RESEARCH ARTICLE

Evaluating Modified Grease Traps with Coconut Coir for Improved Adsorption Efficiency

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Abstract:

Fats, oils, and greases (FOG) from restaurant wastewater can cause significant environmental and infrastructure issues. Grease traps are employed to prevent these pollutants from entering sewer systems. This study investigates the efficiency of conventional and modified grease traps enhanced with coconut coir activated carbon (CCAC) in treating restaurant wastewater. The objectives were to evaluate the effectiveness of both systems in reducing oil, grease, and turbidity levels. In the experimental setup, wastewater from a restaurant was treated using a standard grease trap and a modified trap with CCAC. Results showed that the conventional grease trap achieved an oil and grease removal efficiency of 89.54%, while the modified trap had a lower efficiency of 50.38%. However, the modified trap significantly improved turbidity reduction by 81.86%, compared to 24.64% in the conventional trap. Both systems showed no thermal influence on treatment. Overall, while the conventional grease trap was more effective at oil and grease removal, the addition of CCAC in the modified trap improved water clarity, suggesting a potential for combining both approaches to optimize wastewater treatment. This study emphasizes the importance of improving grease trap technologies to achieve better environmental sustainability in restaurant wastewater management.

Keywords: Grease Trap, Oil and Grease, Restaurant Wastewater

1. INTRODUCTION

Fats, oils, and greases (FOG) discharged from commercial and domestic kitchens produce several waste materials that have a negative influence on the sewer system (Collin et al., 2020). FOG are byproducts of food processing plants (meat plants, for example), food service establishments (restaurants, for example), and domestic properties (Wallace et al., 2017). Wallace et al. (2017), mentioned that these FOG clogs cause sanitary sewer overflows, property flooding, and sewage contaminating of water bodies. Grease trap has been proven to be able to remove FOG from wastewater (Wong et al., 2007, Wongthanate et al., 2017). Grease traps act as a system that keeps FOG from clogging pipes, overflowing, and polluting the environment by entering the wastewater system. Grease traps protect the wastewater treatment process by removing FOG before it enters the system, which minimizes the need for costly and time-consuming repairs and maintenance. Grease traps also contribute to environmental sustainability by lowering the quantity of FOG released into the environment, which can harm aquatic life and water quality. By making sure of the amount of FOG that is released into the environment the sustainable development goal can be achieved successfully which is good health well-being and life on land.

Depending on the source of generation, FOG can have a wide range of physical and chemical properties. FOG can be liquid or solid and has no colour, odor, or taste in its pure form (Husain et al., 2014). According to Sultana et al., (2020) studies the treatment of wastewater with excessive amounts of fat, oil, and grease (FOG) produced by an increasing number (annually 2% of FSEs) is a big challenge for water utilities. Sewer clogs are caused mostly by the buildup of FOG deposits in sewer pipes, and sewer management requires an annual supplementary maintenance expense. According to Sello (2021), fats, oils, and grease in wastewater have been discovered to have a variety of negative impacts on the sewer, the wastewater treatment facility, and the environment into which it is discharged. It is also clear that the removal of FOG is primarily determined by the physical and chemical properties of the FOG, environmental circumstances, the performance of the wastewater treatment plant, and the effectiveness of each method used.

In improving the potential of wastewater treatment, several studies have been found to be conducted by using different materials or substances. Examples are by using eggshell (Rozi et al., 2023, Azhar et al., 2018), sugarcane bagasse (Saâ et al., 2016), powdered activated carbon, anthracite, and clay adsorbents (Mueller et al., 2003). A study found that Coconut Coir Activated Carbon (CCAC) showed significant capability to be used as a low-cost, re-generable and eco-friendly adsorbent in oil spill clean-up (Abel et al., 2020). Based on those investigations, this study was designed to investigate the effectiveness of conventional grease traps and modified grease trap with CCAC in removing oil and grease and turbidity in wastewater from restaurants.

2. MATERIALS AND METHODS

The study was conducted at Restaurant A7 Nasi Lemak Kukus in Bandar Baru Jaya Gading, selected for its adequate wastewater supply necessary for the investigation. This experimental and quantitative research requires approximately 50 liters of wastewater samples and a substantial quantity of coconut coir to produce coconut coir activated carbon (CCAC). The experimental setting will use a grease trap with dimensions of 50 cm x 30 cm x 30 cm and a capacity of 42 litres. The experiments was carried out in the laboratory of Centre for Environmental Health and Safety Studies in UiTM Puncak Alam. The experimental design includes two: a control that uses a grease trap device without any adsorbent material, and another setting that uses coconut coir as an adsorbent.

There are various stages involved in preparing the adsorbent. Initially, coconut coir samples are dried in a laboratory drying chamber at 105°C for 24 hours to eliminate volatile components and excess water content. The dried samples are then crushed, sieved, and stored at room temperature before being impregnated into smaller particles (1-2mm). The impregnated crushed coconut coir is then pre-treated with KOH pellets at a 1:2 impregnation ratio before being carbonised in a muffle furnace for two hours in an oxygenless environment. After a 12-hour drying time at 105°C to remove moisture, the mixture is activated for one hour at 800°C in a muffle furnace. The resulting CCAC is cooled, washed with distilled water until the pH reaches 6-7, and then washed with a 0.1 M HCl solution to remove any residual ash. The CCAC is oven-dried at 105°C for 2 hours, crushed, sieved into 63-500 µm particles, and kept in a desiccator until needed for the adsorption experiment.

The Total Oil and Grease (TOG) experiment, adapted from Klemz et al. (2021), uses a liquid-liquid extraction method. In this approach, 30 ml of n-hexane is poured into a separatory funnel and vigorously shaken for at least two minutes before settling. The lower layer is drained into a container, and the water layer is kept for future extractions. Sodium sulphate is used to filter the solvent layer, and the extraction procedure is repeated several times. Finally, the weight of the extracted oil and grease is measured to determine the effectiveness of the adsorption process.

3. RESULTS AND DISCUSSION

3.1. Characterization of Wastewater

All wastewater samples exhibit similar visual characteristics, including a greasy appearance and an unpleasant odor. Contrary to expectations, the color was neither yellowish nor white. The water appeared slightly cloudy with some foam, likely due to the presence of soap mixed with residue from dishwashing. Additionally, floating oil droplets and other foreign particles were observed throughout the wastewater.

3.2. Oil and Grease Efficiency

Table 3.1 Restaurant Wastewater Reading Before and After for Grease Trap

Grease Trap	pH	Turbidity, NTU	Temperature, °C
Before	6.22	82.96	24
After	7.29	62.52	24
Change (%)	17.20	-24.64	0

Table 3. 2 Restaurant Wastewater Reading Before and After for Modified Grease Trap

Modified Grease Trap	pH	Turbidity, NTU	Temperature, °C
Before	6.89	109.8	24
After	10.12	19.92	24
Change (%)	46.87	-81.86	0

Tables 3.1 and 3.2 present the results for three key parameters: pH, turbidity (NTU), and temperature (°C). Table 3.1 displays the values for these parameters in untreated wastewater and after treatment with a conventional grease trap, along with the corresponding percentage of change. In comparison, Table 3.2 illustrates the same parameters, but the grease trap used in this case has been enhanced with coconut coir activated carbon (CCAC). These tables enable a direct comparison of the performance of the standard and modified grease traps in improving wastewater quality.

The comparison between the regular grease trap and the modified grease trap with coconut coir reveals key differences in their efficiency in treating restaurant wastewater. In terms of pH adjustment, the regular grease trap increased the pH by 17.20%, moving the wastewater from mildly acidic (6.22) to near-neutral (7.29), which is ideal for most environmental standards. In contrast, the modified grease trap increased the pH by 46.87%, raising it to 10.12, making the wastewater more alkaline. While this significant increase may be beneficial for certain downstream treatments, it could pose a risk if not carefully managed in systems where neutral pH is preferred.

The most notable difference lies in the turbidity reduction, where the modified grease trap outperformed the regular trap by a large margin. The regular grease trap reduced turbidity by 24.64%, indicating moderate removal of suspended particles. However, the modified grease trap achieved an 81.86% reduction, substantially improving water clarity and demonstrating superior removal of suspended solids. This suggests that the addition of coconut coir enhances the trap's ability to adsorb fine particles and oils more effectively. Both systems maintained a constant temperature of 24°C, indicating no thermal influence on the treatment process. Overall, the modified grease trap proves to be far more effective, especially in reducing turbidity and improving effluent quality, though its impact on pH must be considered depending on the specific wastewater management needs.

Table 3. 3 The Quantity of Oil and Grease for Grease Trap

Grease Trap	Oil and Grease, g/L
Before	1.1589
After	0.1212
Percentage of removal	89.54%

Table 3. 4 The Quantity of Oil and Grease for Modified Grease Trap

Modified Grease Trap	Oil and Grease, g/L
Before	0.6500
After	0.3225
Percentage of removal	50.38%

Table 3.3 and 3.4 above shows the removal efficiency of oil and grease from the usage of conventional grease trap and the modified grease trap respectively. The table compares the performance of a standard grease trap and a modified grease trap (with coconut coir activated carbon) in removing oil and grease from wastewater. For the standard grease trap, the oil and grease concentration in the wastewater before treatment was 1.1589 g/L, which was significantly reduced to 0.1212 g/L after treatment. This represents a removal efficiency of 89.54%, indicating that the conventional grease trap was highly effective in reducing oil and grease levels.

On the other hand, the modified grease trap started with a lower initial oil and grease concentration of 0.65 g/L. After treatment, the concentration dropped to 0.3225 g/L, resulting in a removal efficiency of 50.38%. Although the modified grease trap was effective in reducing oil and grease, it performed less efficiently than the standard grease trap.

In summary, while both grease traps were able to lower the oil and grease content in the wastewater, the standard grease trap achieved a much higher percentage of removal compared to the modified version. This suggests that the conventional system might be more efficient under the conditions tested, despite the inclusion of coconut coir activated carbon in the modified system.

3.3. The Capacity of Grease Trap

Plates 3. 1 Restaurant Wastewater in Grease Trap

Plates 3. 2 Restaurant Wastewater in Modified Grease Trap

The removal of oil and grease using grease traps occurs through a purely physical process. This is evident as the wastewater in each compartment undergoes significant changes without the formation of any new substances. The only modification is the separation of oil and grease, which rise to the surface and are removed from the water. Observations of this separation can be seen in Plate 3.1, which illustrates the distinct color changes in the wastewater as it passes through the compartments of the grease trap. Plate 3.2 shows the physical characteristics of the wastewater as it flows through a grease trap containing coconut coir as an adsorbent. The color of the wastewater turns black, reflecting the color of the coconut coir.

Notably, the final wastewater sample collected from the grease trap shows that the coconut coir particles pass alongside the wastewater without dissolving into it. This phenomenon is likely due to the small size of the coconut coir particles, allowing them to pass through the first compartment and into subsequent sections of the grease trap. Physical observations suggest that the total oil and grease content is reduced in the final compartment, as indicated by the progressive color changes between compartments. The water in the last compartment appears less oily and greasy compared to that in the second compartment. Although it is difficult to distinguish color differences in Plate 3.2 due to the black coloration, the texture of the water from the final compartment is less greasy compared to the control group.

These findings suggest that coconut coir is effective in reducing the total oil and grease in wastewater. Additionally, the total volume of wastewater remained constant between the first and third compartments.

4. CONCLUSION

In conclusion, this study highlights the effectiveness of both conventional and modified grease traps with coconut coir in treating restaurant wastewater, particularly in reducing oil, grease, and turbidity levels. While the conventional grease trap demonstrated a higher oil and grease removal efficiency (89.54%) compared to the modified grease trap (50.38%), the addition of coconut coir activated carbon (CCAC) in the modified trap significantly improved turbidity reduction, achieving a notable 81.86% decrease. These results suggest that while traditional grease traps remain highly effective for oil and grease removal, the use of adsorbents like CCAC enhances overall wastewater quality by improving the clarity of the effluent. Thus, combining conventional and modified approaches can optimize grease trap performance for more comprehensive wastewater treatment. Overall, the study verifies the usefulness of grease traps in oil and grease reduction and calls for additional investigation of modification effects, supporting continuous efforts to improve wastewater treatment. These findings highlight the importance of flexible techniques to ensure sustainable restaurant wastewater treatment following environmental goals, which will guide future improvements in grease trap technology for cost-effective and environmentally friendly solutions.

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