OPTIMIZATION OF THE PERFORMANCE OF DATE SEED AS A NATURAL COAGULANT FOR INDUSTRIAL WASTEWATER TREATMENT

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"I declare that all the information within this thesis has been gathered and presented in accordance with academic regulations and ethical principles and I have according to the requirements of these regulations and principles cited all those which do not originate in this work as well."

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ABSTRACT

M. Sc. Thesis

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The globe in general suffers from water pollution in its salty and fresh environments resulting from industrial waste, which exports large quantities of waste to the environment, causing damage to the environment and the living and non-living components it contains. Accordingly, there are many and varied methods used to treat polluted water in order to obtain an environment free of pollutants, and one of these effective methods is the technology of treating water contaminated by date (*Phoenix dactylifera*) seed powder, which is considered to be highly effective in removing pollutants and treating water due to its chemical composition. In this study, in order to use the date stone powder as a natural coagulant in the purification process, the date stone were washed and dried, then ground and added to the water to be treated by drying again, and optimum dose and optimum pH conditions were determined to provide the highest amount of purification.

Key Words : Wastewater, Natural coagulant, Removal, Industrial, Coagulation, Treatment.

Science Code : 90319

ÖZET

Yüksek Lisans Tezi

ENDÜSTRİYEL ATIKSU ARITIMI İÇİN DOĞAL BİR PIHTILAŞTIRICI OLARAK HURMA TOHUMUNUN PERFORMANSININ OPTİMİZASYONU

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Dünya geneli tuzlu ve tatlı ortamlarında endüstriyel atıkların çevreye büyük miktarlarda atık vermesinden kaynaklanan, çevreye ve içerdiği canlı ve cansız bileşenlere zarar veren su kirliliği sorunlarıyla karşı karşıyadır. Buna göre, kirleticilerden arınmış bir çevre elde etmek için kirli suyu arıtmak için kullanılan çok ve çeşitli yöntemler vardır ve bu etkili yöntemlerden biri, kimyasal bileşimi nedeniyle kirlilikleri gidermede oldukça etkili olduğu düşünülen hurma (*Phoenix dactylifera*) çekirdeği tozu kullanılarak kirlenmiş suyu arıtma teknolojisidir. Bu çalışmada, hurma çekirdeği tozunun arıtma işleminde doğal bir pıhtılaştırıcı olarak kullanılması için, hurma çekirdekleri yıkanıp kurutuldu, ardından öğütüldü ve tekrar kurutularak arıtılacak suya eklendi ve en yüksek miktarda arıtma sağlayan optimum doz ve pH koşulları belirlenmiştir.

Anahtar Kelimeler : Atıksu, Doğal pıhtılaştırıcı, Uzaklaştırma, Endüstriyel, Pıhtılaşma, Arıtma.

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ABBREVITIONS

COD : Chemical oxygen demand

DCO : Demande Chimique en Oxygen

WHO : World Health

SEM : Scanning Electron Microscopy

FTIR : Fourier Transformed Infrared Analysis

ANOVA: Analysis of Variance for parameters removal

PART 1

INTRODUCTION

In the recent periods of time, many problems appeared arising from the activity of consumers in residential cities at one time, and at other times from natural factors that worked to reduce the amount of water purity, such as the activity of volcanoes.

Also, the residential areas began to crawl and increase, which resulted in the consumption of larger quantities of water than the usual level [1] . Incorrect treatment methods played a major role in the spread of pollutants or impure water, due to the survival of materials after poor treatment methods in the water, such as nutrient residues and pathogens [2] . Many transmissible diseases go by water from one place to another, thus giving a great chance of infection by swallowing these pollutants with water [3,4]. The issue of treating pollutants is of great importance as it is the first factor in dealing with the scarcity of fresh water [5]. The soil is contaminated with many pollutants according to its source, but the largest usually comes from the discharge of water laden with pollutants coming from factories into the cultivated soils, so the polluted toxic compounds are transmitted through the food chain until they reach the consumer organism, or these pollutants are deposited until they reach the pure groundwater and pollute it regardless of the damage caused to the soil and the organisms that live in it [6]. On a daily basis, very large amounts of pollutants accumulate around the world, resulting from the misuse of water or the mistreatment of sewage water, which is usually laden with cleaning materials, sodium salts, oils, etc [7,8]. It is worth noting that the sewage and other wastewater pollutants come to it as a result of the lack of complete treatment of water coming from industrial activity such as mining or activities that operate with a treatment system that is harmful to the environment [9]. All heavy metals, according to their different names, have a toxic effect on humans and cause malfunctions in their vital functions [10,11,12].

1.1. PROBLEM STATEMENT

Persistence in the spread of pollutants without devising a final solution to treat them is sufficient to make them an insurmountable problem that cannot be solved, and no one can be spared from its danger. Because this is compounds are dangerous to live components, Each industrial wastewater treatment process achieves the treatment results, but there are differences in the results. and the majority of these systems used in the process of detoxing these toxins have many drawbacks Such as the money spent on maintenance and side protection that results in difficult treatment stages. Conventional treatment processes are characterized by the production of secondary waste after completion of the treatment process. The deficit in the process of treating polluted water is highlighted by the fact that it is subject to and affected by climatic factors and has a small and limited capacity for treatment. Many of those interested in the field of processing worked to make efforts to discover a method of treatment that does not have defects. their research docked was based on finding date seeds and their great ability to process.

1.2. AIM OF THE STUDY

To find out the effectiveness of date seeds in the process of purifying polluted water from various sources of pollution, whether domestic or industrial.

To determine and diagnose the optimal factors that work to treat the pollutants and evaluate the possibility of response and interaction when the natural coagulant is date seeds. Reducing the secondary results that emanate sideways from the use of coagulants of a chemical nature.

PART 2

LITERATURE REVIEW

2.1. THE ORIGIN AND DEVELOPMENT OF THE INDUSTRY

Industry is an organization or a group of institutions working to transform a group of raw materials into commodities of benefit to human society [14] It is known that industry is not limited to the field of manufacturing only, but also goes beyond that to include commercial activities that provide goods such as transportation, agriculture...etc [15]. Since ancient times, the industry began depleting stocks and over-exploiting environmental services, without taking into account the limits to be observed in the biosphere [16], The industrial movement arose at the beginning of the 18th century, when the communities based on agriculture moved into urban and industrial societies that depended heavily on industry, with most of the economy shifting from an economy based on agriculture and handicrafts to one that depends on industrial and machinery out of From Britain to various parts of the world, and transforming the world from an agricultural-based world to an industrial world based mainly on industry [17]. The development of technology and the accompanying development in other industries involves a lot of risks, and despite the good advantages that modern technology offers to the world and the innovations that have been made to provide human welfare and provide it with the requirements [18], there are many risks brought about by this technology and caused damages And suffering to humanity [19, 20]. Such as noise, high temperatures, radioactive materials, and toxic substances that cause great harm to humanity [21]. Therefore, at present, various industrial wastes cause a lot of damage to living organisms and non-living components such as soil and water humanity [6, 20, 19].

2.2. THE SPREAD OF INDUSTRIAL POLLUTANTS

The industry is working to send pollutants of all kinds to the environment, as many environments in different countries of the world struggle with industrial pollution problems. These industries emit various oxides of sulfur, carbon, and other materials that spread toxicity in the environment [22]. On the other hand, the rate of contamination of usable water is increasing as a result of the pollution of this freshwater with pollutants resulting from the spread of industry from heavy elements and other toxic substances [23]. The spread of industries accompanies trade openness in industrialized countries at the expense of the environment, as it has been observed that countries with trade openness have environmental deterioration as trade increases the economy, which generates environmental deterioration [24]. However, the spread of industry left effects and changes in the climate, causing environmental problems and health problems [25], at the same time, as scarce freshwater was diverted and treated poorly with agricultural waste, chemicals, and industrial wastewater, which had its effects on agricultural lands, where it lost its fertility and resulted in desertification, Also, the risk of the spread of the industry reached wild animals and coral reefs due to water pollution with oils coming from the industry [26].

2.3. THE EFFECT OF POLLUTED WATER ON THE ENVIRONMENT

Environmental pollution has become a source of great concern to the ecosystem, as industrial wastes are disposed of in our soil, water, and the atmosphere, as these pollutants affect the growth and vital functions of living organisms, while some of them remain accumulated in a particular member of the organism causing serious diseases such as asthma and cancer [27], and When heavy metals enter our bodies, they accumulate biologically in our system and thus become a source of danger, as this biological accumulation results in physiological complications[28].Contaminated water can also affect the soil through the use of polluted water for irrigation such as sewage irrigation, fertilizers, sludge from sewage treatment, and landfilling [29]. Water environments are affected by the sediments of water bodies that come from the runoff of the water of villages, cities, and industries. The toxicity of this water depends on several factors, including the nature of the mineral in the water, the nature of the biological role of the mineral and the age of the organism [30], when exposed, and this leads to the accumulation of toxic elements in the food chain[31]. Table 2.1 describes the impact of pollutants on human health and the form that these pollutants take.

Table 2.1. Sources and types of pollutants [22].

Pollutant type	Effects (diseases) on human health	Potential opportunities for human absorption	Key references
Pharmaceuticals e.g. antimicrobial compounds	These pollutants cause - Antimicrobial resistance. -Neurotoxic effects. -Mutagenic effects.	These pollutants reach the body through contaminated food contaminated and contaminated water	[19,29,71]
Metals that can be toxic such as As, Hg	-Some of these minerals are necessary for human metabolism, such as copper and iron, but they are toxic in the case of large concentrations. -These pollutants cause Carcinogenic effects, and neurotoxic effects, and inflammation and irritability. .	- soil contaminated with these elements and contaminated water sediments. -Inhalation of vaporized metals and airborne particles	[122,16]
pollutants in the air such sulfur dioxide	These pollutants cause -Respiratory disease ,cardiovascular disease and neurotoxic effects	Inhalation of gases and airborne particles	[27,13]
Noise	These pollutants cause -Stress. -contributions to cardiovascular problems. -loss of hearing. - sleep disturbance	-Exposure to continuous noise of 85-90 dB[18] -Effects determine the duration of the noise and the frequency spectrum and intensity.	[81,4,51]
industrial dyes	-mutagenic effects and carcinogenic effects and respiratory problems.	Ingestion of pollutants and dyes with drinking water	[141]

2.4. TYPES AND CASES OF WATER POLLUTION

2.4.1. Physical Pollution

2.4.1.1. Thermal Pollution

Thermal pollution is the pollution resulting from the high temperature of water bodies as a result of throwing water used to cool generator engines or from nuclear plants, causing the effect on the network of food chains in the water [32]**.** Thermal pollution coming from power plants disrupts and deteriorates aquatic ecosystems by subtracting the water used in cooling processes into the water, which raises the water temperature, and affects the biological diversity that lives in certain ranges of temperature [33], The increase in temperature greatly affects the phytoplankton and zooplankton that live in the water bodies, which leads to an environmental disaster as the plankto is a source of food for the community [34]. There are many conditions that change the behavior of thermal waste, such as the topography of the sea floor, the depth of water, waves, the direction and speed of tidal currents, and the location of the emission source [35].

2.4.1.2. Radioactive pollution

Radiation is energy that is electromagnetic waves traveling in space or energetic particles in the form of a current radioactive pollution consists of particles and radiation emitted from some substances, and there are three types of radiation associated with radioactivity: gamma rays, alpha rays, and beta rays [36]. The treatment of ores, waste, mineral concentrates, solutions and waste are all human processes that affect the dispersal and spread of radioactive contamination during the development of rare earth resources [37], and Nuclear plants are considered one of the most dangerous sources of radioactive contamination during their operation [38].

2.4.2. Chemical Pollution

2.4.2.1. Industrial Pollution

It is the pollution resulting from the release of pollutants into the environment through industry, and its percentage varies from one country to another according to the level of industry, leaving great damage to vital systems [39]. The development in the field of industry brought an increase in the discharge of the number of pollutants, industrial solid waste, mining, and coal washing [40] and Industrial pollution is one of the most serious consequences of human impact on the natural environment, as polluted areas have less biological diversity [41].

2.4.2.2. Pollution With Pesticides and Agricultural Fertilizers

Agrochemicals add serious risks to the consumer organism, as some pesticides affect the human immune system and endocrine glands and may help in the development of cancer [42], excessive use of fertilizers in agriculture leads to the aggravation of non-point farming, such as phosphate fertilizers and nitrogen fertilizers, which leads to economic losses as well as pollution in soil and water , also, the use of pesticides has an undeniable effect, like pesticides, although they kill pests, they pose a threat and danger to humans and the environment through the toxins that they present to the environment [42].

2.4.2.3. Oil Pollution

It is the pollution resulting from offshore platforms, well drilling platforms, and marine tankers by throwing crude oil into water bodies [42]. The process of dumping crude oil into water bodies may occur as a result of pipe corrosion, mechanical failure, excessive pressure ... etc. These cases are very common in marine environments, and the competent authorities are not informed in the case of small spills, especially in countries whose environment is calibrated at the lowest level [43]. All of these result in the pollution of water bodies, generating severe consequences, which are summed up in a great loss of the biological revolution and disruption of activities in water bodies in addition to the danger to human health [44].

2.4.2.4. Acid Rain

acid rain is defined as the rain whose acidity is less than (5.6) which affects the living components and the acid rain contains sulfur oxides and nitrogen oxides [37], change in the composition of acid rain gradually occurs from rain known as sulfuric acid rain to rain known as nitric acid rain with the deposition of an increasing amount of nitrogen and acid rain consisting of the dissolution of nitrogen oxides and sulfur oxides in the atmosphere [45]. Acid rain are considered a threat to the environment that should not be ignored, as they caused the alienation and killing of fish, as happened in the Scandinavian waters, as well as the destruction of trees, as happened in European forests [46].

2.4.3. Biological Pollution

Is one of the most important types of pollution that causes danger to living organisms [47]. Biological pollution works to continuously change the quality of living organisms in the mud, and this, in turn, works to change the ecosystem and thus causes effects on human health [48]. Micro-parasites of bacteria and other single-celled organisms and pathogens represent invasive and introduced types that exist naturally or abnormally, but they are located in the wrong place. Thus, biological pollution differs from chemical pollution in that it is an increase in the number of living organisms, and its impact does not shorten the possibility of dispersal [49].

2.5. HEAVY METALS

It is considered one of the highly toxic substances and affects vital systems due to its stability and accumulation in the environment. Therefore, it is classified as an environmental pollutant. These elements come from natural sources such as volcanic eruptions and weathering of rocks that contain heavy metals, and from unnatural sources such as human resources such as agriculture, mining, and industrial activities [50]. It is considered a source of danger to human health when it is present in his food, which arrives through mineral fertilizers and fertilizer doses [51]. Trace elements such as zinc, chromium, mercury, cadmium, lead, and copper are among the major pollutants of freshwater environments due to their toxicity and non-degradability. Industrial development is the first factor to introduction of these elements into the environment, whether in soil, insects or water [52]. These elements are famous for their high solubility and then reach humans through the food ladder [53]. The wrong treatment of sewage from human activities in general, agricultural or industrial [54], is one of the reasons for the spread of heavy metals. Wastewater loaded with heavy metals is received in freshwater environments, causing the accumulation of these elements in aquatic environments and their transmission through food chains [55]. High concentrations of heavy metals cause many risks when they enter the human body and accumulate in it, causing disruption of the work of body systems such as kidney failure, nervous disorders, anemia and cancer. Arsenic, lead, cadmium and chromium, these metals are classified as exposure to them, even in small proportions, causing organ damage, this has been proven by experiments and epidemiological tests [56]. There are many methods by which heavy metals are removed from the water, including physical methods and chemical methods such as coagulation, chemical filtration, coagulation, microfiltration, photocatalysis, ion exchange, and biological methods in which microorganisms are used [57]. Traditional wastewater treatment procedures exist, but the majority of them are prohibitively expensive and produce vast amounts of sludge containing toxic chemical deposits that cause damage to environmental components [58]. The risks resulting from the spread of heavy metals are shown in Table 2.2.

Table 2.2. The source of heavy metals and the most important environmental effects resulting from them [57].

Heavy metal	**Adverse effect on health**	**Anthropogenic source**	**References**
Cadmium (Cd)	diseases in the respiratory system, liver, kidney, lung cancer, and reproductive organs, Hepatic toxicity	Synthetic chemicals, petroleum products, Electroplating Industries,Insecticides, Metallurgical industries	**[140,138]**
Lead (Pb)	nervous and Kidney system damage, cancer to the human body, and mental retardation	Pesticides, coal, mineral refining, fertilizers, vehicles, gasoline and emissions	**[56]**
Copper (Cu)	An imbalance in the amount of blood in the body Kidney destruction	pesticides and mining industries	**[45,89,34]**
Nickel (Ni)	diarrhea chest gastrointestinal ache	Metal alloys, electroplating Industries, petroleum refineries, fertilizers, battery plants and pulp and paper mills.	**[76,90]**
Mercury (Hg)	Damage in the respiratory system, brain, reproductive, and kidney	Electronics industries and fossil fuel combustion	**[32,19,33]**
Zinc (Zn)	fever, pain, anemia, vomiting, skin inflammation	Mining, coal combustion, electroplating, metal alloys pigments, and Industrial waste	**[67,80,27]**
Arsenic (As)	Increased risk of cancer, Circulation problems, and skin damage.	Fly ash, composts, electronics production, pesticides, livestock manures	**[134,79.40]**
Chromium (Cr)	inflammation of liver and kidney and ulcer and vomiting, damage, pulmonary, and skin inflammation	Leather industries , electroplating, anticorrosive products	**[140,59]**

2.6. WASTEWATER TREATMENT

In addressing water shortages, the world is working to develop and discover all available possibilities to stop the massive exploitation of freshwater resources In addition to the remaining treatment processes, whether mechanical or physical, the process depends mainly on analysis of pollutants in water [59]. The first water treatment plant that was built in Scotland was designed to treat municipal water in the nineteenth century and since then this process has spread in the world to treat wastewater [60]. Issues related to environmental pollutants of all kinds, biological and chemical, have become a source of concern for the community that must be addressed because of the pollutants they produce as a result of domestic and industrial activity [61] and The causes of pollution are many and varied, such as radioactive waste, sewage, urban development and pesticides. The main objective of controlling, managing, and treating wastewater is to preserve the environment in a way that adapts to health and economic concerns in light of the expansion of the industrial sector and the increase in human numbers [62]. That water is consumed means that it contains substances that cause pollution, regardless of its use, whether it is agricultural or industrial [63]. Many treatment methods have been reported during the past three decades that would treat polluted water and reduce the percentage of damage it provides, such as electrochemistry, biodegradation, evaporation, solvent extraction, sedimentation, and phytoremediation [64]. Therefore, it is necessary to treat the polluted wastewater to reduce the percentage of pollution and toxicity and protect the environment [65]. And wastewater treatment witnesses many processes that are performed on it until it becomes usable [60], as in Figure 2.1.

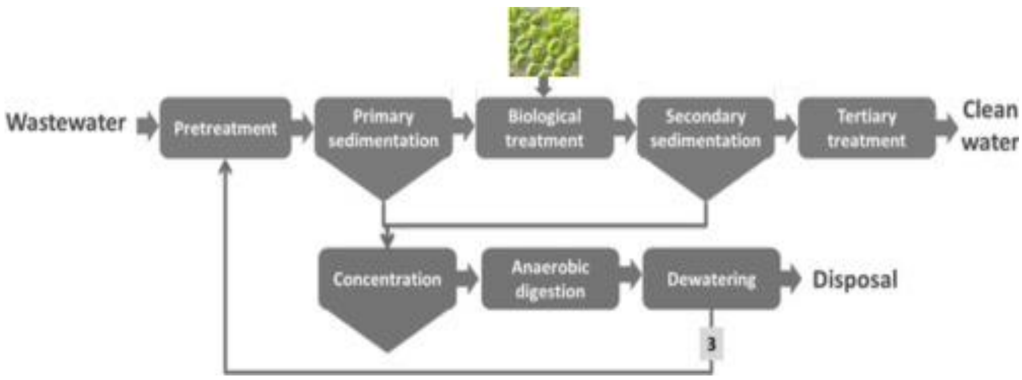


Figure 2.1. Wastewater treatment stages [60].

2.7. WASTE WATER TREATMENT TECHNOLOGIES

2.7.1. Biological Methods

Biodegradation is the process in which microorganisms such as fungi, bacteria and algae are used to break down and analyze molecules of large molecular weight, and we can divide them into aerobic processes that represent the batch chain reactor, membrane bioreactor and active sludge, and anaerobic processes include anaerobic film reactors and anaerobic sludge [66]. The biological treatment represents the secondary stage of wastewater treatment, and this treatment is carried out in bioreactors through microbial growth, using the process of photosynthesis in the analysis of pollutants, and it has two stages of bound and suspended growth [67].

2.7.1.1. Anaerobic Treatment

It is a biological process that saves energy and effort and at the same time is economical and is widely applied in the treatment of organic waste and wastewater. Anaerobic treatment is considered to be very reliable and effective. Wastewater is treated through a series of biological treatments that occur in the absence of oxygen by a group of anaerobic microbes [68]. As methane and carbon dioxide are produced in the Alzheimer's process from the conversion of organic matter, this method is very effective in treating waste and reducing the emission of gases that cause Global Warming [69].

2.7.1.2. Aerobic Treatment

The oxidation process takes place in oxidation basins, which are large and shallow stability basins the treatment mechanism in it is the interaction of bacteria and algae with sunlight [70]. To ensure good access of oxygen to the microorganisms in the active sludge, aerators of different types are used to ensure that air reaches the biological reactors of the treatment plants, which is the most common diffuse aeration (coarse, fine, and medium bubbles) and surface (mechanical) aeration [71]. The work of this technology is based on a group of microorganisms that lived in an environment that contains a large amount of oxygen in order to oxidize the organic matter into carbon dioxide, a cellular compound and water. This technology is promising, effective and reliable in terms of cost [72].

2.7.1.3. Phytoremediation

The large use of chemicals in agriculture has its negative effects on the soil, as it works to pollute the soil with toxins, and these pollutants persist in the field for a long time because they are not degradable and cannot be destroyed. Therefore, plant treatment is used to eliminate pollutants in the soil without causing damage to biological diversity. or soil fertility [73]. The presence of vegetation has many benefits as it works to provide oxygen during photosynthesis and absorption of nutrients ... etc. The plants used mostly in removing or withdrawing toxic pollutants from the soil are Phragmites, Typha, and Scirpus spp. These are the most common and used plants [74]. These plants provide the removal of pollutants without maintenance or energy costs through the interaction between water and vegetation, and these plants are generally large and can resist flooding and live for a long time [75].

2.7.1.4. Membrane Filtration

It is the process of separating suspended matter or filtering polluted water by relying on a membrane barrier. Each process needs a different layer that separates impurities at the cellular level or acts as a filter [70]. This technology is used in the treatment of wastewater and is also a successful alternative to traditional treatment plants because of its advantages such as the quality of treated water is better, the need for chemicals is little or no, and the production of sludge is reduced [76]. Membrane water treatment can be classified into integrated membrane processes and stand-alone membrane processes, the latter It is a treatment process using only membranes Such as nanofiltration, ultrafiltration, and microfiltration [77]. This technology meets sustainability criteria in terms of ease of use, environmental impacts and land use [78]. This technology separates molecules based on their acidity, size, and solution concentration by treating the membrane with chemical agents. This membrane consists of a material that has the ability to filter water in the process of treating polluted water with heavy metals by removing these metals [79].

2.7.2. Physical Methods

2.7.2.1. Degasification

This technique removes the gases present in the solution in a dissolved form the duration of degassing depends on the tank capacity, the temperature of the treated wastewater, and the frequency and power of the ultrasonic waves [80]. The degassing process takes place at a certain temperature. In the beginning, when the process of discharging the solution at a certain temperature, another process cannot be carried out when the temperature increases. An emptying process can occur when the wastewater solution is heated, the formation of bubbles containing gas in the solution that collects and rise to the surface after reaching sufficient buoyancy [70].

Sedimentation

It is a technique that separates particles during the treatment of wastewater from liquids through gravity sedimentation. Reducing the water velocity causes the suspended particles to remain safe during wastewater treatment, where these particles then settle by the force of gravity [81]. This technique works to reduce the concentration of the solid matter before coagulation occurs to obtain a smaller amount of coagulants in the coagulation process. Some substances are absorbed during the deposition of organic chemicals present on the surface of the suspended matter. Sedimentation efficiency is also dependent on flocculation and thickness [82].

Filtration

Filtration is a wastewater treatment technique that removes pollutants in water based on the size of the pollutants. In this technology, there are several types of filters depending on the types of pollutants in the wastewater there are two types of wastewater filtration: membrane filtration and particulate filtration [83]. Filtration is one of the basic steps in wastewater treatment, as it removes solids that are more than one micron in size the two main types of filters used in wastewater filtration are cartridge and bag filters [84]. Filtration technology can be used to remove suspended particles and microbial groups such as viruses, bacteria, and many chemical contaminants [85].

2.7.3. Chemical Methods

To reduce the process of transferring pollutants to water bodies with wastewater, chemical methods are used to treat the presence of these pollutants and remove them to make the water usable. These methods are chemical precipitation, scarring, coagulation, ion exchange, adsorption, and ozone [70].

2.7.3.1. Ozonation

Ozone is a strong oxidizing substance that can be used in wastewater treatment by removing organic pollutants, inorganic ions, and microorganisms. Initially, ozone was used to eliminate microorganisms in drinking water. Ozone removes arsenic, iron, and manganese through oxidation from water in an insoluble form that is separated by filtration [86]. Because ozone is unstable, it reacts with wastewater by forming the hydroxyl radical indirectly or directly through molecular ozone [87]. Ozone removes substances that produce colors, odors, and tastes, oxidizes organic pollutants, and treats compounds that rarely biodegrade. Therefore, this method has received more attention in the field of industrial water treatment [88].

2.7.3.2. Coagulation and Flocculation

Among the most important methods of industrial wastewater treatment is the coagulation and Flocculation method, and the mechanism of this method is the addition of coagulants that work to destabilize the colloidal suspensions by determining their charge, which results in the accumulation of small particles [82]. There are many factors on which coagulation and flocculation processes depend, including process variables such as the type of reagent used, the origin of the substance used for coagulation, the dose of the coagulant, the rate of circulation, pH, temperature, color... etc [89]. considered as this method of treatment is important in the wastewater treatment process, but it is economically costly because of the large economic cost of the chemicals used [90], Coagulation is one of the methods of wastewater treatment, where the colloidal particles present in the water to be treated are shaken off by determining the type of their electrical charge. Then the coagulation process follows the flocculation stage, in which the suspended particles vibrate gently to form a larger mass called lumps. These two processes are followed by the sedimentation process, which is the separation and isolation of insoluble solid particles from the liquid through gravity Figure2.2. These processes are shown [91].

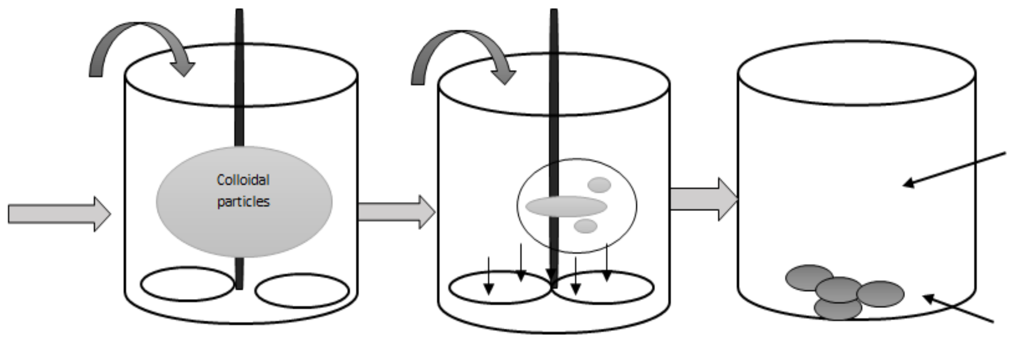


Figure 2.2. Coagulation, flocculation, and sedimentation of wastewater [92].

2.7.3.3. Adsorption

In many of the methods used to remove pollutants from wastewater, adsorption is the most used method because it is low cost and easy to operate [93], therefore, adsorption has been widely used to remove organic and natural pollutants from different environments [73]. In most cases, adsorption is accompanied by a process that operates in the opposite direction, namely absorption. There are many adsorbents that remove impurities from wastewater and can be used directly or modified, such as clay minerals, biomaterials, zeolite, and activated carbon [94].

2.7.3.4. Chemical precipitation

Chemical precipitation one of the effective In making water free of heavy metals, through the interaction of chemicals with the elements in the wastewater. An insoluble precipitate is formed and separated using the sedimentation technique [95]. Because of its ease of operation and low cost of economy, chemical precipitation is widely used. There are two types of precipitation processes, which are sulfide precipitation and hydroxide precipitation. But the second type is the most common and widely used because of the ease of acidity control and its low cost [96].

2.7.3.5. Ion Exchange

Is widely used in water treatment in both municipal and industrial water treatment systems. This technology provides many advantages compared to other treatment methods used, as it is a process that produces less sludge when used in wastewater treatment, and its maintenance cost is low and environmentally friendly [97]. And the materials from which the presence of the pollutants is inferred are called resins [98]. Among the synthetic resins used are acrylic acid copolymers, while the natural resins used in the ion exchange process are heavy metal silicate, carbon materials, clay, and proteins [79].

2.7.3.6. Coagulants

The materials used in coagulation are minerals or polymers that are used on wastewater to eliminate the forces that cause colloidal particles to stabilize coagulants [99].

2.7.3.7. Organic Coagulants

Iron and aluminum salts are widely used coagulants. The water of biological quality and chemical properties can be successfully treated using Fe and Al-based coagulants [100]. The materials used in the organic coagulation technique are iron salts and aluminum salts, which decompose into ions when added to water. This decomposition results in solid deposits and monomers that have the ability to dissolve [101]. Organic coagulants are commonly used to separate insoluble (solid) materials from the liquid in order to form the process that produces sludge [102]. The existing secondary coagulants in pre-decomposed forms Iron and aluminum are more effective in the wastewater treatment process than conventional additives and Organic coagulants are unaffected by pH, produce less sludge and require lower doses [103].

2.7.3.8. Inorganic Coagulants

For many decades, inorganic iron or aluminum salts have been used to coagulate colloidal particles and this process is preceded by the process of filtration, stagnation, or sedimentation. Despite its effectiveness, the method of treatment using inorganic materials has many drawbacks, such as large quantities of sludge resulting from treatment and the damage it leaves to the aquatic environment resulting from the use of mineral coagulants [104]. Inorganic coagulants work to destabilize colloidal suspensions during wastewater treatment in order to remove natural organic matter and turbidity [105]. Among the most inorganic materials that are used in the purification and treatment of wastewater are the salts (coagulants), which are aluminum salts, and the second type is iron salts. Aluminum minerals include sodium aluminate, aluminum chloride, and aluminum sulfate [102]. Excess amounts of iron and aluminum in effluents are It is considered a risk factor for humans and the environment, as they cause many human health problems such as abdominal cramps, intestinal constipation, and cramps [106]. The materials used in the mineral-based coagulation process are the most widely used because of their availability and cheapness. However, it has many disadvantages, such as poor temperature variation and high sludge generation, In Table 3.2, it appears that inorganic coagulants have many many qualities [102].

Table 2.3. Positive and negative properties of inorganic coagulants [102].

Name	Disadvantages	Advantages
Lime Ca (OH)2	Large amounts of sludge are left behind. Waste water quality is reduced	Very effective and a lot of use. It is not permissible to add salt to wastewater
FeSO 4·7H 2O	Often you need to add alkali	Not as pH sensitive as lime
Al2(SO4)3·18H 2O	Effective within a limited pH range and sometimes may add salts to wastewater	It is considered one of the most widely used types of coagulant and is easy to apply and use and effective at pH 6.5–7.5
Al13(OH)20(SO)4Cl15	Low in use compared to other aluminum compounds and Limited applicability	It is sometimes used in some applications as the formed clumps have faster stability than alum and are more dense
$FeCl_3 \cdot 6H_2O$	Increase the consumption of alkaline and may add salt to the water	Effective between pH 4 and PH 11
Na2AL2O4	Expensive and ineffective in hard water and is usually applied with alum	Often a small dose is needed and it is effective in hard water
Fe2(SO4)3	You need to add alkaline that may add salts to the waste water	It is effective between Ph (4–6 and 8.8–9.2)

2.8. NATURAL COAGULATION

Coagulation is an efficient and cost-effective process in sewage treatment and removal of suspended pollutants in water, it is an indispensable process, even with technological development. This process is still used to provide water suitable for human use [107]. Natural coagulants are as effective and of high quality as chemical coagulants and Natural coagulants [108]. At the present time, there is a great demand and interest in the selection of natural coagulants and their use in wastewater treatment [109]. From plant and animal residues we can make natural coagulants

[110]. Chemical coagulants such as ferric chloride, alum, Polyaluminium chloride and synthetic polymers are used to purify contaminated water, but the use of these materials is not sustainable, so a new, more sustainable approach has been found using vegetable coagulants [99]. as these materials are non-corrosive, non-degradable and economical Less from chemical coagulants [111]. It is worth noting that natural coagulants are of great interest to researchers and treatment workers because of their biodegradable properties, environmentally friendly and safe for human health [112], and they do not produce toxins and do not emit secondary pollution, and the volume of sludge. Small compared to chemical coagulants [99]. The coagulation mechanism depends on destabilizing the particles' charges and destabilizing them. Coagulable materials that have opposite charges to the charges of suspended solids are added to the Contaminated water in order to equalize the charges negative present on the dispersed solid materials that do not have the ability to sediment such as organic materials and clay [113].

2.9. DISCUSSING PREVIOUS STUDIES

There is a common goal agreed upon by previous studies, which is the removal of water pollutants from industrial wastewater by natural coagulation technique. It was also agreed on the effectiveness of these agricultural wastes in treating polluted water and removing pollutants from it, despite the different materials used such as coconut pulp, olive seeds, date grains, and walnut shells. The uses of these materials differed from one study to another, as some were used naturally without activation, while others were used as activated carbon. The difference is due to several factors, including the properties of the absorbent, the conditions of the experiment, the pH, the temperature of the solution, and the concentration and quality of the substances present in the water to be treated. However, everyone came to one conclusion, which is that the efficiency of natural coagulants in treatment is much greater than that produced by chemicals with byproducts. And by reviewing the similarities, differences and results between previous studies, we say that the current study agrees with it in the main objective and the general objective, although it differs from it in some aspects that this study deals with. This study included the use of palm residues (date seeds) as natural coagulants in the wastewater treatment process Industrial and also the high efficiency in processing compared to other technologies.

2.10. ADVANTAGES AND DISADVANTAGES OF NATURAL COAGULANT

Recently, natural coagulants have gained great popularity due to their ability to treat problems resulting from the use of chemical coagulants. [114]. Natural coagulants of plant origin perform the coagulation process through charge determination or polymer bridging natural coagulation has a property that distinguishes it and makes it superior to chemical coagulation for many reasons, including that natural coagulation is safer than its chemical counterpart [115], as treating water with a chemical coagulant creates the possibility of these substances after the treatment process, because it can cause diseases such as Alzheimer's disease that it causes Alum residue[116], on the other hand, the remnants of natural coagulation after treatment will not be harmful. Also, chemical coagulants are an economic cost that makes their use difficult in poor countries, while natural coagulants can be taken from plant residues, which makes them much cheaper [117]. But do not forget that treatment with natural coagulants sometimes requires disinfection of the treated water by adding additional chlorine due to the increased activity of bacteria resulting from the increase in organic matter, which increases the cost of treatment [118].

PART 3

METHODOLOGY

3.1. ANALYTICAL STUDY

Table 3.1 It displays what happens during the experiments of the methods used and the characterization parameters [119] and Figure 3.1 also shows the practical steps that were taken during the experiment.

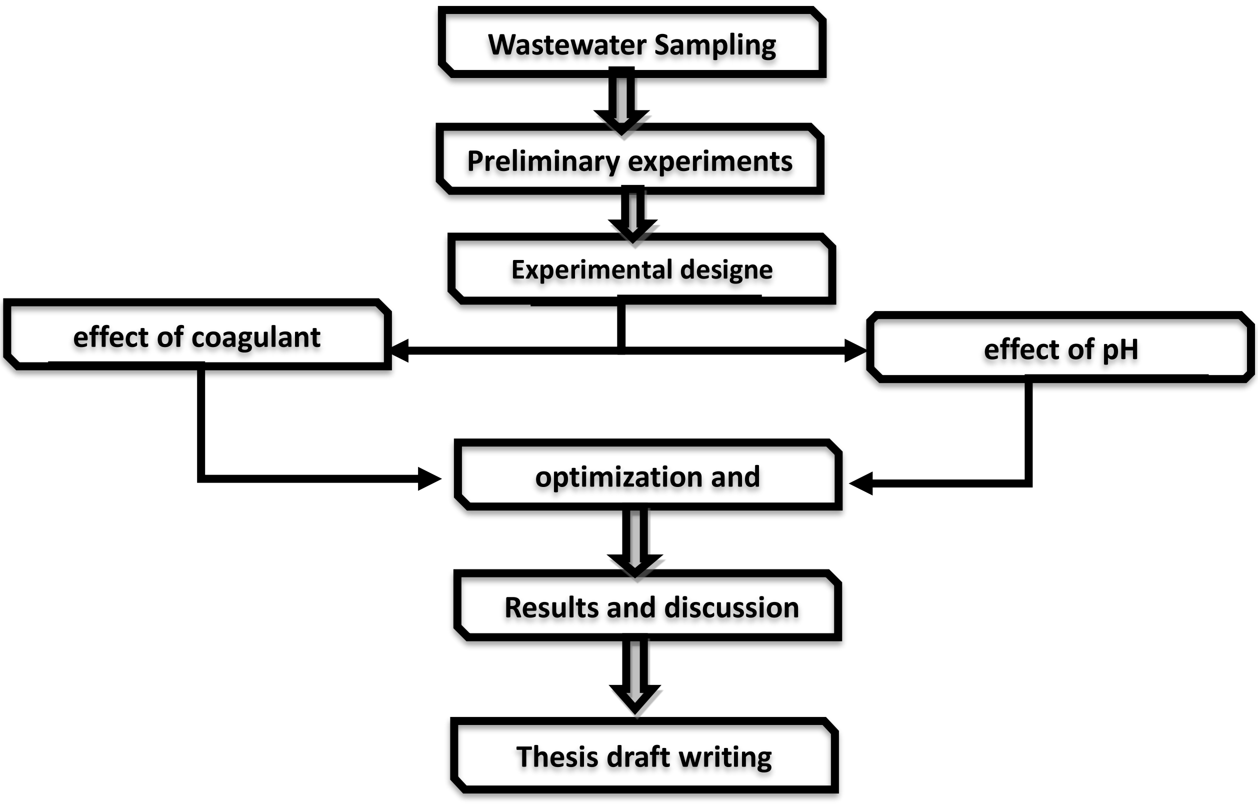


Figure 3.1. Steps that were followed while working on the experiment.

Many experiments have been conducted in the field of industrial wastewater treatment and many different methods have been according to the water to be purified. The pH was changed with a solution (1 N H2SO4/NaOH) to reach optimal conditions In order to purify water polluted by heavy metals. show table 3.1 the descriptive parameters and methods used.

Table 3.1. description parameters and methods.

Method	**parameters**
(pH meter)	_pH_
SM 2123 C	Coloor (Pt-Co)
SM 2531 D	TSS (mg/L)
ASTM-D1253-A	COD (mg/L)
TS-EN ISO 11732	NH_3-N(mg/L)
TS-EN ISO 11875	"Mn(mg/L)
TS-EN ISO 11886	Fe(mg/L)
TS-EN ISO 11884	Zn(mg/L)
TS-EN ISO 11884	Al(mg/L)
TS-EN ISO 11886	Ni(mg/L)

3.2. MATERIALS AND METHODS

3.2.1. Manufacture of Date Seed Powder

The date seeds were obtained from the market and then transferred to the university laboratory. In order to remove the suspended objects, the date seeds were washed with water, then left to be dried under the heat of the sun, then transferred to the oven to be placed under 50 degrees Celsius for a period of not less than 8 hours. As shown in Figure 2.3, date stones are ground by means of a mill in order to be used in processing as a coagulant.

Figure 3.2. Date seed

3.2.2. PH Meter

It is a device that measures the acidity or basicity of a specific liquid and consists of a tool that measures potential difference and is connected to another device that senses the pH [120]. PH measurement is an important part of many applications' chemistry, biology, civil engineering, environmental science, food science, oceanography, chemical engineering, medicine, water purification and water treatment, and nutrition [121]. Figure 3.3 shows a pH meter from category WTW InoLab pH 720

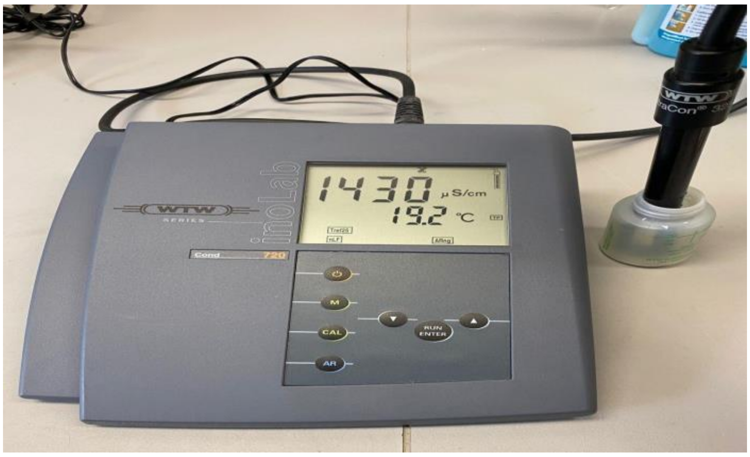


Figure 3.3. WTW InoLab pH 720

3.2.3. Shaker PSU-10i

It is a device found in small and large laboratories with multiple disciplines and provides an orderly orbital motion of the platform. The shape and design of the device allow it to be used in biotechnology laboratories as shown in Figure 3.4 [122].

Figure 3.4. Shaker PSU-10i

3.2.4. Sartorius Median Electric Balance Germany

It is a device for measuring small weights. It is considered a very sensitive scale. It is characterized by ease of use, effectiveness, and accuracy in weighing. It is widely used in scientific laboratories as it is one of the most widespread devices in the laboratory and is used to determine the mass of objects and consists of one arm.as shown in Figure 3.5 [123].

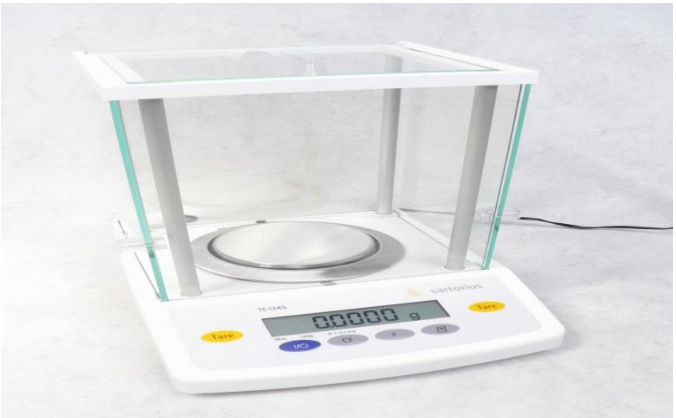


Figure 3.5. Electric Balance Germany Sartorius TE124S balance.

3.2.5. Filter Papers

They are filters that purify the water that passes through them and are made of cellulose. They are generally used in the filtration process, as they have a great purification efficiency as they have particles retention levels of 2.5

micrometers[124]. The filter papers are placed in a glass funnel, then the liquid is poured through it, and it is purified by filtering the insoluble particles As shown in Figure 3.6.

Figure 3.6. Filtering the solution through filter paper.

3.2.6. Erlenmeyer Flask

It is a container in a conical shape that is widely used in scientific laboratories and various scientific experiments. Its most uses are in storage, transportation, and mixing. It has a neck that allows it to be closed with a plug without spilling the liquid [125]. as shown in Figure 3.7 .

Figure 3.7. Erlenmeyer flask.

3.3. SAMPLING

The sample was taken from the industrial wastewater of the contemporary iron factory in Karabuk city from the wastewater flow of the factory during its operation period. To work on it, the plastic containers were washed several times, and then samples were placed in them, sealed tightly, and taken to the lab to work on. It was taken into account to take a large amount of wastewater in order to be sufficient to conduct several experiments, The sample is representative of the source of the water from which it was taken.

3.4. PREPARATION OF NATURAL COAGULANT

The crushed date seed was selected as a natural coagulant in the processing process. The date seed are the solid part that occupies the center of the fruit. They are rectangular and pointed at both ends, and their characteristics vary depending on the environmental conditions and their type. The date seed were brought and washed to get rid of all impurities and dried at a temperature of 50 degrees Celsius. They were ground and dried again at a temperature of 105 degrees Celsius before being used in the wastewater treatment process. As shown in Figure 3.8.

Figure 3.8. Converting date seed to powder.

3.5. EXPERIMENTAL SETUP AND PROCEDURE

3.5.1. Experimental Procedure

In order to simulate the process of flocculation and coagulation, we used cups each of which has a capacity of 500 ml (three cups), and an orbital shaker device, and in each of the three cups, there is 200 ml of water sample to work on and to adjust the speed for slow and fast mixing and the time, use the automatic control device (the shaker apparatus).

The work was done in the laboratory, they performed flocculation and coagulation in the following manner: rapid mixing for a period of (15 minutes) under the influence of mixing (200) revolutions per minute, then after that we made slow mixing (30) minutes under the influence of (90) revolutions per minute, We put the samples under the influence of 60 minutes of sedimentation process, Coagulation was evaluated based on its ability to remove NH3-N, COD, and TSS, taking into account that the pH value was not modified throughout the experimental period. The plastic containers were shaken before opening the containers and taking samples from them. Different weights of crushed date seeds were added to 200 ml of wastewater to reach the optimum dose that provides maximum efficiency for removing organic matter and heavy metals.

After that, the best dose that performs the highest water treatment process in previous experiments is known and evaluated by treating it with concentrations of pH (10 to 5).Before the process of adding the material that coagulates, the pH concentrations are adjusted using an amount of (1 ml) of sodium hydroxide and hydrochloric acid, and in order not to allow the solids to sediment the samples are shaken vigorously.
removal efficiency is calculated as follows:

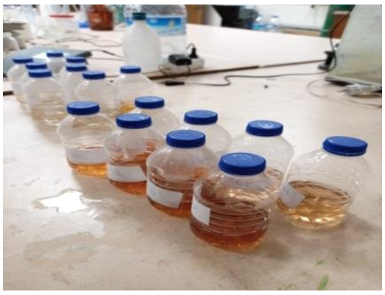
$$Removal\ efficiency(\%) = \left[1 - \left(\frac{C_f}{C_i}\right)\right] * 100 \quad (3.1)$$

Table 3.2. shows the water specifications used in the experiments

Industrial-wastewater-Parameters	Results	Units
Nickel "Ni"	0.14	mg/L
Color	865.7	Pt-Co
TSS	109	mg/L
pH	8	--
COD	840.30	mg/L
NH_3-N	42.0	mg/L
Zn	5.46	mg/L
Mn	6.29	mg/L
Al	0.40	mg/L
Fe	5.29	mg/L

The pH was measured for every 200 ml of the sample before adding the crushed date seeds to it. Each time the pH was changed, to measure the pH effect changing on the efficiency of removing organic matter and heavy metals from the water was evaluated. and as indicated in Table 3.3, where 200 ml was taken and its pH was measured, then different doses of date seed powder were added and the vial was closed with a stopper as shown in Figure 3.9 and placed on the Shaker PSU-10i for 45 minutes, Then the solution was filtered through filter paper in a plastic package and the package was numbered as in Figure 3.10. The same process was repeated with the rest of the samples of different weights and different pH. To measure the impact of the evaluation the pH on the efficiency of removing organic matter and heavy metals from water. Each time the tools are washed with distilled water in order to get rid of contaminants, and the pH measurement is also zeroed.

Figure 3.9. Wastewater after adding date seed powder.



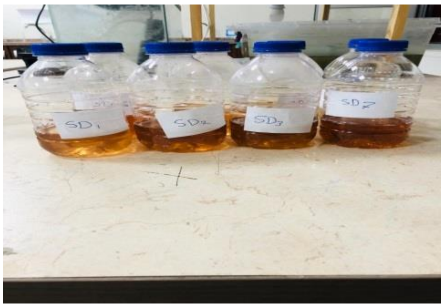


Figure 3.10. Packages containing the filter solution.

3.5.2. Factorial Design and Optimization

In the current study, we used the scientific technique of analyzing data and experiments based on the response surface and CCD (Design Expert Software). Whereas, RSM is a technique used to increase industrial processes and chemical reactions, and at the same time it is a statistical and mathematical technique that is widely used in determining the boundaries of the parameter optimal [126] , The interaction and correlation between the response of the input parameters and the process of the input parameters is described according to equation (3.2).

$$\boldsymbol{Y} = \boldsymbol{f}\ (X_{\mathbf{1}}, X_{\mathbf{2}} X_{\mathbf{3}} \ldots\ldots X_{\boldsymbol{k}}) \ \pm \varepsilon \qquad (3.2)$$

Where each of (x1 and x2 and x3, and --- -- X_k) are variables that can affect the processing efficiency (by affecting the response value), Ɛ they represent the random error that may occur

Depending on the number of design parameters, the Design Expert Software offered a number of designs. The capacity of the designs to estimate higher order words varies. Only the quadratic model is suitable for the majority of designs. The following equation can be used to represent the second order model (3.4).

$$Y = \beta_0 + \sum_{j=1}^{k} \beta_j X_j + \sum_{j=1}^{k} \beta_{jj} X^2{}_j + \sum_{i} \sum_{<j=2}^{k} \beta_{ij} X_i X_j + e_i \qquad (3.3)$$

where Y is the response; X_i and X_j are the variables; β is the regression coefficient; k is the number of factors studied and optimized in the experiment; and e is the random error.

In order to process the interaction between the responses and the process variables, (ANOVA) is relied upon in order to raise the efficiency of treatment techniques for data analyzes.

We use the coefficient of determination (R2) to express the probability of a polynomial model.

In order to evaluate and raise the level of the relationship between the two variables (pH and the dose of dried dates), RSM and CCD are applied as described in Table 3.3.

Table 3.3. Independent variables (Ph, data seed).

B: pH	**Date stone**	**Level of Value**
8	1.3	1
5.39	1.00	0
7.6	0.5	-1

After the treatment process that took place on the wastewater, the removal efficiency of (Ni, Mn, Fe, COD, NH3-N, Al, and TSS) was evaluated and considered as response factors, by analyzing the removal of NH3-N, color, and COD, the performance and efficiency of the process were evaluated [127]. Based on the studies that preceded the current study, a change was made on three levels for each variable separately between (1 and -1).

The total number of experiments that we carried out in the laboratory was 13 experiments for each of the two factors (pH and date seeds). The table below explains the details of the exponential design related to the resulting ozone oxidation (Table 3.4).

Table 3.4. Total experiments under the influence of pH and date seeds (summary of the experimental matrix).

Run	Date Seed Dosage	PH	Type
SD3	0.59 g	9	fact
SD4	1.04 g	5.4	Axial
SD10	0.58 g	5.59	Fact
SD6	1 g	7.51	Center
SD2	1.55 g	7.5	Axial
SD7	1.39 g	9	fact
SD8	0.40 g	7.5	Axial
SD5	1.02 g	9.6	Axial
SD1	0.99 g	7.49	Center
SD9	1.4 g	6	Fact

PART 4

DISCUSSION AND RESULTS

4.1. DATE SEED POWDER UNDER ELECTRON MICROSCOPE LENS CHARACTERIZATION

Figure 4.1 shows the morphological structure of the surface of ground date seeds after and before using it as a coagulant, as it has a brick- shape and has a crystalline structure. Figure 4.1 shows the ability of the coagulant to collect particles and form large clumps that have been easily settled. Therefore, we can say that bridging is responsible and the reason for the ability of crushed date seeds to coagulate, As shown by SEM images [128,129].

1) 2)

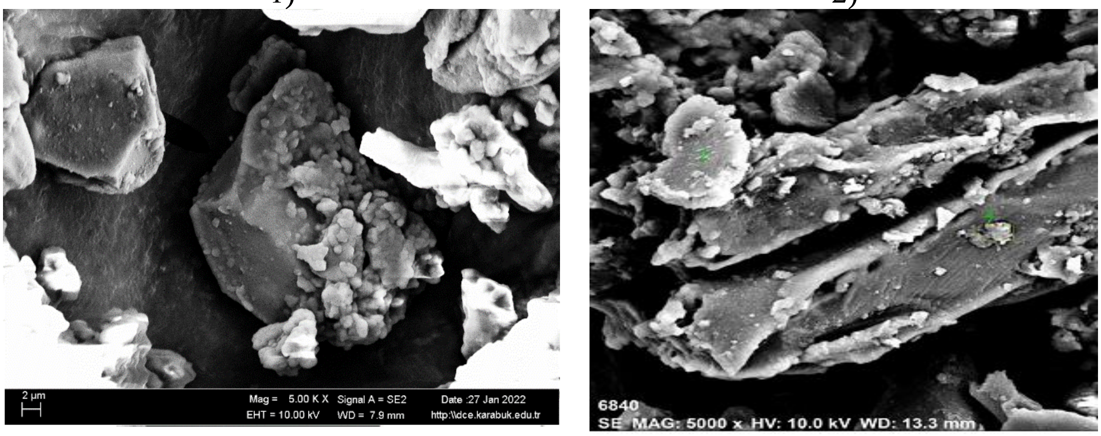


Figure 4.1. Date seed powder under the microscope before and after (1 before 2 after) coagulation process with accuracy (2 µm).

4.2. FOURIER TRANSFORMED INFRARED (FTIR) ANALYSIS

The groups date seeds were quarried in order to ascertain the presence or absence of the possible main functional groups, the corresponding (IR) look to Fig. 4.2.

In order to highlight and simplify, an analysis (FTIR) was conducted on the main functional groups affiliated to it. The functional groups of crushed date seeds can be highlighted within wavelength limits (peaks) in order to easily perform infrared spectrum analysis. Within limits (300-2500 cm -1) there will be a strong amine salt by observing the noticeable peak. This salt participates in the bridging process within the coagulation process used by the particles, and this process is effective in removing the presence of ammonia from the waste water.

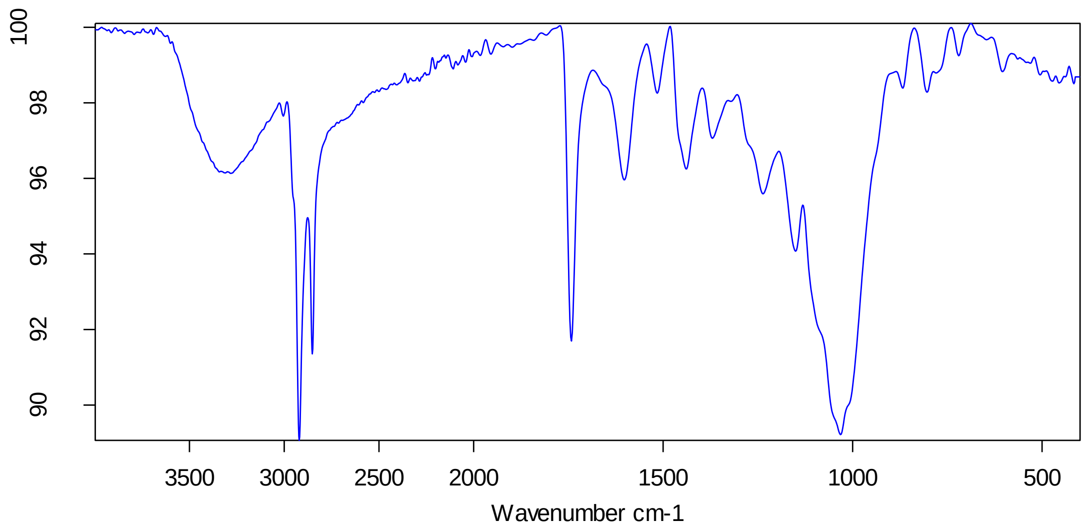


Figure 4.2. FTIR Spectral analysis curve for the date seed powder ingredient.

4.3. EFFECT OF QUANTITY (DOSE) OF GROUND DATE SEEDS

The removal efficiency of target parameters under the effect of date seed powder was evaluate. Therefore, different dosages of 0.2, 0.6, 1, 1.4 and 2 g/200ml of coagulants were adopted. The maximum removal of NH3-N and COD was 92.06,59.43 %.respectively using 1.4g/200ml of coagulant maintaining the original pH (8) for industrial effluent (Fig 4.3).

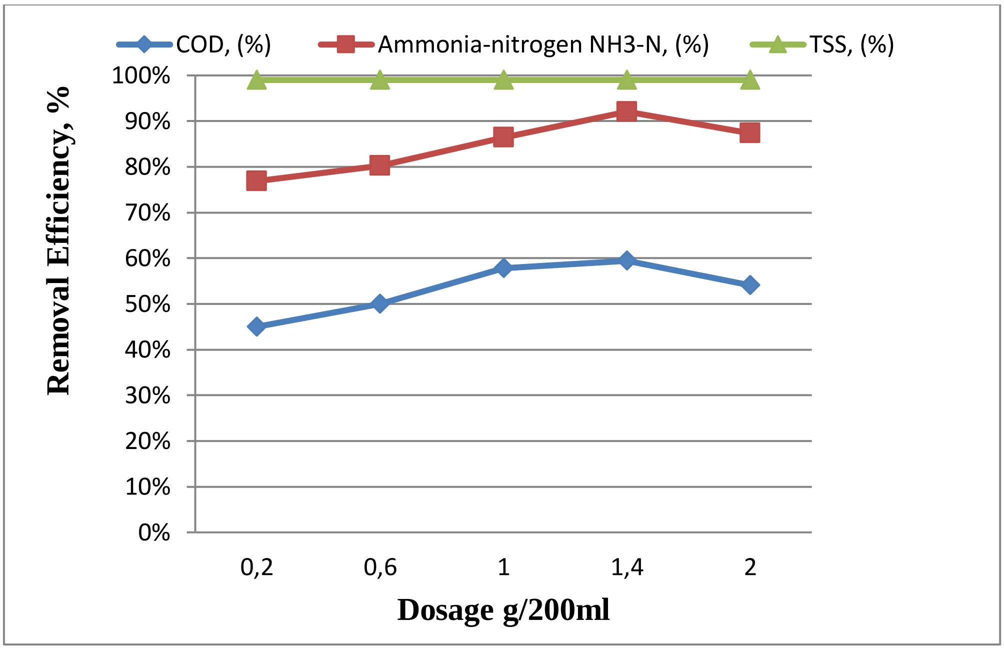


Figure 4.3. Effects of date stone powder dose on removal TSS, NH3-N and COD (pH: 8).

In the beginning, the removal efficiency increased gradually until it reached a dose of 1.4 g/200 ml, and then decreased with increasing the amount of crushed date seeds until it reached 2 g/200 ml. shown in Fig 4.3.

Due to the aggregation of coagulants and their congestion, an imbalance occurs in the removal efficiency and decreases when removing NH3-N and COD, or it may be due to saturation or reaching equilibrium at a dose of 1.4 g / 200 ml. Therefore, the added dose has no effect on increasing or decreasing the removal efficiency.

On the other hand, the removal efficiency of TSS was observed to be constant at 99% at each dosages throughout the experiments. The high efficiency of date seed powder in the process of treating and removing (TSS, COD and NH3-N) comes from its molecular structure as it contains coagulants in it. In fact, the waste water contains solid particles that gather on each other and increase in size, and then pour into the bottom of the support. In order to reduce the production of sludge and achieve an optimal treatment efficiency, the optimal dose of crushed date seeds must be determined. Therefore, the removal efficiency differed in wastewater treatment when removing NH3-N and COD.

The reason for the ability of date seed powder to treat pollutants in wastewater is that it contains natural polyphenols that absorb mineral ions and dissolved organic matter in water [130]. The parameters to be removed are less efficient when using larger doses of date seeds [131].

The process of bridge mechanism the colloids and particles present in the water to be treated was improved, and the flocculation process was also improved due to the presence of amino groups that contain a positive charge in the date seeds [132].Due to the high molecular weight of non-aqueous date powder found in wastewater, higher doses of date seeds when used in processing inhibit and reduce flocculation efficiency due to precipitation in large quantities [133].

The performance of date stone powder on heavy metal removals from industrial effluent was presented in Fig 4.4. The highest removal efficiencies for Fe, Zn, Al and Ni were 97.74, 94.85, 65.79 and 80% respectively at 1.4g/200ml, while the highest removal efficiency of Mn was 87.56% of Mn at 1g/200ml, in the same time the removal efficiency of Mn shows considerable removal efficiency of 87.06% at 1.4g/200ml, therefore we consider that the optimal dosage of date stone powder are 1.4g/200ml for all tested heavy metals in this experiments. Furthermore, no It was observed that when adding doses higher than recommended amount (1.4 g / 200 ml.), a large elimination process occurred, as happened in our current study

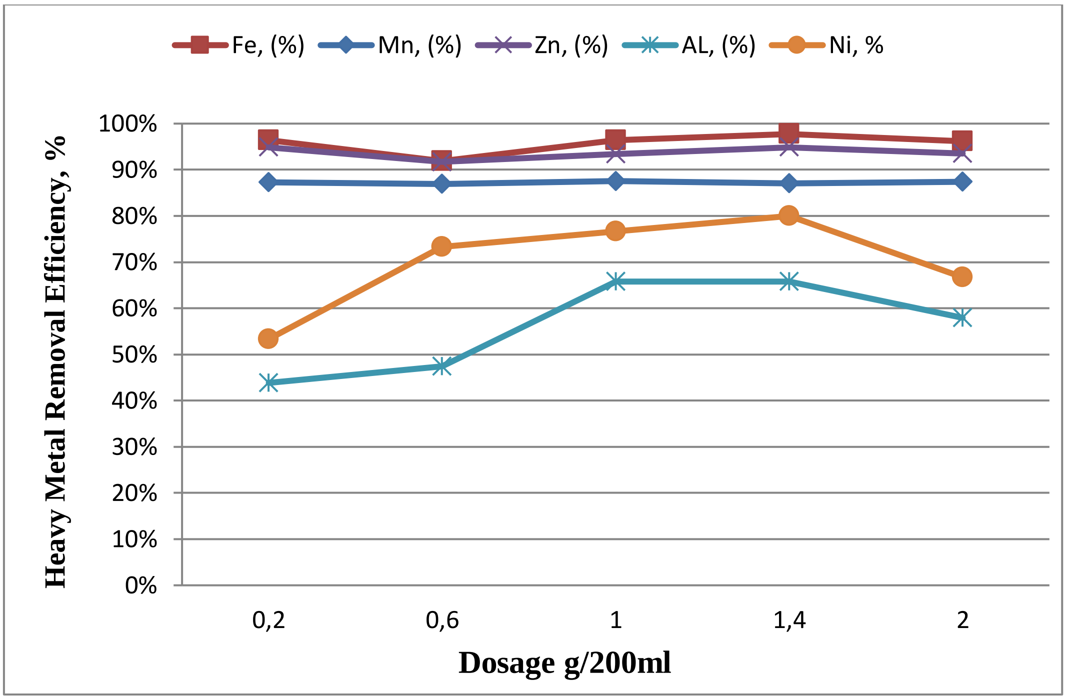


Figure 4.4. Effect of date seed powder dose on removal of Zn,Mn,Fe,Ni and AL (pH: 8).

The coagulation mechanism can be improved by cations by destabilizing and neutralizing the negative charges of the remaining coagulant functional groups by incorporating them with crushed date seed particles [134,135,136,137].

4.4. EFFECT OF PH VARIANCE

The effect and efficacy were evaluated at a pH between 10 and 4 with an optimal anticoagulant dose being maintained at 1.4 g/200 mLusing a 1 N NaOH/H2SO4 solution. As shown in Figure 4.5 pH was adjustedWhen the pH concentration is 8, the removal efficiency is observed to be at the highest level of the parameters, with 92.06% NH3-N removed and 59% COD removed.When the pH concentrations rise, the removal efficiency rises and increases gradually for NH3-N and COD until reaching the highest value in removal, and the chance of removing NH3-N and COD decreases with the increase in the ideal pH value..

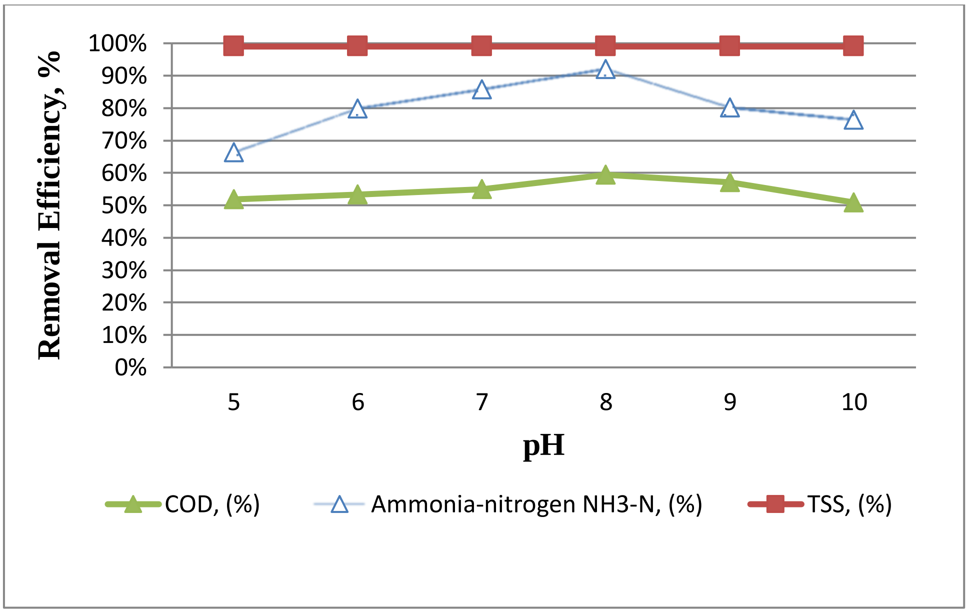


Figure 4.5. Effect of pH on removal NH3-N ammonia-nitrogen TSS,and COD.

In each cup, the pH was changed to the desired typical pH before adding date seed powder to carry out the treatment process as shown in Figure 5.5. The removal efficiency for NH3-N was (92.06%) and COD was (52). As shown in Fig 4.5 the removal efficiency start increase with increase of pH from 5 to 10 and then decrease trend occurs. Due to the organic nature of the date stone, there was no need to change the pH in the treatment, so the pH of the wastewater remained unchanged after adding the date seed powder.

On the other said, Total dissolved solids were observed to remain unchanged by 99% with pH adjustment throughout the 5-10 experiments. While the pH ranges (7-9), the molecules have a greater ability to absorb, and the reason for this is due to the neutral electrical charge of ammonia-nitrogen NH3-N and COD [139].

Many experiments were conducted under variable pH values with the optimal dose (1.4 g / liter) in order to determine the optimal pH range, as it was noted that the optimal pH value is was 8 with better removals were obtained by using the coagulant. The removals of Fe, Mn, Zn, Ni and Al by using date stones powder were 97.74, 87.06, 94.85, 80.33 and 65.79 %, respectively, at pH 8 (Fig 4.6).

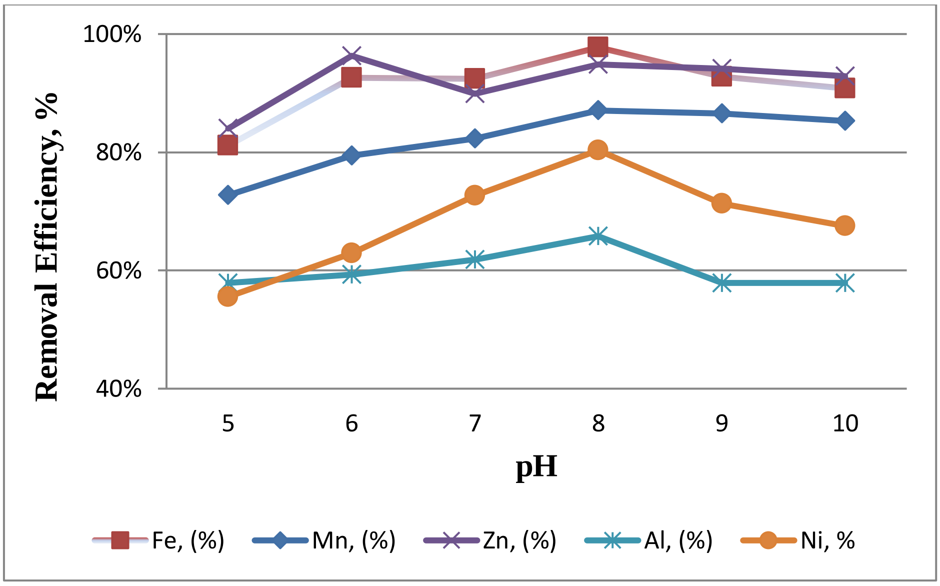


Figure 4.6. Removal of heavy metals under the influence of pH.

Changing the pH was not necessary as it remained unchanged when adding date seed powder during wastewater treatment due to the organic nature of date seeds.

Table 4.1. Summary of coagulation of wastewater using date seed powder.

		Factors		_Responses_						
Run	**Type**	**A:Date seed dosage**	**B:pH**	**Fe**	**Mn**	**COD**	**NH3**	**Ai**	**Ni**	**Cu**
		g		**Removal %**	**Removal %**	**Removal %**	**Removal %**	**Removal %**	**Removal %**	**Removal %**
1	Center	1.00	7.51	92.01	92.5	35.9	28.05	92.8310	90.68	63.2
2	Axial	1.55	7.5	95.90	92.31	6.5	64.01	87.1326	87.9	63.19
3	Fact	0.59 g	9	96.71	93.9	65.5	65.4	93.76	86.5	47.39
4	Axial	1.04	5.4	94.30	83.40	44.3	58.08	74.8159	81.05	34.09
5	Axial	1.02	9.6	94.1	94.73	41.1	24.5	93.9337	85.90	60.49
6	Center	0.99	7.49	92.02	91.75	41.4	34.0	82.5367	89.90	60.49
7	Fact	1.39	9	96.03	89.0	9.00	64.9	78.3089	80.69	60.40
8	Center	1.00	7.51	92.02	92.6	35.7	28.02	92.8310	90.68	63.09
9	Center	1.00	7.51	92.01	92.50	35.7	28.02	92.8310	90.69	63.10
10	Axial	0.40	7.5	90.00	90.20	67.00	93.01	89.1542	89.25	42.00
11	Fact	1.4	6	96.71	87.93	14.3	97.5	91.3610	84.90	65.70
12	Fact	0.58	5.90	89.07	82.62	70.5	77.7	70.7719	83.09	31.4
13	Center	1.00	7.49	92.01	92.5	35.00	28.3	92.8310	90.74	63.10

Removal results for COD after adding date seed powder with different weights with changing pH values, where the removal ranged from 6.5% to 70.5%, and the removal percentage to NH_3 ranged from 24.5% to 97.5% and the removal rate for Fe was 89.07 % to 96.71%, The removal ratio for Mn is 82.62% to 94.73%, the removal ratio for Ai is 70.7719% to 92.8310% and the removal ratio for Cu ranges from 31.4% to 65.70%, and the removal ratio for Ni is 90.68% to 80.69%. The results showed a high treatment efficiency of date seed powder in removing NH_3 and iron, while we note that the treatment efficiency decreases when it is treated with Cu and Ai due to the cohesion of Cu and Ai particles as shown in Table 4.1.

4.5. THE ANALYSIS OF VARIANCE

The Table 4.2. shows the regression parameters of the exponential response area projection models and additional statistical parameters for the ANOVA for CU, COD, Al, Mn, NH3, and Fe. The data in the following table show in all models were significant for the P-value at the 5% confidence level. The 2 R values (values of the coefficient of determination) in this study were for me (Al,CU, Mn, COD, Fe, and NH3).R2: 0.8786, 0.8760, 0.8958, 0.9413, 0.8104, R2: .09217, 0.9800, which higher than 0.8 to fit the model well, We notice that there is a good agreement between the calculated and expected results when looking at the value of R2 close to 1. Typical terms were excluded from the study (not important) and six quadratic models remained in Table 4.2 due to their limited effect.

Using Design Expert 6.0.7software, the selected model is confirmed to be identical to the real system by providing normal protection plots for diagnostics and the studentized residuals, Models were judged by probability charts provided by (Design Expert 6.0.7) software.

Table 4.2. The Analysis of the Variance (ANOVA) for parameters removal.

	Source	**Squares**	**DF**	**Square**	**Value**	**Prob > F**	
COD removal %		**Sum of**		**Mean**	**F**		
	Model	5047.00	4.99	1009.40	65.30	< 0.00009	-significant-
	A	4962.00	1	4961.9	321.00	< 0.0001	
	B	27.70	1	27.70	1.80	0.2230	
	A2	0.090	1	0.090	5.725E-002	0.9420	
	B2	56.95	1	56.96	3.70	0.0969	
	AB	0.0001	1	0.0001	0.0001	1.0	
	Residual	108.2	6.99	15.45			
	Lack of Fit	85.36	3	28.45	4.99	0.0774	not – significant-
	Pure Error	22.83	4	5.71			
	Cor Total	5155.15	12				
	Std. Dev. 3.95 R2: 0.9800, Mean:38.74						
	Source	**Squares**	**DF**	**Square**	**Value**	**Prob > F**	
NH3 Removal %		**Sum of**		**Mean**	**F**		
	Model	7297.99	4.9	1459.63	9.92	0.0043	-significant-
	A	61.00	1	60.76	0.44	0.5409	
	B	1080.99	1	1081.24	7.33	0.0300	
	A2	5760.00	1	5760.00	39.20	0.00039	
	B2	714.99	1	715.30	4.90	0.0630	
	AB	108.11	1	107.99	0.73	0.4199	
	Residual	1030.00	7.5	147.00			
	Lack of Fit	998.89	2.99	332.27	45.17	0.0014	-significant-
	Pure Error	30.00	3.90	7.40			
	Cor Total	8329.50	11.95				
	Std. Dev. 12.12 R2: 0.8760, Mean: 53.19						
	Source	**Squares**	**DF**	**Square**	**Value**	**Prob > F**	
Fe removal %		**Sum of**		**Mean**	**F**		
	Model	66.35	4.99	13.27	10.10	0.0041	-significant-
	A	29.20	1	29.20	22.23	0.0020	
	B	5.5	1	5.5	4.25	0.0799	
	A2	3.65	1	3.67	2.80	0.1387	
	B2	12.23	1	12.23	9.34	0.0185	
	AB	17.22	1	17.22	13.13	0.0084	
	Residual	9.20	6.9	1.30			
	Lack of Fit	9.19	2.5	3.07			
	Pure Error	0.0001	3.99	0.000			
	Cor Total	75.49	11				
	Std. Dev. 1.16 R2:0.8786, Mean:93.27						
	Source	**Squares**	**DF**	**Square**	**Value**	**Prob > F**	
Mn removal %		**Sum of**		**Mean**	**F**		
	Model	159.83	4.97	31.98	22.45	0.00039	-significant-
	A	1.38	1	1.38	0.97	0.3592	
	B	98.62	1	98.62	69.90	< 0.0001	
	A2	6.93	1	6.93	4.88	0.06339	
	B2	30.18	1	30.16	21.18	0.00249	

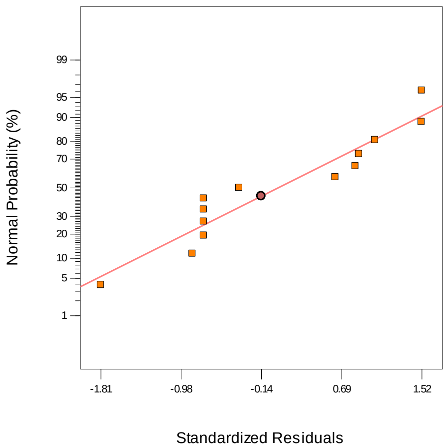
	AB	25.97	1	25.97	18.20	0.0038	
	Residual	9.99	6.89	1.42			
	Lack of Fit	9.53	2.99	3.18	27.87	0.00389	-significant-
	Pure Error	0.47	4.0	0.10			
	Cor Total	169.84	11				
	Std. Dev. 1.20 R2: 0.9413, Mean: 90.40						
Al removal %	**Source**	**Squares**	**DF**	**Square**	**Value**	**Prob > F**	
		Sum of		**Mean**	**F**		
	Model	616.15	4.99	123.25	6.00	0.01809	-significant-
	A	0.66	1	0.67	0.0319	0.8637	
	B	170.80	1	170.79	8.310	0.02359	
	A2	27.60	1	27.60	1.35	0.2849	
	B2	104.52	1	104.54	5.09	0.0590	
	AB	324.52	1	324.54	15.78	0.0055	
	Residual	144.10	6.99	20.60			
	Lack of Fit	59.30	4	19.79	0.94	0.5027	not significant-
	Pure Error	84.79	3.9	21.20			
	Cor Total	760.20	11.9				
	Std. Dev. 4.56, R2: 0.8104, Mean 87.18						
Cu removal %	**Source**	**Squares**	**DF**	**Square**	**Value**	**Prob > F**	
		Sum of		**Mean**	**F**		
	Model	1608.40	6	321.69	16.48	0.00108	-significant-
	A	743.86	1	743.84	38.10	0.00051	
	B	284.90	1	284.90	14.59	0.0065	
	A2	151.79	1	151.77	7.78	0.0271	
	B2	370.99	1	371.00	19.00	0.00339	
	AB	110.82	1	110.83	5.68	0.04879	
	Residual	136.74	8	19.56			
	Lack of Fit	131.22	4	43.75	31.57	0.0031	-significant-
	Pure Error	5.55	3.9	1.40			
	Cor Total	1745.14	11.9				
	Std. Dev. 4.44 R2: 9217, Mean:55.27						
Ni removal %	**Source**	**Squares**	**DF**	**Square**	**Value**	**Prob > F**	
		Sum of		**Mean**	**F**		
	Model	148.76	4.9	29.77	12.02	0.00249	-significant-
	A	4.82	1	4.80	1.96	0.20518	
	B	5.68	1	5.68	2.30	0.17390	
	A2	15.14	1	15.12	6.109	0.0428	
	B2	114.58	1	114.58	46.239	0.00029	
	AB	17.37	1	17.35	7.02	0.03309	
	Residual	17.34	7	2.49			
	Lack of Fit	17.00	2.99	5.68	63.73	0.00079	-significant-
	Pure Error	0.35	5	0.090			
	Cor Total	166.13	11.9				
	Std. Dev. 1.59 R2: 0.8958, Mean87.14						
	Source	**Squares**	**DF**	**Square**	**Value**	**Prob > F**	
		Sum of		**Mean**	**F**		

COD removal %	Model	5046.97	5.1	1009.40	65.309	< 0.00010	-significant-
	A	4961.86	1	4961.86	321.04	< 0.00010	
	B	27.67	1	27.67	1.80	0.2228	
	A2	0.089	1	0.089	5.724E-0030	0.9417	
	B2	56.93	1	56.95	3.69	0.0965	
	AB	0.0001	1	0.0001	0.000	1.00001	
	Residual	108.20	6.9	15.45			
	Lack of Fit	85.37	3	28.46	4.989	0.0775	not – significant-
	Pure Error	22.84	3.9	5.70.9			
	Cor Total	5155.16	11.9				
	Std. Dev. 3.94 R2: 0.9790, Mean:38.76						
NH3 Removal %	**Source**	**Squares**	**DF**	**Square**	**Value**	**Prob > F**	
		Sum of		**Mean**	**F**		
	Model	7298.17	5.0	1459.64	9.94	0.00439	-significant-
	A	60.75	1.0	60.75	0.4109	0.54090	
	B	1081.239	1.0	1081.25	7.34	0.03010	
	A2	5759.36	1.0	5759.36	39.18	0.00039	
	B2	715.30	1.0	715.30	4.87	0.0633	
	AB	108.11	1.0	108.11	0.75	0.4197	
	Residual	1029.37	7.0	147.04			
	Lack of Fit	999.85	3.0	333.29	45.17	0.00149	-significant-
	Pure Error	29.53	4.9	7.39			
	Cor Total	8327.53	11.9				
	Std. Dev. 12.14, R2: 0.8765, Mean: 53.210						
Fe removal %	**Source**	**Squares**	**DF**	**Square**	**Value**	**Prob > F**	
		Sum of		**Mean**	**F**		
	Model	66.3	5.001	13.259	10.1200	0.004190	-significant-
	A	29.19	1.00	29.1800	22.2400	0.00219	
	B	5.51	1.0	5.510	4.2100	0.07980	
	A2	3.67	1.00	3.6590	2.800	0.13879	
	B2	12.25	1.0	12.23900	9.3299	0.01839	
	AB	17.229	1.00	17.2400	13.1500	0.0086	
	Residual	9.179	6.90	1.3100			
	Lack of Fit	9.190	3.00	3.06001			
	Pure Error	0.0000	3.90	0.00000			
	Cor Total	75.49	11.90				
	Std. Dev. 1.149 R2:0.8785, Mean:93.259						
Mn removal %	**Source**	**Squares**	**DF**	**Square**	**Value**	**Prob > F**	
		Sum of		**Mean**	**F**		
	Model	159.819	4.9	31.959	22.429	0.00040	-significant-
	A	1.369	1.0	1.380	0.959	0.35939	
	B	98.6001	1.	98.6001	69.190	< 0.000101	
	A2	6.919	1.	6.930	4.87	0.06350	
	B2	30.18	1.	30.180	21.169	0.002490	
	AB	25.949	1.0	25.949	18.209	0.00369	
	Residual	9.99	6.9	1.440			

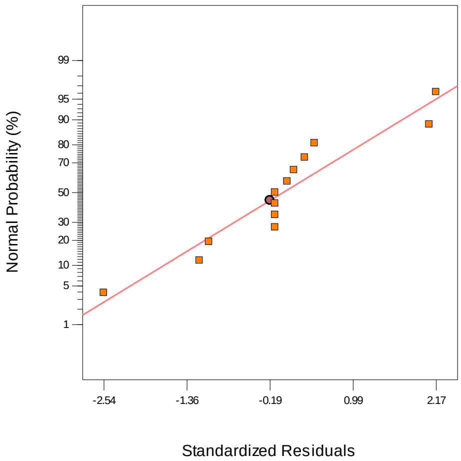
	Lack of Fit	9.53	3.0	3.169	27.87	0.00390	-significant-
	Pure Error	0.459	3.9	0.110			
	Cor Total	169.8001	12.00				
	Std. Dev. 1.18 R2: 0.9413, Mean: 90.42						
Al removal %	**Source**	**Squares**	**DF**	**Square**	**Value**	**Prob > F**	
		Sum of		**Mean**	**F**		
	Model	616.15	4.9	123.240	6.0	0.01820	-significant-
	A	0.649	1.0	0.649	0.0319	0.86359	
	B	170.79	1.0	170.790	8.3001	0.02370	
	A2	27.62	1.00	27.620	1.350	0.2849	
	B2	104.529	1.0	104.530	5.09	0.0590	
	AB	324.54	1.	324.54	15.780	0.0055	
	Residual	144.090	6.99	20.579			
	Lack of Fit	59.310	2.99	19.780	0.9299	0.5029	-not significant-
	Pure Error	84.79	4.0	21.189			
	Cor Total	760.219	12.0				
	Std. Dev. 4.55 R2: 0.8106, Mean 87.159						
Cu removal %	**Source**	**Squares**	**DF**	**Square**	**Value**	**Prob > F**	
		Sum of		**Mean**	**F**		
	Model	1608.409	4.9	321.69	16.480	0.001000	-significant-
	A	743.84	1.0	743.84	38.079	0.0005001	
	B	284.919	1.00	284.919	14.59	0.006610	
	A2	151.779	1.00	151.779	7.769	0.0271	
	B2	370.99	1.00	370.99	19.0	0.00329	
	AB	110.81	1.0	110.81	5.68	0.04879	
	Residual	136.749	6.90	19.55			
	Lack of Fit	131.220	3.0	43.75	31.59	0.00301	-significant-
	Pure Error	5.550	3.9	1.40			
	Cor Total	1745.140	12.00				
	Std. Dev. 4.430 R2: 9217, Mean 55.27						
Ni removal %	**Source**	**Squares**	**DF**	**Square**	**Value**	**Prob > F**	
		Sum of		**Mean**	**F**		
	Sample	148.78	5.000	29.749	12.0100	0.00249	-Significant-
	A	4.829	1.00	4.840	1.960	0.2053	
	B	5.669	1.0	5.680	2.30	0.17410	
	A2	15.129	1.000	15.129	6.120	0.04269	
	B2	114.569	1.000	114.580	46.239	0.00029	
	AB	17.359	1.00	17.3700	7.020	0.03309	
	Residual	17.349	6.990	2.4790			
	Lack of Fit	17.0	2.99	5.6599	63.730	0.00079	-significant-
	Pure Error	0.37	4.00	0.090			
	Cor Total	166.119	11.99				
	Std. Dev. 1.59 R2: 0.89559, Mean87.140						

4.6. TREATMENT EFFICIENCY

3D Surface and Contour Response Diagrams in Design Expert 6.0.7 6.0.7 Software as shown in the picture 4.8(1-7) and Design Expert was used to analyzing the interactive links between individual model responses and independent factors.In Figure 4.8 has been removed of the largest rate of COD and NH3are 66.5% and 82.2%, respectively, when a dose of date seeds ground is 1.4g, and the concentration of PH is 9.0 and Mn, Fe, Ai, Ni, and Cu, the rate removal is 94.9% and 97.2%, 98.24%,90.8% and 67.6%, respectively. Ambient experimental conditions (pH concentration) and concentration of these elements present in the wastewater All are factors on which the amount of processing depends as shown in the response charts.



1



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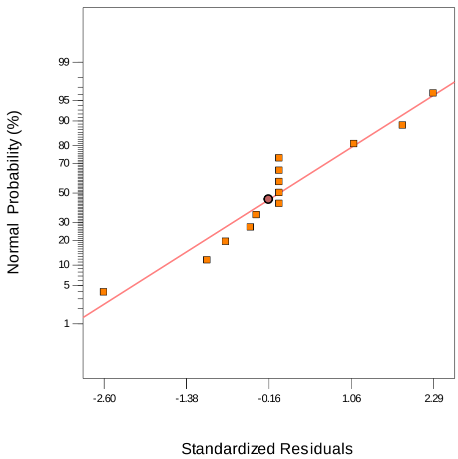

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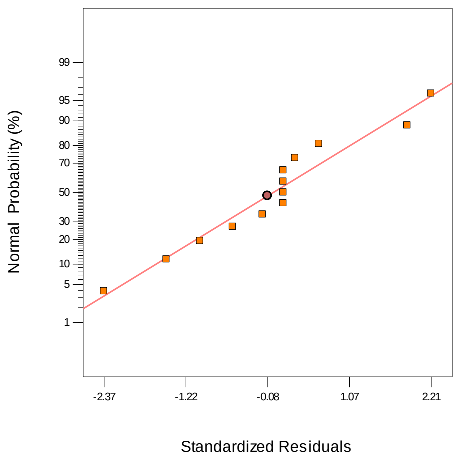

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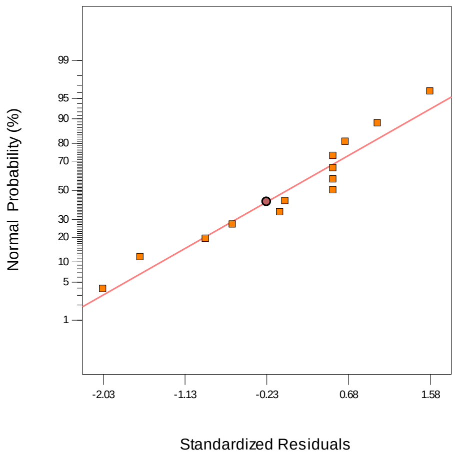

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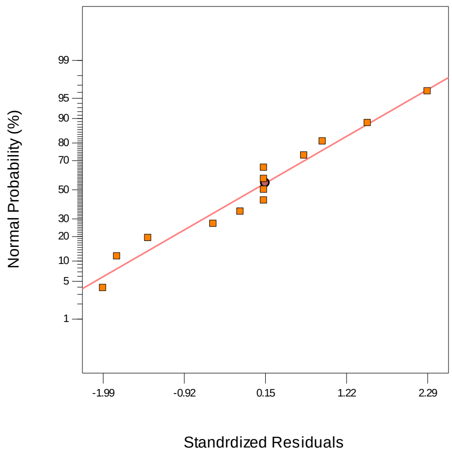

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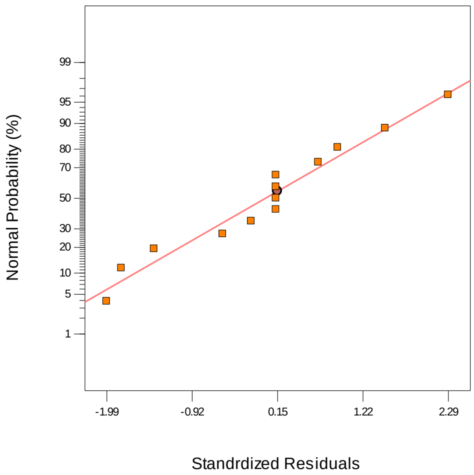
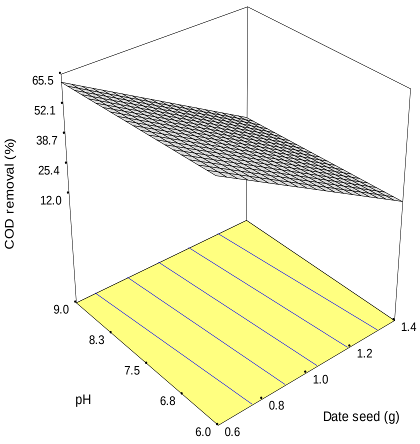
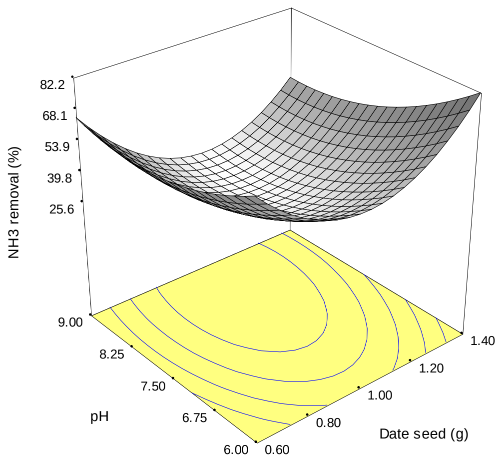


7

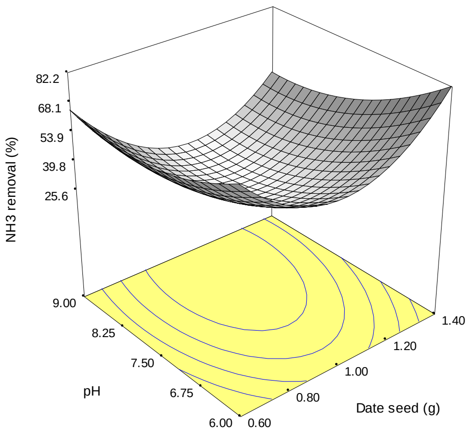
Figure 4.7. The Normal the probability plots for removals 1 (COD), 2 (NH3), 3 (Fe),4 (Mn), 5 (Ai), 6(Cu), and 7(Ni).


COD removal (%)
65.5
52.1
38.7
25.4
12.0
pH
9.0
8.3
7.5
6.8
6.0
Date seed (g)
0.6
0.8
1.0
1.2
1.4

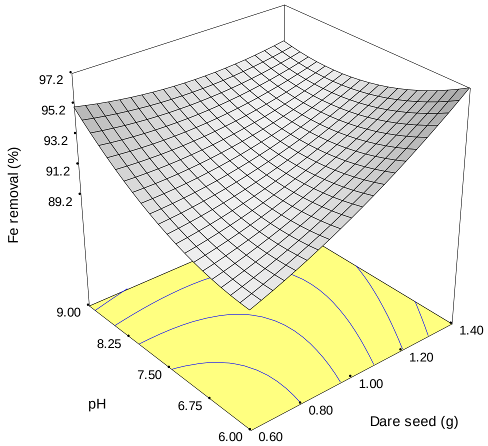
1


NH3 removal (%)
82.2
68.1
53.9
39.8
25.6
pH
9.00
8.25
7.50
6.75
6.00
Date seed (g)
0.60
0.80
1.00
1.20
1.40

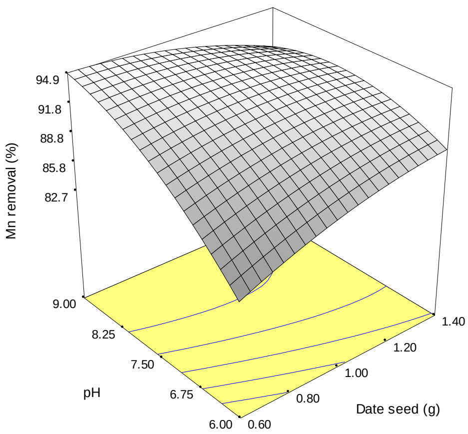
2


NH3 removal (%)
82.2
68.1
53.9
39.8
25.6
pH
9.00
8.25
7.50
6.75
6.00
Date seed (g)
0.60
0.80
1.00
1.20
1.40

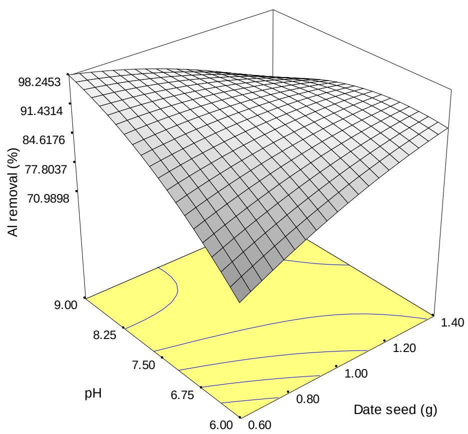
3


Fe removal (%)
97.2
95.2
93.2
91.2
89.2
pH
9.00
8.25
7.50
6.75
6.00
Dare seed (g)
0.60
0.80
1.00
1.20
1.40

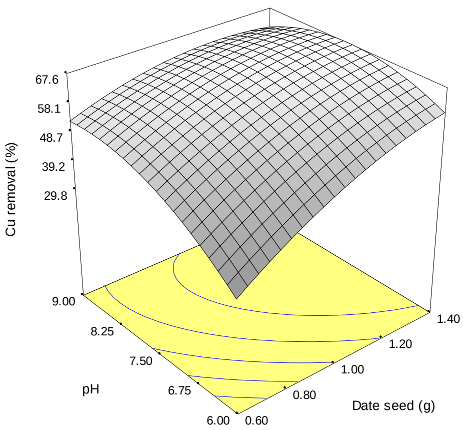
4


Mn removal (%)
94.9
91.8
88.8
85.8
82.7
pH
9.00
8.25
7.50
6.75
6.00
Date seed (g)
0.60
0.80
1.00
1.20
1.40

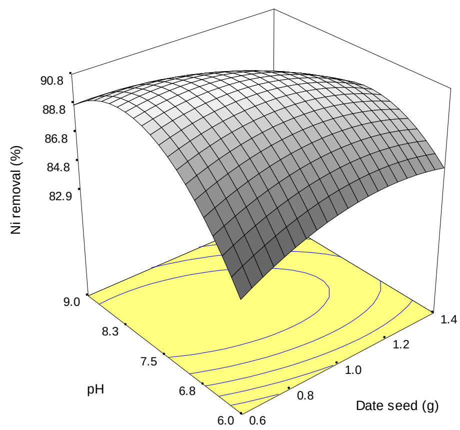
5


Al removal (%)
98.2453
91.4314
84.6176
77.8037
70.9898
pH
9.00
8.25
7.50
6.75
6.00
Date seed (g)
0.60
0.80
1.00
1.20
1.40

6



7



8

Figure 4.8. The Response surface diagrams for removals 1(COD), 2(NH3), 3(Fe), 4 (Mn),5 (Ai), 6(Cu) and 7(Ni) removals.

4.7. OPTIMIZATION THE OPERATIONAL THE CONDITIONS

Some work has been done to determine this optimal value to treat the presence of COD and NH3, Fe, Mn, Ai, Cu, Ni w Wastewater with program (Design Expert 6.0.7). therefore, experimental conditions (dose of crushed date seeds and pH concentration). were determined for and the responses were identified as the best bounds to hit the maximum processing value. The program combines individual needs into a single value which it then attempts to optimize based on the response Target. The result that is best working conditions and the best removal were determined and the results are presented in Table 4.3.

As shown in Table 4.3, Maybe remove 61%, 65%, 95%, 94%, 98%, 52%, and 88% DOC and NH3, Fe, Mn, Al, Cu, and Ni respectively. under optimized working conditions (pH 9, date seeds 0.6 g).

to ensure the validity of the optimal results An experiment was performed in the laboratory, and the results of the experiment were found to agree with the expected response value.

Table 4.3. Response optimum to results from predicted lab and model.

	pH	Date seed (g)	COD removal (%)	NH_3-N removal (%)	Mn removal (%)	Fe removal (%)	Ai removal (%)	Ni removal (%)	Cu removal (%)	Desirability
Lab.Experment				64	92	94	96.5	52	50	
Prediced	9	0.6	62	66	94	96	98	89	52	0.926

PART 5

CONCLUSION

5.1. CONCLUSION

In general, the percentage of TSS, COD, NH3-N, The timely removal of Mn, Fe, Zn, Al and Ni from stone dust has shown great promise as a natural coagulant of plant origin in the transformation of iron and steel. the Experience has shown the remarkable curdling properties of dates. the Specific search results are shown below. FTIR analysis confirmed the presence of multiple functional groups is involved in the coagulation process. At 1.4g/200ml, date stone powder high proportion of TSS, COD, NH3-N, Zn, Mn, Ni, Fe and AL removed Effluent with pH 8, with percentages of 99.00, 59.43, 92.06, 94.85, 87.06, 80.33, 97.74, and 65.79%, respectively. The influence of pH ranges (5-10) show that the natural pH of a wastewater sample indicates optimal removal was 59.43% COD, 99.00% TSS and 92.06% NH3-N, while the percentage of heavy metal removal was 87.06, 97.74, 94.85, 65.79 and 80.33% respectively for Mn, Fe, Zn, Al and Ni. Due to the organic structure of the date Stones to powder, the pH of the industrial effluent remained unchanged thereafter Add on.

5.2. RECOMMENDATIONS

Based on the study and the results obtained during this research, we can make the following recommendations:

- Industrial wastewater causes severe damage and economic losses, so it must be treated before being discharged into water bodies.

- Washing the date seeds with distilled water well to rid them of ions and pollutants before proceeding with the treatment process.
- Date seeds have been widely used in the treatment of polluted water due to their high treatment efficiency.
- Seek to discover new environmentally friendly methods that do not cause secondary damage during the treatment process.
- Using vegetable waste from agriculture in the pollutant treatment process.

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RESUME

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