ID: 5062

Optimizing Urban Sludge Conditioning: A Comparative Study of Chemical Flocculation and Ultrasound/Flocculation Coupling of Sludge Collected from Baraki Wastewater Treatment Plant

Teguar Marwa[1*], Lounici Hakima[1], Kebaili Maya[2]

[1]Laboratoire Matériaux et Développement Durable, Université Akli Mohand Oulhadj-Bouira,Algeria
[2] Mechanics Research Center (CRM), Constantine, Algeria
*Corresponding author's email: marwa.tgr96@gmail.com

ABSTRACT

The main objective of this investigation is to enhance the conditioning efficiency of urban sludge, collected from Baraki wastewater treatment plant. The study aims to evaluate and compare two distinct conditioning methods, namely chemical flocculation and ultrasound/flocculation coupling, with the goal of optimizing the treatment process for improved sludge management. Chemical conditioning trials, based on the flocculation process using a cationic polyelectrolyte, were conducted. Various doses were injected into 100 ml volumes of sludge [1]. The slurry suspensions were stirred at 140 rpm for 20 seconds. Then, this speed was reduced to 30 rpm for 2 minutes. The conditioned sludge was mechanically dehydrated by centrifugation at 4000 rpm for 10 minutes. The results showed an increase in dryness from 3.1% to 26.84%, a significant drainage efficiency of 80%, and a substantial reduction in turbidity from 137 to 13.43 after the application of 7 kg/T of dry sludge of polyelectrolyte. The pH remained almost unchanged, ranging from 7.72 to 7.43 for 2 to 9 kg/T of dry sludge of flocculent. For the conditioning by the ultrasound/flocculation coupling process, sludge samples underwent ultrasonic irradiation for varying durations of 10, 15, 30, and 60 minutes. Subsequent to this, a flocculation operation was conducted, involving the addition of escalating doses of cationic polyelectrolyte (ranging from 3 to 9 kg/T of dry sludge). The results indicated a correlation between dryness and both ultrasonication time and polyelectrolyte dose. Notably, the maximum dryness achieved was 45.03% after 30 minutes of sonication, coupled with flocculation using 5 kg/T of dry sludge of polyelectrolyte, compared to the initial dryness of 14.51% before the flocculation process. A sonication time of 30 minutes and a dose of 6 kg/T of dry sludge of polyelectrolyte have increased the volume of supernatant drained after ultrasound/flocculation coupling, with a maximum removal of 96%. A significant decrease in turbidity from 360 to 8.90 NTU was recorded with a dose of 5 kg/T of dry sludge and 30 minutes of sonication. The obtained results provide at least a clearer understanding of the efficiency and technical potential of ultrasound/flocculation coupling.

Keywords: Urban sludge conditioning, Cationic polyelectrolyte, flocculation, Sludge dewatering, Centrifugation, Dryness, Turbidity, Ultrasonic irradiation

1 Introduction

In the realm of industrial wastewater management, the treatment of sludge originating from the Algerian oil refinery stands as a pressing concern. This study delves into the refinement of sludge through chemical conditioning, specifically employing the floculation method. Additionally [3], an innovative approach is explored, integrating ultrasonication with floculation for enhanced efficiency. By examining these techniques, this research aims to contribute to more sustainable and effective solutions for the challenges posed by sludge generated in the Algerian oil refinery.

2 Experimental

In this study, raw mixed sludge samples were obtained from the stabilization tank of a wastewater treatment plant (WWTP) at the Algiers oil refinery in Sidi R'cine, Algeria. The mixed sludge, composed of physicochemical sludge from primary oil and secondary oil extraction, along with excess biological sludge, was collected in triplicate to enhance representativeness. The sludge underwent filtration, storage at 4°C,

DOI: 10.21467/abstracts.170 ISBN: 978-81-970666-1-0 (eBook)

and occasional degassing to prevent composition changes. Two types of conditioners, a cationic polyelectrolyte and an alfalfa seed-based biopolymer, were used at a concentration of 10% of the raw sludge dryness. The chemical conditioning involved Jar tests to optimize polymer dosage, while microwave pretreatment was performed to facilitate water release and enhance thickening. Centrifugation tests were conducted to evaluate the performance of sludge conditioning and thickening techniques, measuring parameters such as pH, COD, total solids, volatile solids, moisture content, specific resistance to filtration, dry solids content, and supernatant characteristics. Standard Methods were followed for analyses, including the determination of oil and water content as well as organic impurities in raw sludge.

3 Results and Discussion

The findings revealed a clear association between the degree of dryness and both the duration of ultrasonication and the quantity of polyelectrolyte administered. Remarkably, the highest dryness level attained was 45.03% following a 30-minute sonication period, complemented by flocculation using 5 kg/T of dry sludge of polyelectrolyte, in stark contrast to the initial dryness rate of 14.51% pre-flocculation. Implementing a 30-minute sonication period and a 6 kg/T dose of dry sludge of polyelectrolyte resulted in a substantial increase in the drained supernatant volume during ultrasound/flocculation coupling, achieving a remarkable removal efficiency of 96%. Furthermore, a noteworthy reduction in turbidity from 360 to 8.90 NTU was documented with a polyelectrolyte dose of 5 kg/T of dry sludge coupled with a 30-minute sonication duration [3] [2]. These outcomes not only enhance our comprehension of the effectiveness but also underscore the technical prowess of ultrasound/flocculation couplin.

4 Conclusions

In summary, a strong correlation between sludge dryness and ultrasonication duration, coupled with polyelectrolyte quantity has been found. The highest dryness level achieved was 45.03%, with a 30-minute sonication period and 5 kg/T of dry sludge polyelectrolyte, which was a significant improvement from the initial rate of 14.51% pre-flocculation. A 30-minute sonication and a polyelectrolyte dose of 6 kg/T resulted in a significant increase in drained supernatant volume, achieving a notable removal efficiency of 96%. Additionally, using 5 kg/T of dry sludge polyelectrolyte with a 30-minute sonication duration resulted in a remarkable reduction in turbidity from 360 to 8.90 NTU. These findings improve our understanding of the effectiveness of ultrasound and flocculation, and highlight their technical ability to enhance sludge dewatering and treatment efficiency.

5 Acknowledgements

I would like to express my sincere gratitude to the SEAAl (insert full name or acronym if applicable) of Algiers for their invaluable support and resources throughout the course of this project.

References

[1] GAÏD, A. 2008. Présentation des procédés de traitement. Traitement des boues. 2008. C5221 v1.
[2] Turovskiy, I.S et Mathai, P.K. 2006. Wastewater sludge processing. New Jersey: John Wiley & Sons, 2006.
[3] Berland, J.M. 2014. Traitement des boues d'épuration. s.l. : téchnique de l'ingénieur, 2014. C5221 v2

ISBN: 978-81-970666-1-0
Series: AIJR Abstracts
DOI: 10.21467/abstracts.170