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Slaughterhouse in Uttar Pradesh with Hygienic Environment - A Case Study

***Jiban Singh, M., Biswas, M. K., Anamika Sagar, Suneel Dave and Akolkar, A. B.**
Central Pollution Control Board,
Parivesh Bhawan, East Arjun Nagar, Delhi, India.
***Corresponding author: mjscholar@gmail.com**

ABSTRACT
In Uttar Pradesh there are 56 authorized slaughterhouses located both in and around the city. Most of them have poor hygienic standards, despite the meat processing industry being worth billions of rupees in India. Poor hygienic, in turn, poses huge public health and environmental change due to indiscriminate waste disposal and highly polluted effluent discharge. Unit-1 (Slaughterhouse) is one of the large scale legal complex with very high hygiene standard of public health and environmental hazards due to recycling of effluent and manufacturing the nutrition and protein supplement in the formulation of feed for fish and poultry within the premises from solid waste. Effluent Treatment Plant of capacity 642.5 KLD is installed and the final treated effluent is utilized in the 27.41 acres area of land for horticulture and other washing purposes. It is a partially zero liquid discharge unit. Ratios of BOD/COD raw effluent is > 5 mg/l and indicated that the proportion of the biodegradable contents is higher than the non-biodegradable contents and TSS content in treated effluents is 16 mg/l, indicated that is cannot lead to the development of sludge deposits. Fluoride, Nitrate and Sulphate concentration in groundwater is 0.56, 7.2 and 67 mg/l respectively and values are found much below the desirable limit as per BIS. A comparison between concentration of trace elements in groundwater sample shows the abundance of Fe >Zn >Mn >Pb >Cu >Cr >Ni >Cd >Se >Al >Hg >Cn, indicating lithogenic origin of Fe in groundwater not from the wastewater and absent Coliform counts is observed in the groundwater suggesting well-established of pit latrine, septic tank, soakage pit system, ETP maintenance and drainage system exists.
Keyword: ETP, Groundwater, Horticulture, Model, Nutrient, Recycle and Waste.

INTRODUCTION

One of the most industrial sectors that produce large quantities of wastewater is the slaughterhouse sector which often contains high concentration of biodegradable organic matter (Al-Mutairi *et al.*, 2003). As has been reported by Al–Mutairi *et al.*, 2004; Al–Mutairi *et al.*, 2003; Quinn and Farlane, 1989; Sangodoyin and Agbawhe, 1992, slaughterhouse wastewater is very harmful to the environment. Unscientific waste disposal leads to soil, air and water pollution as well as leading to health concerns among residents in the vicinity. Effluent discharges from slaughterhouses can result in the depletion of oxygen from water bodies and the contamination of groundwater. However, Water is extremely essential for socio economic development (Al-Kloub *et al.*, 1998). The proper treatment and reuse of treated wastewater constitutes a viable alternative in many cases; as wastewater generation rates can be as high as 80% of the total water consumption (Metcalf and Eddy, 2003).

A slaughterhouse is a facility, where animals are butchered for consumption as food products. In India there are approximately 3600 authorized slaughterhouses located both inside and in the city outskirts. Among them 56 units are located in Uttar Pradesh State only. All the major Indian cities have central slaughterhouses mostly dating back to the British period (>70 years old) (Lakshmi *et al.*, 2014). And the process of treatment, management and disposal or recycling of organic solid and liquid wastes generated from slaughterhouses are threatening works because of the huge volume in which these wastes are generated every day in solid and liquid forms (Bergleiter, 2011).

However, Unit-1 is one of the legal complex slaughterhouse located in the city of Meerut, Uttar Pradesh with size of Large Scale Red Meat (LSRM) and it was established in the year of 1970 with a surface area (premises) of 27.41 acres (Figs. 1).

Further, complex has been operating in integrated incorporating live-stock quarantine facilities, mechanized abattoirs, chilling, deboning, packing, freezing and cold storage facilities at strategic locations, and also own a fleet refrigerated and insulated trucks for movement of the finished products from the manufacturing complex to the 1250 MT. Central cold storage facilities and subsequently to the ports. The export of meat by complex cover lots of countries in South East Asia, Middle East, Africa and the Pacific Basin Nations. The range of products processed include frozen boneless compensated Buffalo meat which includes the hindquarter cuts such as Topside, Silverside. Thick flank, Rump steak, Tenderloin, Stripling and Fore quarter meat comprising of Blade, Cube Roll, Chuck Tender, Brisket PE Brisket NE and shanks. All the boneless meat products prepared in this composition are guaranteed 95% chemical lean. Each carton and the rest of the packing materials bear the respective product code nos. for easy identification. The polyline cartons are ply-shrink wrapped. The full range of offals (fany meats) are sanitary packed and individually quickly frozen at -40°C.

Figure 1: Unit-1 premises as study area.

The tripe's are processed on latest models of La-Parmantiere, French origin machines and it is also possible to supply bleached and scalded tripe's. Tendons and Spinal cords are also hygienically collected and quick frozen at -40°C. All frozen meat products & offals are compulsorily examined by the competent official designated Government agency which issues international Sanitary and Health Certificate confirming suitability of product for human consumption. These certificates issued after microbiological analysis also confirm the aspect of the meat being derived from healthy, disease free livestock subjected to Ante & Post Mortem examinations.

METHODOLOGY

Study Area

Unit-1, complex is located at 11 Km, milestone, Alipur Jijmana, Hapur road, Meerut, Uttar Pradesh, India in national capital region, and 65 Km from the capital city Delhi (Fig.1). It has been designed and built to meet most stringent Equipment Engineering Capabilities (EEC) and U S Food and Drug Administration (US FDA) standards.

This complex is very well recognized amongst the pioneers in frozen meat exporters, exporting its products to destinations worldwide when it was established in 1970 with a vision to be a leader in processed meat production and to focus on export market.

Sampling

In this context, Central Pollution Control Board (CPCB), Delhi and Uttar Pradesh Pollution Control Board (UPPCB), Meerut formed a joint team of their officials to conduct investigation. The questionnaire included information such as name and address of the unit, occupier, status of the unit, products, capacity of animal slaughtering, species of animals slaughtered, Fresh water consumption, availability of flow measuring devices, sewage generation, solid waste generation, Effluent Treatment Plant (ETP) details and mode of effluent final disposal etc.

One liter sterile bottle was attached to the end of a nabber pole and dipped into the wastewater at the desired level and 4 waste water samples were taken from inlet (holding tank), equalization tank, aeration tank, outlet (primary clarifier) and one bore well sample which is used as fresh water sources in the complex. After the collection the samples were properly labeled and sealed then transported to laboratory at 10°C to prevent any contamination with pre acid.

Further, all required parameters for Effluent (pH, TSS, TDS, COD, BOD) and for Bore well (Color, Odor, Turbidity, Alkalinity, pH, Ca, TH, TDS, Cl, F, SO_4, NO_3, Fe, Zn, Mn, Pb, Cu, Cr, Ni, Cd, Se, Al, Hg, As, Cn, & Coliform) were analyzed at CPCB, Ghaziabad Testing Analytical Services and Kamal Einviro & Food Pvt. Ltd. Laboratories.

RESULT AND DISCUSSION

With respect to number of animals slaughtered (> 200 large animals/day) and available of multi manufacturing units, Unit-1 is classified as a Multi large scale unit. This complex is 20 years old with adequate basic amenities viz. proper flooring, ventilation, water supply, lairage, transport and solid and liquid waste management etc. (Figs. 3, 4A, 4B, 4C & 4D).

Complex has been managing by the team of highly motivated and skilful 500 professionals, who take excellent care in all aspects from selection of livestock to maintenance of mechanical hide puller flays and skins hides, veterinarians conducts post-mortem examination of offal and carcasses, carcasses chilling room, deboning of sides and trimming of cuts in air-conditioned deboning halls maintained, automatic corned buffaloes can filling machine, automatic corned buffaloes can vacuum seamer, loading of corned buffaloes cans for sterilization in retorts, vacuum packing of boneless ground meat. Also, Effluent Treatment Plant (ETP), recycling of waste, hygienic environment, product quality and prompt delivery of products as well as customer satisfaction have excellent dedicated persons. After mandatory inspection, performed by the competent managing team average 450 Buffalos/day were slaughtered under the consent of Uttar Pradesh Pollution Control Board, Meerut (UPPCB) and Agricultural and Processed Food Products Export Development Authority, India (APEDA).

Further, fresh water consumption, waste water generation, details of ETP, mode of effluent disposal and hygienic environment management and solid waste management are the major objectives in this case study. Complex have installed bore well with flow meters for fresh water requirement and 300 KLD fresh water consumption record has been maintained on daily basis in the log book. As per the consent of the UPPCB, the industry has installed magnetic flow meters at both inlet and outlet of ETP to record the raw effluent generated from complex and treated effluent discharged from the ETP respectively. Effluent Treatment Plant of capacity 642.5 KLD is installed to treat the effluent generated quantity of 240 KLD with the process consists of Holding Tank (inlet), Gravity Separator, 2-Equalization Tanks, and Ariation

Tank with Sludge tank, Primary and Secondary Settler Tanks and Carbon filter Tank (outlet) (Figs. 3, 4A, 4B, 4C & 4D). The final treated effluent is utilized in the 27.41 acres area of land for horticulture and other washing purposes (Fig. 5D). This complex has planted more than 10, 000 numbers of Eucalyptus trees in the premises.

In addition, zero waste (solid and liquid) management in this complex is the distinctive philosophical concept that vary from different aspects. Generally, zero waste management is the technique by which all the discarded materials are used for productive purposes through material conversion or directly use of it (Giampietro and Ulgiati, 2005). It needs to be noted that almost all the wastes generated by a slaughterhouse can be processed to obtain various products which have commercial value (Annual Report, 2001). On the contrary, the potential pollutants from those wastes, if not properly managed the major pollution problems associated with these wastes are surface and groundwater contamination and surface air pollution caused by odors, dust, ammonia, and H_2S (CPCB, 1992).

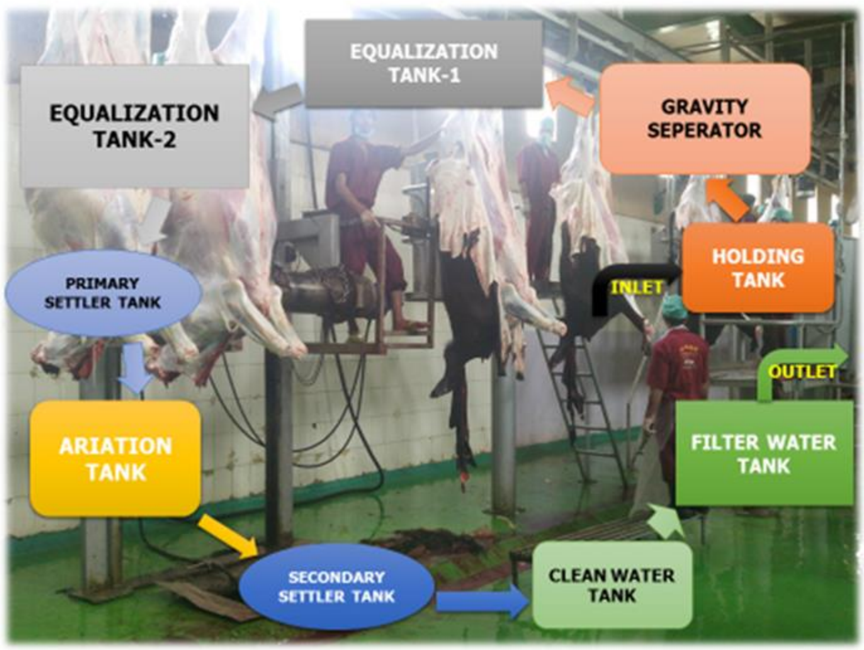

Figure 3: Flow chat of ETP.

According to Lakshmi Singh *et al.*, 2014, estimate a Buffalo weighs about 2 quintals and almost 25% of the total body weight becomes waste. Hence, 4.5 m^3 of pure blood, 240 KLD effluent and various 225 quintals of solid waste (carcass, bones, hooves, rumen, intestine contents, dung etc.) were generated per day from slaughtering of 450 Buffaloes/day. Collected all pure blood and solid waste as commercial wastes to manufacture the nutrition and protein supplement in the formulation of feed for fish and poultry within the premises except skin and dung (Figs. 5A, 5B, 5C & 5D). But all skin have transported to Tannery Industries for further products. This idea of recycling these wastes through agriculture and animal husbandry is gaining importance because of multiple benefits like reduction of environmental pollution arising out of disposal of the wastes, prevention of loss of huge nutrients contained in these wastes and curtailing in production cost in agriculture and animal husbandry (De Silva and Anderson, 2009; Zhu *et al.*, 2011 and Jayathilakan *et al.*, 2012, Ribeiro *et al.*, 2011; Aladetohun and Sogbesan, 2013, Kader *et al.*, 2012).

Accordingly, slaughterhouse wastewater has been classified as industrial waste in the category of agricultural and food industries. Wastewaters from slaughterhouses and meat processing industries have been classified by Environmental Protection Agency (EPA) as one of the most harmful to the environment and also to health of the people living in surrounding area (Walter *et al.*, 1974). For the treatment of this type of wastes, conventional biological processes do not offer the solution to satisfy environmental requirements. As an alternative to more efficient treatment process for treating highly loaded effluents, the anaerobic process is particularly designed to effluents discharged at high concentrations of COD and other biodegradable components (Spece, 1999). Discharging slaughterhouse wastewater without treatment contribute to greatly degrading the aquatic environment and pollution of irrigation water (Michael *et al.*, 1988).

Figure 4: A. Primary clearance tank; B. Ariation tank; C. Sludge activate tank and D. Secondary clearance/ policing tank and Carbon filter.

Further, Khaled Zaher Abdallaa & Gina Hammamb, 2014 and Sangodoyin & Agbawhe, 1989, if BOD/COD ratio is > 0.6mg/l then the waste is fairly biodegradable, and can be effectively treated biologically. If ratio is between 0.3 and 0.6 mg/l, then seeding is required to treat it biologically, because the process will be relatively slow, as the acclimatization of the microorganisms that help in the degradation process takes time. However, in this study ratios of BOD/COD inlet and equalization tanks is > 5 mg/l and indicated that the proportion of the biodegradable contents is higher than the non-biodegradable contents as well as BOD final discharge of 16 mg/l does meet the standards (30 mg/l as per BIS: 3025) through biological treatment. In addition to the organic content, the pH is of concern when chemical properties of wastewater are being investigated. Low pH value may inhibit the growth of microorganisms and pH values of inlet (raw effluent) and outlet (treated effluent) of ETP installed in this complex is 7.1 and 8.0 respectively have within the range (5.5-9.0 as per BIS: 3025 & 6.5-8.5 as per BIS: 10500) favored by the bacteria (Tchobanoglous *et al.*, 2003 and Mittal, 2003 & 2004).
Total Dissolve Solid (TDS) content in treated wastewater and bore well sample are 1704 (2100 mg/l as per BIS: 3025) and 352 mg/l, (500 mg/l as per BIS: 10500) found below the standards respectively, while the TDS of the raw effluent is 4432 mg/l. It can also be observed that TSS content in treated wastewater recorded 16 mg/l and in the raw sample is 616 mg/l. Hence, TSS concentration cannot lead to the development of sludge deposits when treated wastewater is utilizing in horticulture and washing purpose.

Figure 5: A. Solid waste management; B. Tallow manufacturing unit; C. Nutrition manufacturing unit & product and D. utilization of treated effluent into horticulture.

Further, Chloride concentration in the bore well sample is found 45.03 mg/l. This very low concentration in the present case can definitely be attributed to the non-industrial activities in the vicinity (Jiban Singh and Somashekar, 2015b). Nitrogen compounds are present in groundwater in the form of nitrate (NO_3^-) and nitrite (NO_2^-) ions. Nitrates are extremely soluble in water and can move easily through soil into the groundwater. The fertilizers and domestic wastes are the main sources of nitrogen-containing compounds and its concentration may be further affected by complex hydro-chemical processes such as nitrification or denitrification (Arnade, 1999; Graniel *et al.*, 1999 and Rosen *et al.,* 1999). Fluorides are common in ground and surface waters. The main source of Fluoride in water is Fluoride bearing rocks. The maximum permissible limit for Fluoride, Nitrate and Sulphate in drinking water is 1, 45 and 200 mg/l respectively (BIS: 10500). The concentrations of Fluoride in groundwater vary considerably over short distance. In this study, Fluoride, Nitrate and Sulphate concentration are 0.56, 7.2 and 67 mg/l respectively and values are found below the desirable limit. Wastewater reused in agricultural activities and washing purpose are also not contributing amounts of fluoride to the groundwater regime in complex (Jiban Singh and Somashekar, 2015b). Hence, septic tanks, garbage dump disposals and effluent are also not responsible for the low concentration of NO_3^- (Gumtang *et al.*, 1999; Basappa Reddy, 2003 and Owens, 2003) in this complex.

The aquatic environment is frequently the ultimate recipient of heavy metal pollution (Obasohan *et al.*, 2006). Manganese, copper, zinc, lead, etc. also occur as trace metals in groundwater.

In the present investigation, Mn and Cu content of groundwater is <0.1 and < 0.05 mg/l respectively with below the BIS requirement limit of 0.1 mg/l for Mn and 0.05 mg/l for Cu (Fig.14). Manganese tends to be adsorbed on to the clay, organic matter, freshly precipitated hydrated iron oxides, aluminates, silicates and calcite (Mehrotra and Mehrotra, 2000).

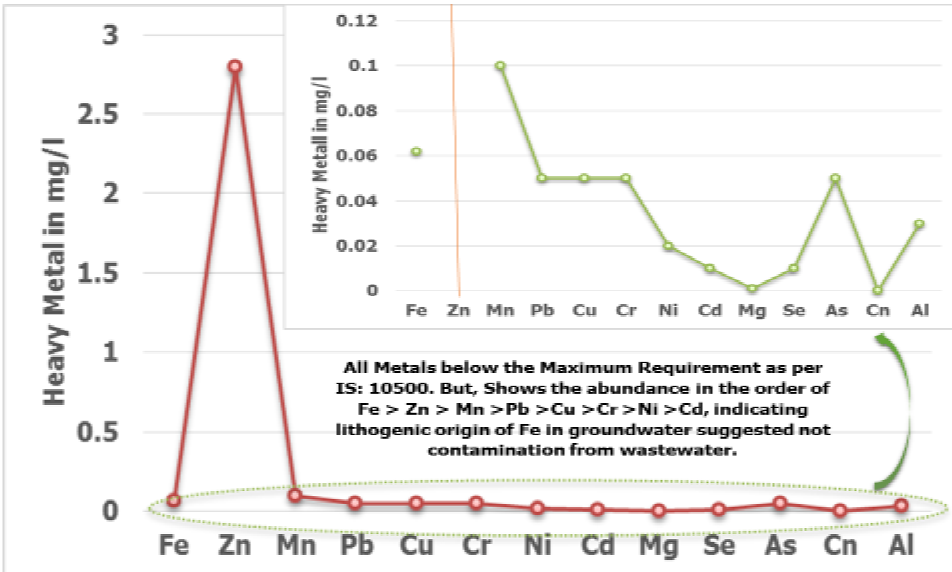

Figure 6: Heavy Metals concentration in the treated effluent.

The concentration of Zinc in groundwater of the complex is 2.8 mg/l (Fig. 6) indicated the agricultural activity (fertilizers, micronutrient fertilizer and reuse of wastewater) is not source for low concentration of zinc in the groundwater of the study area. Lead in the groundwater samples was found to be much lower than the other elements except Fe (Fig. 6). A comparison between concentration of trace elements in groundwater sample shows the abundance in the order of Fe (0.062), Zn (2.8), Mn (<0.1), Pb (<0.05), Cu (<0.05), Cr (<0.05), Ni (<0.02), Cd (<0.01), Se (<0.01), Al (<0.03), Hg (<0.001), As (<0.05), Cn (Nil), indicating lithogenic origin of Fe in groundwater (Fig. 6).

The concentration of Cadmium, Selenium, Aluminum, Mercury, Arsenic and Cyanide are < 0.01, < 0.01, < 0.03, < 0.001, <0.05 and Nil mg/l respectively and the concentrations of several heavy metals have not changed in the past few years with constant in Pb and Fe, suggesting the contamination not from wastewater (Fig. 6). The lowest amount of Chromium and Nickel is < 0.05 and <0.02 mg/l (Fig. 6). The reason for lower values of these parameters may be ascribed to the not disposal of wastewater activities (Lokhande and Keikar, 1998). Then, these values are below maximum limit confirmed it not be due to wastewater discharge into the groundwater from the variety of sources and lower concentration of Chromium and Nickel in drinking water has no adverse effect.

Coliforms are normal inhabitants of digestive tracts of animals, including human and are found in their wastes, besides soil material (Subba Rao, 2004). They are also considered as indicator organisms of water pollution caused by fecal contamination which is a serious problem due to the potential for contracting diseases from pathogens. As per WHO and BIS guidelines Coliforms count should be absent in water used for drinking purpose. Absent Coliform counts is observed in the bore well sample of Unit-1 premises where well-established of ETP.

CONCLUSION

Unit-1 is one of the large scale legal complex and capturing a daily average of 4.5 m^3 of pure blood and 225 quintal of solid waste, which is generally manufacturing the nutrition and protein supplement in the formulation of feed for fish and poultry within the premises.

Effluent Treatment Plant of capacity 642.5 KLD is installed to treat the effluent generated quantity of 240 m^3/day and final treated effluent is utilized in the 27.41 acres area of land for horticulture with planted more than 10, 000 numbers of Eucalyptus trees in the premises and other washing purposes.

BOD/COD ratio of raw effluent is > 5 mg/l and indicated that the proportion of the biodegradable contents is higher than the non-biodegradable contents as well as BOD concentration in treated have below the CPCB and BIS standards. Through using the conventional technology in this complex the ETP is meeting the CPCB discharge of 30 mg/l. Total Suspended Solid content in treated effluents is 16 mg/l, indicated it's cannot lead to the development of sludge deposits when treated wastewater is utilizing in horticulture and washing purpose. Fluoride, Nitrate and Sulphate concentration in groundwater is 0.56, 7.2 and 67 mg/l respectively and values are found below the maximum permissible limit as per BIS. Wastewater reuse in agricultural and washing purpose are also not contributing amounts of fluoride to the groundwater regime in complex. A comparison between concentration of trace elements in groundwater sample shows the abundance of Fe (0.062), Zn (2.8), Mn (<0.1), Pb (<0.05), Cu (<0.05), Cr (<0.05), Ni (<0.02), Cd (<0.01), Se (<0.01), Al (<0.03), Hg (<0.001), As (<0.05), Cn (Nil), indicating lithogenic origin of Fe in groundwater and suggesting the contamination not from wastewater. Absent Coliform counts is observed in the groundwater of Unit-1 premises where well established pit latrine, septic tank, soakage pit system, ETP maintenance and drainage system exists.

Finally, Complex is Compliance and very high hygiene standard posing a major public health and environmental hazards.

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