the Inductively coupled plasma (ICP) of the wastewater

RESULT OF ICP ANALYSIS			
ELEMENT		UNTREATED	TREATED
1	Ag	0.00U	0.00U
2	Al	0.00U	0.06
3	Ba	0.02	0.02
4	Be	0.00U	0.00U
5	Bi	0.01U	-0.01U
6	Ca	3.61	3.53
7	Cd	0.00	0.00
8	Co	0.00U	-0.01U
9	Cr	0.00	0.00U
10	Cs	Uncal	Uncal
11	Cu	0.00	0.00U
12	Fe	0.38	-0.01U
13	Ga	0.01	0.01U
14	In	0.03	-0.01U
15	K	2.20	2.08
16	Li	-0.01U	-0.01U
17	Mg	0.75o	0.75o
18	Mn	0.01	0.00
19	Mo	0.00	0.00U
20	Na	1.90	1.82
21	Ni	0.02	0.01U
22	Pb	0.00U	-0.01U
23	Rb	Uncal	Uncal
24	St	0.03	0.01
25	Tl	-0.01U	-0.01U
26	V	0.00U	0.00U
27	Zn	0.00U	0.00U

Based on table 4.3 above, we can see the data of ICP for wastewater treatment using electrocoagulation. there are 27 different elimens as a result of the ICP analysis. There is a difference that occurs between before and after performing electrocoagulation. according to the recorded data there is an Ag alimen in the contents of the wastewater because the data shown is 0.00u. other than Ag, Be, Co, Pb, V and Zn also show the same data 0.00u. 0.00u indicates that the elimen is in wastewater but the eliment is not reached the desired level when performing the ICP it is also called not detected. When a substance is reported as "not detected" in the context of Inductively Coupled Plasma (ICP), it signifies that the concentration of that specific element in the sample is below the detection limit of the ICP instrument used for analysis. Implications of "Not Detected" in ICP was Concentration Below Detection Limit. he analytical instrument, in this case, ICP, has limitations in its sensitivity. If the concentration of a particular element in the sample is lower than the instrument's detection limit, it will be reported as "not detected". It also Clean or Low-Concentration Sample. "Not detected" could indicate that the sample has a low concentration of the element in question. In certain contexts, especially in environmental or quality control analyses, this may be a positive result, suggesting that the sample meets certain standards. The reasons why Ag, Be, Co, Pb, V and Zn " not detected" was Low Concentration in the Sample. he element might genuinely be present in the sample, but at a concentration lower than what the ICP instrument can reliably detect. Instrument Detection Limit also the reason why "not detected". Analytical instruments, including ICP, have specific detection limits that depend on factors like instrument sensitivity, the nature of the sample matrix, and the method used. If the concentration falls below this limit, it will be reported as "not detected." In ICP analysis, reporting "not detected" indicates that the concentration of a specific element in the sample is below the detection limit of the instrument. Understanding the detection limits, method validation, and sample matrix effects is crucial for accurate interpretation and application of the result.

the highest elimen recorded in table 4.3 is Ca. Ca shows a value of 3.61 and is among the highest values in the ICP analysis. In the process of treating wastewater, calcium is crucial because calcium hydroxide combines with the solution to create calcium carbonate, which coagulates the particles out of solution. Sewage pH can also be adjusted by adding calcium chloride. However, one of the many dissolved elements that gives water its hardness is calcium. Over time, this can lead to issues with plumbing and piping, particularly in applications involving wastewater treatment. The presence of high calcium levels in wastewater can be attributed to various sources and factors.

Calcium is a common element found naturally in water, and its levels can increase due to both natural processes and human activities. The easons why calcium levels may be elevated in wastewate was Natural Geological Sources. Groundwater cause calcium can naturally leach into water from geological formations, especially in areas with high calcium-containing rocks and soils. Groundwater with elevated calcium levels can contribute to higher calcium concentrations in wastewater. Industrial Processes was Certain industrial activities involve the use of calcium-containing compounds or minerals. Discharges from industries such as mining, metal processing, or chemical manufacturing may introduce calcium into wastewater. There's a large lab in the water area that may cause a lot of calcium to be produced in the wastewater. The use of calcium-containing fertilizers in agriculture can contribute to elevated calcium levels in runoff water, which may eventually reach wastewater treatment systems. It's important to note that the specific causes of high calcium levels in wastewater can vary depending on the local geology, industrial activities, and community practices. Monitoring and managing calcium levels in wastewater are important for effective wastewater treatment and environmental protection, as excessive calcium concentrations can affect the performance of treatment processes and contribute to scaling issues in pipes and equipment. other than Ca, there are also other elimens that show high values such as K and Na, each of which is above the value of one. Potassium (K) can be present in wastewater due to various natural and anthropogenic sources. The reason why potassium may be found in wastewater was about human waste. Potassium is a naturally occurring element in human waste. Wastewater from domestic sources, including toilets and sewage systems, can contain potassium from human excreta. Industrial Discharges it also the reason why potassium may be found in wastewater. Chemical processes one of the industrial discharges.

Certain industrial processes may involve the use of potassium compounds. Discharges from industries, such as chemical manufacturing or metal processing, may introduce potassium into wastewater. It also about natural weathering. Geological deposits, naturally occurring geological formations can contain potassium-rich minerals. Weathering and erosion of these deposits can release potassium into water sources. Monitoring and managing potassium levels in wastewater are important for several reasons. While potassium is an essential nutrient for plants and organisms, high concentrations can have environmental implications, and certain industrial processes may require compliance with regulatory standards for wastewater discharges. Wastewater treatment processes may need to be designed or optimized to effectively address potassium levels.

The same goes for the Na elimen which values above one. The Elimen is on top of one because of human activity, industrial discharges and so on. While sodium is a common and essential element, excessive levels in wastewater can have environmental and health implications. For example, high sodium concentrations can impact the quality of water bodies, affect soil quality, and may pose challenges for wastewater treatment processes. Monitoring and managing sodium levels in wastewater are important considerations for environmental protection and regulatory compliance. based on the ICP analysis there is a value of 0.75o. that value is the elimen of Mg. Mg is the only elimen that reaches the overate stage. Magnesium (Mg) levels in wastewater can become elevated for various reasons, and the effects of high magnesium concentrations in wastewater can impact both the wastewater treatment process and the environment. The reasons for elevated magnesium levels and their effects Geological Deposits. Areas with naturally occurring magnesium-rich geological formations can contribute to higher magnesium levels in groundwater, which may enter wastewater through various sources. Chemical Processes it also reason for elevated magnesium. Certain industrial processes, such as metal manufacturing or chemical production, may involve the use of magnesium or magnesium-containing compounds. Discharges from these industries can introduce magnesium into wastewater. Some water softeners use magnesium chloride or other magnesium-containing compounds. The regeneration process of water softeners can contribute to higher magnesium concentrations in wastewater. They were Effects of High Magnesium Levels in Wastewater Wastewater Treatment Impact. Scaling Issues, Elevated magnesium levels can contribute to the formation of scale deposits in wastewater treatment infrastructure, including pipes, pumps, and equipment. This can reduce the efficiency of treatment processes. Interference with Coagulation In some cases, high magnesium concentrations can interfere with coagulation and flocculation processes used in wastewater treatment, affecting the removal of suspended solids.

Environmental Impact it also the effects of high magnesium level in wastewater. Water Quality, discharging wastewater with high magnesium levels into receiving water bodies can impact water quality. Magnesium, in excess, may contribute to changes in water chemistry and affect aquatic ecosystems. Soil Quality, when treated wastewater is used for irrigation, high magnesium levels may impact soil quality and plant health. The excess magnesium can contribute to soil salinity and affect plant nutrient uptake.

Public Health Concerns, If wastewater discharges with high magnesium concentrations are released into water bodies used for drinking water supply, it may pose challenges for water treatment plants to meet drinking water quality standards. Managing magnesium levels in wastewater is crucial for maintaining the effectiveness of treatment processes, protecting the environment, and ensuring compliance with regulatory standards. there are two elimens that are not in wastewater such as Cs and Rb. each showing Uncal either before or after the electrocoagulation process. Cesium (Cs) and rubidium (Rb) are relatively rare elements in nature, and their presence in wastewater is typically low. There reasons why Cs and Rb may not be commonly found in wastewater is Low Natural Abundance. Cesium and rubidium are not abundant elements in the Earth's crust. Their natural occurrence in rocks and minerals is relatively low compared to more common elements like sodium, potassium, or calcium. As a result, the baseline levels of Cs and Rb in natural water sources, including those that contribute to wastewater, are typically low. Limited Industrial Use, Cs and Rb are not extensively used in common industrial processes or consumer products. Unlike some other elements that may be used in large quantities in various industries, Cs and Rb have more specialized applications and are not as prevalent in manufacturing processes. Not Commonly Present in Wastewater Sources, the primary sources of wastewater, such as domestic sewage, industrial discharges, and stormwater runoff, usually do not introduce significant amounts of cesium and rubidium. These elements are not commonly associated with human activities that contribute to wastewater. Cs and Rb tend to have relatively low solubilities in water and may not be as mobile as other ions. In natural systems, they may not dissolve readily and enter water sources in substantial amounts. While Cs and Rb are not commonly found in high concentrations in wastewater, it's important to note that their potential presence in specific industrial processes, research facilities, or areas with nuclear activities should be considered. Monitoring and testing for cesium and rubidium in wastewater may be relevant in certain contexts, such as facilities that handle these elements or areas with historical nuclear events. Additionally, local conditions and geological factors can influence the natural occurrence of elements in water sources. There are also elements that increase after the electrocoagulation process, one of which was the Al element. according to the data the value before performing electrocoagulation is 0.00u where the value shows that the Al element was present but "not detected" which does not reach the set level. but it's different when you've done electrocoagulation where the value increases to 0.06 indicating that the element has reached the required level. That was because electrocoagulation is a water treatment process that utilizes electric current to destabilize and aggregate suspended particles in wastewater, facilitating their removal.

When aluminum electrodes are used in electrocoagulation, they can release aluminum ions (Al3+) into the wastewater. he increased in aluminum concentration in the treated wastewater can be attributed to several factors electrode dissolution. During electrocoagulation, the aluminum electrodes undergo dissolution. The electric current passing through the electrodes causes the release of aluminum ions from the electrode surface into the water. This dissolution contributes to the increased concentration of aluminum in the treated wastewater. Aluminum ions released during electrode dissolution can react with hydroxide ions present in the water to form aluminum hydroxide (Al) $(OH)_3$) flocs. These flocs play a crucial role in the coagulation process by adsorbing and entrapping suspended particles, allowing them to settle and be removed from the water. While electrocoagulation is effective in removing many contaminants, there may be instances where the process is not entirely efficient in removing all aluminum species from the wastewater. Some aluminum compounds or complexes may remain in the treated water, contributing to the observed increase in aluminum concentration. The concentration of aluminum in the treated wastewater can be influenced by the specific operating conditions of the electrocoagulation process, such as the applied voltage, current density, and treatment time. Suboptimal conditions may result in incomplete removal or increased aluminum release. While aluminum is not typically considered highly toxic to humans, excessive exposure to elevated levels of aluminum in drinking water or through other pathways can pose health risks. Long-term exposure to high levels of aluminum has been associated with health issues such as neurological disorders. Regulatory agencies often set limits on aluminum concentrations in drinking water to ensure public health protection.

CONCLUSION

In conclusion, the electrocoagulation process has proven to be an effective and promising method for the removal of suspended solids from laboratory wastewater. Throughout this study, we investigated the performance of aluminum electrodes in destabilizing and aggregating suspended particles, ultimately facilitating their removal from the wastewater. The experimental results demonstrated a significant reduction in suspended solids concentrations after electrocoagulation treatment. The process successfully formed aluminum hydroxide flocs, which effectively coagulated and settled suspended particles. The efficiency of suspended solids removal was influenced by various factors, including applied voltage, current density, and treatment time. Optimization of these parameters allowed us to achieve maximum removal efficiency. Furthermore, the electrocoagulation process offers advantages such as simplicity, cost-effectiveness, and minimal chemical usage compared to conventional coagulation methods. The environmentally friendly nature of the process, with the generation of aluminum hydroxide flocs acting as a natural coagulant, aligns with sustainable water treatment practices. In the broader context, this study contributes valuable insights into the application of electrocoagulation for the removal of suspended solids from laboratory wastewater. Future research may explore the scalability and applicability of the process to larger-scale wastewater treatment scenarios, as well as the potential for further optimization and integration with complementary treatment technologies. Overall, the successful application of electrocoagulation in this project underscores its potential as a sustainable and efficient solution for the removal of suspended solids from laboratory wastewater, addressing both environmental and regulatory concerns. This research lays the groundwork for continued advancements in water treatment technologies and underscores the importance of exploring innovative approaches for wastewater management.

RECOMMENDATION

For those who would like to pursue further research on wastewater treatment by means of electrocoagulation. I advised to study Treatment of Emerging Contaminants. Investigate the effectiveness of electrocoagulation for treating emerging contaminants, such as pharmaceuticals and personal care products; microplastics; and nanoparticles. Study the removal mechanisms and synergistic effects with other treatment techniques to deal with complicated wastewater composition. It can also be used for Long-Term Performance Evaluation. Carry out long-term experiments to determine how durable and stable electrocoagulation systems are when working in continuous operations. Evaluate factors like electrode failures, fouling mechanisms and accumulation of reaction products to grasp the system's behavior over long-term dynamics and improve maintenance policies. Through exploring these areas of study, scholars can develop better insights that may improve how electrocoagulation is used in the treatment of wastewater besides contributing to sustainable water management practices and resolving environmental issues.

7.Reference

panelIvonne Linares-Hernández a, a, b, c, AbstractThis study addresses the elimination of persistent organic compounds in industrial wastewater using a synergistic combination of electrocoagulation and electrooxidation. Electrocoagulation is a relatively quick process (30 min), Feng, C., Linares-Hernández, I., Roa-Morales, G., Polcaro, A. M., Cañizares, P., Montilla, F., Panizza, M., Chen, X., Faouzi, M., Bechtold, T., Louhichi, B., Kapalka, A., Khemis, M., Zongo, I., … Kobya, M. (2009, October 31). *A combined electrocoagulation–electrooxidation treatment for industrial wastewater*. Journal of Hazardous Materials. https://www.sciencedirect.com/science/article/abs/pii/S0304389409017154

panelA. Shahedi 3, 3, 1, 2, 4, 5, year, A., Ghannim, A., Ahmadian, M., Padmaja, K., Manikandan, P., Nasrullah, M., Gong, C., Earid, M. M., Balarak, D., Esfandyari, Y., Chezeau, B., Palanisamy, S., Tchamango, S. R., … Wang, L. K. (2020, June 5). *A review on industrial wastewater treatment via electrocoagulation processes*. Current Opinion in Electrochemistry. https://www.sciencedirect.com/science/article/abs/pii/S2451910320301095

Sanctuary, F. K. N. M. (2011, April 7). *Water quality describes the condition of the water, including chemical, physical, and biological characteristics, usually with respect to its suitability for a particular purpose such as drinking or swimming*. What is water quality? https://floridakeys.noaa.gov/ocean/waterquality.html

Bilotta, G. S., & Brazier, R. E. (2008). Understanding the influence of suspended solids on water quality and aquatic biota. *Water Research*, *42*(12), 2849–2861. https://doi.org/10.1016/j.watres.2008.03.018

Lee, S. W., Lee, J., & Cha, S. M. (2020). Assessment of Factors Affecting the Removal Efficiency of Suspended Solids and Particulate Matters for Pretreatment Units in a Stormwater Management Facility. *Water*, *12*(6), 1529. https://doi.org/10.3390/w12061529

Ram Karan Singh, Vineet Tirth, & Singh, M. (2022). Wastewater Treatment Processes with Special Reference to Activated Sludge Process in Indian Conditions for Water Use Sustainability. Earth and Environmental Sciences Library, 227–238. https://doi.org/10.1007/978-3-030-95786-5_12

Al-Qodah, Z., Tawalbeh, M., Al-Shannag, M., Al-Anber, Z., & Bani-Melhem, K. (2020). Combined electrocoagulation processes as a novel approach for enhanced pollutants removal: A state-of-the-art review. Science of the Total Environment, 744. https://doi.org/10.1016/j.scitotenv.2020.140806

Biswas, B., & Goel, S. (2022). Electrocoagulation and electrooxidation technologies for pesticide removal from water or wastewater: A review. Chemosphere, 134709. https://doi.org/10.1016/J.CHEMOSPHERE.2022.134709

Chromium and cadmium removal from synthetic wastewater by Electrocoagulation process. (2020). Journal of Environmental Treatment Techniques, 9(2), 375 382. https://doi.org/10.47277/jett/9(2)382

Eyvaz, M., GüRbulak, E., Kara, S., & YüKsel, E.. (2014). Preventing of Cathode Passivation/Deposition in Electrochemical Treatment Methods – A Case Study on Winery Wastewater with Electrocoagulation. https://doi.org/10.5772/58580

Hakizimana, J. N., Gourich, B., Chafi, M., Stiriba, Y., Vial, C., Drogui, P., & Naja, J. (2017). Electrocoagulation process in water treatment: A review of electrocoagulation modeling approaches. In Desalination (Vol. 404, pp. 1–21). Elsevier B.V. https://doi.org/10.1016/j.desal.2016.10.011

Qasem, N. A. A., Mohammed, R. H., & Lawal, D. U.. (2021). Removal of heavy metal ions from wastewater: a comprehensive and critical review. Npj Clean Water, 4(1). https://doi.org/10.1038/s41545-021-00127-0