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VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JNANA SANGAMA", BELAGAVI – 590 018

PROJECT REPORT

ON

A STUDY ON RUBBER WASTEWATER FROM RUBBER INDUSTRY NAGAPATNA

Submitted in partial fulfillment of requirement for the award of the degree

BACHELOR OF ENGINEERING

IN

CIVIL ENGINEERING

SUBMITTED BY

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CERTIFICATE

*Certified that the project work entitled **"A STUDY ON RUBBER WASTEWATER FROM RUBBER INDUSTRY NAGAPATNA"** carried out by,*

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*The bonafide student of K.V.G COLLEGE OF ENGINEERING in partial fulfillment for the award of **BACHELOR OF ENGINEERING** in **CIVIL ENGINEERING** of the **VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAVI** during the year 2023-2024. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the Report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of Project work prescribed for the Bachelor of Engineering Degree.*

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DECLARATION

I, **student name (USN)**, hereby declare that the project work entitled **"A STUDY ON RUBBER WASTEWATER FROM RUBBER INDUSTRY NAGAPATNA**" has been independently carried out by us under the guidance of **Prof. ARUN KUMAR H, Assistant Professor, Department of civil engineering**, **KVG College of Engineering, Sullia**, D.K in partial fulfillment of the requirements of the degree of Bachelor of Engineering in civil Engineering of **Visvesvaraya Technological University, Belagavi**. I further declare that I have not submitted this report either in part of in full to any other university for the reward of any degree.

STUDENT NAME

Place: Sullia

Date:

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ABSTRACT

Water is one of the vital necessities for the survival of human beings. Several industries utilize heavy metals in their industrial processes, eventually discharging them in their wastewater. Water contamination by heavy metals is a major environmental problem due to their acute toxicity and heavy metal pollution adversely affects all living organism. A number of efficient methods have been reviewed for the removal of heavy metals such as chemical precipitation, ion exchange, reverse osmosis, electro-dialysis, ultra-filtration, membrane filtration, coagulation etc. Compared to these methods Adsorption process being very simple, economical, effective and versatile has become the most preferred methods for removal of toxic contaminants from rubber wastewater. Hence present study carried out experimental work on adsorption process using zeolite as an adsorbent for the removal of ammonical nitrogen, Total suspended solids, Turbidity, Biochemical oxygen demand (BOD), Chemical oxygen Demand from natural rubber waste water. Removal of Ammonical nitrogen is 98.94% efficiency, Total suspended solids 96.84%, Turbidity 80.36%, BOD 96.98%, COD 95.66% is done by Natural Zeolite powder (Clinoptilolite) The study proved that zeolite show great promise for being able to remove ammonical nitrogen from rubber waste water.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Water is the most precious and one of the most important elements without which living things cannot survive. However, with rapid industrialization, heavy metal contamination has become a major problem in water quality maintenance and hygiene management. Water is an essential element of national and regional economies and is needed to create and sustain jobs in all sectors of the economy.

In addition to agricultural and industrial jobs, jobs that are highly dependent on water include forestry. inland fisheries and aquaculture, mining and resource extraction, water supply and sanitation, power generation, tourism and ecosystem management. The analysis estimates that more than 1.4 billion jobs, representing 42% of the world's active workforce, are heavily dependent on water. Furthermore, it is estimated that 1.2 billion jobs, representing 36% of the total workforce worldwide, are moderately dependent on water. Between 2011 and 2050, the world population is expected to increase by 33% from 7 billion to 9.3 billion, and food demand is expected to increase by 60% over the same period. Furthermore, the urban population is projected to nearly double from 3.6 billion in 2011 to 6.3 billion in 2050. Water use by various sectors is generally based on estimates that suggest that global freshwater withdrawals increased by about 1% per year between 1987 and 2000, based on available evidence. It shows a slightly lower growth rate (0.6%) over the past 15 years. Agriculture accounts for approximately 70% of the world's total freshwater withdrawals, while energy production and large-scale industry account for 15% and 5% of the world's freshwater withdrawals, respectively. The remaining 10% of global freshwater withdrawals occur in urban systems that meet the water-related needs of households, institutions, and most small and medium-sized industries.

The quality of our environment is deteriorating day by day. Large cities are reaching a saturation point and can no longer withstand the increasing pressure on their infrastructure. Industrial wastewater, sewage and agricultural waste are the main pollutants polluting the environment. Most industrial facilities discharge wastewater and wastewater containing hazardous substances into rivers without proper treatment. The release of large amounts of hazardous substances into the natural environment has caused many environmental problems, and because they are not biodegradable or persistent, they accumulate in environmental elements such as the food chain, posing a serious threat to human health . Environmental pollution, especially heavy metals in wastewater, is India's biggest problem. Heavy metals are major contaminants in oceans, soil, industrial wastewater, and even treated wastewater. Most point sources of heavy metal pollutants are industrial wastewater from mines, metal processing, tanneries, pharmaceuticals, pesticides, organic chemicals, rubber and plastics. Wood and wood products. Heavy metals are carried by wastewater and contaminate water sources beneath industrial sites. To avoid health risks, it is important to remove these toxic heavy metals from wastewater before disposal.

Heavy metals are elements with atomic weights between 63.5 and 200.6. Specific gravity is 5.0 or higher. Heavy metals are natural components of the earth, are durable, well known to be highly toxic, and also act as non-biodegradable pollutants. They are very difficult to remove naturally from the environment. Almost all heavy metal elements are highly toxic when concentrations in ecosystems exceed permissible limits. High concentrations of heavy metals can accumulate in the body when they break down the human food chain, and exceeding acceptable concentrations can actually cause serious health problems. Heavy metals can be classified into three different types, including toxic metals such as Hg and Cr. Pb, Zn, Cu, Ni, Cd, As, Co, Sn, etc. Noble metals such as Pd, Pt, Ag, Au, Ru, and radionuclides such as U, Th, Ra, Am. Heavy metals entering water systems can originate from both natural and anthropogenic sources. The main sources of heavy metal pollution are industrial aerosols in urban areas, solid waste from animals, mining activities, industrial and pesticides. At times, most heavy metals contaminate water systems through various industrial activities and acid rain, which decomposes soil and rocks and releases heavy metals into water resources.

1.2 SCENARIO OF WATER

Water is essential to all aspects of life and is a feature of our planet. Her 97.5 percent of all water is in the ocean. As shown in Figure 1.1, only 2.5% of the water on Earth is fresh water. Approximately 70% of freshwater is frozen in the Antarctic and Greenland ice sheets, and most of the remaining freshwater is either too deep underground to be accessed or exists as soil water, making it available for extraction and consumption for human use. Only 1% of fresh water is available. As shown in Figure 1.2.

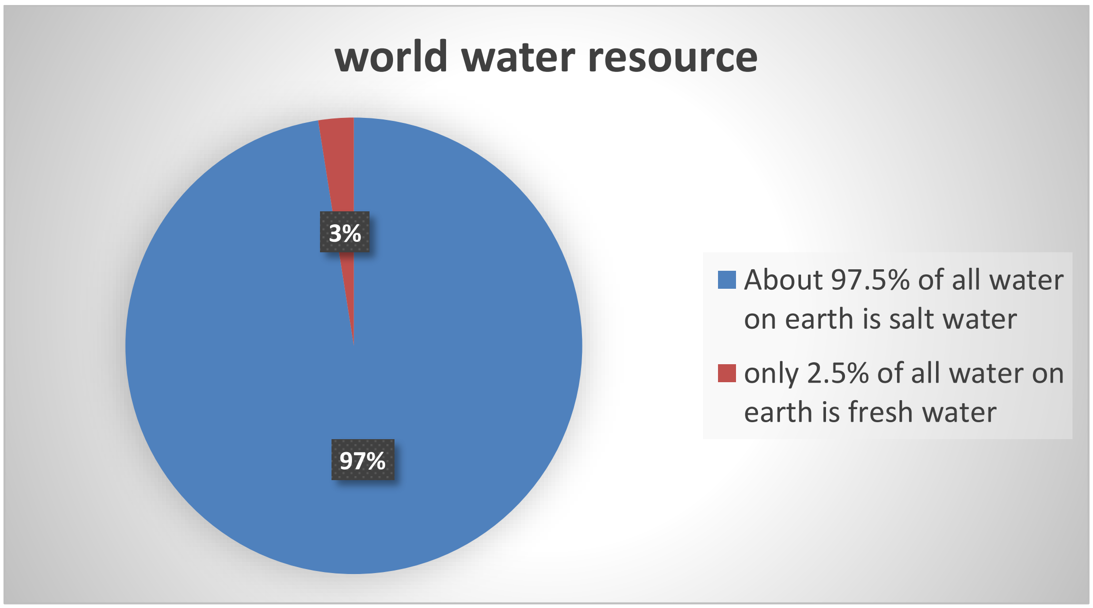

Fig 1.1 World water Resource

(Source: United Nations Environment Programme (UNEP),2021)

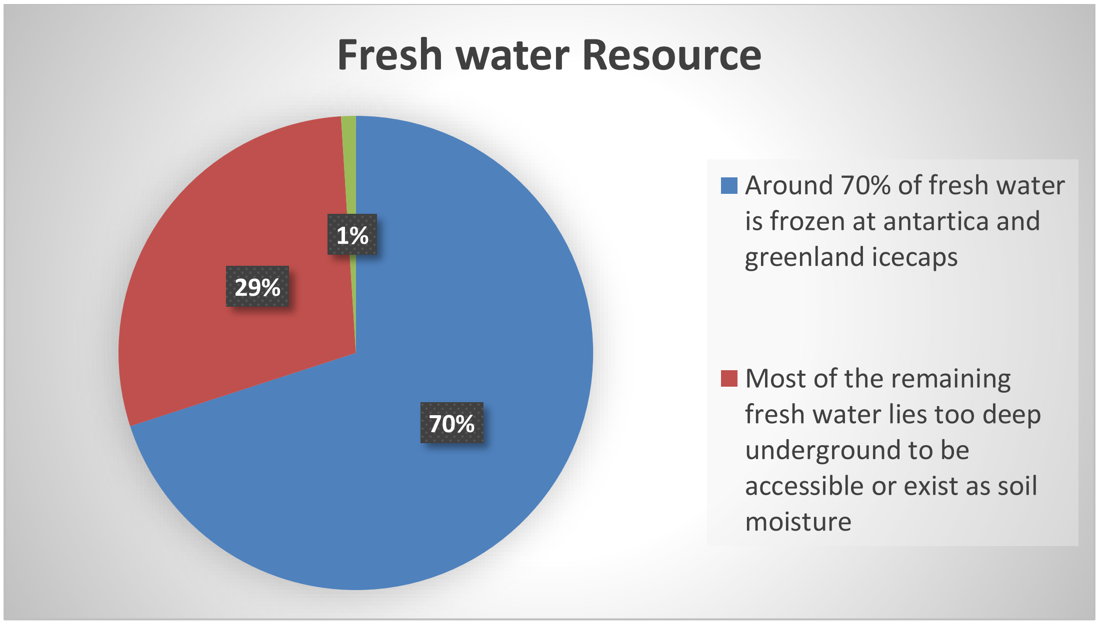

Fig 1.2 Fresh water resource

(Source: United Nations Environment Programme (UNEP),2021)

Despite the depletion of freshwater resources due to some natural and anthropogenic activities, water demand is increasing worldwide, resulting in persistent droughts, coupled with the implementation of stringent water quality standards. , population growth, and climate change pose threats. Most developing countries are forced to use non-conventional water sources as freshwater supplies become increasingly scarce. Our highly centralized water management systems (treatment systems, distribution systems, hygiene trends) no longer seem (sustainable) for the nation. Therefore, we must further develop water treatment for the survival of the country. Currently, more than 780 million people around the world lack access to clean water, leading to serious health problems. It also assumes that over the next few decades, more than 1 billion people around the world will experience difficulty accessing safe water, and current water supplies will decline by one-third. In contrast, the only fresh water available represents 0.5% of the world's water resources of 1.4 billion cubic meters and is even more poorly distributed globally. Furthermore, given today's competing demands, current trends in per capita consumption growth, and water-related challenges due to climate threats and population growth, opportunities to increase fresh water supplies are extremely limited. According to United Nations projections, the world's population is expected to increase by 2.9 billion people from 2019 to 2050.

Sustainable Development and Water states: Keep it clean, use it more wisely, and share it fairly. Water management and water-related decision-making are critical to addressing urbanization, sustainable industrial development and economic growth, eradicating entrenched poverty, ensuring food security, responding to new consumption patterns, and protecting threatened

ecosystems. will play an important role in addressing the development challenges of the 21st century. The need for water is increasing in all sectors, especially in the energy sector.

1.3 CHEMISTRY OF RUBBER WASTEWATER

The chemical properties of wastewater vary depending on the source and composition, but wastewater typically contains a mixture of organic and inorganic compounds. Organic pollutants include substances such as oils, fats, carbohydrates, proteins, and various organic chemicals from industrial processes. These compounds can undergo biochemical reactions that can lead to oxygen depletion and the formation of harmful byproducts.

Inorganic pollutants in wastewater include heavy metals such as lead, mercury, cadmium, and arsenic, as well as nutrients such as nitrogen and phosphorous from sources such as fertilizers and cleaning products. These substances can pose significant risks to the environment, including toxicity to aquatic organisms and contamination of drinking water sources.

Chemical reactions in wastewater treatment processes aim to remove these pollutants or convert them to less hazardous forms. Treatment methods include physical treatments such as sedimentation and filtration, chemical treatments such as flocculation and disinfection, and biological treatments such as aerobic and anaerobic digestion. The aim is to produce treated water that meets legal standards for discharge or reuse while minimizing environmental impact.

1.4 IMPORTANCE OF RUBBER WASTEWATER

Treatment of rubber wastewater is very important because of its environmental impact. Rubber processing generates wastewater containing pollutants such as suspended solids, organic compounds, and heavy metals. Improper disposal can damage ecosystems, contaminate water sources, and endanger human health. Effective treatment is essential to minimize pollution and protect the environment. Additionally, recycled or reused treated rubber wastewater can conserve resources and reduce the industry's environmental footprint.

Treatment of wastewater from various production processes leads to environmental pollution. Wastewater is typically generated during use in homes, businesses, institutions, industries, etc. Wastewater from facilities and industries contains many pollutants that are harmful to the environment and living organisms. One of these wastewaters is rubber wastewater from the rubber industry. Rubber wastewater contains harmful pollutants such as organic compounds, heavy metals, and toxic chemicals used in rubber processing. One industry generates approximately 40 m3 of liquid rubber waste. There are around 16,880 rubber manufacturing plants in India. Producing 1 kg of rubber generates approximately 20.5 liters of waste liquid.

1.5 SOURCES OF RUBBER WASTEWATER

Extracting and processing latex from the rubber tree (Hevea brasiliensis) removes latex residue, natural rubber latex, and chemicals used in the processing steps, such as ammonia, surfactants, and stabilizers. Containing wastewater is produced. The manufacturing of rubber products generates wastewater from processes such as compounding, mixing, calendaring, extrusion, molding, and vulcanization. This wastewater contains rubber compounds, processing aids, lubricants, and cleaning agents. Wastewater from rubber plantations can contain pesticide residues such as fertilizers, pesticides, and herbicides used for crop care and disease control. Wastewater is also generated during cleaning processes, equipment maintenance and factory hygiene in rubber processing plants. Disposal of solid wastes such as rubber crumbs, residues, and scrap products can lead to the formation of leachate and contaminate groundwater and surface waters. Rainwater runoff from rubber storage areas, yards, and outdoor storage facilities can carry pollutants such as rubber dust, residue, and chemicals into surrounding waterways.

1.6 EFFECTS OF RUBBER WASTEWATER

Discharge of untreated or poorly treated rubber wastewater can pollute not only groundwater but also surface waters such as rivers, lakes, and streams. This pollution can damage aquatic ecosystems, disrupt the balance of aquatic life, and affect biodiversity. When rubber wastewater is dumped on land or seeps into the soil, it can contaminate the soil and affect soil quality. This pollution can stunt plant growth, reduce soil fertility, and pose risks to agricultural productivity. Exposure to untreated rubber wastewater can pose health risks to surrounding communities.

Contaminants in wastewater, such as heavy metals, organic compounds, and pathogens, can leach into drinking water sources or contaminate plants, leading to health problems such as gastrointestinal illness, skin irritation, and long-term health problems. may cause. Certain volatile organic compounds (VOCs) and odorants in rubber wastewater can evaporate into the air and cause air pollution and unpleasant odors in the surrounding area. This can affect air quality and affect the health and well-being of residents.

Rubber wastewater pollution can destroy natural ecosystems, causing habitat degradation, biodiversity loss, and negative impacts on flora and fauna. Aquatic organisms may be particularly vulnerable to the toxic effects of pollutants, which can lead to population declines and ecosystem imbalances. Rubber wastewater pollution can result in lower property values, loss of recreational opportunities (such as fishing and swimming), and potential damage to industries that depend on clean water, such as agriculture and tourism. , which could have an economic impact. and a healthy ecosystem.

1.7 CHEMISTRY OF ZEOLITE

Zeolites are crystalline, microporous aluminosilicate minerals commonly used in a variety of industrial applications such as catalysis, adsorption, and ion exchange. Their unique structure consists of a framework of SiO_4 and AlO_4 tetrahedra, connected by oxygen atoms to form cages and channels. These cavities allow zeolites to selectively adsorb molecules based on size and shape, making zeolites useful in processes such as water purification, gas separation, and oil refining. Zeolites also exhibit ion exchange properties, allowing cations within the framework to be exchanged with other ions present in solution. This versatility makes zeolites important materials in environmental and industrial processes.

1.8 IMPORTANCE OF ZEOLITE

Zeolites act as catalysts in many chemical reactions due to their large surface area, shape selectivity, and acidity. These are used in petroleum refining, petrochemical synthesis, and environmental catalysis. The microporous structure of zeolites allows for selective adsorption of molecules based on size, shape, and polarity. This makes them valuable in processes such as gas separation, water purification, and removal of heavy metals from wastewater. Zeolites have ion exchange capabilities that allow them to selectively exchange cations within their structure with other ions in the solution. This property is used to soften water, recover nutrients in agriculture, and purify radioactive waste. Zeolites can be used to remediate contaminated soil and water by adsorbing pollutants such as heavy metals, organic compounds, and radioactive elements.

Used in cleaning products as a builder that binds calcium and magnesium ions to soften water, improving surfactant effectiveness and cleaning performance. Zeolites have applications in drug delivery systems, wound healing and medical imaging due to their biocompatibility and ability to adsorb and release molecules in a controlled manner. Zeolites are essential for processes such as drying gases, removing water from solvents, and increasing the efficiency of cooling systems by adsorbing water and other contaminants. fig 1.3 shows the Morphology of natural zeolite.

Table 1. XRF analysis data of chemical composition zeolite

Formula	Concentration
Original (g)	7
Added (g)	3
SiO_2	64.5 %
Al_2O_3	15%
K_2O	3.55%
CaO	3.23%
Fe_2O_3	0.94%
C	1%
Na_2O	0.8%
MgO	0.7%
TiO_2	0.16%
SrO	0.12%

(Source – Removal of ammonia nitrogen from rubber industry wastewater using zeolite as adsorbent journal Pg no. – 863)

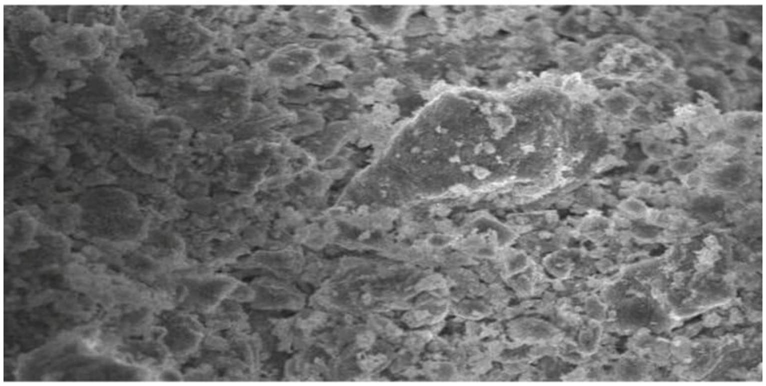

Fig 1.3 Morphology of zeolite

(Source – Removal of ammonia nitrogen from rubber industry wastewater using zeolite as adsorbent journal Pg no. – 863)

1.9 CHEMISTRY OF AMMONICAL NITROGEN

Ammonical nitrogen refers to nitrogen compounds that contain ammonia (NH_3) or its ionized form, ammonium (NH_4+). This can include substances like ammonia gas, ammonium salts, or organic compounds containing nitrogen that can be converted to ammonia under certain conditions. The chemistry of ammonical nitrogen primarily involves the behavior of ammonia (NH_3) and its ionized form, ammonium (NH_4+), in various chemical reactions and environmental processes. Ammonia can react with acids to form ammonium salts, such as ammonium chloride (NH_4Cl) or ammonium sulfate ($(NH_4)_2SO_4$). In water, ammonia can undergo a reversible reaction with water to form ammonium ions and hydroxide ions:

$$NH_3 + H_2O \rightleftharpoons NH_4 + OH$$

This reaction plays a significant role in the pH of aqueous solutions containing ammonia.

In environmental contexts, ammonium ions can be assimilated by plants as a nitrogen source, while ammonia can volatilize into the atmosphere or be oxidized by bacteria to nitrite (NO_2-) and nitrate (NO_3-), a process known as nitrification.

Understanding the chemistry of Ammonical nitrogen is crucial in various fields such as agriculture (for fertilizer management), wastewater treatment, and environmental monitoring.

1.10 EFFECTS OF AMMONICAL NITROGEN ON ENVIRONMENT

High levels of Ammonical nitrogen in water bodies can lead to eutrophication, disrupting the balance of aquatic ecosystems by promoting excessive algae growth. Ammonium ions can be directly toxic to aquatic organisms, particularly fish, by impairing their ability to regulate ions and disrupting their respiratory functions. Ammonical nitrogen can contribute to soil acidification when it undergoes nitrification, which may affect soil microbial activity and nutrient availability for plants. While nitrogen is essential for plant growth, excessive levels of Ammonical nitrogen can lead to nutrient imbalances and reduce soil fertility.

Ammonia volatilization from agricultural activities can contribute to air pollution, especially in concentrated animal feeding operations (CAFOs) and areas with intensive fertilizer use. Ammonia can react with other air pollutants to form particulate matter and aerosols, which can impact respiratory health and visibility. Inhalation of ammonia gas can irritate the respiratory tract and lead to respiratory problems. Exposure to high concentrations of ammonium ions in drinking water or food can potentially cause health issues, although this is less common.

Ammonical nitrogen is a common component of nitrogen-based fertilizers, which are essential for promoting plant growth and increasing agricultural yields. However, improper application or excess use of nitrogen fertilizers can lead to environmental pollution and negative impacts on ecosystems. Overall, managing the input of ammonical nitrogen into the environment is crucial for minimizing its adverse effects while harnessing its benefits for agricultural productivity and human well-being. This requires implementing sustainable agricultural practices, wastewater treatment systems, and environmental regulations to mitigate pollution and protect ecosystem health.

1.11 IMPORTANCE OF AMMONICAL NITROGEN

Removing ammonical nitrogen from wastewater prevents its release into water bodies, where it can contribute to eutrophication and harm aquatic ecosystems. Proper treatment helps maintain water quality and supports biodiversity in rivers, lakes, and coastal areas.

Treatment of ammonical nitrogen in wastewater also helps reduce ammonia emissions into the atmosphere, mitigating air pollution and its associated impacts on human health and the environment. Many countries have regulations and standards for the discharge of ammonical nitrogen into water bodies. Treatment is necessary to comply with these regulations and avoid fines or legal consequences. High levels of ammonical nitrogen in drinking water can pose health risks to humans. Treatment ensures that drinking water supplies are free from harmful levels of ammonia and ammonium ions.

Supporting Sustainable Agriculture: Treatment of ammonical nitrogen from agricultural runoff or livestock waste allows for the recycling of nitrogen-rich wastewater as a nutrient source for crops, promoting sustainable agricultural practices and reducing the need for synthetic fertilizers.

By reducing the input of ammonical nitrogen into ecosystems, treatment helps maintain the balance of nutrient cycles and supports the health of terrestrial and aquatic ecosystems. Overall, treatment of ammonical nitrogen is essential for protecting both environmental and human health, supporting sustainable development, and ensuring compliance with regulatory requirements

Table No 2: Parameters for discharging industrial wastewater to river water

SL NO.	PARAMETERS	MAX LIMIT
1	Ammonical nitrogen	50 mg/l
2	Total suspended solids	30-40 mg/l
3	Biochemical oxygen demand	250-500 mg/l
4	Chemical oxygen demand	250-500 mg/l
5	Turbidity	5-15 NTU

(Source: Agriculture Water Management Volume 146, December 2014, Pages 262-269)

1.12 OBJECTIVE OF THE STUDY

- Characterization of wastewater from rubber industry
- To determine optimum dosage of natural zeolite to remove ammonical nitrogen.
- To study the effect of zeolite dosage on other parameters.

SCOPE OF THE STUDY

- Characterization of wastewater include the study of impurities such as ammonical nitrogen, turbidity, biochemical oxygen demand, chemical oxygen demand, total suspended solids.
- Zeolite addition to the sample water from 2.5g to 4.5g per 100ml
- Effect of zeolite on turbidity, biochemical oxygen demand, chemical oxygen demand, total suspended solids to be studied.

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

The potential of various low-cost adsorbents for removing heavy metals from contaminated water was investigated. Various conventional methods are used to remove heavy metals, such as precipitation, evaporation, galvanization, and ion exchange. However, these methods have some drawbacks. Therefore, it can be seen that adsorption using inexpensive adsorbents is more environmentally friendly. A review was conducted of all methods for removing heavy metals from wastewater.

2.2 METHODS OF REMOVING AMMONICAL NITROGEN

1. Chemical precipitation

2. Ion exchange

3. Electro dialysis

4. Coagulation/coagulation

5. Ultra filtration

6. Membrane Filtration

7. Reverse Osmosis

8. Adsorption

2.2.1 CHEMICAL PRECIPITATION

Chemical precipitation processes involve the addition of chemical reagents and subsequent separation of precipitated solids . From purified water. Precipitation of metals occurs by adding coagulants such as alum, lime, iron salts, and other organic polymers.

Mahmoud M. Bulboutolu et al. (2011) conducted an experiment to remove heavy metals by chemical precipitation. Single and multi-component hydroxides of various heavy metals, namely iron (III), chromium (III), copper (II), lead (II), nickel (II), cadmium (II) from aqueous solutions. Precipitation and adsorption were studied.

Solution. The results show that the metal removal rate is high. When the MgO dosage increases to a certain limit, the ion increases to about 99%. The optimal MgO dosage was determined to be 1.5–3.0 g/l. The pH values range from 9.5 to 10 for MgO precipitants and 11.5 to 12 for CaO precipitants. In the vessel experiments, the rotational speed was 180–200 rpm (G 460–480 s^{-1}) during 2 min of mixing. The metal ion removal efficiency was above 97% at MgO doses (1.0–4.0 g/L).

2.2.2 ION EXCHANGE

Ion exchange is a reversible chemical reaction in which ions from a solution are exchanged with similarly charged ions bound to immobile solid particles. These solid ion exchange particles are either naturally occurring inorganic zeolites or synthetically produced organic resins. Organic ion exchange resins are composed of high molecular weight polyelectrolytes that can exchange their mobile ions with like charges from the surrounding medium. Each resin has a certain number of mobile ion sites that determine the maximum exchange rate per unit of resin. Most of the resins used are synthetic, and their properties can be tailored to specific applications. A synthetic resin made by polymerizing organic compounds with a porous three-dimensional structure.

Borklu (2013) conducted experiments to remove heavy metals from wastewater using synthetic ion exchange resins. The influence of resin type on the removal of copper and zinc metal ions from synthetic wastewater was investigated. Experimental results show that Amberjet 1200 is a strongly acidic cation exchange resin with excellent ability and efficiency to remove these metals from waste resin aqueous media. The conditions tested were 350 mg/L Cu (II) and 600 mg/L Zn (II) or 2.5 ml/min and 4.0 ml/min, and the resin volume was 30 cm3. The results obtained show that the strong cation exchange resin Amberjet 1200 is effective in adsorbing these two metals from synthetic rinse water in the electroplating industry.

2.2.3 ELECTRODIALYSIS

Electro dialysis (ED) is a membrane process in which ions are transported through a semi permeable membrane under the influence of an electric potential. Membranes are cation- or anion-selective, which basically means that positive or negative ions can pass through. Cation-selective membranes are polyelectrolytes containing negatively charged substances that reject negatively charged ions and allow positively charged ions to pass through. A new working system to study the removal of hexavalent chromium ions was carried out using a constructed electrodialysis (ED) pilot plant consisting of a series of ion exchange membranes.

Alves et al. (2014) conducted an experiment to remove lactobionic acid by electrodialysis. Removal efficiency exceeded 95%. The best conditions for the investigated system were a potential of 60 V and NaCl concentrations in the concentrate flow and electrode space of 3 g/L and 25 g/L, respectively.

2.2.4 COAGULATION/FLOCCULATION

Coagulation and flocculation are an integral part of drinking water treatment and wastewater treatment. Coagulation is a chemical reaction that occurs when a chemical or coagulant is added to water. Coagulants encourage colloidal substances in water to combine into small aggregates called "flocs." Airborne particles are attracted to these flakes. Flocculation involves slow and gentle mixing of water to promote flake formation and growth to a size that tends to settle. The basic mechanisms in the removal of organic contaminants by flocculation are the effects of initial pH and turbidity, dose before alum and ozone treatment, and flocculation time on the removal of dissolved organics during alum coagulation.

Konstantinos et al. (2011) conducted experiments to remove nickel, copper, zinc, and chromium from synthetic and industrial wastewater by electrocoagulation. The parameters that affect the electrocoagulation process are: B. Initial pH, current density. The initial metal ion concentration, COD, and contact time were investigated. Removal capacity for all tested metals was achieved in the pH range of 8. A mixed solution containing all metals at the same concentration was tested. H. 75, 150, 300 mg/L. Chromium was completely removed in 20, 40, and 50 min, respectively, while nonreactive chromium required 40, 60, and 80 min to be completely removed. The results showed that the best distance was achieved at a current density of 40 mA/cm2 . Electrocoagulation is a faster and more economical method for removing metal and organic contaminants from water and industrial wastewater.

2.2.5 ULTRAFILTRATION

Ultra filtration is a separation process that uses membranes with pore sizes ranging from 0.1 to 0.001 micrometers. Ultra filtration removes high molecular weight substances, colloidal substances, organic and inorganic polymer molecules. This is a pressure-driven purification process in which water and low molecular weight substances pass through a membrane while particles, colloids and macromolecules are retained. Although the primary removal mechanism is size exclusion, the charge and surface chemistry of the particles or membranes can influence cleaning efficiency.

Barnato et al. (2007) conducted an experiment on the removal of heavy metals by Ultra filtration. Ultra filtration has been introduced as a useful technique to recover heavy metals in aqueous solutions without adding other substances. The recovery of a mixture of iron (II), iron (III), copper (11), and chromium (III) was investigated. Shows the influence of transmembrane pressure and pH value. A solution containing 1.0 mg of copper (II) was filtered at a natural pH of 5.2. The reduction in permeation flux was very small compared to that observed for solutions containing iron (III) and iron(II). This behavior is consistent with the retention rate, which has always been less than 12%. Similar to the filtration of iron mixtures and copper solutions, the higher the TMP, the greater the reduction in permeate flow rate. On the other hand, as the pH of the solution are filtered increases, the decrease in permeating flux increases. The results show that the 5 kDa ceramic Ultra filtration membrane can be used in heavy metal recovery processes as long as the ionic nature does not result in soluble charged hydroxides in solution.

2.2.6 MEMBRANE FILTRATION

Membrane filtration has attracted much attention in the treatment of inorganic wastewater because it can remove not only suspended solids and organic compounds, but also inorganic pollutants such as heavy metals. Depending on the size of the particles to be retained, different types of membrane filtration can be used to remove heavy metals from wastewater, including Ultra filtration, nanofiltration, and reverse osmosis. Thanks to its unique feature, UF retains macromolecules with a size larger than the membrane pore size while allowing the passage of water and low molecular weight solutes. The only drawback of this procedure is the formation of sludge.

Srisuwan and Thongchai (2002) conducted experiments on the removal of heavy metals from electroplating wastewater through membranes. The experiments were carried out by chemical precipitation of synthetic and industrial wastewater in the first stage and membrane filtration of the supernatant at pressures of 50, 100, and 200 kPa in the second stage. The concentrations of chromium, copper, nickel, and zinc in the treated water were compared with standard values. In both microfiltration and Ultra filtration processes, the removal efficiency of chromium, copper, nickel and zinc from composite synthetic wastewater was higher than that from composite industrial wastewater. The results of membrane surface cleaning studies showed that the flux increased slightly after cleaning the membrane by stirring at 400 rpm for 30 min using a propeller at a distance of 2 mm from the membrane surface.

2.2.7 REVERSE OSMOSIS

Reverse Osmosis Process (RO) A cellophane-like membrane separates purified water from contaminated water. RO is the application of pressure to the concentrate side of the membrane to force purified water to the dilute side, washing the pollutants removed from the concentrate side into the removed water. Reported applications for the RO process include treatment of organic wastewater, wastewater from electroplating and metal smelting, pulp and paper, mining and petrochemicals, textile and food processing industries, radioactive wastewater, municipal wastewater and contaminated groundwater. It is included. [2]

Haider (2011) conducted an experiment to remove heavy metals using reverse osmosis. The maximum yields of copper, nickel, and zinc are 40.8%, 41.35%, and 38.44%, respectively. The maximum removal rates for copper, nickel, and zinc are 96.6%, 95.7%, and 98.2%, respectively. The pure water permeation constant of the TFC membrane is 2.713 gmol H2O.bar^1 m^2 s, and the investigated variables are metal concentration (50-150 ppm) and time (15-90 min). It was found that increasing the time increased the metal concentration in the permeate water, the feed concentration in the feed container, and the recovery rate. The reverse osmosis process ensures high efficiency of metal separation. An increase in time leads to an increase in metal permeation. The permeate flow rate from the reverse osmosis system decreases as the operating time increases.

2.2.8 ADSORPTION

Adsorption is the process that occurs when a gaseous or liquid solute accumulates on the surface of a solid or liquid (adsorbent) and forms a film of molecules or atoms (adsorbate). Adsorption is effective in most natural physical, biological, and chemical systems and is widely used in industrial applications such as activated carbon, synthetic resins, and water purification. Among these methods, adsorption methods are currently considered to be very suitable for wastewater treatment due to their simplicity and cost-effectiveness. This process is a commonly used technique to remove metal ions from various industrial wastewaters. In a bulk material, all bonding requirements of the constituent atoms of the material are met. But the atoms on the surface form bonds with those available at the time. Although the exact nature of the binding depends on the details of the species involved, adsorbed substances are generally classified as physisorbents and chemisorbents. It is a biological and chemical system often used in industrial applications such as activated carbon, synthetic resins, and water purification. Among these methods, adsorption methods are currently considered very suitable for wastewater treatment due to their simplicity and cost-effectiveness. Adsorption is a commonly used technique to remove metal ions from various industrial wastewaters.

2.2.8.1 TYPES OF ADSORPTION

Physical adsorption: is the result of intermolecular attraction between molecules of adsorbent and adsorbate. Physical adsorption occurs when the intermolecular attraction between the molecules of the solid and the gas is greater than the intermolecular attraction between the molecules of the gas itself and is below or near the critical temperature of the adsorbate.

Chemisorptions: The result of chemical interactions between a solid and an adsorbing surface. This is also called active adsorption and is irreversible. This is especially important in catalysis. Therefore, the energy of chemisorptions can be considered as a chemical reaction. They can be exothermic or endothermic processes ranging from very small scale to very large scale. The basic steps of chemisorptions often require large activation energies.

Nidhi Jain (2015) conducted an experiment to remove heavy metals using various fruit and vegetable peels and organic waste as adsorbents. Heavy metal removal was found to be dependent on adsorbent dosage, initial concentration, pH, and temperature. The efficiency of these adsorbents is 43% to 96% in the temperature range 50 to 29 °C, concentration range 21.7 to 50 mg/l, and effective pH 6 to 8. The biosorbents used are cost-effective and economically advantageous.

Shahla and Afsaneh (2015) conducted an experiment to remove chromium (VI) from aqueous solution using modified sawdust. The effects of various parameters such as pH, adsorbent dosage, contact time, stirring speed, and initial Cr(VI) concentration were studied, and the Cr(VI) removal efficiency varied between 70% and 81%. The results showed that this method is suitable for the analysis of real samples. The main advantages of this method are long distance, simplicity, and high adsorption capacity of the adsorbent.

Nishiganda et al. (2015) conducted an experiment to remove the heavy metal lead (Pb) from industrial wastewater using a low-cost adsorbent. A batch method using charcoal and coconut shell powder was carried out to remove lead. For the removal of lead from wastewater, the parameters of pH, contact time, and carbon dose were found to play an important role in the adsorption of heavy metals. Using the same amount of carbon from coconut shell and charcoal, the maximum efficiency of Pb is achieved at pH 6, contact time 120 min, and dosage 0.25 g/L. Here, cost is an important parameter to compare sorption materials. Considering the cost of activated carbon, the removal of metals from industrial wastewater requires the use of inexpensive and locally available adsorbents.

Jurgita et al., (2014) Review paper on coffee grounds as an adsorbent for the removal of copper and lead from aqueous solutions. Studies were conducted to investigate the influence of parameters such as particle size and heavy metal concentration. The adsorption efficiency of copper is 86% (particle size > 200 Dm), 97% (particle size 200 Dm), and 96% (particle size 200 Dm) when the metal concentration is 0.5 mg/m. All change little as the concentration of Po adsorbent increases. Experiments and result analysis showed that coffee grounds can be an excellent natural adsorbent for removing heavy metals from aqueous solutions.

Hossein et al. (2012) studied the removal of copper from water by adsorption on banana peel as a biosorbent. The adsorption of copper on banana peel depended on the control parameters such as particle size, dose, and pH. Contact time, stirring speed. Copper concentration and temperature. The copper removal efficiency varies between 80% and 96% at a dosage of 5 g/L, pH 6–6.5, contact time 24 h, stirring speed 120 rpm, and Eu concentration 10 mg/L. And the temperature is 20℃. Banana peel is a powerful, economical, efficient and low-cost adsorbent for removing copper.

Obedeji et al. (2010) investigated the removal of copper (II), iron (III), and lead (II) ions from simulated single-component wastewater by adsorption on coconut shells. Batch experiments were conducted to investigate the effects of different adsorbent loadings, pH values, contact times, metal ion concentrations, and adsorption temperatures. The adsorption of Pb(II) was found to be maximum (94% ± 3.2) at pH 5, temperature 100 °C, metal ion concentration 30 ppm, and contact time 30 min. The adsorption of Cu (II) and Fe (III) was maximum in the pH range 5–7, metal ion concentration 50 ppm, and temperature 50 °C (92% 2.8 and 94% ± 1.4). 30 °C and 100 °C for 90 min each. 1 g of adsorbent was found to be optimal for all metal ions. Coconut shell can be considered as a cost-effective alternative for removing toxic metal ions from aqueous industrial wastewater.

Adsorption processes have several advantages over traditional heavy metal removal methods, including:

- Economic
- Simple operating conditions
- Wide pH range
- High metal binding capacity
- No generation of toxic sludge
- Metal recovery
- Effective and environmentally friendly treatment technology.
- The process is robust enough to meet water reuse efforts and industry's high wastewater standards.

The only limitations are low selectivity and waste generation. However, many techniques can be used to treat wastewater contaminated with heavy metals. It is important to note that the selection of the optimal treatment for metal-contaminated wastewater depends on several fundamental parameters such as pH, initial metal concentration, contact time, and amount of adsorbent. Overall processing performance compared to other technologies, environmental impact, and economic parameters such as capital and operating costs. Finally, technical applicability, equipment simplicity, and cost-effectiveness are important factors that play an important role in selecting the optimal wastewater treatment system.

Removal of ammonia nitrogen from rubber industry wastewater using zeolite as adsorbent

Nazlizan Nasir et al (2017) a, Zawawi Daud demonstrated that the zeolite may be a low-cost and ecologically inviting fabric competent to evacuate alkali nitrogen with more than 80 efficiency from characteristic elastic wastewater. The energy information was best portrayed by pseudo-second order energy demonstrate as the R2 was closed to solidarity which was 0.998. Be that as it may, assist inquire about is essential to discover the viability of the zeolite for the evacuation of other contaminants in normal elastic wastewater such as suspended solids, COD, and others.

CHAPTER 3

MATERIALS AND METHODOLOGY

3.1 GENERAL

After the intended goals and objectives of the research project were established, this chapter described a detailed experimental program based on the literature review. The effectiveness of the adsorption process depends on parameters such as pH, dosage, contact time, and rotation speed and was studied on banana peels. The materials, equipment, and detailed experimental methods used are described in the next section.

3.2 MATERIALS

3.2.1 RUBBER WASTEWATER

Rubber wastewater is contaminated water produced during various stages of rubber processing such as latex extraction, manufacturing, and product finishing as shown in fig 3.1 . It typically contains a mixture of substances such as rubber residues, chemicals used in processing (surfactants, stabilizers, etc.), heavy metals, organic compounds, suspended solids, and potential pathogens. If not properly managed and treated, this wastewater poses risks to the environment, including water pollution, soil contamination, damage to aquatic ecosystems, and dangers to human health. Effective wastewater management practices and treatment technologies are needed to reduce these risks and ensure responsible management of rubber wastewater.

Fig 3.1 Rubber wastewater

3.2.2 ADSORBENT

The use of zeolite-based adsorbents offers special advantages compared to traditional methods used for industrial wastewater treatment. Natural zeolites are highly porous materials as shown in fig 3.2 . It has a natural negative charge, which gives it the ability to adsorb cations. Zeolites also have a high cation exchange capacity (CEC), which increases the potential for their use in the removal of ammonia nitrogen from wastewater.

Natural zeolites (clinoptilolites) have a three-dimensional crystal structure making the use of natural zeolites for ammonia nitrogen removal a competitive problem. It is considered to be a reliable and effective treatment method. These contain exchangeable alkali metal and alkaline earth metal cations such as K^+, Na, Ca2, and Mg^{2+} that maintain charge neutrality. The microporous crystal structure of zeolites allows for the exchange of ions.

Fig 3.2 Natural Zeolite (clinoptilolite) powder as Adsorbent

3.2.3 PH METER

A pH meter is a scientific instrument that measures the hydrogen ion concentration (pH) in a solution and indicates its acidity or alkalinity. A pH meter measures the potential difference between a pH electrode and a reference electrode. It usually consists of a glass electrode and a calomel reference electrode or a combination electrode. In addition, special probes are sometimes used to measure the pH of semisolid materials. It is shown in Figure 3.3.

Fig 3.3 pH meter

3.2.4 JAR TEST

Jar testers are used to test the effectiveness of flocculation or precipitation reagents. A single motor drives all positions with a constant stirring speed. The stirrer bar shafts can be stopped individually and the height can be adjusted while the system is in operation. Choose from lab or portable tester models. Laboratory vessel testers are available with four or six positions and a digital display showing agitation speed and time. In this study, the stirring speed is very important to increase the absorption efficiency and helps accelerate the process. As shown in Figure 3.4.

Fig 3.4 Jar test Apparatus

3.2.5 AIR OVEN

An air oven, also known as a forced air oven, is commonly used in laboratory settings for various applications such as drying, baking, sterilizing, and testing. It uses forced air circulation to maintain uniform temperature distribution throughout the chamber, ensuring consistent results. These ovens are often equipped with digital temperature controls and timers for precise operation and can be used for a wide range of temperatures depending on the specific requirements of the experiment or process. As shown in Fig 3.5

Fig 3.5 Hot air Oven

3.2.6 BOD INCUBATOR

A BOD (Biochemical Oxygen Demand) incubator is a specialized piece of equipment used in laboratories for culturing and maintaining biological samples under controlled conditions. It's commonly used in environmental microbiology to assess the oxygen demand of organic pollutants in water samples.

BOD incubators typically maintain a constant temperature, humidity, and often feature adjustable airflow to ensure optimal conditions for microbial growth. They're equipped with digital controls for precise regulation of temperature and other parameters, allowing researchers to replicate specific environmental conditions for their experiments. As shown in Fig 3.6

Fig 3.6 BOD Incubator

3.2.7 COD DIGESTER

A COD (Chemical Oxygen Demand) digester is a laboratory instrument used to determine the amount of oxygen required to chemically oxidize organic and inorganic matter in a water sample. It's an essential tool for assessing water quality and pollution levels.

The COD digester typically operates by heating the water sample with a strong oxidizing agent, such as potassium dichromate or potassium permanganate, under controlled conditions. This process oxidizes the organic and inorganic compounds in the sample, releasing oxygen, which is then measured to determine the COD value. As shown in Fig 3.7.

Fig 3.7 COD Digester

3.2.8 TURBIDITY METER

A turbidity apparatus, also known as a turbidity meter or nephelometer, is used in laboratories to measure the turbidity of a liquid sample. Turbidity refers to the cloudiness or haziness of a fluid caused by suspended particles.

The apparatus typically consists of a light source that shines through the sample and a detector that measures the amount of light scattered by the suspended particles. The intensity of the scattered light is then correlated with the turbidity of the sample. As shown in Fig 3.8.

Fig 3.8 Turbidity Meter

3.3 METHODOLOGY

3.3.1 COLLECTION OF RUBBER WASTEWATER SAMPLE

5 litres Wastewater is collected from discharge point. Fig 3.9 shows the collection of rubber wastewater from exit pipe.

Fig 3.9 Collection Rubber wastewater from Rubber industry Nagapatna.

3.3.2 PH TEST

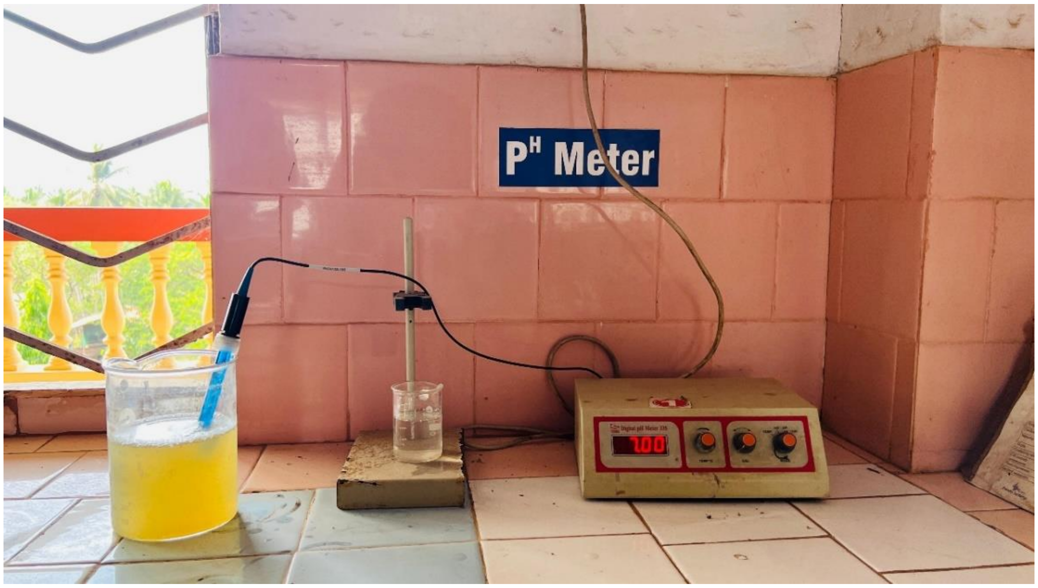

Fig 3.10 Increasing and Maintaining pH from 2.9 to 7 of Natural rubber Wastewater

3.3.3 JAR TEST

- Adding of Zeolite varing from 2.5 g to 4.5 g for 100 ml of sample of wastewater.
- The test is done for a quantity of 200 ml and addition of zeolite varing from 5g ,6g ,7g , 9g ,10g .as shown in fig 3.11, 3.12, 3.13, 3.14, 3.15.
- Mixing of Zeolite to the samples.
- Placing the samples in Jar Test
- Setting Jar test apparatus at 150 rpm and contact time for 100 minutes

Fig 3.11 Measuring 5g of Natural Zeolite for 200ml sample

Fig 3.12 Measuring 6g of Natural Zeolite for 200ml sample

Fig 3.13 Measuring 7g of Natural Zeolite for 200ml sample

Fig 3.14 Measuring 9g of Natural Zeolite for 200ml sample

Fig 3.15 Measuring 10g of Natural Zeolite for 200ml sample

Fig 3.16 Mixing of Zeolite to the sample

Fig 3.16 shows the mixing of zeolite varying from 2.5g to 5g with .5g interval.

Fig 3.17 Setting RPM of Jar Test at 150 RPM.

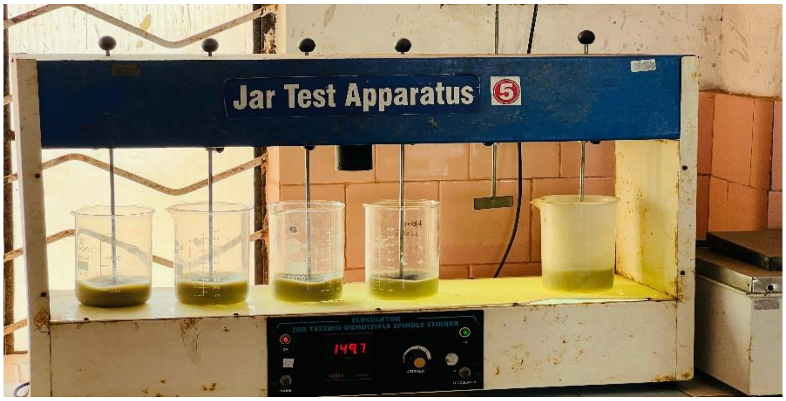

Fig 3.18 Jar Test Contact Time 100 Minutes at 150 RPM.

Fig 3.19 Sample Before Treatment

Fig 3.19 is the raw sample collected from rubber industry. Fig 3.20 shows five sample treated with zeolite. each sample is treated with5g ,6g ,7g, 9g ,10g.

Fig 3.20 Sample after Treatment

3.3.4 TOTAL SUSPENDED SOLIDS TEST

- Taking Samples of natural rubber wastewater before treatment and after treatment.
- Measuring the sample about 15ml and placing in cups..
- Before placing to oven Initial weight of cups of before treated sample and after treated samples are taken .
- Placing the samples in oven about 24 hours.
- After 24 hours final weight of cups are taken.
- By calculation we could know the Total Suspended Solids of Samples.

Fig 3.21 Hot air oven

3.3.5 TURBIDITY TEST

- Take the samples after treatment .
- Place the samples in turbidity test tube as in fig 3.22.
- Note down the Reading in Turbidity apparatus.

Fig 3.22 Turbidity Apparatus

3.3.6 BIOCHEMICAL OXYGEN DEMAND (BOD) TEST

- Take the treated samples and place in BOD bottles .
- Place these BOD bottles in BOD incubator at 20°c for 5 days as in fig 3.23.
- After 5 days add 2ml of manganese sulphate solution to water sample.
- Add 2ml of alkali iodide-azide reagent to sample..
- Once the precipitates have settled at the bottom, add 2ml of strong sulfuric acid.
- Transfer 203ml of BOD sample to Flask
- Titrate with 0.025N sodium thiosulfate solution using starch indicator until the blue hue fades and note the burette reading.
- By calculation we could know the BOD of sample .

Fig 3.23 BOD Incubator.

Fig 3.24 Placing the BOD samples in BOD Incubator

Fig 3.25 BOD samples after addition of manganese sulfate and iodide alkali-azide reagent.

Fig 3.26 BOD samples after addition of concentrated sulphuric acid.

Fig 3.27 BOD sample turns blue after adding Starch indicator.

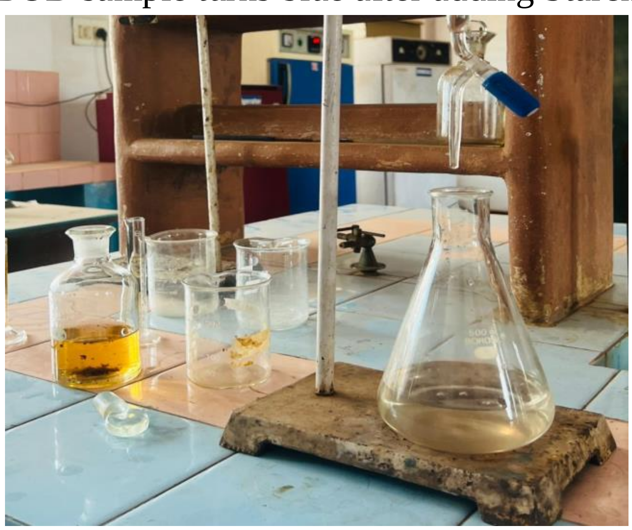

Fig 3.28 BOD sample turns blue to colorless.

3.3.7 CHEMICAL OXYGEN DEMAND (COD) TEST

- Preheat the COD Digester at 100°c .
- Add the 2ml sample in COD Digester tube.
- Add 1.5ml of potassium dichromate.
- Add 1ml of diluted sulfuric acid.
- Mix thoroughly and place in COD Digester.
- The mixture is heated for 2 hours.
- After Digestion allow the sample to cool.
- Titrate the sample with ammonium sulfate (FAS) solution.
- Note down the burette reading.
- By calculation we could get the values of COD in the samples.

Fig 3.29 COD Digester.

Fig 3.30 Addition of Potassium Dichromate to sample.

CHAPTER 4

RESULTS

4.1 GENERAL

This chapter describes the results obtained before and after the adsorption of Ammonia nitrogen using Natural Zeolite. In batch studies, the effects of pH, adsorbent dosage, contact rate, and rotational speed are investigated using adsorption methods. We also present an effective measurement device for the Ammonia nitrogen adsorption process. table 4 shows the characteristics of natural rubber wastewater produced in rubber industry.

Table 4 Characteristics of natural rubber wastewater

SL No.	Parameters	Results
1	Total Suspended Solids mg/l	1014
2	BOD for 4 days @ 27ºC mg/l	10500
3	COD mg/l	15600
4	Ammonical Nitrogen as N mg/l	2660

4.2 AMMONICAL NITROGEN

The effect of adsorbent dosage (varying between 2.5 g and 5 g) on the removal rate of ammonia nitrogen is as follows: Shown in Figure 4.1. The removal efficiency of ammonia nitrogen increases as the dosage increases from 2.5 g to 5 g. The best results were achieved with a zeolite loading of 4.5 g and a removal efficiency of 98.94%. Optimum Dosage of Zeolite is 4.5g. table 4.1 shows the Reduction of Ammonical Nitrogen After Treatment using zeolite .

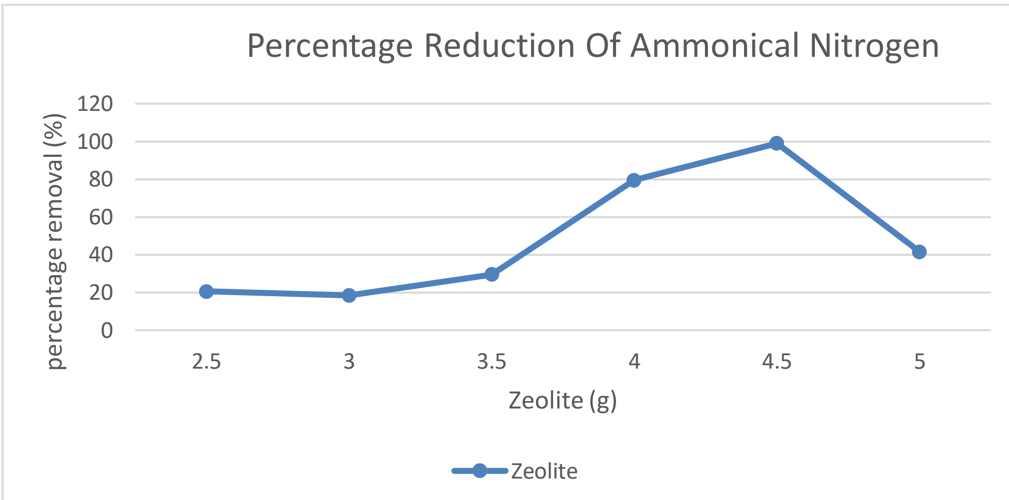

Fig 4.1 Effect of dosage on adsorption

Table 4.1 Reduction of Ammonical Nitrogen After Treatment (%)

SL No	Samples	Zeolite (g/100ml)	Ammonical Nitrogen (mg/l)	Reduction in %
1	Sample 1	2.5	2114	20.52
2	Sample 2	3	2170	18.42
3	Sample 3	3.5	1876	29.47
4	Sample 4	4	540	79.4
5	Sample 5	4.5	28	98.94
6	Sample 6	5	1554	41.57

4.3 TOTAL SUSPENDED SOLIDS

Dose is an important factor in determining the quantitative absorption of pollutants. The effect of adsorbent dosage (varying between 2.5 g and 4.5 g) on the removal rate of Total Suspended Solids is as follows: Shown in Figure 4.2. The removal efficiency of Total Suspended Solids increases as the dosage increases from 2.5 g to 4.5 g. The best results were achieved with a zeolite loading of 3.5 g and a removal efficiency of 96.84%. Optimum Dosage of Zeolite is 3.5g. table 4.2 shows the Reduction of Total Suspended Solids

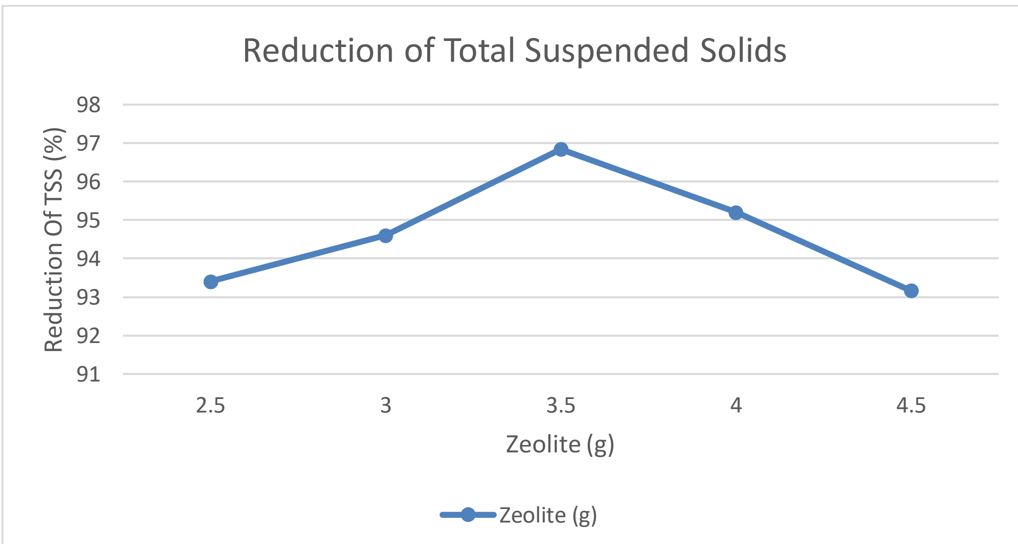

Fig 4.2 Reduction of Total Suspended Solids (%)

Table 4.2 Reduction of Total Suspended Solids (%)

Sl No.	Samples	Zeolite (g)	TDS (mg/l)	Reduction (%)
1	Sample 1	2.5	66	93.4
2	Sample 2	3	54	94.6
3	Sample 3	3.5	32	96.84
4	Sample 4	4	48.67	95.20
5	Sample 5	4.5	69.34	93.16

4.4 TURBIDITY

Dose is an important factor in determining the quantitative absorption of pollutants. The effect of adsorbent dosage (varying between 2.5 g and 4.5 g) on the removal rate of Turbidity is as follows: Shown in Figure 4.3. The removal efficiency of Turbidity increases as the dosage increases from 2.5 g to 4.5 g. The best results were achieved with a zeolite loading of 4 g and a removal efficiency of 80%. Optimum Dosage of Zeolite is 4g. table 4.3 shows the Reduction of Turbidity after using zeolite.

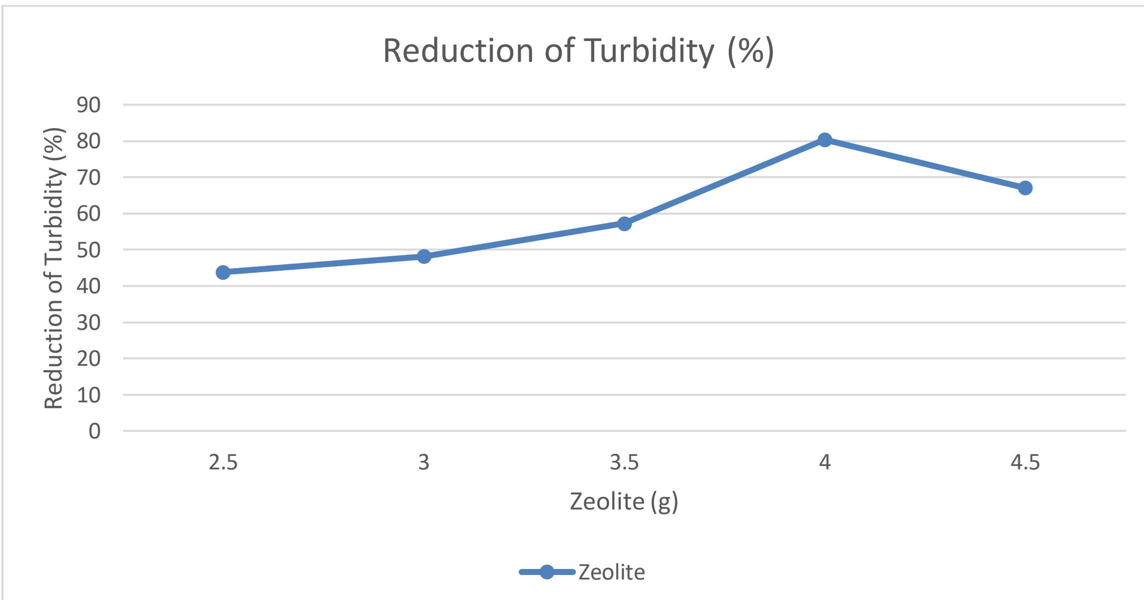

Fig 4.3 Reduction of Turbidity (%)

Table 4.3 Reduction of Turbidity (%)

Sl No.	Samples	Zeolite (g)	Turbidity NTU	Reduction (%)
1	Sample 1	2.5	30.9	43.81
2	Sample 2	3	28.5	48.18
3	Sample 3	3.5	23.5	57.27
4	Sample 4	4	10.8	80.36
5	Sample 5	4.5	18.1	67.06

4.5 BIOCHEMICAL OXYGEN DEMAND (BOD)

Dose is an important factor in determining the quantitative absorption of pollutants. The effect of adsorbent dosage (varying between 2.5 g and 4.5 g) on the removal rate of BOD is as follows: Shown in Figure 4.4. The removal efficiency of BOD increases as the dosage increases from 2.5 g to 4.5 g. The best results were achieved with a zeolite loading of 4 g and a removal efficiency of 96.48%. Optimum Dosage of Zeolite is 4g. table 4.4 shows the Reduction of Biochemical oxygen Demand after using zeolite.

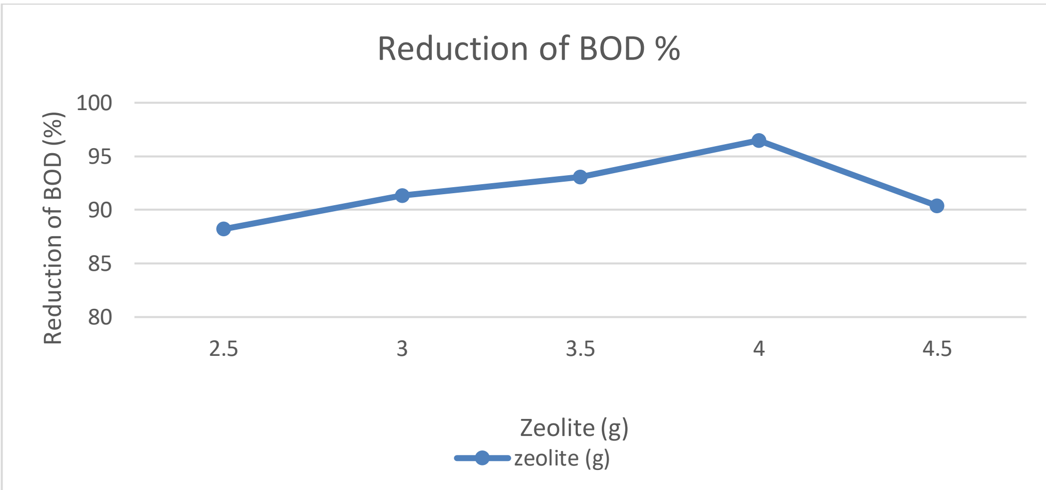

Fig 4.4 Reduction of Biochemical oxygen Demand

Table 4.4 Reduction of Biochemical oxygen Demand

Sl no.	Samples	Zeolite (g)	BOD (mg/l)	Reduction (%)
1	Sample 1	2.5	1237.6	88.21
2	Sample 2	3	908.88	91.34
3	Sample 3	3.5	727.8	93.06
4	Sample 4	4	369.4	96.48
5	Sample 5	4.5	1009.7	90.38

4.6 CHEMICAL OXYGEN DEMAND (COD)

Dose is an important factor in determining the quantitative absorption of pollutants. The effect of adsorbent dosage (varying between 2.5 g and 4.5 g) on the removal rate of COD is as follows: Shown in Figure 4.4. The removal efficiency of COD increases as the dosage increases from 2.5 g to 4.5 g. The best results were achieved with a zeolite loading of 4 g and a removal efficiency of 95.66%.

Optimum Dosage of Zeolite is 4g.

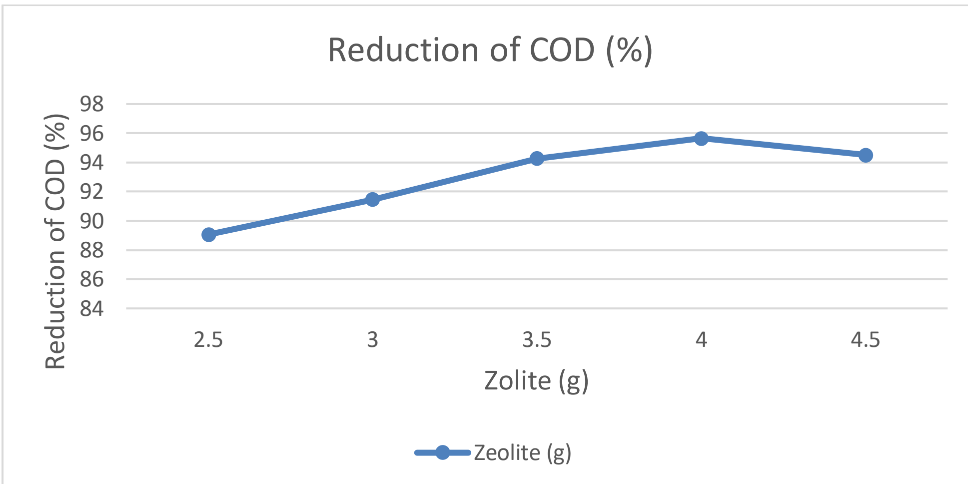

Fig 4.5 Reduction of COD (%)

Table 4.5 Reduction of COD (%)

Sl no.	Samples	Zeolite (g)	COD (mg/l)	Reduction (%)
1	Sample 1	2.5	1706	89.06
2	Sample 2	3	1333	91.45
3	Sample 3	3.5	890	94.26
4	Sample 4	4	426	95.66
5	Sample 5	4.5	668	94.5

CHAPTER 5

CONCLUSION

5.1 GENERAL

Based on the result analysis for the removal of ammonia nitrogen, Total Suspended Solids, Turbidity, Biochemical Oxygen Demand and Chemical Oxygen Demand using natural Zeolite powder as an adsorbent the following conclusion are made:

5 .2 CONCLUSIONS

- Optimum of operating parameters for ammonia nitrogen removal

    - The Ammonia nitrogen removal efficiency increases as the pH of the solution increases till pH 7 and gradually decreases after pH 7.

    - The Adsorption rate increases with increase in dosage of adsorbent up to a optimum level and contact time.

    - The overall best conditions concluded from the experiment was at pH 7, contact time 100 minutes, adsorbent dosage of 4.5gm per 100ml, and revolution speed of 150 RPM.

- Optimum of operating parameters for Total Suspended Solids removal

    - The overall best condition concluded from experiment was at 3.5gm per 100ml of zeolite which reduced the Total Suspended Solids with 96.84% efficiency.

- Optimum of operating parameters for Turbidity Removal

    - The overall best condition concluded from experiment was at 4gm per 100ml of Zeolite which reduced the turbidity with 80.36% efficiency.

- Optimum of operating parameters for Biochemical Oxygen Demand Removal

  - The overall best condition concluded from experiment was at 4gm per 100ml of zeolite which reduced the BOD with 96.48%

- Optimum of operating parameters for Chemical Oxygen Demand Removal

  - The overall best condition concluded from experiment was at 4gm per 100ml of zeolite which reduced the BOD with 95.66%

- From this study, it is proven that the zeolite is a low cost and environmental friendly material capable to remove ammonical nitrogen with 98.94% efficiency, Total Suspended Solids with 96.84% efficiency, Turbidity with 80.36% efficiency, BOD with 96.48%, COD with 95.66 % efficiency from natural rubber wastewater.

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