Validation of Slaughterhouse Wastewater Using Expanded Granular Sludge Bed Reactor

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Abstract

Poultry butcher houses produce enormous volumes of wastewater with astoundingly charged in dissolvable and insoluble organics. These wastewater contains huge degrees of organics, for instance, Biochemical Oxygen Demand (BOD5), Chemical Oxygen Demand (COD), Nitrogen and Phosphorus from, for instance, blood, fat, oil, and proteins. Adequate treatment of this wastewater is fundamental before discharge as a result of the development of common issue. Poultry definition, prepared foul taking everything into account and especially those regarded for their meat and egg, as chickens, turkeys, ducks, geese and guinea foul. Anaerobic wastewater treatment offers different focal points including low ooze yield, energy recovery, slop amassing capacities, and low enhancement need. The goal is to diminish the proportion of sludge that ought to be masterminded. The most extensively used procedure for overflow treatment is anaerobic ingestion. In this cycle, a tremendous division of the characteristic issue (cells) is isolated into carbon dioxide (CO2) and methane (CH4), and this is developed without oxygen. About segment of the entirety is then changed over into gases, while the remainder of dried and transforms into an excess soil-like material. The purpose of this work is to endorse the display of Expended Granular Sludge Bed Reactor (EGSB) to treat the butcher house wastewater in a clear up stream way, expected to take out high COD capability coming about as a result of high biomass upkeep in the structure.

Keywords: Slaughtterhouse granular slop bed reactor, waste water, etc,

I. Introduction

In India, there are around 4,000 selected butcher houses with the close by bodies and more than 25,000 unregistered premises, where animals are butchered to fulfill the solicitations of local buyers. Around 45-portion of the animals can be changed into edible things (MEAT).About 15% waste and the overabundance 40-45% of the animal is changed into by things, for instance, Leather, Soaps, Candles (fat) and pastes. Wastewater from slaughterhouse is a blend of the getting ready water from both the butchering line and the cleaning of the guts, which causes a gigantic assortment in the centralization of common issue. The principal poison in slaughterhouse discharge is normal issue. The dedication of characteristic weight to these effluents are gut, crap, oil, fat, and oil, undigested sustenances, blood, suspended material, pee, free meat, dissolvable proteins, squander, waste, coarseness and colloidal particles(Bazrafshan et al., 2012). The consumed water per butchered animal is unmistakable as demonstrated by animal kind and the butchering cycle, and ranges from 1 to 8.3 m3. A critical segment of this value is discarded as wastewater, with values going from 0.4 to 3.1 m3 per butchered anima.. Metcalf and Eddy, (2003), declared wastewater age rates can be as high as 80% of the hard and fast ate up water..

II. Objectives of the Study

The destinations of the examination are portrayed underneath:

- To create trial conventions for the evaluation of high quality slaughterhouse wastewater for treatment in an Anaerobic Expanded Granular Sludge Bed Reactor.
- To create Laboratory scale AEGSBR for the evaluation of the slaughterhouse gushing.
- To gather and portray the slaughterhouse wastewater test.
- To lead a trial concentrate under fluctuating operational conditions, for example, Hydraulic Retention Time and Organic Loading Rate.
- To assess the treatment execution of the model concerning rate expulsion of COD.
- To screen the Bio-gas assortment all through the activity of the reactor.

Slaughtering Process and Techniques
- The Humane Method and Conventional Technique of Slaughter.
- Traditional and Ritualistic Slaughter
- African Traditional Slaughter
- Jewish Method/Schechita
- Muslim Method (Halal) of Slaughter
- Jhakta (Sikh) Method

Current Scenario on Indian Slaughter House
- Most of the Slaughter house are inadequate concerning fundamental workplaces like water, power, ventilation, drainage, terminated ground surface, overhead rails and trash evacuation.
- Animals are butcher in ordinary way on the open ground with/less any extra planning.

Meat Processing Plants
- Lair age
- Slaughter and Bleeding
- Dressing
- Paunch Handling
- Rendering
- Processing and Cleaning

Pollution Parameter
- Biochemical oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Chloride (Cl)
- Dry matter orTotal Solids (TS)
- Grease fat and oil (FOG)
- pH
- Nitrogen (N)
- Temperature
- Turbidity and Colour
- Volatile Solids

Table - 1 General Biochemical Oxygen Demand (BOD)

Source	BOD mg/lt
Poultry meat plant	1000 – 1200
Pig meat plant	15000 – 2000
Cattle/sheep meat plant	1400 – 3200
Fish processing	1000 – 3000
Dairy (washing)	600 – 1300
Natural Domestic Sewage	250 – 300

Slaughterhouse Wastewater Treatment

Primary Treatment
Crucial and basic treatment before natural cycles is used to avoidsludge lightness and unit over-troubling. For starter and fundamental treatment, coarseness chambers, screens, settling tanks and separated air lightness units (DAF) are commonly used. Coarseness chambers and screen can kill particles while settling tanks dispense with fat, oil and oil (FOGs) and fine solid particles by gravity (del Nery et al., 2007; de Nardi et al., 2008). In slaughterhouse wastewater, fats add to 40% of TCOD while lipids address under 1% of SCOD anyway over 67% of particulate COD (Masse et al., 2003). Engineered coagulation and flocculation is commonly used as pre-treatment by adding ferric and aluminum salts and

aluminum-polymerised blends to dispense with turbidity, COD, and SS from slaughterhouse wastewater (Masse et al., 2003; Al-Mutairi et al., 2004). By applying different coagulants and flocculants, past what 90% of SS can be profitably dispensed with while gigantic assortments in COD and Oil and Grease 10 departures have been seen (Table 2.2). Other basic/pre-treatment headways have similarly been assessed, for instance, hydrolysis pretreatment (Masse et al., 2001 and 2003), and electrocoagulation (Bayramoglu et al., 2006; Bayar et al., 2011). Basic and basic treatment of slaughterhouse wastewater is summaried in Table 2.2. Powerful SS and COD departures are cultivated by using DAF and coagulation.

Secondary Treatment

Basic or potentially substance pretreatment isn't sufficient to diminish poisons to satisfy discharge rules. Given the high biodegradability of slaughterhouse wastewater, natural cycles are seen as sensible for slaughterhouse wastewater treatment. Couillard et al. (1989) investigated the thermophilic lively cycle treating slaughterhouse wastewater at 52 - 58 oC in a semi-reliably dealt with bioreactor and achieved over 93% of COD departure and 72 - 90% of orthophosphate ejection. High operational temperature and short SRT are the musings behind the thermophilic oxygen devouring cycle, anyway limit its application basically. Anaerobic assimilation has been represented to vanquish above issues, for instance, upflow anaerobic sludge cover reactor (UASB)(Sayed et al., 1987; Manjunath et al., 2000; Nery et al., 2001; Caixeta et al., 2002), anaerobic channels (Campos et al., 1986; Ruiz et al., 1997), fluidized-bed reactors(Borja et al., 1989), fixed-bed reactors (Tritt et al., 1992; Saddoud et al., 2007), and anaerobic baffled reactors (ABR) (Barber and Stuckey, 1999). Differentiated and the oxygen devouring cycle, anaerobic systems were found to have high characteristic clearing efficiencies with lower costs. 70% - 95% of COD ejection can be cultivated by using UABR developments anyway with low N and P clearings (Table 2.3). Due to issues of high assortment of SS, low slop quality and floating fats, anaerobic osmosis structures anticipate that progression should avoid those detriments. Masse et al. (2003) got hydrolysis pretreatment for fat degradation during the anaerobic absorption measure. Manjunath et al. (2000) used a DAF cycle as pretreatment for UASB structures.

Slaughterhouse Wastewater

Rough slaughterhouse wastewater was assembled from the chidambaram market of a local slaughterhouse and set aside in the exploration community at for test use. The credits of the slaughterhouse wastewater are showed up in Table.
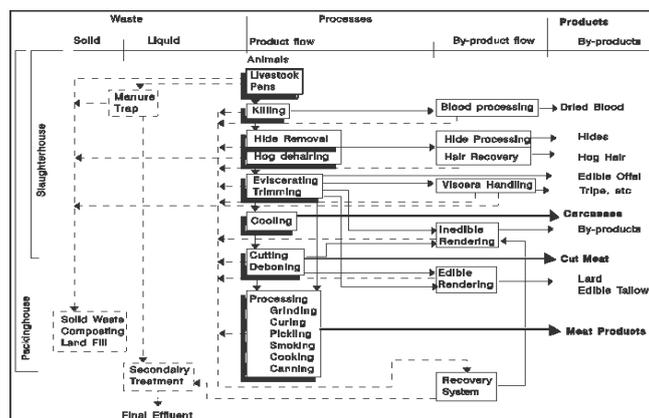

FIG 1.1 Slaughterhouse Process Flow Diagram

III. Methodology

The present exploratory work was done to evaluate the introduction of anaerobic expanded granular slime bed reactor for the clearing of organics in the butcher wastewater. A schematic outline of an EGSB reactor is showed up in Figure 3.1. The preliminary examination office model was included plexiglass. The reactor includes a segment partition 9.54liters and a gas-solid separators (GSS) package 4.93liters. The height and inside estimation of the chamber section segment are 121.5 cm and 10 cm. The working volume of the reactor is 14.47liters including GSS. The real component of the exploratory plan is showed up in Table 3.1. A variable speed of peristaltic siphon (PP-10) was used to control the stream rate. The photographic point of view on the exploratory plan is showed up in Figure 3.3.
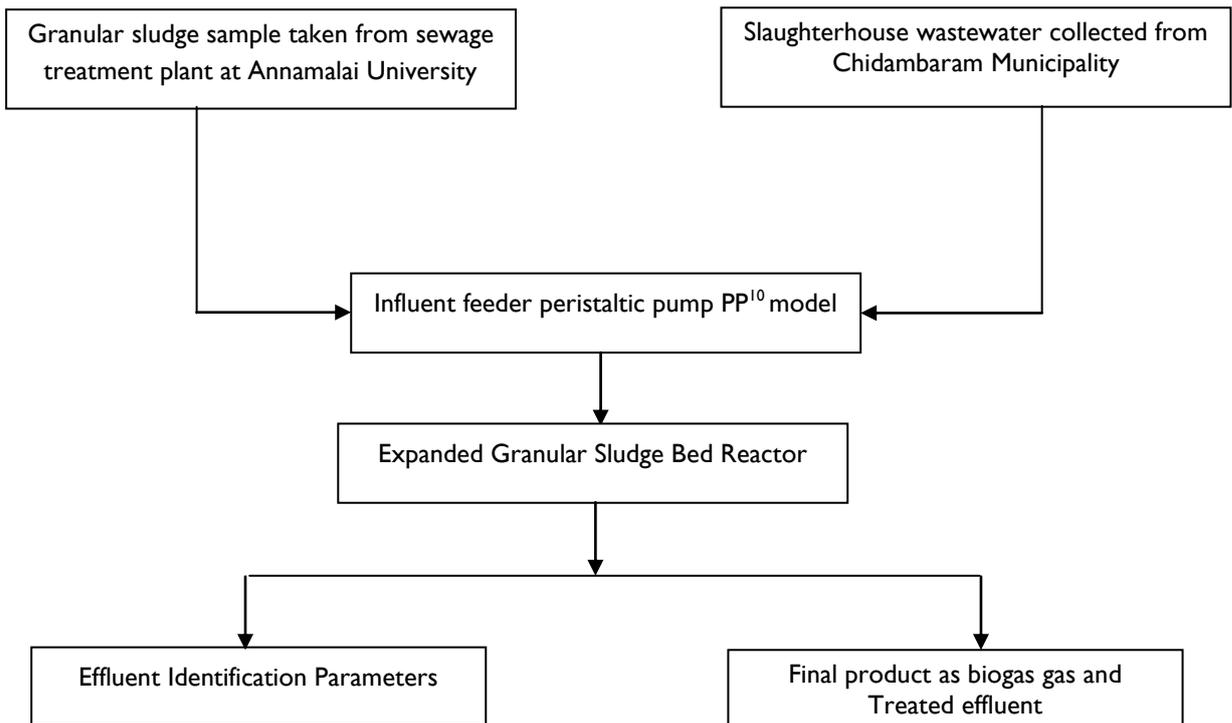
Granular sludge sample taken from sewage treatment plant at Annamalai University		Slaughterhouse wastewater collected from Chidambaram Municipality

Influent feeder peristaltic pump PP^{10} model

Expanded Granular Sludge Bed Reactor

Effluent Identification Parameters	Final product as biogas gas and Treated effluent

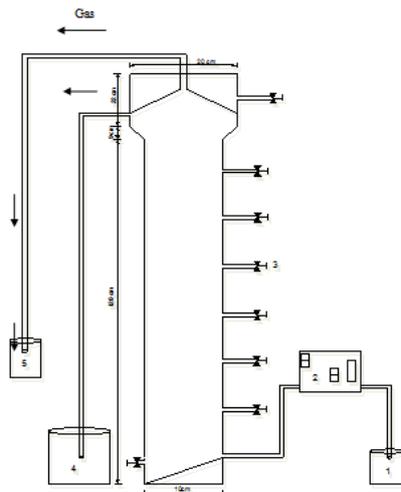**Figure 3.1 Flow Chart of Experimental Methodology**

Fig. 3.2 Schematic of Anaerobic

Expanded Granular sludge bed reactor

- Influent tank
- Peristaltic Pump
- Sampling Ports
- Effluent tank
- Bio gas collecting jar
- EGSBR

Fig 3.3 Photographic view of Anaerobic Expanded Granular Sludge Bed Reactor

Table 3.1 Physical features and process parameters of experimental model

Specification	Dimensions
Total height of the reactor	152.5cm
Column portion	121.5cm
Diameter of the cylinder column	10cm
Triangle portion	9cm
Total liquid volume	14.47liters
Peristaltic pump	PP – 10 model
Free board	11cm

Monitoring parameters

The lab model of an anaerobic expanded granular seepage bed reactor was endlessly worked all through the assessment time period and the going with limits were checked.

- Influent COD mg/l.
- Influent flow rate, l/day.
- Effluent COD mg/l.
- Hydraulic Retention Time, days.
- Organic Loading Rate, kg COD /m^3.day.
- p^H
- Turbidity (NTU).
- Bio gas, ml/minute.

Characterization of Slaughterhouse Wastewater

The butcher house spouting was assembled from the market zone of Chidambaram Municipality. The models were depicted by the Standard philosophy (APHA 2005) which are presented in Table .3.2.

Table.3.2 Characterization of real time slaughterhouse wastewater

Sl. No.	Parameters	Raw wastewater	Desirable limit of IS 10500
1.	p^H	6.9	6.5 to 8.5
2.	Total solids, mg/l	8820	500
3.	Total volatile solids, mg/l	2400	-
4.	Suspended solids, mg/l	2200	100
5.	Chemical oxygen demand(COD) ,mg/l	2080	250
6.	Biochemical oxygen demand(BOD$_5$),mg/l	1120	30
7.	Turbidity, NTU	31.5	1
8.	Phospharous, mg/l	55	-
9.	Sodium, mg/l	680	200
10.	Potassium, mg/l	90	-
11.	TKN, mg/l	480	100

Results

Startup Process
The influent and gushing examples from the reactor were gathered once in three days and were broke down right away. At first, the influent was gathered from the treatment office at Annamalai University and feed to the reactor with a COD of 440mg/l with an OLR of 0.0085Kg COD/m3.d. The low introductory stacking rate was suggested for the effective beginning up of AEGSB. A low starting natural stacking rate was valuable for the development of anaerobic dynamic muck and the low COD natural stacking brought about low creation of gas rate and low wastewater up-stream speed. Brief beginning up is fundamental for the exceptionally proficient activity of AEGSB, because of moderate development paces of anaerobic microorganisms, particularly Methane delivering microbes.

Stabilization process
The start up period is considered as the period taken for stable movement to be refined. This is a vital development for the consistent movement of the AEGSB and other anaerobic reactors at an arranged normal stacking rate (OLR). One of the focal issues zeroed in on is the vaccination with phenomenal methanogenic overflow. Likewise, working temperature is unquestionable during fire up. In this work, the AEGSB reactor, ensuing to developing, was worked at a temperature some place in the scope of 24°C and 37°C (Mesophilic range). The COD removal rate, during first fifteenth day, was low in the extent of 10-20%. The low capability in departure close to the beginning of the cycle is inferable from the biomass change in the new atmosphere. The low removal adequacy during fire up stage, can be attributed to the presence of un changed seed slop. During the hour of 36 to 60 days, moderate departure of COD was cultivated. The reactor achieved a reliable state from 55 to 60 days with a COD removal efficiency of 76% was cultivated in (Figure 4.1).
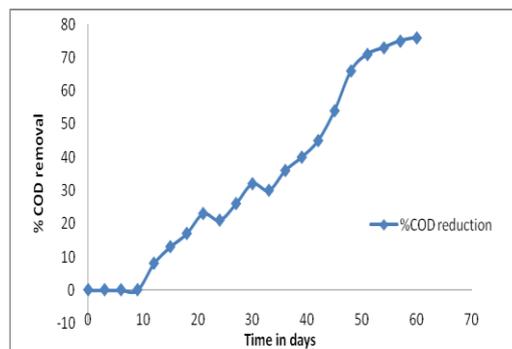

Figure 4.1 Time in days with Respect to % COD Removal Efficiency

Performance of the AEGSB reactor
The continuous slaughterhouse wastewater was used during the preliminary examination time frame. The AEGSB reactor was guided with three plan of ordinary COD stacking with 1752, 1744, 1820 mg/l and the stream rates, for instance, 15.120, 12.240, 9.360, 6.480 and 3.600 l/day continually using peristaltic siphon. The influent COD of the slaughterhouse wastewater was going from 1520 to 2080 mg/l with HRT of 2.00, 2.18, 3.20, 4.13 and 8.16 days. The Performance of AEGSB reactor treating slaughterhouse wastewater for three ordinary influent COD obsession were presented in Table 4.1, 4.2 and 4.3.

Table.4.1. Performance of AEGSBR treating slaughterhouse wastewater for an average influent COD of 1752mg/l

Sl. No.	Flow rate l/day	HRT, days	OLR,Kg COD/m³.day	pH	Influent COD, mg/l	Effluent COD, mg/l	%COD removal Efficiency	Gas Conversion, ml/minute
1.	15.120	2.00	0.017	6.75	1680	560	66.67	76
2.	12.240	2.18	0.015	7.85	1840	568	69.13	102
3.	9.360	3.20	0.011	8.40	1760	720	59.09	98
4.	6.480	4.13	0.082	7.20	1840	728	60.43	105
5.	3.600	8.16	0.039	7.86	1600	512	68.00	121

Table.4.2. Performance of AEGSBR treating slaughterhouse wastewater for an average influent COD of 1744mg/l

Sl. No.	Flow rate l/day	HRT, days	OLR,Kg COD/m³.day	pH	Influent COD, mg/l	Effluent COD, mg/l	%COD removal Efficiency	Gas Conversion, ml/ minute
1.	15.120	2.00	0.017	6.75	1680	560	66.67	76
2.	12.240	2.18	0.015	7.85	1840	568	69.13	102
3.	9.360	3.20	0.011	8.40	1760	720	59.09	98
4.	6.480	4.13	0.082	7.20	1840	728	60.43	105
5.	3.600	8.16	0.039	7.86	1600	512	68.00	121

Table.4.3. Performance of AEGSBR treating slaughterhouse wastewater for an average influent COD of 1820mg/l

Sl. No.	Flow rate, l/day	HRT, days	OLR, Kg COD/m³.day	pH	Influent COD, mg/l	Effluent COD, mg/l	%COD removal Efficiency	Gas Conversion, ml/ minute
1.	15.120	2.00	0.015	7.86	1520	1120	70.00	142
2.	12.240	2.18	0.017	8.20	2080	680	67.00	180
3.	9.360	3.20	0.013	7.51	1750	500	64.04	216
4.	6.480	4.13	0.850	7.20	1900	450	78.03	284
5.	3.600	8.16	0.460	7.15	1850	290	84.32	332

Effect of Hydraulic Retention Time

The introduction ascribes of HRT in days with respect to rate COD departure viability is showed up in Figure. 4.3. The overall show of the EGSB reactor at room temperature 240 to 370C between the upkeep time and COD clearing viability. The most extraordinary COD departure was cultivated at 84.32% with a HRT of 8.16 days. with an influent COD of 1850 mg/l. As a result of the serious degree of organics is in suspended structure supports the higher capable degradation in the reactor. The Bio gas change with respect to HRT as showed up in Figure 4.5 focused the most extraordinary change was gotten at 8.16 days. The change was not progressive since it was fluctuating one, and it occurred considering the starvation of the living things and besides the pH and normal conditions inside the reactor. The credits twists were drawn for the effect of pH concerning Hydraulic Retention Time (HRT) as showed up in Figure 4.4. The exuding pH in Stage 1 dropped from 8.40 to 6.72 due to an extended methanogenic activity. During this period, there were slight changes in the pH. Further, the decline in the HRT caused liberal change in the pH profile of the reactor system with ordinary radiating pH in Stage 3 is being 7.86, 8.20, 7.51, 7.20 and 7.15 with the HRT of 2.0, 2.18, 3.20, 4.13 and 8.16 days. The assessment of pH insignificantly waver during this stage exhibits the power of destructive maturing over methanogens. It shows strong anaerobic atmosphere, which is incredible for methanogenic living things.

Effect of Organic Loading Rate

The most extraordinary change of biogas was refined at 332 ml of gas/minute with an OLR of 0.460 Kg COD/m3.day. The graphical depiction of OLR in Kg COD/m3 day concerning biogas change is showed up in Figure 4.7. The pH obsession was assessed for various extents of COD with contrasting OLR were spoken with in Figure4.6. The OLR was gradually extended from 0.01353 to 0.850 Kg COD/m3.days. The COD clearing capability was cultivated at a constraint of 84.32% at an OLR of 0.460 Kg COD/m3.days Figure4.8.
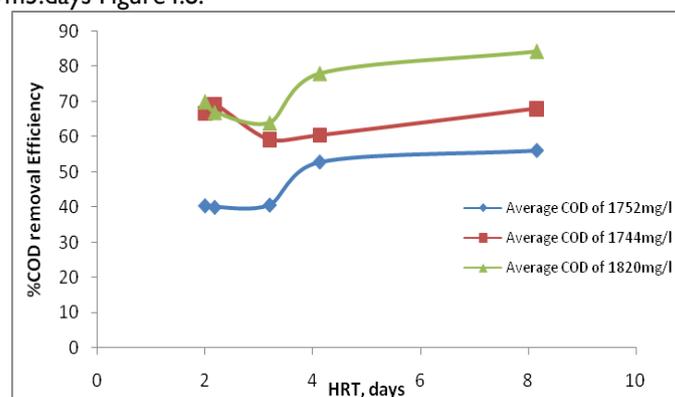
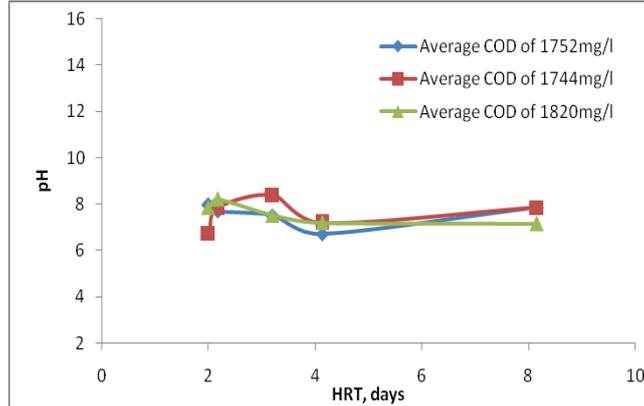**Figure 4.3 HRT in days Vs % COD removal efficiency**

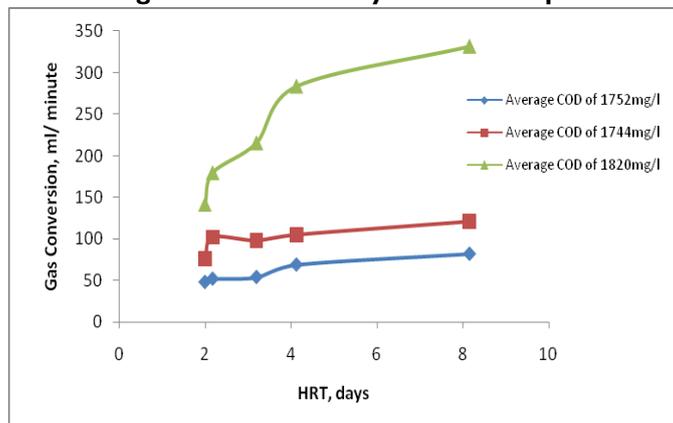**Figure 4.4 HRT in days Vs effluent pH**

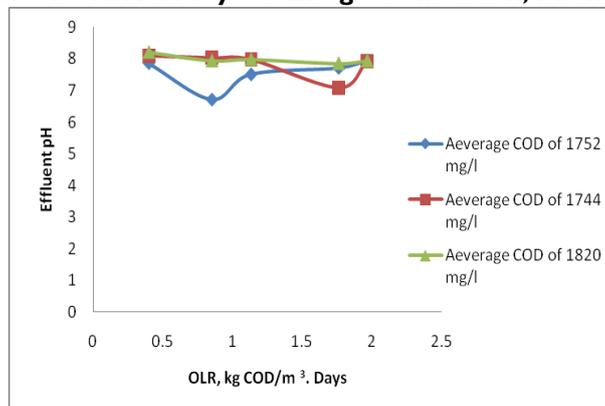
Figure 4.5 HRT in days Vs Bio-gas conversion, ml/minute

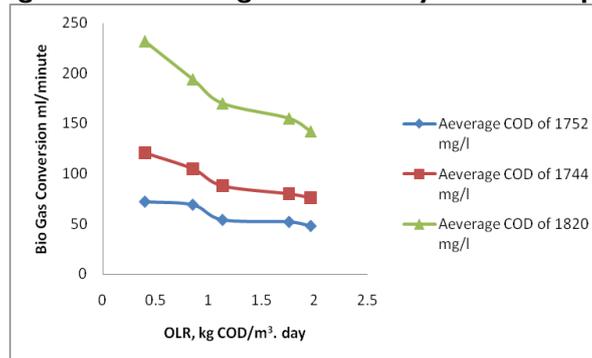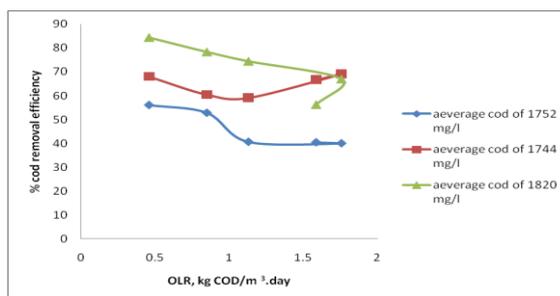**Figure 4.6 OLR in kg COD/ m³ .day Vs effluent pH**

Figure 4.7 OLR, kg COD/m³.day Vs Bio-gas conversion in ml/minute

Figure 4.8 OLR in kg COD/m³.day Vs % COD removal efficiency

Scanning Electron Microscopy (SEM) analysis

The model was seen under various enhancements in a Scanning Electron Microscopy Figure 4.9. A huge bit of the examinations were based on the microbial people scattering in the AEGSBR, and the results showed midway contrast of microbial people apportionment under different preliminary conditions (Sallis P.J and Uyanik S, 2003). In this examination, the slop was light hearty shaded and was taken from the reactor for SEM evaluation.
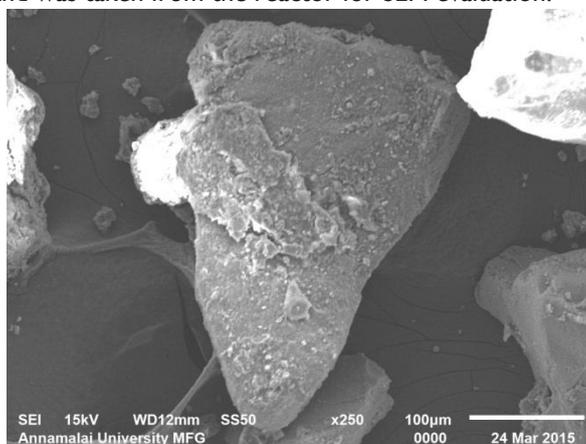
Figure 4.9 SEM Image of Sludge Granule

IV. Conclusions

The discussions of slaughterhouse wastewater under changing working conditions were likely analyzed in the past parts. Considering the test outcomes and assessments, the presentation of the AEGSB structure is extraordinarily sensible for getting slaughterhouse wastewater wipe out great common toxins. The water fueled support time was satisfactory to think about degradation of organics in the reactor. The best COD ejection efficiency was refined at 84.32% with a HRT of 8.16 days. The better Organic Removal Efficiency in regards to level of COD ejection is most prominent with an OLR of 0.460 kg COD/m3.day. Keeping up a sensible and stable pH inside the reactor was a critical subject for methanogenic works out. Graph of anaerobic treatment is a result of different central focuses, for instance, low energy use, low compound use, low seepage creation, less equipment required. Finally according to the result of this examination, the AEGSB reactor developing with granular ooze shows extraordinary cycle execution for the treatment of butcher house wastewater at room temperature. The temperature was the determinant factor for achieving high efficiency. The AEGSB reactor can prepared to apply for the treatment of some other excellent wastewater as well.

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