Presence of Heavy Metals in Slaughterhouse Wastewater, A Study at Al Sahafa Abattoir Khartoum, North Sudan

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Abstract:- Heavy metals have been classified under environmental pollutant category because of their toxic effects on both environment and public health. Consumption of plants which irrigated by untreated wastewater or contaminated soils will have effects on animals and human health on the long term. The animals which were going to be slaughtered should consume unpolluted plant and water. The negative environmental impacts of heavy metals on water, air and soil make the significance of this study. This research paper aimed to determine the presence of heavy metals in Al SahafaAbattoir effluents and evaluation of the performance of existing aerobic plant on the removal of the above mentioned dissolved metals. Three composite samples were collected from different sources Drinking water which being utilized for the hole process, Process inlet and Process outlet. All samples were collected, preserved and prepared following APHA Standard methods. The studied parameters were pH and temperature using Hanna HI99163, TDS measured with Hanna HI98302, TSS Method APHA 2540-D, Turbidity using Method APHA 2130 and BOD_5 using Method APHA 5210-B. Total coliform count test carried out using Standard method SM 9222D.Other tests for dissolved metals such as Ni, Fe, Cd, pb, Zn and Cu were carried out using the below standard methods APHA 3111 Flame atomic absorption spectrometry.Results from the work carried out reflected that there were no presences of heavy metals in the drinking water. Process inlet found with high iron 12.1ppm and that may be due to blood was not segregated from slaughtering process wastewater.Iron was removed efficiently with the existing process treatment however; the treated effluent did not meet the discharge limits of bothKhartoum state 2008 and Local order 1970 and hence it cannot be discharge as such to river, surface water or public sewer.TDS, pH, temperature and dissolved heavy metals meet the discharge limits while TSS, Turbidity and BOD5 were not. The existing treatment process plant needs some modification to enhance the BOD removal efficiency. The treated effluents generated from Al Sahafa slaughterhouse meet the discharge limits in terms of heavy metals removal while it needs process modification to meet the discharge limits in terms of BOD removal.Further studies to be carried out in order to propose a cost effective treatment unit of AL Sahafaslaughterhouse wastewater.

Keywords:- Abattoirs, Treatment, Heavy Metals.

I. INTRODUCTION

Sudan is one of the third world nations where aplenty of fresh water is readily available to most of the population. The treasure which Sudan has is the fresh water resources but unfortunately they misused it and the contamination level increasing dramatically. In the earlier 1970s environmental protection law and the standards which regulate the discharge of domestic wastewater and industrial effluents have been made. Implementation of these regulations was the great challenges to the local state government as result many studies have been carried out which revealed that most of the industrial effluents were discharge directly to the great river Nile without proper treatment.

Al-Sahafa modern slaughterhouse inaugurated in June 2012, it has been designed by a Turkish expertize with production capacity of the day 200 head of cattle and 300 head and sheep respectively. The designed capacity of the slaughterhouse will meet the demand of the local market and contribute on the total export (HalaAbdalwahabAbdulraheem; Jan 2015)[1].

The effluent generated from this slaughterhouse is about $10m^3$/day which being processed through a series of aeration tanks prior to discharge in the public sewer or main canal which end at White Nile River. The existing treatment plant consist of inlet mechanical screen followed by three process tanks aerated mechanically by Air Blower and the air distributed in the tanks using air diffusers. Each process tank designed with holding capacity of 60m3 and the blowers will run for three hours daily in order to remove the offensive odour. In this study we shall evaluate the treatment process in terms of BOD_5 removal.

The activities which have been carried out at the Abattoirs may be another source of pollution these activities have been reported to impact negatively on the soil, water and air (Adesemoye AO 2006)[2]. Slaughterhouse wastewater has been reported to be very harmful to the environment. The animals which ingest polluted plants and drink from contaminated waters with heavy metals when they are killed these metals are release in the soil and cause soil pollution (Ojekunle OZ* and Lateef ST 2017)[3].

Recently, the concerns have been upraised about the environmental pollution with heavy metals. Industrial wastes which contains heavy metals when discharge to the environment it presents a potential hazard to the aquatic life (Tang W;2014)[4].

Heavy metals are classified under environmental pollutant category because of their toxic effects on the ecosystem. As a result of anthropogenic (human activities)and natural activities the soil got contaminated with heavy metals (Raja Rajeswari, * Namburu sailaja;2014)[5].

➢ *Environmental Impact of heavy metals:*

Heavy metals have been classified under environmental pollutant category because of their toxic effects on both environment and public health. Consumption of plants which irrigated by untreated wastewater or contaminated soils will have effects on human health on the long term. Sudan is one of the third world nations in where industrial effluents are discharged untreated to waterbodies. Industrial effluents especially from slaughterhouse may consist of heavy metals which are toxic in nature. Some of heavy metals are essential nutrients such as iron and zinc and can be toxic in large amounts. Lead and Cadmium are heavy metals which do not have any beneficial use for plants or animals and known to be extremely toxic. Lead has effects on the central nervous system, anaemia and may cause kidney damage. Cadmium and cadmium compounds are water soluble compared to others heavy metals. It can be easily mobile in the soil and accumulated. Copper is a trace of elements which is very essential for human health but it can cause health problems if consumed in very large quantity. Humans are consuming copper in many forms such food, drinking water and atmosphere. Nickle has effects on human and environment when it is in high quantity and it can be available in different sources such as industrial wastewater. As of now slaughterhouse wastewater in Sudan discharged untreated on the most of the abattoirs while some of them have pre-treatment of the effluent prior to being discharged to the waterbodies.The disposal of untreated effluents can contaminate the aquatic life especially fishes which will be consumed by human. A discharging of untreated slaughterhouse effluent to water surface and waterbodies contaminate the soil and drinking water sources and directly affects the human health and the environment.Considering all the above mentioned impacts of heavy metals on human health and environment make this study more significance.

➢ *Aim of the study (Area):*

In this paper we shall determine the presence of heavy metals in the slaughterhouse wastewater which is located at Khartoum North Sudan. The parameters which are to be studied in this paper are pH, Temperature, TDS, TSS, Turbidityand dissolved metals such as Ni, Fe, Cd, pb, Zn and Cu. Fresh water used in the slaughterhouse process shall be analysed for its dissolved heavy metals characteristics and Total coliform count using standard method SM 9222D. Moreover we shall evaluate the performance of existing aerobic plant on the removal of the above mentioned dissolved metals.

II. METHODOLOGY

Three sets of composite samples were collected from three different sources. Fresh water (drinking water)sample collected from main supply tank while other two samples from inlet and outlet of the existing aerobic treatment process plant. All samples were collected in plastic containers which have been rinsed with 50ml deionized water to avoid contamination. Sampling and samples preservation performed as per Method APHA 3010 B.Then As per the methodology all tests carried out as below pH and temperature using Hanna HI99163, TDS measured with Hanna HI98302, TSS Method APHA 2540-D and Turbidity using Method APHA 2130. Other tests for dissolved metals such as Ni, Fe, Cd, pb, Zn and Cu were carried out using the below standard methods APHA 3111 Flame atomic absorption spectrometry.Total coliform count test carried out using Standard method SM 9222D. Prior topreserve samples using 1.5ml/ L nitric acid maintaining pH <2all samples filtered with 0.45um membrane filter.

III.   RESULTS

Sr.No.	Drinking water supplied to the slaughterhouse	Results	WHO Standard Maximum allowable	Acceptability
1	pH	7.2	7.0 to 9.2	Yes
2	TDS	650	100 to 1000	Yes
3	Temperature	32.5	-	
4	TSS	18	-	NO
5	Turbidity	12	4	NO
6	Nickel	ND	0.07	Yes
7	Iron	ND	0.2	Yes
8	Cadmium	ND	0.003	Yes
9	Lead	ND	0.01	Yes
10	Zinc	ND	5	Yes
11	Copper	ND	2	Yes
12	Chromium Hexavalent	ND	0.05	Yes
13	Total coliform count	23	0	NO

*All units are mg/l except pH, turbidity unit FTU and Total coliforms in MPN/100ml

Table 1:- Drinking water characteristics.

Sr.No.	Process Inlet	Results	Khartoum State Law 2008 Disposal Limits			Acceptability
			Public Sewer	Water Surfaces	River Nile	
1	pH	6.9	6-9	6-9	6-9	Yes
2	TDS	750	-	800	1200	Yes
3	Temperature	28	43	35	35	Yes
4	TSS	3160	500	30	30	NO
5	Turbidity	2800	30	2	20	NO
6	BOD5	10320	400	20	30	NO
7	Nickel	ND	0.1	0.1	0.1	Yes
8	Iron	12.1	-	1	1	NO
9	Cadmium	ND	0.2	0.01	0.01	Yes
10	Lead	ND	0.1	0.05	0.05	Yes
11	Zinc	0.01	-	1	1	Yes
12	Copper	0.07	1.5	1	1	Yes

*All units are mg/l except pH and turbidity unit FTU

Table 2:- Process inlet wastewater characteristics

Sr.No.	Process Outlet	Results	Khartoum State Law 2008 Disposal Limits			Local Order 1970	Acceptability
			Public Sewer	Water Surfaces	River Nile	Public Sewer	
1	pH	7.5	6-9	6-9	6-9	5.5 - 10	Yes
2	TDS	800	-	800	1200	-	Yes
3	Temperature	28	43	35	35	-	Yes
4	TSS	580	500	30	30	-	NO
5	Turbidity	1000	30	2	20	-	NO
6	BOD5	9930	400	20	30	800	NO
7	Nickel	ND	0.1	0.1	0.1	2	Yes
8	Iron	0.92	-	1	1	5	Yes
9	Cadmium	ND	0.2	0.01	0.01	-	Yes
10	Lead	ND	0.1	0.05	0.05	-	Yes
11	Zinc	ND	-	1	1	0.3	Yes
12	Copper	0.03	1.5	1	1	0.2	Yes

*All units are mg/l except pHand turbidity unit FTU

Table 3:- Process Outlet wastewater characteristics

IV. DISCUSSION

All samples were collected, preserved, prepared and analysed using the standard methods for the examination of water and wastewater 23rd edition, American Public Health Association (APHA). Results finding and discussion are as below:

➢ Table 1, **Drinking water characteristics**, shows the quality of fresh water supplied to the slaughterhouse which is being used for drinking, hands washing, floor cleaning and all other activities in the plant. The fresh water quality as the results shown in table 1 need immediate actions it has to meet the WHO standard on total coliform and turbidity. Total coliforms are not likely to cause disease but its presence indicated that the water supply exposed to contamination by harmful microorganisms.On the other hand, turbidity is exceeding the WHO standard and it has no direct risk to the public health but it can indicate the presence of other pathogen microorganism.

➢ Heavy metals in the drinking water meet the WHO standard and it indicates that drinking water has not contributed to slaughterhouse wastewater heavy metals contamination.

➢ In table 2, Process inlet wastewater characteristics, shows process inlet found with high iron 12.1ppm and that may be due to blood was not segregated from slaughtering process wastewater. Iron was removed efficiently with the existing process treatment however; the treated effluent did not meet the discharge limits of both Khartoum state 2008 and Local order 1970 and hence it cannot be discharge as such to river, surface water or public sewer.

➢ TDS, pH, temperature and dissolved heavy metals meet the discharge limits while TSS, Turbidity and BOD5 were not.

➢ In table 3 Process Outlet wastewater characteristics, the existing treatment process plant needs some modification to enhance the BOD removal efficiency.

➢ The treated effluents generated from Al Sahafa slaughterhouse meet the discharge limits in terms of heavy metals removal while it needs process modification to meet the discharge limits in terms of BOD removal.

V. CONCLUSIONS AND RECOMMENDATIONS

Fresh water supplied to the slaughterhouse should be disinfected before being used to avoid the pathogenic contamination and the turbidity shall be less than 5NTU. Fresh water is being used for animals drinking and slaughtered animals cleaning hence shall be treated and disinfected prior to uses. The treated effluents generated from Al Sahafa slaughterhouse meet the discharge limits in terms of heavy metals removal while it needs process modification to meet the discharge limits in terms of BOD removal. We recommended to use a proper mechanical screen, chemical coagulation flocculation process, increase the blower operation time to provide a sufficient air flow to the aerobic reactors, automatic skimmer to be provided or any approved method to remove the secondary sludge and finally a proper sludge dewatering system to be provided which will decrease the organic load. Further studies to be carried out in order to propose a cost effective treatment unit of slaughterhouse wastewater.

REFERENCES

[1]. HalaAbdalwahabAbdulraheem; Jan 2015; Treatment of Wastewater in Alsahafa Slaughterhouse in Khartoum State; M.Sc. thesis University of Khartoum, Sudan

[2]. Adesemoye AO, Opere BO, Makinde SCO (2006) Microbial Content of abattoir waste water and its contaminated soil in Lagos, Nigeria. Afr J Biotechnolgy 5: 1963-1968.

[3]. Ojekunle OZ* and Lateef ST 2017; Environmental Impact of Abattoir Waste Discharge on the Quality of Surface Water and Ground Water in Abeokuta. J Environ Anal Toxicol 2017, 7:5

[4]. Tang W-W, Zeng G-M, Gong J-L, Liang J, Xu P, Zhang C, et al. Impact of humic/fulvic acid on the removal of heavy metals from aqueous solutions using nanomaterials: a review. Sci Total Environ. 2014; 468:1014–27. doi: 10.1016/j.scitotenv.2013.09.044 PMID: 24095965

[5]. Raja Rajeswari, * Namburusailaja; 2014; IMPACT OF HEAVY METALS ON ENVIRONMENTAL POLLUTION,;ISSN: 0974-2115

[6]. Rodger; B.Biard; Andrrew D. Eaton; Eugene. W. Rice "Standard method for the examination of water and wastewater."23rd edition, American Public Health Association (APHA).