A Comparative Study of Natural and a Synthetic Coagulants in the Treatment of Oily Wastewater

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Abstract

Oily wastewater is notoriously difficult to treat using traditional methods as its constituents tend to be non-biodegradable. With a view to reduce the high volumes of non-biodegradable sludge that typically accompany the use of natural coagulants as well as facilitate compliance with local regulations a comparative study of natural and synthetic coagulants was undertaken.

The natural coagulants under investigation are Moringa oleifera powder, Cicer arietinum seeds and chitosan. The synthetic coagulant under the review is Alum (aluminum sulphate).

The natural coagulants under review have efficiencies exceeding 95 % for COD removal, 87 % for oil and grease removal and 98 % for turbidity reduction. These efficiencies were achieved however with widely varying dosage rates of the natural coagulants.

This project aims to determine the optimal dosage rate associated with the treatment of Oily Wastewater from a local Petroleum refinery that will match or exceed the performance of synthetic coagulants currently being used.

Key words: coagulation, natural coagulants, COD, turbidity, conditioning time, produced water

Background

Oily wastewaters are generated in many industrial processes, such as petroleum refining, petrochemical, food, leather and metal finishing. Fats, oils, and greases (FOG's) present in these wastewaters must be removed and treated to limit the dangerous effects of it on the environment. To treat and make these oily wastewaters safe, coagulation and flocculation is one of the methods introduced. Coagulation is technique used to destabilize negatively charged colloids in wastewater to encourage the agglomeration of particles. The process uses small, highly charged molecules to destabilize the charges on particles, colloids, or oily materials in suspension in water. Flocculation further encourages the gathering of these micro flocs to form macro flocs. Coagulants are the compounds used in the coagulation and flocculation process. Currently, most industries use Alum (Aluminum Sulphate) which is a synthetic (inorganic) coagulant as the coagulant for treating oily wastewater. However, like most processes, the safety of the environment and for the individuals using these chemicals and costs of the chemical to companies must be at the forefront in optimizing the process.

Natural coagulants have been introduced in the latter years as a cheaper alternative compound in treating oily wastewater. According to a study by EH, Mohammed & Mirghaffari (2018), the experiments of a jar test showed that Cicer arietinum seed at dose 1.5 mg/L and the best pH and oil concentration can remove 95.2% of chemical oxygen demand (COD), 83.8% oil content and 98.89% of turbidity from high strength synthetic oily wastewater. According to Jagaba et al. (2020), Moringa oleifera powder at a dose of 2000 mg/L can remove 95.42% of TSS, 88.30% of turbidity as well as 87.05% of oil and grease from high strength palm oil mill effluent. According to Jagaba et al. (2020), chitosan at a dose of 400 mg/L was able to remove 98.95% TSS, 98.35% turbidity and 68.31% COD from high strength palm oil mill effluent. From these results,

it can be stated that Cicer arietinum seed, Moringa oleifera and Chitosan show strong potential as natural coagulants. The parameters normally examined for effective wastewater treatment are pH, turbidity, BOD, COD, Oil and grease removal, total suspended solids.

Problem Statement

Though chemical coagulants are widely used, the by-products produced creates large quantities of non-biodegradable sludge and toxic compounds. A need therefore exists for less harmful natural alternatives. The purpose of this research is to compare the effectiveness of plant and animal based coagulants such as Moringa Oleifera, Chitosan and Cicer arietinum seed against a widely used synthetic coagulant Alum (Aluminum Sulphate) for the removal of COD, turbidity, and oil and grease from oily wastewater.

Sub-Problems

1. To compare the removal efficiency of Turbidity, COD, oil and grease using Moringa Oleifera, Cicer Arietinum and Chitosan against Alum (Aluminum Sulphate).

2. To assess the required conditioning time and dosages of Moringa Oleifera, Cicer Arietinum and Chitosan in comparison to the Alum.

3. To assess the optimum pH required for Moringa Oleifera, Cicer Arietinum and Chitosan in comparison to the Alum.

Significance of Study

According to Rohana et al. (as cited in Jagaba, Kutty, Hayder et al., 2020, p. 3) aluminum sulphate is the most popularly used coagulant in wastewater treatment, because of its accessibility, cost effectiveness and an established efficiency. Unfortunately, research has revealed that its large consumption can contribute to the growth of neurodegenerative disorders. On the other hand, natural coagulants which are a very promising alternative have a positive widespread impact on the society, economy and environment. Natural coagulants are non-toxic, biodegradable and reduces the volume of sludge produced. Compared to chemical coagulants, natural coagulants are safe to use since they are non-toxic. This enables persons as well as flora and fauna to be safe in the event of contamination. From an economic point of view, natural coagulants are cheaper to use to treat oily wastewater. This is because there is a reduction of the sludge produced which results in a reduction in the cost to get it removed. Moringa Oleifera seeds, Chitosan and Cicer arietinum seeds are also readily available in many counties including Jamaica. Natural coagulants can also perform just as good as synthetic coagulants. From an environmental perspective, utilizing natural coagulants is advantageous. This is because it encourages persons to plant more Moringa Oleifera and Cicer arietinum trees which can decrease the carbon dioxide emissions in the atmosphere. The collection of seafood shells would also be encouraged since persons would be able to earn from it.

References

Jagaba, A. H; Kutty, S. R. M; Hayder, G. et al. (2020). Sustainable use of natural and chemical coagulants for contaminants removal from palm oil mill effluent: A comparative analysis. Ain Shams Engineering Journal. Retrieved from https://doi.org/10.1016/j.asej.2020.01.018

Javid, A., Malakootian, M., & Mehdipour, M. (2015, February 10). Investigation of ozone and coagulant material's (aluminum sulfate, ferric chloride, poly aluminum chloride and lime) efficiency in "Kerman Kork" industry wastewater treatment. Retrieved November 02, 2020, from http://ehemj.com/article-1-47-en.html