Treatment of poultry slaughterhouse wastewater using a Static Granular bed Reactor (SGBR) coupled with Ultra-filtration (UF) membranes

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Abstract

The South African poultry industry has grown exponentially in recent years due to an increased demand for poultry products. As a result, poultry processing plants consume large volumes of high quality water for processing to ensure the production of hygienically safe poultry products. Furthermore, poultry industries generate high strength wastewater, which can be treated successfully at low cost using anaerobic digesters. In this study, the performance of a bench-scale mesophilic Static Granular Bed Reactor (SGBR) containing fully anaerobic granules coupled with ultra-filtration (UF) membranes as a post-treatment was investigated. The poultry slaughterhouse wastewater was characterized by a chemical oxygen demand (COD) range between 1223 and 9695 mg/L, average biological oxygen demand (BOD) of 2375 mg/L and average fats, oil and grease (FOG) concentration of 554 mg/L. A continuous bench-scale SGBR anaerobic reactor was operated for 64 days at different hydraulic retention times, (HRT), i.e. 55 and 40 hrs with an average organic loading rate (OLR) of 1.01 and 3.14 g COD/L.day. The SGBR results showed an average COD, TSS and FOG removal of 93%, 95% and 90% respectively, for both OLRS. The UF post treatment results showed a further average COD, TSS and FOG removal of 64%, 88% and 29%, respectively. The overall COD, TSS and FOG removal of the system (SGBR plus UF membrane) was 98%, 99.8%, and 92.4%, respectively. The results of the combined SGBR reactor coupled with UF membrane showed the potential for environmentally friendly treatment of poultry slaughterhouse wastewater.

Key words: chemical oxygen demand; poultry slaughterhouse wastewater; static granular bed reactor, ultra-filtration

INTRODUCTION

Due to an increased demand of poultry products, the poultry industry in South Africa (SA) has grown exponentially in recent years with more than 470 slaughterhouses with varying throughputs (Department of Agriculture and Rural Development, 2009). The poultry product annual consumption in SA exceeds the combined consumption of all other animal protein sources. Furthermore, 65.5% of locally produced animal protein consumed on a volume basis is supplied by the poultry industry (The South African Poultry Industry Profile, 2012). The use of high quality water for the processing of poultry products remains critical in ensuring that a hygienically safe product is available to consumers (Department of Agriculture and Rural Development, 2009). Due to increasingly stringent governmental legislation, increasing treatment costs, imminent water scarcity and environmentally conscious consumers, the treatment of wastewater has become a source of major concern in the general meat industry and more specifically in the poultry industry (Kobya *et al.*, 2005; Park, 2009).

Poultry slaughterhouses' water consumption varies according to the type of process employed, equipment used, productivity of the processing facility, and the waste management practices (Molapo, 2009). Poultry slaughterhouses consume consinderably high amounts of water for cleaning, rinsing carcasses and poultry products. Furthermore, fresh water is used for sanitizing and disinfecting slaughterhouse facilities and equipment (Department of Agriculture and Rural Development, 2009; Plumber, 2009; Avula *et al.*, 2008). South African poultry slaughterhouses use approximately 15-20 liters of water per bird processed (CSIR, 2010). A summary of the water consumption for a typical poultry slaughterhouse in SA is shown in Table 1.

Table 1: Water consumption in a typical South African poultry slaughterhouse (Molapo, 2009)

Area	Operations	Range of % water consumed	Average % water consumed
Processing	Lairages	5 – 12	10
	Slaughter and carcass dressing	12 – 33	20
	Offal handling	11 – 60	25
Utilities	Hot water	14 – 36	25
	Cooling and refrigeration	5 – 11	8
	Steam raising	2 – 9	5
Services	Ablutions, laundry and general washing	1 – 12	7

The poultry slaughterhouse industry consumes high amount of freshwater and generates large quantities of wastewater during its processing (Yornadov, 2010). The composition of these wastewaters may differ from one slaughterhouse to another depending on the type of bird, the water consumption per processed bird, as well as the type of process implemented (Debik & Coskun, 2009; Del Nery *et al.*, 2007). These wastewaters are typically characterized by high concentrations of organic compounds such as BOD and COD and high levels of nitrogen, phosphorous, pathogenic microorganisms, suspended solids, and FOG, resulting from the accumulation of blood, faeces, carbohydrates, feathers and proteins (Oh *et al.*, 2014; Yornadov, 2010). The high content of organic matter can be attributed to the residual blood in the wastewater (Debik & Coskun, 2009). The chemical constituents present in the wastewater originate from the cleaning and sanitizing stages. These stages account for a large portion of the water consumed and are crucial in ensuring that the process is hygienically safe and the poultry products are fit for human consumption (Mohammed, 2014; Department of Agriculture and Rural Development, 2009). The choice of treatment method and design of equipment used in the wastewater treatment process is greatly influenced by the quality and amount of wastewater generated (Molapo, 2009). Table 2 summarises the tyical characteristics of poultry slaughterhouse wastewater and treatment method previously studied.

Table 2: Typical poultry slaughterhouse wastewater

Treatment process	Parameter					Reference
	COD (mg/L)	BOD (mg/L)	pH	TSS (mg/L)	FOG (mg/L)	
Static Granular Bed Reactor (SGBR)	3137-7864	1543-5732	5.6-6.9	840-2355	-	Oh, 2012
Sequencing Batch Reactor (SBR) and Chemical Dissolved Air Floatation (DAF)	2060-4380	1559-26983	6.3-7.0	480-1230	131-261	De Nardi *et al.*, 2011
Ultra-Filtration (SBR)	3610-4180	1900-2200	-	2280-2446	289-389	Yordanov, 2010
Static Granular Bed Reactor (SGBR)	4200-9100	-	5.6-8.1	1850-3750	-	Debik & Coskun, 2009
Chemical DAF and Up-flow Anaerobic Sludge Bed reactor (DAF-UASB)	2360-4690	1190-2624	6.5-7.0	640-1213	249-702	Del Nery *et al.*, 2007
Up- flow Anaerobic Sludge Bed Reactor (UASB)	2000-6200	1300-2300	6.3-6.6	850-6300	40-600	Caixeta *et al.*, 2002

As shown in the Table 2, treatment methods such as physical, chemical, and biological (Kiepper, 2001) have been utilised in the treatment of poultry slaughterhouse wastewater. Each type has unique treatment advantages and operational limitations. Table 3 provides a brief summary of these treatments methods.

Table 3: Poultry slaughterhouse wastewater treatment technologies (Molapo, 2009; Mittal, 2005; Kiepper, 2001; Masse, 2000; Johns, 1995)

Treatment Type	Physical Treatment	Chemical Treatment	Biological Treatment
Application	Removal of suspended solids, fats, oil and grease	Removal of fats, suspended solids, nutrients	Removal of organic matter (COD and BOD), pathogens
Treatment Method	Screening, fat traps, catch basins, settling	Dissolved air flotation (DAF) chemical flocculation, electrocoagulation	Activated sludge systems, anaerobic and aerobic systems

Biological treatment involves the removal of organic compounds and pathogens from wastewater using microorganisms (Molapo, 2009). There are two types of biological treatment processes, namely aerobic and anaerobic treatment. Both processes require sufficient contact time between the wastewater and the microorganisms (Kiepper, 2001). Poultry slaughterhouse wastewater is well suited to anaerobic treatment because it contains high organic compounds (Debik & Coskun, 2009). Anaerobic treatment reduces organic compounds to methane and carbon dioxide using microorganisms in the absence of oxygen (Mittal, 2005). Included in this category are lagoons, anaerobic contact (AC), up-flow anaerobic sludge bed reactors (UASB), expanded granular sludge bed reactors (EGSB), static granular bed reactors (SGBR), and anaerobic filter (AF) processes. Major advantages and disadvantages of the anaerobic treatment process over the conventional aerobic treatment process are listed in Table 4.

Table 4: Advantages and disadvantages of anaerobic treatment (Rittmenn & McCarty, 2012, Metcalf & Eddy, 2003)

Advantages	Disadvantages
• High degree of waste stabilization • Less biological sludge production • No oxygen required (hence less energy and cost for operation) • Low nutritional requirement • Methane (clean energy source) production • Smaller reactor volume required • Elimination of off gas air pollution • Rapid response to feed addition after long period without feeding • Capable of destroying most chlorinated hazardous compounds	• Longer start up time needed • High buffer required for pH control • No nitrogen and phosphorous removal • Slower growth rate of microorganisms • More sensitivity to the adverse effects of environmental variables (i.e. pH, temperature) • More susceptibility to upsets due to toxic substances • Possibility of production of odour and corrosive gas • Probable requirement of post-treatment to meet discharge standards

In food industries, anaerobic treatment technology is one of the most used treatment methods due to its advantages of treating high strength wastewater (Karnchanawong *et al.* 2009). Several treatments have been reported in the treatment of poultry slaughterhouse wastewater. High rate and low rate anaerobic digestion have been used in treating poultry slaughterhouse wastewater due to its high content of particulates and FOG. The UASB reactors have been widely used to treat poultry slaughterhouse wastewater. Del Nery *et al*. (2005) obtained 65% total COD and 85% soluble COD removal at an average organic loading rate (OLR) of 1.64 kg COD/m^3.day using a full scale UASB reactor. Furthermore, De Nardi *et al.* (2008) investigated the use of Dissolved Air Flotation (DAF) as a pretreatment prior to the UASB reactor to lower the influent load by reducing the concentration of FOG and suspended solids. Basitere *et al. (*2016) reported an average COD removal of 65% using an EGSB coupled with anoxic and aerobic bioreactor. Yodanov (2010) reported COD removal greater than 94% for treatment of poultry slaughterhouse wastewater using ultra-filtration membranes. Debik *et al*. (2009) used the SGBR to treat poultry slaughterhouse wastewater and obtained an average COD removal of 95%.

In this study, the feasibility of using a two-stage process involving a mesophilic SGBR, anaerobic digester, coupled with a UF membrane was investigated. The use of this two-stage system has not been reported before and has not been applied on an industrial scale in the South African context in the poultry slaughterhouse wastewater treatment. The purpose of this study was to evaluate the treatment efficiency of lab-scale SGBR anaerobic digester coupled with UF membrane in reducing the COD content of poultry slaughterhouse wastewater to a level compliant with the City of Cape Town (CCT) for industrial wastewater discharge standards.

MATERIALS AND METHODS

Experimental Set-up and equipment

Figure 1 represents the laboratory bench-scale SGBR anaerobic digester coupled with the UF membrane that was operated over a period of 64 days. The purpose of the bench-scale SGBR reactor was to reduce the organic load of the feed effectively subsequent to the effluent being passed through the UF membrane. The bench-scale SGBR anaerobic digester consisted of a polyvinyl chloride (PVC) cylinder-shaped reactor with a total working volume of 1.53 L and an inner diameter and height of 0.071 m and 0.5867 m, respectively.

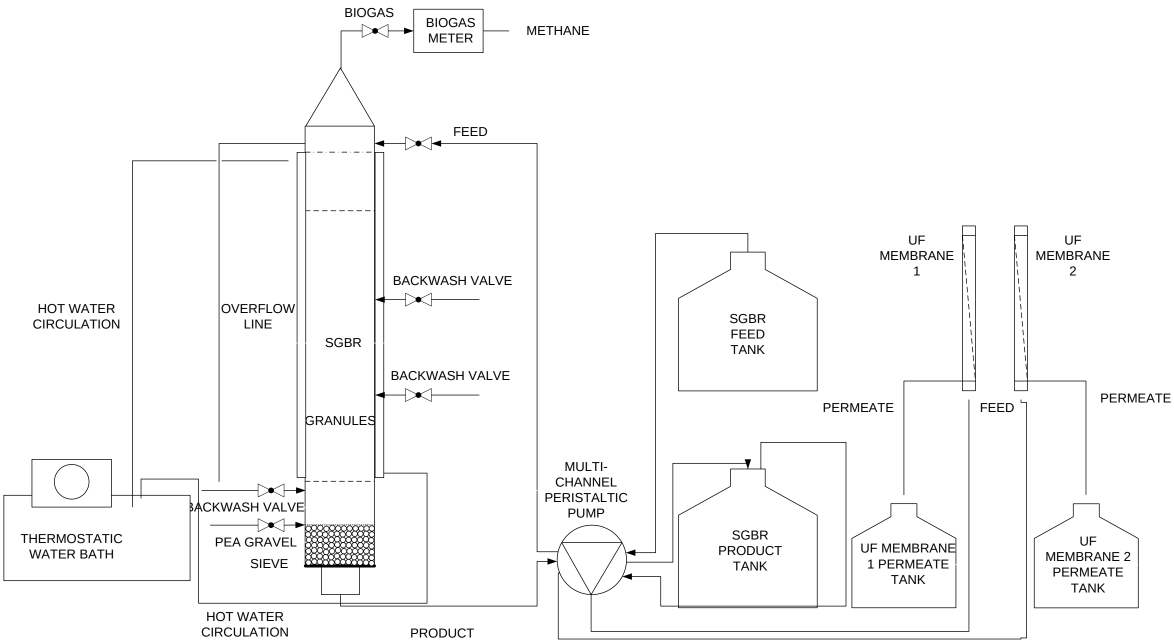

Figure 1 | Schematic diagram for laboratory bench-scale SGBR coupled with Ultra filtration (UF) membranes.

Separate 5 L PVC sample containers were used for feed storage and product storage. A perforated PVC pipe was placed at the top of the SGBR to distribute the feed across the entire cross-section of the reactor. Pea gravel with an average diameter of 5 mm was used as an under-drain to prevent granular sludge wash-out and clogging of under-drain pipes. A 2 mm grit sieve was positioned at the bottom of the SGBR to retain the pea gravel. Silicon piping was used to construct the overflow line and backwash system installed in case of reactor clogging. The influent was fed at the top of the reactor using a multi channel Gilson (Germany) peristaltic pump and the effluent was withdrawn from the bottom of the reactor. The reactor operated at a mesophilic temperature range between 35 to 37 °C. The temperature was regulated using a water jacket through which water from a thermostatic water bath circulated. The reactor was also insulated to prevent heat losses to the environment. The biogas produced was collected in a 0.50 L plastic Tedlar bag through a pipe installed at the top of the SGBR. The SGBR reactor was backwashed using SGBR product effluent through the backwashing line to remove suspended solids accumulating on the pea gravel to prevent the system from clogging.

Slaughterhouse wastewater

The poultry wastewater was collected from a slaughterhouse located in the Western Cape Province, South Africa. The fresh poultry slaughterhouse wastewater samples were stored in a refrigerator at a temperature of

4˚C. The characteristics of the wastewater are summarized in Table 5, which lists averaged values of parameters quantified over a 9-week on-site sampling period. All measurements were performed according to Standard Methods (APHA 2005).

Table 5: Characteristics of the wastewater from an industrial slaughterhouse located in the Western Cape, South Africa.

Parameter	Unit	Poultry slaughterhouse waste water	
		Range	Average
pH		6.5-8.0	6.88
Alkalinity	mg/L	0- 489	489
TCOD	mg/L	2133-4137	2903
SCOD	mg/L	595-1526	972
BOD5	mg/L	1100-2750	1667
TKN	mg/L	77-352	211
Ammonia	mg/L	29-51	40
TKN	mg/L	77-352	211
TP	mg/L	8 - 27	17
FOG	mg/L	131-684	406
TDS	mg/L	372-936	654
TSS	mg/L	315-1273	794
VSS	mg/L	275-1200	738
Soluble proteins	mg/L	0-368	72
VFA	mg/L	96-235	235

SGBR Inoculation

The SGBR was inoculated with 0.95 L of anaerobic granular sludge collected from a full-scale UASB reactor operated at SAB Miller (Newlands Brewery, South Africa). Also added was 0.43 L of poultry slaughterhouse wastewater collected from a poultry slaughterhouse located in the Western Cape. A Gilson peristaltic pump was used to feed the wastewater into the SGBR. Dry milk solution prepared with distilled water was used as feed during the acclimation period of 48 h. The COD concentration of the dry milk solution used was 2000 mg/L.

SGBR operating conditions

For the first 28 days, the poultry slaughterhouse wastewater was diluted with distilled water to prevent shock loading. During the last 36 days the SGBR was fed with undiluted poultry slaughterhouse wastewater. After the acclimation period of 48 hours, the flow rate was adjusted to 0.0278 L/h to set the start-up HRT to 55 h and the system was allowed to reach pseudo steady-state. The HRT of 55 h was maintained for a total of 44 days with an average OLR of 1.01 g COD/L.day. For the first 19 days, the SGBR was fed with 50% diluted poultry slaughterhouse wastewater. For the next 9 days, diluted poultry slaughterhouse wastewater with a concentration of 67% (2:1) was fed to the SGBR. Thereafter, undiluted poultry slaughterhouse wastewater was fed for a period of 16 days at an HRT of 55 h.

The HRT was then reduced to 40 h for the last 20 days by increasing the feed flow rate to 0.0383 L/h and the average OLR of the undiluted feed used during this period was 3.14 g COD/Lday. Table 6 provides the operating conditions which governed the continuous operation of the SGBR over a period of 64 days. The product generated by the SGBR was used as the feed for the bench-scale UF membrane post-treatment system.

Table 6: Operating conditions (HRT and OLR) for the SGBR system over a period of 64 days

Dilution (%)	Operating Time (days)	Flow rate (L/h)	HRT (hrs)	OLR (g COD/Lday)
50	1-19	0.0278	55	0.56
67	20-28	0.0278	55	0.67
None	29-44	0.0278	55	1.73
None	45-64	0.0383	40	3.14

The ultra-filtration (UF) membranes

An inorganic tubular membrane with an inner diameter of 2 mm and an outer diameter of 3 mm was utilised for the treatment as a post-treatment for the SGBR reactor. The membrane consisted of an alpha aluminium oxide (Al_20_3) ceramic material with a membrane pore size of 40 nm. The UF membranes were operated in a dead-end flow configuration. The UF membranes were replaced after 7 consecutive days due to intensive flux reduction. The clogged UF membranes were cleaned using 10% hydrogen peroxide solution for 24 hrs to remove suspended solids.

Analyses of poultry slaughterhouse wastewater

The performance of the SGBR was monitored using the feed and product analysis for the :pH, temperature, conductivity, TDS, salinity, turbidity, TSS, and COD. Samples of the SGBR feed and product and UF permeate were taken every second day (i.e. Mondays, Wednesdays and Fridays) for in-house analysis in duplicate. Weekly samples of the SGBR product and UF permeate were taken to an external South African National Accreditation System (SANAS) accredited laboratory (Scientific Services, City of Cape Town, South Africa) for COD, FOG, TSS, VFA and alkalinity analysis for verification and comparative purposes.

RESULTS AND DISCUSSION

The SGBR effluent (i.e. SGBR product) was used as the feed for the UF membrane. The findings of this study represent the SGBR operation for different OLRs applied under different HRTs for a period of 64 days. The SGBR coupled with UF membrane was continuously operated for a period of 64 days at different HRT and OLR.

Variation of OLR and HRT on the EGSB reactoralinity tolerance test

The poultry slaughterhouse wastewater was diluted with distilled water to prevent shock loading. The HRT of 55 h was maintained for a total of 44 days with an average OLR of 1.01 g COD/Lday.

The COD in the SGBR feed ranged between 1223 to 9695 mg/L with an average COD of 4681 mg/L as shown in Table 7. The COD was used in this study as a comparative parameter to quantify the system performance and to monitor the effect of the OLR throughout the study. The COD of the SGBR product ranged between 15 mg/L and 940 mg/L, with an average COD of 263 mg/L.

Table 7: Composition of the raw poultry slaughterhouse wastewater (SGBR feed) and product

		Composition of SGBR feed			Composition of SGBR product		
Parameters	Units	Minimum	Maximum	Average	Minimum	Maximum	Average
pH	-	6.31	7.26	6.78	7.30	7.97	7.61
Temperature	°C	19.3	22.5	21.2	18.7	23.5	21.1
Conductivity	µS/cm	1384	2040	1708	1461	1916	1710
TDS	ppm	986	1450	1213	1040	1360	1216
Salinity	ppm	733	1040	887	769	1010	888
Turbidity	NTU	72.6	841	397	9.06	50.8	28.4
TSS	mg/L	734	4992	2651	21	111	53
COD	mg/L	1223	9695	4681	15	940	263

SGBR performance and COD removal

The average COD removal of the SGBR for the 64 days period was found to be 93%. The COD removal during the first week of operation fluctuated due to the system stabilizing. Thereafter, the COD removal remained relatively constant at an efficiency greater than 90%. The COD removal fluctuated between days 50 and 64 during the last two weeks when the HRT was decreased to 40 h and the OLR increased to 3.14 g COD/Lday. The decrease in COD removal during this period may be attributed to the system stabilization subsequent to the increase in the organic load, as well as the backwashing process. The average COD removal during this period was 90%, which was still relatively high.

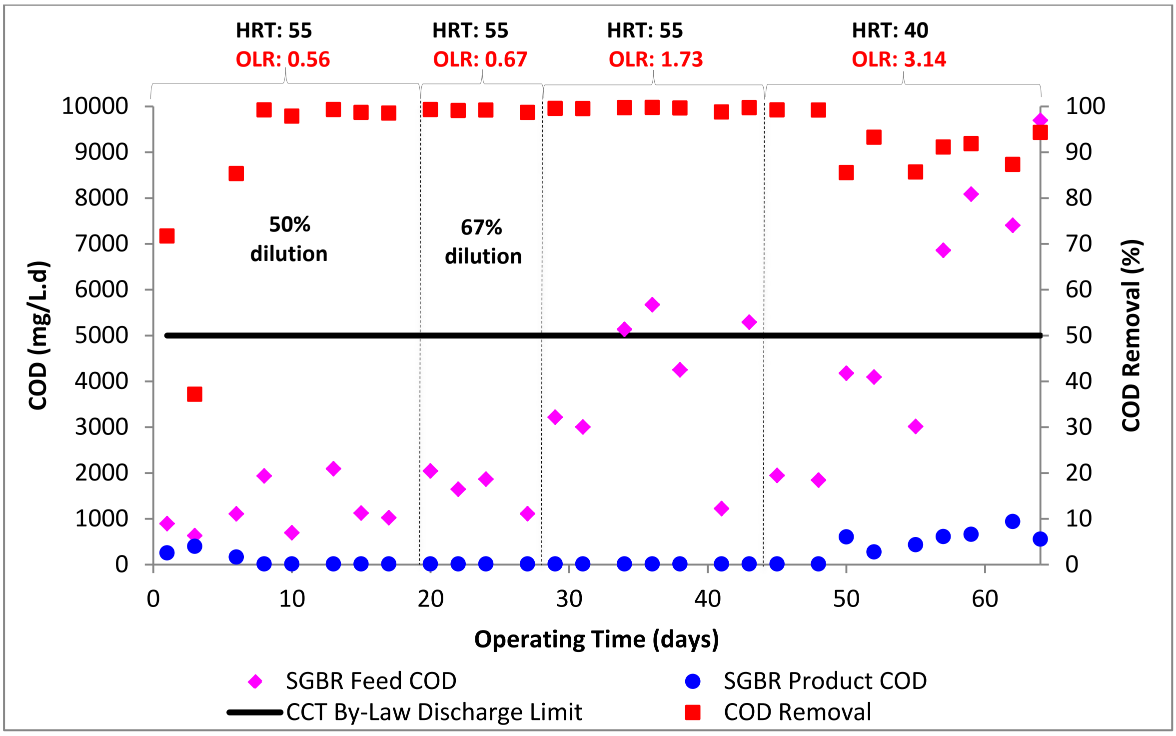

Figure 2 |: COD removal efficiency of the SGBR reactor at different HRT and OLR.

This treatment efficiency of this study compares to that by Evans (2004), who reported a COD removal range of 92% to 94% and 83.7% to 95.7% for a lab-scale SGBR for treatment of municipal wastewater. Debik and Coskun (2009) also reported COD removal efficiencies varying between 85% and 97% for the treatment of poultry slaughterhouse wastewater in a lab-scale SGBR operating at an HRT of 60 h. For HRTs of 40 and 36 hr COD removal was >90% and >93%, respectively.

COD Industrial discharge standard

The COD of the SGBR feed and SGBR product was compared to the city of Cape Town (CCT) discharge standard as shown in Figure 2 above. The results showed that the average COD concentration of the poultry slaughterhouse wastewater obtained from the industrial partner did not meet the maximum limit permitted for discharge of 5000 mg/L (CCT Wastewater and Industrial Effluent By-Law, 2013). Subsequent to the anaerobic treatment in the SGBR, the COD concentration was significantly reduced to below 93% consistently in the SGBR product below the discharge standard and the level required for discharge penalties of 1000 mg/L.

TSS removal

The TSS was measured to determine the concentration of the insoluble organic and inorganic matter suspended in the poultry slaughterhouse wastewater. The TSS was also used in this study to evaluate the performance of the SGBR under the varying HRTs and OLRs as shown in Figure 4. The TSS percentage removal over the 64 day period ranged between 76% and 99% with an average of 95%. The minimum TSS removal of 76% was achieved during the first week of operation, specifically days 3 to 5, while the system was still stabilizing. On day 8, the TSS removal increased to 91% and remained relatively steady throughout the operation. The average TSS removal for the HRT of 55 h and 44 h was found to be 93% and 98%, respectively, which indicates the excellent efficiency of the SGBR throughout the study. Oh *et al.* (2014) reported a TSS removal of 80% for a HRT of 48 h for the pilot-scale SGBR used for treating dairy processing wastewater at ambient temperature. Furthermore, reducing the HRT to 40 h did not have an adverse effect on the SGBR performance with regard to TSS removal. Despite the variation in the TSS of the feed, the SGBR was consistent in reducing the TSS. However, the TSS of the SGBR product was not only dependent on the anaerobic digestion process but also the physical process of retaining the suspended solids in the granular bed. This suggests that the downflow operation of the SGBR aids the removal of suspended solids since the granular bed and pea gravel act as a filtration system.

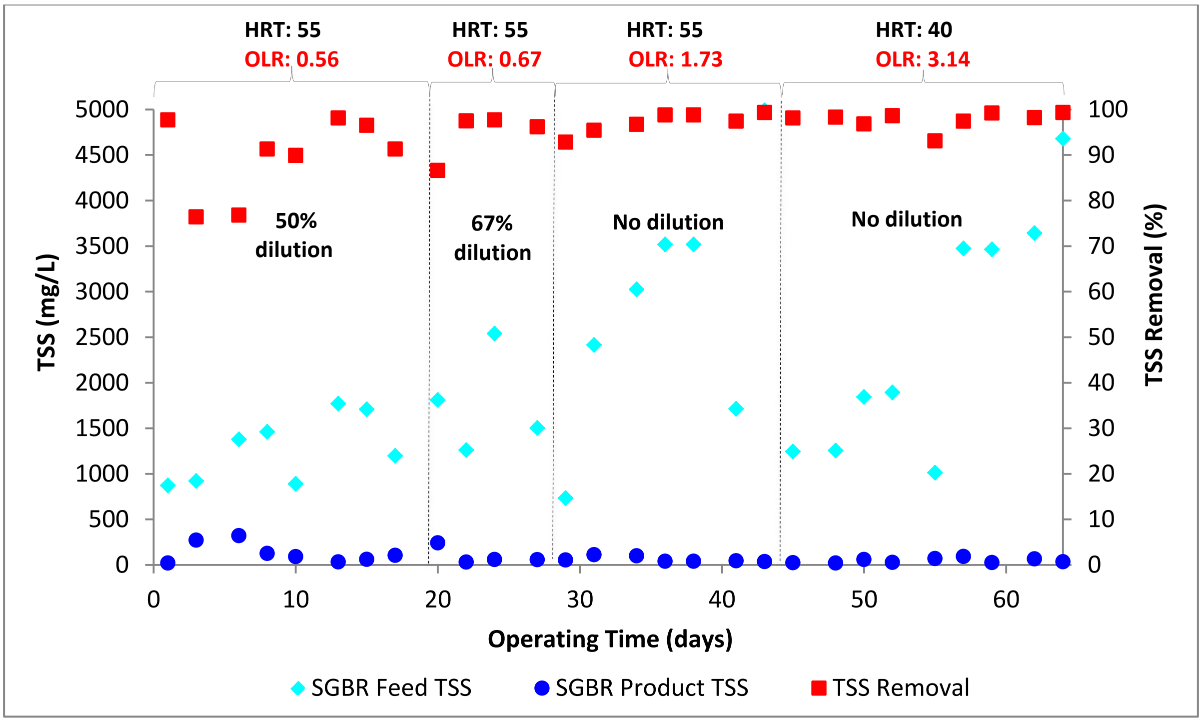

Figure 4 |: variation of TSS concentration at different OLR and HRT and TSS removal efficiency of the SGBR reactor.

TSS and Turbidity

Figure 4 shows the relationship between the TSS and the Turbidity through the SGBR operation. The turbidity was measured in order to determine the relative clarity of the wastewater indicated by the extent to which solid particles obstruct the transmittance of light through the wastewater. Despite TSS and turbidity being related, turbidity is not a direct measurement of the suspended particles present in the wastewater. The TSS and Turbidity of the SGBR feed varied substantially throughout the study due to the variation in the SGBR feed. The TSS and Turbidity of the SGBR product was relatively stable and followed a very similar trend throughout the study. The TSS of the SGBR feed ranged between 734 and 4992 mg/L while the TSS of the SGBR product ranged between 20 to 320 mg/L. The Turbidity of the SGBR feed varied between 73 and 841 NTU with an average turbidity of 482 NTU while the SGBR product turbidity varied between 9.06 and 225 NTU with an average of 60.4 NTU.

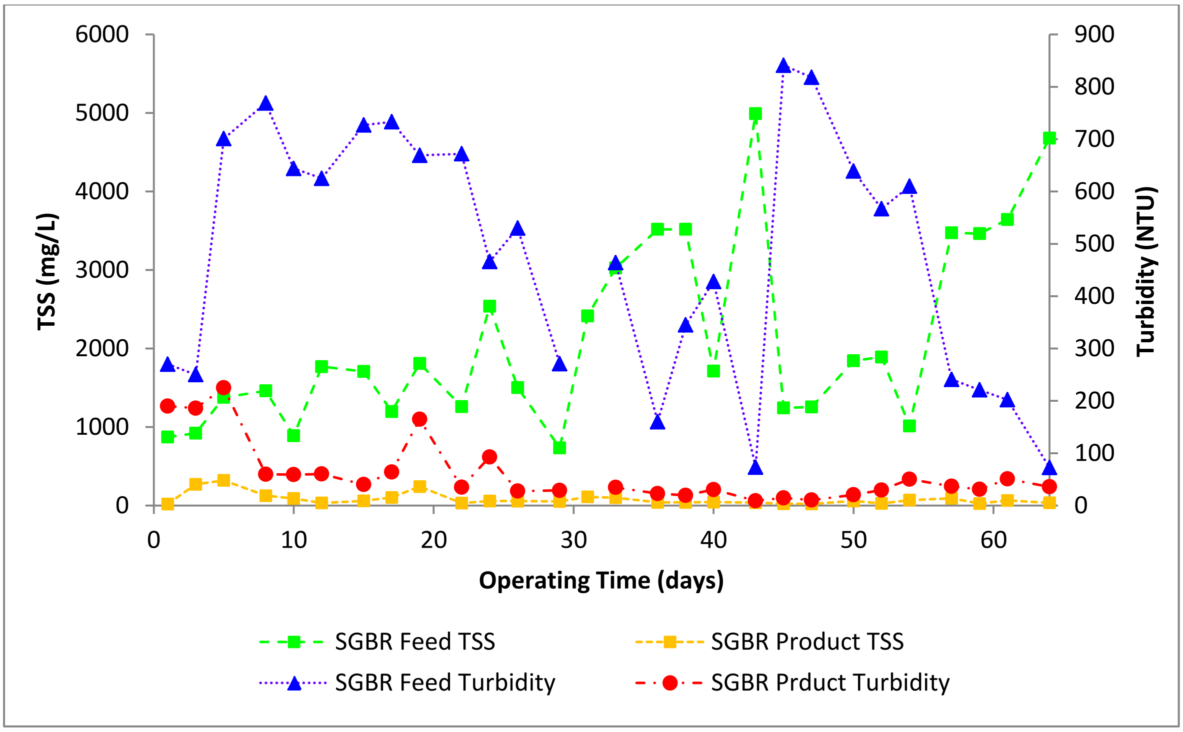

Figure 4 |: variation of TSS and Turbidity during the operation of SGBR system.

pH and temperature variations

The influent pH varied from 6.4 to 7.3 with an average of 6.8, while the effluent pH varied from 6.4 to 7.9 with an average of 7.5 as shown in Figure 5 below. The pH of the SGBR effluent was in a favorable range (6.5 to 8) for methanogenic microorganism.

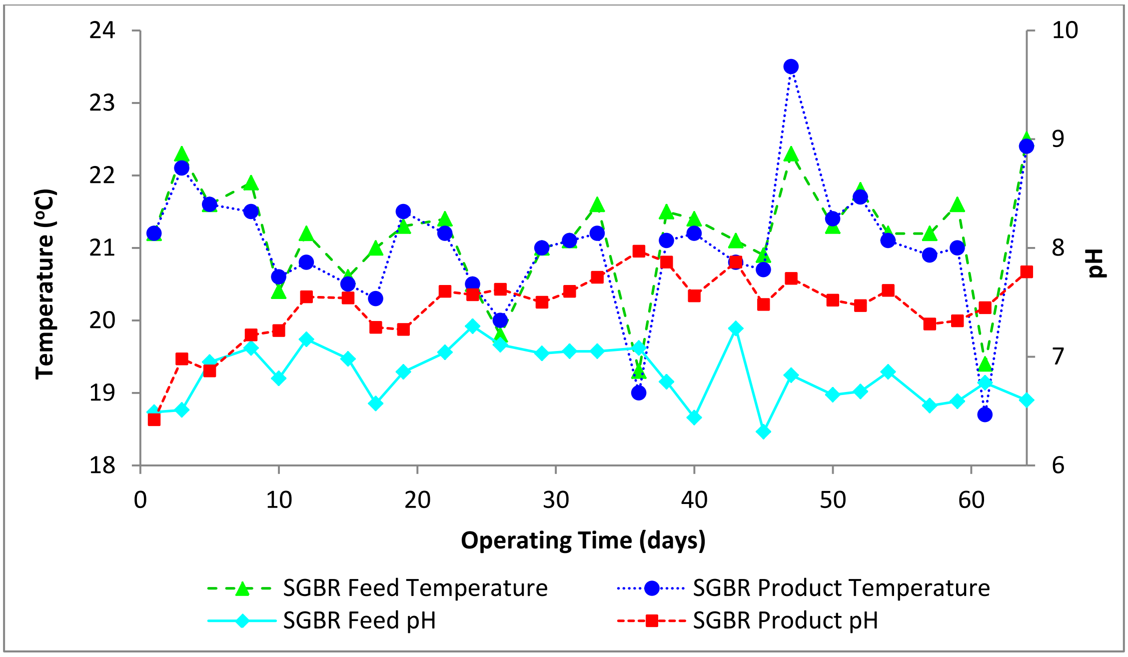

Figure 5 |: pH and temperature variations during the operation SGBR system.

VFA/Alkalinity ratio

Parameters such as alkalinity, VFA and pH are important in monitoring the stability of the anaerobic digester. The ratio of VFA / alkanity can be used to monitor the process stability. VFA / alkalinity ratio less than 0.3 indicates stable operating conditions, while a ratio between 0.3 to 0.4 indicate a potential system operation upset and need for corrective action (Debik & Coskun, 2009). A VFA /Alkalinity ratio exceeding 0.8 results in the inhibition of the methanogens by VFA accumulation resulting in acidification of the anaerobic digester. Figure 6 indicates the average VFA / Alkalinity ratio range to be between 0.01 to 0.14 for this study, indicating that the system was stable throughout the operation as the ratio was below 0.3.

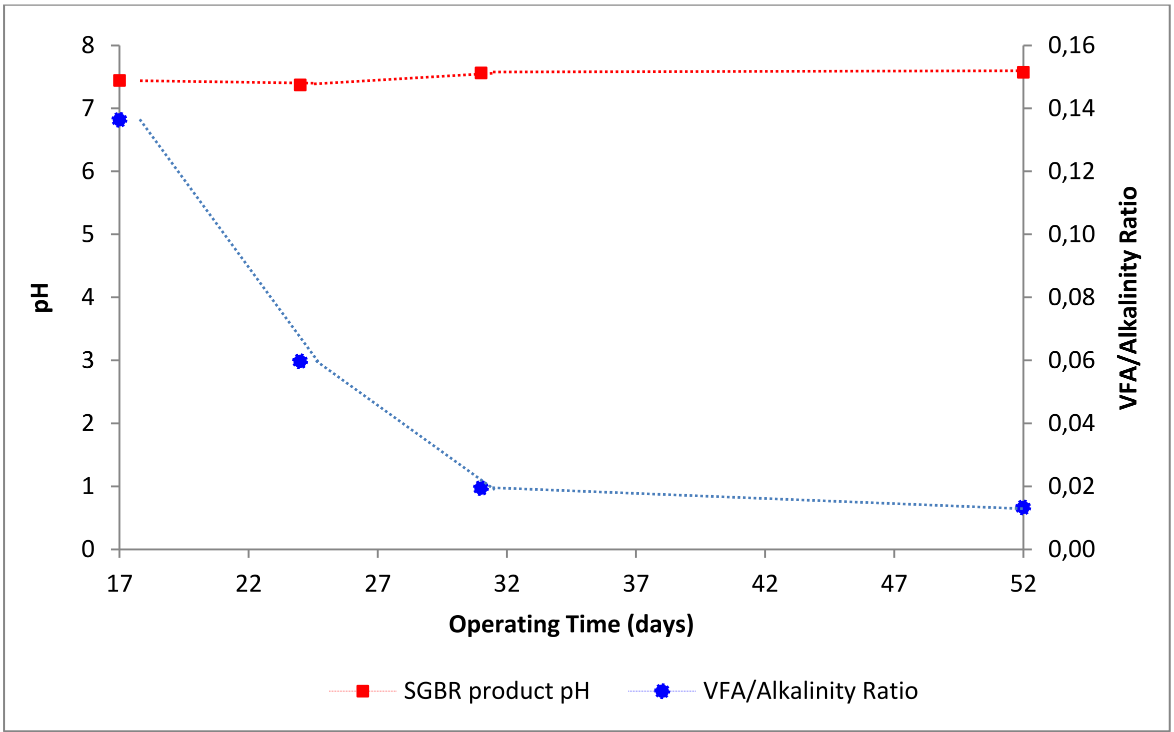

Figure 6 |: variation of average weekly pH and VFA /alkalinity ratio during the operation of SGBR system.

Post-treatment **ultra-filtration (UF) membrane stage**

Table 8 shows the results of the influence of the UF membranes process on the level of pollution indices from SGBR reactor product, which was a feed to the UF membranes. The UF treatment of the poultry wastewater from the SGBR reactor was monitored using COD, TSS and FOG pollution indices. These results indicate an average retention efficiency of 64%, 88% and 29% for COD, TSS and FOG, respectively. The values of the pollution indices are below the CCT industrial discharge limit standards. The results are encouraging since SGBR coupled with UF membranes used as a treatment process could ensure efficiency required to produce environmentally friendly treated poultry slaughterhouse wastewater.

Table 8: Ultra-Filtration permeate composition

Parameter	Units	Average SGBR Product	Averaged UF Permeate	Average Retention (%)
COD	mg/L	162	59	64
TSS	mg/L	29	4	88
FOG	mg/L	60	31	29

Overall COD, TSS and FOG removal of the SGBR and UF membrane

Table 9 below illustrates the overall COD, TSS and FOG removal efficiencies of the system coupled (SGBR and UF membranes). These were determined from the SGBR feed and permeate from the UF membranes. The overall COD, TSS and FOG removal of the coupled e system were 98.7%, 99.8% and 92.4%, respectively.

Table 9: Overall COD, TSS and FOG of the SGBR and UF system

Parameter	Units	Averaged SGBR Feed	Averaged UF Pemeate	Overall % Removal
COD	mg/L	4681	59	98.7
TSS	mg/L	2651	4	99.8
FOG	mg/L	406	31	92.4

CONCLUSIONS

The bench-scale SGBR anaerobic digester coupled with UF membranes was successfully employed for treating poultry slaughterhouse wastewater under mesophilic conditions and two different organic loading rates. The SGBR operated at a stable pH with a VFA / Alkalinity ratio in the range of 0.01 to 0.14 which were fairly lower throughout 64 days of operation. The average COD, TSS and FOG removal efficiencies for the SGBR system were 93%, 95% and 90%, respectively over the period of 64 days. The UF membranes used as a post-treatment for the SGBR product showed an average COD, TSS and FOG removal of 63%, 88% and 29%, respectively, while the overall COD, TSS and FOG removal of the coupled SGBR and UF membranes were 98.7%, 99.8% and 92.4%, respectively.

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