

Slaughterhouse Wastewater Characterization in Local Slaughterhouse, South Khartoum Sudan

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Abstract:- Slaughterhouse wastewaters are considered as highly polluted and very harmful to public health and environment. Therefore, slaughterhouse wastewater must undergo efficient treatment before it is discharged to the sewer line or water bodies. The main objective of this paper is to study the physio-chemical and biological characteristics of the slaughterhouse effluent in local abattoir located at Khartoum state named Al Sahafa Abattoir. In this study we carried out the following tests pH, TDS, Temperature, TSS, BOD₅, COD, NH₃, Total Phosphorus, TKN, Total coliform. Between August 2019 and September 2019, composite samples were collected from Al Sahafa slaughterhouse. The composite samples were collected two litres every hour for five hours to make them more representative. Following the standards methods of sampling all samples were collected in the morning or early afternoon. The results showed that Al Sahafa slaughterhouse waste water is considered as strong wastewater which has to undergo a proper treatment before being disposed of. The COD/BOD ratio is 1.5, which indicates applicability of biological treatment. The results also shows this effluent cannot be reused or dispose to the water bodies because it does not comply with the Sudan Local order 1970 or Khartoum state law 2008. To design a cost effective treatment unit to reuse or dispose of these effluent, blood capturing unit at the inlet of the slaughtering process must be installed in order to reduce the organic load.

Keywords:- Slaughterhouse, Wastewater, Characterization, Treatability.

I. INTRODUCTION

➤ History of slaughterhouses

In the beginning of nineteenth century the slaughterhouse became a unique industrial sector. This development in the slaughterhouse industry accompanied by industrial revolution, rural area developments, advanced technology and the awareness of people about public hygiene. In the early eighteenth century animals were slaughtered for human consumption in different places such as backyard and butcher's shed. By this method they would easily escape from direct monitoring. Private slaughterhouses were considered more spacious and clean as they are regulated by state government. The word abattoir is French which refer to any particular place in which the animals were slaughtered for human consumption and the first public slaughterhouse was in France earlier nineteenth century. (Fitzgerald, 2010)¹.

➤ General Information on Slaughterhouses:

The place where animals are being slaughtered are called slaughterhouse or abattoir and both names are used (Cowi, 2001)². These plants in which slaughter animals and dress carcasses only, sometimes by-products are send without processing. The product from slaughterhouse plants are sold to wholesale and then to retails through butchers. (Hailu, 2003)³.

➤ Sources of Wastewater in Slaughterhouses

The word wastewater is referring to water consumed by human beings or industry which has 99% liquid and 1% of dissolved or suspended solids (Hailu, 2003)³. Industrial effluent is produced from different sources and it has a wide range diversity of chemical characteristics (Hailu, 2003)³.

The water consumption in the abattoirs or slaughterhouses depends on the type of animals cows or camels or sheep's etc. and the technical process used in the plants (Hailu, 2003)³. Slaughterhouses effluent is the water consumed at the slaughterhouse, and the main source of waste load is from the slaughtering processes (Carawan et al., 1979)⁵. Slaughterhouse wastewater consists of high level of organic matter because of the presence of manure, blood and fat. It may also contain high levels of slats, phosphates and nitrates. Blood followed by fat is the most significant contributor to the organic load. The effluent contains nitrogen due to the presence of blood. Manure and stomach contents presence in the effluents are the major contributor to the slat and phosphorus. If the plant process contains rendering so, the most significant source of waste load in the slaughterhouse effluents is from rendering process. (Cowi, 2001)².

Blood is the major contributor to organic load in slaughterhouse effluents as said before, It has a BOD of 405,000 mg/L (Carawan et al., 1979)⁵, it has BOD₅ between 150,000 and 200,000 mg/L and COD of 375 000 mg/L (Hailu, 2003)³. The total number of animals slaughtered during a specific period of time is defined as LWK. Cattle contain up to 22.72 kg of blood per animals and if there is no blood recovery facility all this quantity of blood will inter to the wastewater otherwise 15.9 kg of the blood is recovered and the remaining 6.8 kg of blood will be mixed with the wastewater which represent a waste load of 2.25 to 3.0 kg BOD/1000 kg LWK (USEPA, 2002C)⁶

The other source of waste water generating in the slaughterhouse is Beef paunch or rumen contents. It contains undigested food materials which has BOD₅mof

50,000 m/l. The most common practises are to either screening the rumen contents or to dump on a screen to recover the solids. If the rumen contents processed or transported out and send to land fill it will not contribute to the waste load (Carawan et al., 1979)⁵.

Scalding is also a source of wastewater since it requires a large amount of water. (USEPA, 2002a)⁷.

II. STATEMENT PROBLEM

Water is very essential for human consumption, animals, agriculture and industrial uses. Water forms about 75% of the matter of the earth's crust. Sudan is an underdeveloped country located in the Sahara desert because of the political instability most of population lived a poor life. From 1970s Sudan local government introduced Laws and regulations to manage the disposal of sewage and industrial wastewaters. Industry owners focused mainly on increasing the production rate and paid little attention to treat or dispose of the waste generated. They fear to spend money on the treatment of their effluent before discharging to the water bodies or sewer line. The State government has laws and legislation that have to be implemented in a proper way. Slaughterhouse wastewater is a type of industrial waste classified under agriculture and food industries. Slaughterhouse wastewater is considered as very harmful to public health and environment. Referring the previous studies on slaughterhouse wastewater revealed that they contained high quantity of Ammonia nitrogen which is very toxic to the aquatic life and also it contains phosphorus which causes problems that contribute to algae bloom and Lake Eutrophication. On the other hand if the effluent kept untreated in the slaughterhouse it may

contribute to meat contamination and develop a chance of hydrogen sulphide presence which will create unsafe work place. Considering all these facts we decided to study the characterization of slaughterhouse wastewater in order to propose an efficient process to treat harmful effluent.

III. AIM OF THE STUDY

The aim of this paper is to study the physio-chemical and biological characteristics of the slaughterhouse effluents in local slaughterhouse called Al Sahafa slaughterhouse. In this study we shall determine these parameters of the slaughterhouse wastewater samples: pH, TDS, Temperature, TSS, BOD₅, COD, NH₃, Total Phosphorus, TKN, Total coliform

IV. METHODOLOGY

Between August 2019 and September 2019, a composite sample was collected from Al Sahafa slaughterhouse. , The composite samples were collected two litres every hour for five hours to make them more representative. Following the standards methods of sampling all samples were collected in the morning or early afternoon. Then As per the methodology all tests carried out as below pH and temperature using Hanna HI99163, TDS measured with Hanna HI98302. Other tests such as TSS, Oil & Grease, COD, BOD₅, NH₃, Total phosphorus, TKN and Total coliform were carried out using the below standard methods ASTM D 5907-96, 5520 Oil and Grease Approved by SM Committee 2001, ASTM D 1252 Chemical Oxygen Demand-COD/2000 Photometer Method, ASTM D6238, ASTM D1426, ASTM D4047, ASTM D8083 and ASTM STP63S respectively.

V. RESULTS & DISCUSSIONS

Sr. No.	Slaughterhouse wastewater	Results	Khartoum State Law 2008	Local Order 1970	Acceptability
1	pH	6.7	6-9	5.5 – 10	Yes
2	TDS	990	-	-	No
3	Temperature	32.2	43	-	Yes
4	TSS	1431	500	-	No
5	TCOD	72000	700	-	No
6	BOD ₅	48000	400	800	No
7	NH ₃	739.2	100	-	No
8	Total phosphorous	14.65	5	-	No
9	TKN	161	-	-	No
10	O & G	1512	100	15	No
11	Total coliform count	Uncountable	-	-	No

Table 1:- Shows the slaughterhouse wastewater characterization compared with Khartoum state law 2008 and Local order 1970.

A. Discussions:

The results of the above samples are discussed on the below:

Samples taken between 15th of August 2019 and 15th September 2019. Samples were taken from the specified sampling points agreed upon. The analyses for the samples were carried according to the American standard Test Methods (ASTM).

B. Findings from the above results:

- Table 1 show the result of slaughterhouse wastewater characteristics which raised the alarm of high contaminated wastewater is being generated from the slaughterhouse.
- In terms of COD slaughterhouse wastewater results in table 1 shows blood capturing is not functioning. Blood is the major contributor to waste load which has a chemical oxygen demand (COD) of 375,000 mg/l (Tritt and Schuchardt 1992)⁹.
- Table 1 shows the analyzed slaughterhouse wastewater generated at the study area is very harmful to the environment. It should be treated before being disposed of or reuse to avoid further pollution issues such as oxygen depletion in the water bodies and ground water contamination
- pH shows the hydrogen ion concentration and it indicates the acidity or alkalinity of the wastewater. Ph is very important parameter because it effects the chemical and biological reactions. Ph also effects chlorine disinfection so it should be controlled during the treatment as well. The reported pH values of the slaughterhouse wastewater samples of Al Sahafa slaughterhouse are shows in tables (1), and are within the range to carry on the chemical and biological reactions.
- Table 1 shows the total suspended solids (TSS) is very high which contribute in increasing the organic load.
- Ammonia nitrogen is very high which made the wastewater very toxic to aquatic life if disposed untreated.
- Total phosphorus exceeding the limit which causes problems that contribute to algae bloom and Lake Eutrophication.
- The TDS content of the sample is ranged from 100 mg/l to 1000 mg/l with an average of 500 mg/l. These values are saved to be discharged to the water bodies.
- The measured TCOD and TSS results values derived under strong wastewater classification (Metcalf and Eddy, 2003)¹⁰.
- Further studies to be carried out for impact of Rain water on the quality of slaughterhouse wastewater.

VI. CONCLUSION & RECOMMENDATIONS

The study concluded that the Al Sahafa slaughterhouse wastewater effluents are biologically treatable. The COD values are very high because we found that the blood capturing system is out of order therefore, to make the treatment more efficient and cost effective they should separate the blood from the wastewater line. The

TSS values will contribute in increasing the TCOD hence; we recommended installing a mechanical screen to reduce the overall operation cost. We recommended using high pressure hose to clean the floor in order to reduce the quantity of wastewater. The treatment and reuse of Al Sahafa slaughterhouse wastewater for agriculture purposes are possible.

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