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Study on the Wastewater Characteristics of the Ghee Mill

Nazia Shad[1], Arshad Ali[2, *], Shamin Riaz[1], Adil Khan[1], Muhammad Ullah[1], Jamila Begum[1]

[1]Northern University, Nowsehera Cantonment, KPK, Pakistan
[2]National University of Sciences and Technology, Islamabad, Pakistan

Abstract

For the wastewater quality analysis of the ghee mill effluent, various composite samples were collected from the local mill. The samples were collected at regular interval for a period 0f 4-6 weeks. The wastewater generated by the ghee is highly polluted in terms of releasing a high strength effluent. The mean average values COD, BOD, TSS and TDS observed was 3795mg/L, 2300mg/L, 870mg/L and 2860mg/L, respectively. The effluent is highly alkaline, with a pH of more than 9.0, and has objectionable odor and smell. Moreover, it has very high temperature, i.e., 29^{o}C, at the point of its disposal into the receiving streams. The effluent of the ghee mill is also found to have very critical DO concentration, almost 6.5mg/L. That can adversely effects entire water ecosystem, having such high organic pollutant strength. The proposed wastewater treatment plant for the ghee mill comprises of medium screens, PST and the UASB reactor. The required dimension of the PST operating at SOR of 3.05ft3/ft2-hr was calculated to be LxWxH: 55ft x42ft x12ft. The UASB reactor of 60ft diameter and 12ft height will be able to remove more than 80% of the COD and BOD from the effluent of the ghee mill. Additionally, it will generate a biogas for the domestic requirements of 3000 persons, by an estimated biogas yield 1920m^3/day. A long-term study is suggested to evaluate the overall impacts of the ghee mill on the wastewater receiving stream. Moreover, different cost-effective treatment options need to be study.

Keywords

Wastewater, Ghee Mill, BOC, Pollution, Safe Disposal

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1. Introduction

Pakistan is a water deficient country, the quantity of available water resources has been declining day by day, the year 1960 was 5654 m^3/capita, in the year 2000 it was 1400 m^3/capita and in the year 2010 the capacity is expected to be 1000 m^3/capita [1,2]. The water quantity (flow rate) is decreasing day by day due to different factors like temperature, atmospheric pressure, wastage due to improper management and pollution.

The available water in our country is being polluted at an alarming rate. The pollution mainly occurs due to untreated ghee mill and industrial effluents and agricultural/surface runoffs etc. Ghee mill effluent includes sewage as well as sullage while industrial effluents only include waste sewage. The runoffs may include garbage and sediments [3]. Due to all these effects of pollution, the only clean and potable water available is 18% and the rest 82% is unfit for drinking purpose. Besides water deficiency it is an admitted fact that Pakistan is deficient in energy though it has a substantial potential of energy. The energy is not only confined to

* Corresponding author
E-mail address: aliarshad08@yahoo.com (A. Ali)

electrical energy but the bio-gas has also a significant share in this sector. However bio-gas has not been given attention as it deserves [4,5].

Biomass is the most important sources in Pakistan as it is about 37% of its total primary energy supply. The growing acceptance of anaerobic digestion as a simple, low-cost high rate and effective waste treatment technology makes it a viable solution for pollution control, in addition to give support to energy resources sector. Therefore, this study was design to study the wastewater characteristic of the ghee mill effluent. And to design a low-cost wastewater treatment plant for the ghee mill based on the data obtained.

2. Materials and Methodology

For the wastewater quality analysis of the ghee mill effluent, various composite samples were collected from the local mill. The samples were collected at regular interval for a period 0f 4-6 weeks. All the samples were collected in a proper sterilized 10.L capacity bottles and was immediately shifted to the nearest Public Health Engineering Laboratory for the analysis. Some of the parameters, like temperature, pH DO and turbidity, were tested on the site. And the rest of the wastewater quality parameters were analyzed in the laboratory [6,7].

Table 1. Water Quality Parameters used

Parameter	Technique
pH	pH meter
Temperature	Thermometer
BOD	Dilution method
COD	Open Reflux
Chlorides	Argentrometric method
TDS	Gravimetric meter
TSS	Filter paper
Nitrates	Spectrophotometer

3. Results and Discussion

3.1. Wastewater Characteristics of the Ghee Mill

The wastewater characteristics of the nearby ghee mill effluent were studied by collecting various composite and representative samples from it. The data obtained is shown in the Table 2. The findings indicated that the ghee mill effluent is polluted both in terms of physcio-chemical and aesthetic parameters. The samples were highly turbid and milky in color with bitter smell. The average COD and BOD concentration was recorded as 3795mg/L and 2300mg/L, respectively.

Table 2. Wastewater characteristics of the ghee mill effluent

Ser#	Parameter	Value	NEQS limits
1	Temperature (°C)	29	<40
2	Turbidity (NTU)	6.02	--
3	Color (unit)	7.65	--
4	Odor	Objectionable	--
5	pH	9.2	6-10
6	BOD (mg/L)	2300	80
7	COD (mg/L)	3795	150
8	Nitrates (mg/L)	11.80	--
9	TDS (mg/L)	2860	3500
10	TSS (mg/L)	870	150
11	DO (mg/L)	6.50	--

Figure 1-10 illustrate the wastewater quality of the various locations of the local ghee mill. Temperature is an important indicator with regards to the survival ability of aquatic life. The temperature values depend upon the process of production of the industry. Refer to Figure 1.0, the temperature values ranged from 26-31°C with a mean value of 28.70°C. The highest value was found in the effluent of ghee industry during the 4th week of the sampling period. These values seem to be far beyond the standards set by the Pak-EPA, in terms of NEQS. Such a high temperature value has adverse impacts on the existing flora and fauna of the receiving body ecosystem [8,9]. Therefore, proper measure needs to be taken for reducing its temperature before the final discharge of the wastes in the streams or rivers etc.

Refers to Figure 2.0 and 3.0, the turbidity color concentrations are shown. Though, both the color and the turbidity concentrations of the subject sample are reasonable, but still efforts are required to further reduce them, by means of some physcio-chemical processes. The NEQS has no defined standards for both of these parameters. The maximum turbidity and color concentration was observed to be 8.4NTU and 10.5units, respectively. However, the mean observed value was found to be 6.02NTU and 7.65units for turbidity and color, respectively.

Biological oxygen demand (BOD) is expressed as weight of oxygen consumed per unit volume of water during a defined period of time at a defined temperature was calculated. It measures the biodegradable materials in water and helps in the development of bacteria and other organic byproduct. The BOD of effluent ranged from 1980-2560mg/L with a mean value of 2300 mg/L, as shown in the Figure 4.0. The effluent with highest BOD value was observed during the 2nd week of sampling, whereas, the minimum value was noticed on the 3rd week. Throughout the study period, it was observed that a BOD value of the effluent was far beyond the NEQS limits. It indicates that if such effluent is disposed of directly into fields and river it will have an adverse effect on aquatic life due to the depletion of oxygen level in water [10].

The Figure 5.0, illustrate the concentration of the pH observed during the study conducted on the effluent of ghee mill. The pH of the samples was measure at the site of waste disposal by the mill, with the help of potentiometric, which was standardized by using buffer solutions of known value before analysis. The pH values of samples ranged from 7.8-10.5. The maximum pH value was observed during the 5th week of the study, with a concentration of 10.5. The value of the pH is critical in light of the available NEQS of Pak-EPA. But the same wastes could be easily treated by biological means, as having comparatively favorable pH for the treatment processes. Most of the values of the pH noticed during the study period were within the limits of NEQS.

The COD values of are shown in the Figure 6.0, recorded from 3450mg/L to 4100mg/L during the course of study period, with a mean value of 3795mg/L. The maximum value was observed during the 5th week of the study period, with a concentration of 4100mg/L. The minimum value of 3450mg/L was observed during the 4th week, which is still beyond the limitations of the NEQS. The NEQS limit for COD is 150 mg/L which shows that all these values are beyond the permissible limits. High COD levels decrease the amount of dissolved oxygen available for aquatic organisms. It also causes reduced cell functioning, disturbs circulatory fluid balance in aquatic species and can result in death of individual organism. Hence, a proper mechanism for the treatment of the ghee mill is proposed prior to its final disposal in the receiving streams. The concentration of nitrates also seems to be critical, as the mean value observed during the study was 11.8mg/L, as shown in the Figure 7.0. Since, excessive nitrates causes eutrophication when combines with the phosphates in the water or wastewater courses [11]. Therefore, it also needs to address too.

The Figure 8.0 and 9.0 illustrates the values of TDS and TSS, respectively. Total suspended solids are the portion of solids that usually remains on the filter paper. Total suspended solids of various samples ranged from 750-1050mg/L with a mean value of 877mg/L. The results clearly shows that the TSS values of all the samples are beyond the permissible limits of NEQS. The highest value was recorded during the 3rd week of the study, while the lowest was noticed during the following week. The results suggest that this effluent will cause handling issues if used directly in fields or disposed off in river will cause damage to the aquatic life as it will reduce visibility and absorb light. TSS will also increase the temperature and reduce photosynthesis. Fine particles may also clog and abrade fish and insect gills and tissue and interfere with egg and larval development. Similarly, the TDS concentration, of the ghee mill effluent ranges from 2640-3100mg/L with a mean value of 2862mg/L. The maximum value was observed during the last week, i.e., the 7th week, whereas, the minimum value was noticed during the 6th week of the study period. When compared with the NEQS, it was observed that the TDS values in the effluent of maximum samples are beyond the permissible limits of 3500mg/L. The wastewater with high TDS value can cause salinity problem if discharged to irrigation water. It may also add a laxative effect to the water or cause the water to have an unpleasant mineral taste [12]. Moreover, it can impart undesirable color to the wastewater too.

The concentration of the dissolved oxygen (DO) observed during the study period is shown in the Figure 9.0. Roughly speaking, the effluent is found to have sufficient DO to sustain its quality, but owing to excessive BOD and COD concentration, the same can dropped drastically with few hours, once the biological decomposition of the wastes take place. It will also aggravate the DO concentration issues of the receiving stream, if not properly treated prior to its disposal.

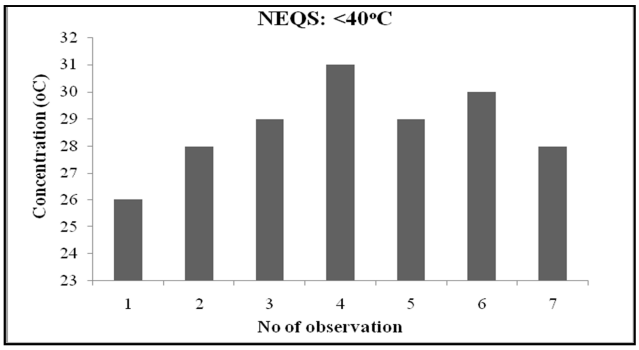

Fig 1. Temperature concentration

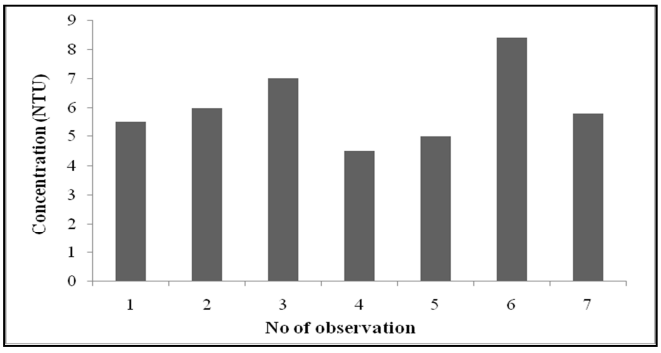

Fig 2. Turbidity concentration

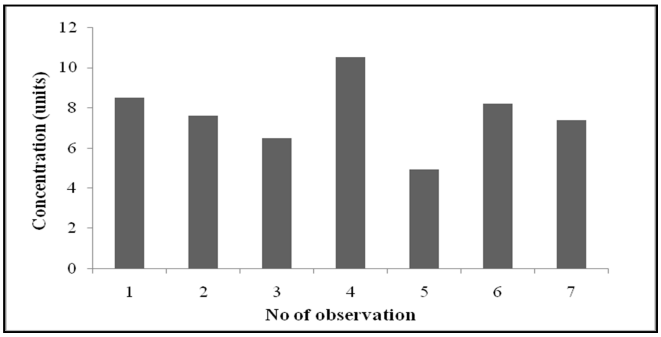

Fig 3. Color concentration

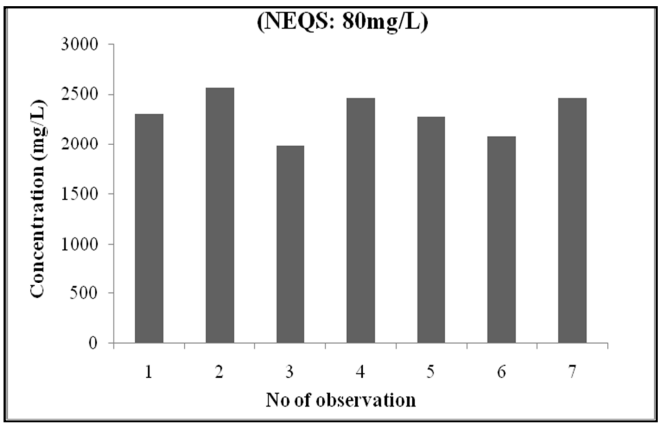

Fig 4. BOD contration

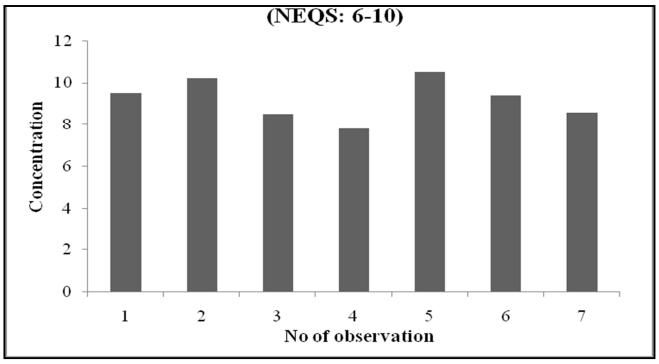

Fig 5. pH concentration

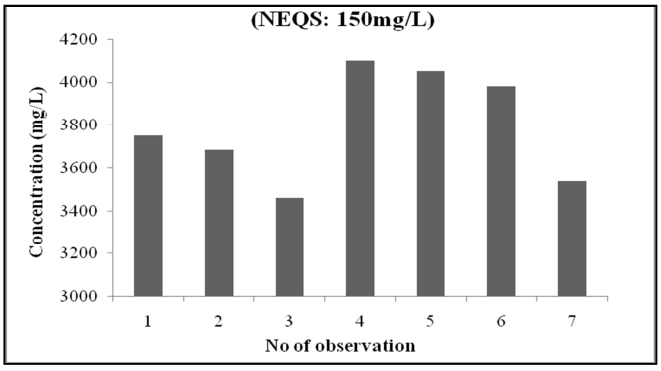

Fig 6. COD conentration

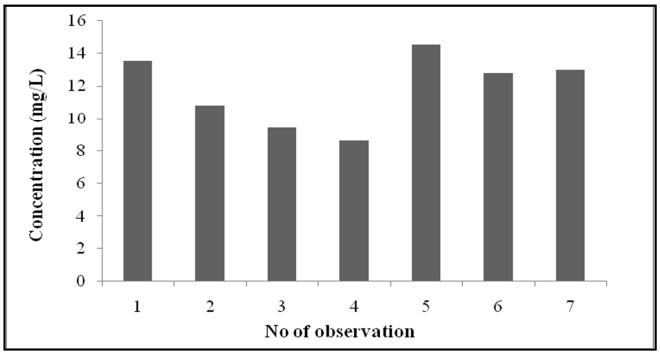

Fig 7. Nitrates concentration

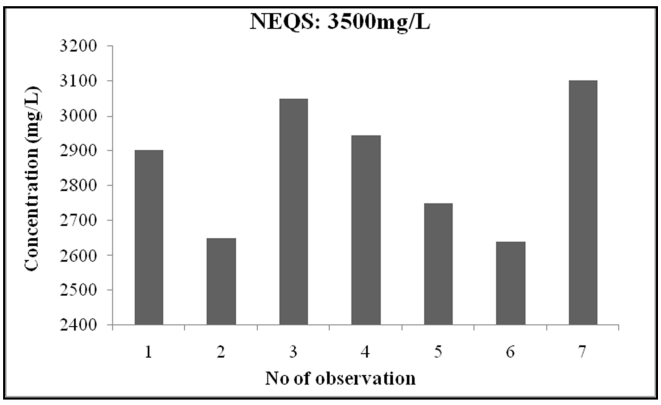

Fig 8. TDS concentration

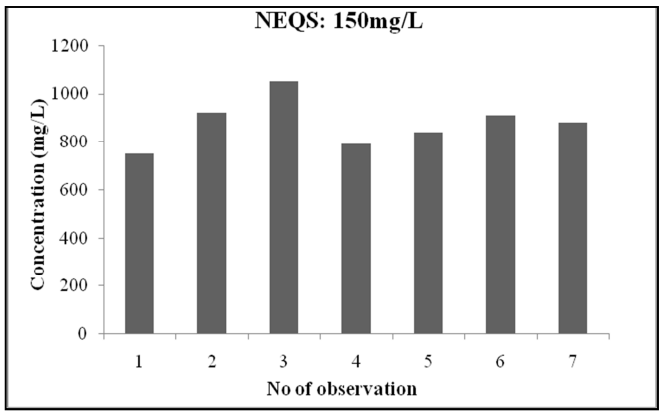

Fig 9. TSS concentration

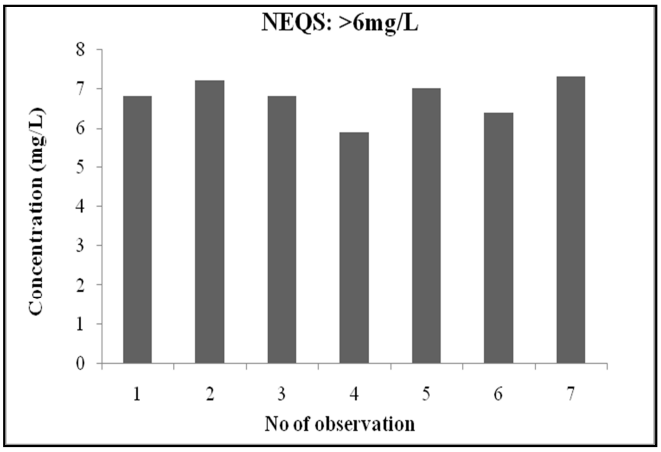

Fig 10. DO concentration

3.2. Proposed Wastewater Treatment Plant

Base on the results of wastewater characteristics of the ghee mill effluent, a wastewater treatment plant was designed as a proposed solution in order to reduce the load of pollution and to contribute to the energy sector too. The layout of the proposed wastewater treatment plant is shown in the Fig 11.

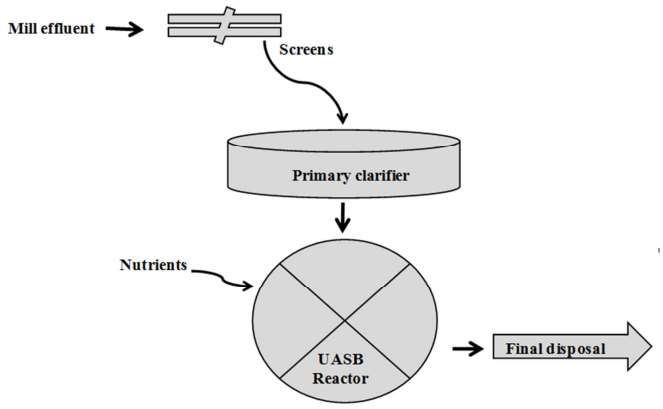

Fig 11. Layout of the proposed wastewater treatment plant for the ghee mill effluent

4. Conclusion and Recommendations

The following are the main conclusion extracted from this study

- The wastewater generated by the ghee is highly polluted in terms of releasing a high strength effluent. The mean average values COD, BOD, TSS and TDS observed was 3795mg/L, 2300mg/L, 870mg/L and 2860mg/L, respectively.
- The effluent is highly alkaline, with a pH of more than 9.0, and has objectionable odor and smell. Moreover, it has very high temperature, i.e., 29^{o}C, at the point of its disposal into the receiving streams.
- The effluent of the ghee mill is also found to have very critical DO concentration, almost 6.5mg/L. That can adversely effects entire water ecosystem, having such high organic pollutant strength.
- The proposed wastewater treatment plant for the ghee mill comprises of medium screens, PST and the UASB reactor.

However, a comprehensive and long term study is suggested to determine the relation of polluting strength of the ghee mill, and to evaluate more cost-effective technique options for the pollution reduction of the same mill.

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