IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

"Effective Removal Of Color And Physicochemical Parameters From Synthetic Textile Industrial Wastewater Using Coagulation-Flocculation Technique- A Review."

P. P. Deshmukh *, A. M. Mokadam **
Student*, Associate Professor**
Department of Civil Engineering
Government College of Engineering Amravati, Maharashtra, India.

Abstract: The textile industry holds significant global importance, offering employment opportunities to individuals without requiring specialized skills. It plays a crucial role in the economies of numerous countries. However, the production of textiles involves the use of various chemicals and substantial amounts of water, leading to the generation of wastewater with high pollutant levels, particularly toxic colorants. These colorants pose a serious threat to living organisms and can have detrimental effects on their health. Therefore, the removal of color using natural flocculants becomes a vital step in safeguarding natural resources. Among the methods available for color removal in textile industry wastewater, coagulation flocculation is widely employed, even for low concentration levels. This paper aims to present the findings of an investigation focused on eliminating color and physicochemical characteristics from wastewater by utilizing natural flocculants, namely Cactus, Aloe vera, and a combination of both. The effectiveness of these flocculants in color removal will be assessed through a batch-wise coagulation flocculation approach. The study will analyze the influence of key parameters on the percentage of color removal to identify the optimal conditions for achieving maximum color removal efficiency. These parameters encompass pH, coagulant dose, flocculant dose, coagulant mixing time and speed, flocculant mixing time and speed, setting time, and wastewater concentration. It is expected that the color removal efficiency, across all parameters, will range from 85% to 100%.

Keywords: Textile Effluent, Coagulant, Cactus, Aloe vera, Coagulation Flocculation, Color

I. INTRODUCTION

Industrialization is widely acknowledged as a crucial catalyst for economic development in nations. One prominent sector that significantly contributes to global economies is the textile industry. This industry provides employment opportunities to individuals without requiring specialized skills or expertise. India, the world's second-largest textile and garment manufacturer after China, particularly benefits from this industry's presence. With a rich history, the textile industry in India has been a cornerstone of the country's manufacturing sector for a considerable time. It encompasses a wide array of raw materials, machinery, and processes to produce diverse textile products. Within the textile production process, various types of fibers are utilized, including cellulose, protein, and synthetic fibers. Each of these fibers requires specific types of dyes for coloring. Chemicals and substantial amounts of water play a vital role in the manufacturing process. Water plays a crucial role in the textile industry, being utilized for the application of chemicals to fibers and rinsing final products. However, if the industrial effluent, which is the discharged water from these processes, is not properly managed and disposed of, it can present considerable environmental and health hazards. Therefore, the appropriate treatment and disposal of industrial effluent are essential to mitigate the potential risks associated with its improper discharge. Textile effluents consist of a complex mixture of chemicals, including trace Metals such as chromium (Cr), arsenic (As), copper (Cu), and zinc (Zn) were

present in the wastewater samples used in the study, with different concentrations and characteristics. These metals were targeted for removal through the application of coagulation and flocculation methods using natural coagulants. The quantities and qualities of these metals varied within the wastewater samples, requiring effective treatment methods to mitigate their presence and potential environmental impact. These industries generate both inorganic and organic waste mixed with wastewater, leading to alterations in the biological and chemical parameters of the receiving water bodies.

Despite being a crucial and rapidly expanding industry, the textile sector encounters significant challenges related to its high-water consumption and the generation of highly polluted wastewater, which is often directly discharged into natural water sources. Textile wastewater constitutes a major contributor to water pollution, containing elevated levels of organic compounds, heavy metals, high temperatures, substantial chemical oxygen demand (COD), high pH, and intense coloration resulting from dyes and suspended solids. The presence of color in textile wastewater has detrimental effects on the visual appeal of water resources and the overall health of receiving water bodies. It impedes sunlight penetration and disrupts aquatic biological processes, thereby disturbing the ecological balance of ecosystems. Reactive dyes, commonly employed in the textile industry, pose a particular challenge for treatment due to their resistance to physical and biodegradation methods once they contaminate wastewater. Numerous treatment technologies, including adsorption, ion exchange, membrane filtration, coagulation, and biological processes, have been utilized to address the treatment of textile wastewater.

Coagulation has been a widely employed method for treating wastewater containing dyes for many years, primarily due to its effectiveness and low capital cost. Different types of coagulants, including inorganic, synthetic organic polymers, and natural coagulants, are utilized in conventional water treatment processes based on their chemical properties. Among these, aluminum sulfate (alum) stands out as the most used coagulant due to its proven performance, cost-effectiveness, ease of handling, and widespread availability. Natural coagulants/flocculants, such as Cactus, Hyacinth bean, Tamarindus indica, Acacia (Babul), Neem, and others, offer a biodegradable and presumed safe option for water treatment. They present several advantages over chemical agents, including biodegradability, low toxicity, minimal residual sludge production, and enhanced human safety. Natural coagulants/flocculants are locally available and represent environmentally friendly alternatives. They demonstrate effectiveness in treating highly turbid water compared to moderately or lightly turbid water. The use of natural coagulants/flocculants holds significant potential for removing turbidity and color in effluents from textile industries when compared to chemical or synthetic alternatives. This paper aims to explore the feasibility and color removal efficiency of various natural coagulants/flocculants through the process of coagulation.

II. MATERIALS AND METHODS

To optimize the removal of color from wastewater originating from the textile industry, natural flocculants such as Cactus and Aloe vera are utilized. These flocculants have been selected based on their potential effectiveness in color removal. By conducting research and experiments, the optimal conditions for achieving maximum color removal can be determined.

III. MATERIALS

Coagulant preparation

In this study, the efficacy of coagulation treatment utilizing Ferrous Sulphate (FeSO4.7H2O) as a coagulant is examined for the elimination of organic compounds and color from synthetic effluents that mimic cotton, acrylic, and polyester dyeing wastewaters. The experiments employ a 10% dilution of Ferrous Sulphate solution. To prepare the solution, the following procedure is followed. An accurate analytical weighing balance, a clean beaker, distilled or deionized water, and a stirrer are required. The beaker is positioned on the balance and the reading is adjusted to zero or tared. Subsequently, using a spatula, 10g of Ferrous Sulphate is precisely weighed on a clean glass plate. Around 90ml of distilled or deionized water is added to the weighed Ferrous Sulphate, and the mixture is stirred until the Ferrous Sulphate completely dissolves. Once dissolved, the solution is transferred into a 100ml volumetric flask. Distilled or deionized water is added until

the solution reaches the mark on the flask, and the resulting solution is vigorously shaken to ensure uniformity.[4]

Fig 1 ferrous sulphate

Flocculant preparation (without dilution)

A. Cactus Juice

Cactus plants possess a range of desirable attributes, including renewability, abundance, eco-friendliness, adaptability, and biodegradability. These characteristics render them well-suited for diverse applications, including their potential utilization in pollutant mitigation. In this investigation, the effectiveness of Cactus juice in pollutant removal was explored. The process for preparing the Cactus juice involved the following steps. Firstly, the Cactus pears were thoroughly rinsed with flowing tap water to ensure cleanliness. The ends of the fruit and thorns were trimmed off, and slits were made to remove the tough outer layer of the Cactus. The sliced fruit was then placed in a deep pot, and the heat was set to medium as the Cactus pears simmered. Once simmered, the fruit was taken out of the water, cut open, and the gel-like portion was blended in a mixer to create a liquid consistency. The resulting juice was stored in the refrigerator to prolong its shelf life.[4]

Fig 2. (A) Cactus juice

B.Aloe vera Juice

Aloe vera, specifically referring to the Aloe Barbadense Miller plant, is widely recognized as the oldest known medicinal plant and extensively utilized for medicinal purposes worldwide. In this investigation, the potential of Aloe vera juice for pollutant removal was examined. To prepare the Aloe vera juice, the following procedure was followed. The leaves of the plant were thoroughly cleansed under tap water to eliminate any dirt or impurities. The thick green outer layer, referred to as the epidermis, was cautiously separated from the gel component of the leaves. Subsequently, the gel was blended in a mixer until it achieved a liquid consistency. The resulting juice was carefully stored in glass bottles and placed in the refrigerator. Prior to

usage, the juice was strained through a sieve with a mesh size of 16 mm to eliminate any solid particles. The obtained filtrate was stored in the refrigerator and utilized within a week to maintain its freshness. [4]

Fig 2. (B) Aloe vera juice

IV. Preparation of Synthetic wastewater

To conduct the batch study and analyze the results, a synthetic wastewater sample was prepared. The purpose of this synthetic wastewater was to mimic the characteristics of actual wastewater effluent generated by the textile industry. The preparation process involved the incorporation of various dyes and chemicals commonly used in the dyeing industry. The synthetic wastewater sample consisted of the following constituents: 300 mg/L of basic red dye 5001 B (a widely utilized direct dye in the region), 3 gm/L of NaCl (sodium chloride), 5.56 mg/L of hydrolyzed starch, 11.12 mg/L of ammonium sulfate, 11.12 mg/L of disodium hydrogen phosphate, and approximately 7-8 drops of liquid detergent. These chemicals were blended in tap water, and the mixture was heated to 80°C for a duration of 1.5 hours to replicate the conditions found in real wastewater. Subsequently, the synthetic wastewater was allowed to cool to room temperature. By creating this synthetic wastewater sample, the study aimed to replicate the composition and properties of actual effluents from the textile industry for experimental purposes. [7]

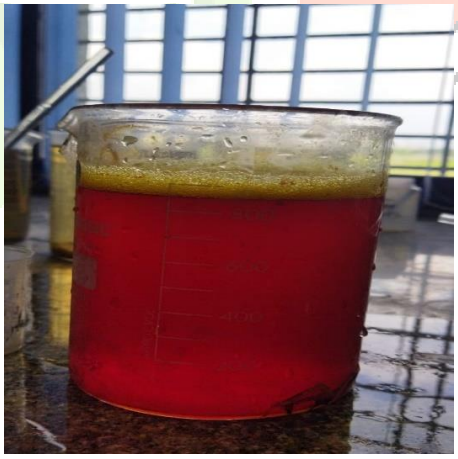

Fig 3. Synthetic wastewater

V. Methods

The coagulation-flocculation method is a highly effective and energy-saving treatment process widely used in wastewater treatment. It remains an essential component of modern wastewater treatment processes. coagulation and flocculation are particularly important for achieving high levels of pollutant removal, including color removal. The process is typically conducted using a jar test apparatus, following standard methods outlined in references such as the APHA (American public health association) 1998 guidelines.[5]

VI. Literature Review

Verma Shilpi et al. (2010) carried out a study focusing on the pretreatment of petrochemical wastewater through the utilization of coagulation and flocculation techniques. The research aimed to investigate the effectiveness of these methods in improving the quality of wastewater generated from petrochemical industries prior to its further treatment or disposal. The study sought to evaluate the performance of coagulants and flocculants in terms of their ability to remove various contaminants and pollutants present in the petrochemical wastewater. By examining the efficiency of coagulation and flocculation techniques, the research aimed to provide insights into effective pretreatment strategies for petrochemical wastewater to minimize its environmental impact. The aim of the research was to assess the influence of various inorganic and organic coagulants on the purification process of purified terephthalic acid (PTA) wastewater. The wastewater samples were obtained from an equalization tank within an effluent treatment plant. The study aimed to evaluate the effectiveness and efficiency of different coagulants in treating the PTA wastewater and to determine their impact on improving water quality. By investigating the performance of both inorganic and organic coagulants, the research sought to identify the most suitable coagulant for the treatment of PTA wastewater in terms of achieving optimal purification outcomes. Coagulation-flocculation is a widely employed method in industrial processes for the separation and removal of dissolved and suspended organic and inorganic colloids from water or solutions. The study investigated the efficiency of various coagulants, including ferric chloride, ferric sulfate, alum, polyaluminium chloride, lime, and natural gum. Cassia javanica seed gum was employed as a coagulant aid to enhance the decolorization of textile dye solutions. Jar tests were conducted using different coagulant concentrations under conditions of rapid mixing and slow mixing. The optimized conditions for coagulation were determined to be 120 rpm for 1 minute during rapid mixing and 40 rpm for 30 minutes during slow mixing. Ferric chloride demonstrated the highest efficacy in terms of chemical oxygen demand (COD) removal, achieving a reduction of 75.5%. Additional analyses, such as scanning electron microscopy and energy dispersive spectroscopy, were performed, and thermal analysis of the sludge indicated an oxidation process. The addition of carboxylic polyelectrolyte (C.PAA) resulted in sludge with favorable settling characteristics. The study also highlighted certain drawbacks associated with this approach, including high construction and operational costs, energy consumption, operational complexity, variability in effluent quality, reliability issues, land requirements, and potential environmental impacts. Two types of flocculation systems were investigated: static hydraulic flocculation and mechanical flocculation. Commonly used chemical coagulants in wastewater treatment include crude alum, ferric chloride, ferric sulfate, and lime. More recently, materials like chitosan and modified chitosan have been utilized as coagulants, and synthetic organic polyelectrolytes have been used as flocculation aids. The research involved collecting samples over a period of three months, with sampling conducted for 16 hours daily. The coagulants used in the study were alum with 99% purity, ferrous sulfate with 97% purity, ferric sulfate with 97% purity, and lime with 99% purity. [1]

Muruganandam et al. (2017) conducted a study to assess the feasibility of employing natural coagulants, including aloe vera, moringa oleifera, and cactus, in the treatment of wastewater using coagulation and flocculation methods. The primary aim of the research was to evaluate the effectiveness of these natural coagulants in comparison to synthetic coagulants for the removal of contaminants from water. The study aimed to determine if natural coagulants could be used as an alternative to synthetic ones while achieving comparable results in terms of water treatment efficiency. Following the coagulation and flocculation process, subsequent steps in wastewater treatment commonly include sedimentation, filtration, and disinfection. However, the adoption of biological coagulants in commercial applications has been restricted due to a lack of comprehensive understanding regarding their efficacy and performance. The study focused on investigating the impact of pH, dosage, chemical oxygen demand (COD), and turbidity Kumawat Nandkishor et al. (2017) conducted a study focusing on the treatment of textile effluent using natural coagulants. The primary objective of the research was to examine the effectiveness of different natural coagulants, namely cactus, Hyacinth bean, Tamarindus indica, moringa, lablab, and Acacia (Babul), in treating wastewater produced by the textile industry. The study utilized the conventional Jar Test method to evaluate the treatment process and determine the efficiency of the natural coagulants in removing contaminants from the textile effluent. The research aimed to provide insights into the potential application of these natural coagulants as an alternative and sustainable solution for textile wastewater treatment. The study revealed that natural coagulants exhibited favorable

performance in treating turbid water, achieving a maximum turbidity on the coagulation effectiveness of the natural coagulants, using Jar test experiments. The optimal dosage for moringa oleifera was determined to be 15 mg/liter at pH 6, while the optimal dosage for cactus was found to be 40 mg/liter at pH 4. Aloe vera demonstrated optimal performance at a concentration of 5% and pH 5.[2]

reduction efficiency of approximately 78%. The research involved testing wastewater samples with varying initial turbidity levels, classified as low (100 NTU), medium (250 NTU), and high (500 NTU). The optimal dosage of natural coagulant ranged from 250 to 1000 mg/L. Among the natural coagulants tested, cactus and Hyacinth bean demonstrated the highest percentage of turbidity removal. The study emphasized the significance of maintaining optimal pH conditions within the system. It was observed that optimizing the pH led to a reduction in the required coagulant dosage and, in some cases, improved turbidity removal. Thus, careful selection of the system's pH could result in lower coagulant requirements and enhanced turbidity removal. Overall, the research highlighted the suitability, cost-effectiveness, and environmental friendliness of utilizing locally available natural coagulants for practical water treatment applications.[3]

VII. CONCLUSION

The coagulation-flocculation technique using organic, low-cost natural flocculants is expected to effectively remove color from textile effluent. A high color elimination efficiency of over 85% should be achieved through this process. Additionally, it can be concluded that this method is environmentally friendly, requiring minimal investment and no specialized skills. The sludge generated during the coagulation-flocculation process with natural flocculants is easily biodegradable, with low toxicity and a minimal residual sludge volume. This sludge can be easily disposed of and is presumed to be safe for human health.

REFERENCES

[1] Shilpi Verma, B. Prasad, Indramani Mishra (2010) "Pretreatment of petrochemical wastewater by coagulation and flocculation and the sludge characteristics" Journal of hazardous materials,2010

[2] L Muruganandam, M P Saravana Kumar, Amarjit Jena, Sudiv Gulla and Bhagesh Godhwani(2017) "Treatment of waste water by coagulation and flocculation using biomaterials" 14th ICSET IOP Publishing,2017

[3] Nandkishor Kumawat, Nikhil Koul, Jayesh Indrekar, Shubham Payghan(2017) "Treatment Of Textile Effluent By Using Natural Coagulants" IJIRSE Vol no 3. Issue 04, April 2017

[4] Patel H.,Vashi R.T. (2013) "Comparison of naturally prepared coagulants for removal of COD and Colour from textile wastewater" Global NEST Journal, Vol 15, No 4, pp 522-528,2013

[5] https://www.apha.org/topics-and-issues/public-health-standards

[6] Bratby John (2016) "Coagulation and Flocculation in Water and Wastewater Treatment" Third Edition IWA Publishing, 2016

[7] E. H. Ezechi, S. R. M. Kutty, M. H. Isa, A. Malakahmad, C.M. Udeh and E. J. Menyechi(2016) "Treatment of Synthetic Domestic Wastewater by Integrated Aerobic/Anoxic Bioreactor (IAAB)" Nature Environment and Pollution Technology An International Quarterly Scientific Journal, Vol. 15 No. 3 pp. 943-946 2016