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Anaerobic digestion for waste water poultry manure by UBF reactor

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Abstract—In this experiment the performance of UBF process treatment for wastewater chicken manure was tested under the condition of constant temperature of 35℃ and the volume of UBF is 4 liters. The experiment covered two stages: the first was start up with phase I and phase II, the second was steady state. The following results average of operation period were obtained: (1) During the period of start up phase I operation the biogas production rate 0.39v/(v.day) at the volumetric COD loading rate of 2.97 kg COD/(m^3.d) with COD removal 76.85% and hydraulic retention time of 10.04 hours and phase II the biogas production rate 3.86 v/(v.day) at the volume loading rate 11.69 kg COD/(m^3.d) have been achieved with COD removal 82.47% and HRT 16.45 hours. UBF process had resistance to the quantitative shock load. (2) During the steady state operation, the biogas production rate 9.83v/(v.day) at loading rate of 28.85 kg COD/(m^3.d) and COD removal efficiency 80.03% and hydraulic retention time of 18.73 hours have been achieved for this reactor. The operation of UBF reactor was very stable.

Keywords: anaerobic digestion; UBF reactor; poultry manure; chicken manure; waste water.

1 Introduction

1.1 Poultry manure

Hobson *et al*. (Hobson, 1981) reported that, poultry excreta are a solid mixture of feces and urine, of about 70% water content.

If the excreta are from caged birds, the materials tend to dry on the collecting days and can be of lower moisture content. However, the excreta are usually collected as a wet solid by flushing

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out excreta which is below the cages and channeling it for disposal. For anaerobic digestion, water would have to be added to make a slurry for use in the contentional types of digestion. So, here the installation of a digester system would not necessarily mean any additional water being added.

In deep-litter system the excreta drop into straw, shaving, corncob or other fibrous material and the mixture is scraped from the poultry house for disposal. This type of material mixed with slurry, could pose mechanical problems as digested feed stock, because of the large fibrous particles that could clog pumps and pipes and cause scum problems.

1.2 Anaerobic digestion for poultry manure

The poultry manure is suitable substrate for anaerobic digestion. Laboratory study has demonstrated that methanogenic bacterial culture can be easily initiated and systematically selected for the most efficient methane producer(Gramms, 1971; Converse, 1980; Huang, 1982; Hills, 1984; Shin, 1988).

1.3 UBF reactor

A UBF reactor consists of up flow anaerobic sludge blanket reactor(UASB) and some filter material. Chnoweth and Ronisaacson(Chnoweth, 1987) described that, UASB reactor consists of three distance zones: a sludge bed, a sludge blanket and settling/gas separating zone. Wastewater is pumped into the reactor upwards through a bed of dense granular sludge and a blanket of flocculated sludge particles. A UBF reactor was utilized in the present study. Ghanem(Ghanem, 1992) mentioned that, there are three reasons why UBF process was utilized to treat chicken manure: (1) The first reason is that UBF process has high SRT which results in high treatment efficiency, stability during operation period, and benefit for acclimatization of seed sludge. (2) The anaerobic granular sludge formed in UBF reactor can decreased the effect of toxic material such as NH_3-N on bacterial generation time. (3) Finally there are many cases of experience in operation, maintenance, design and management of UBF reactor.

2 Material and methods

2.1 Anaerobic sludge

Anaerobic sludge was collected from an old anaerobic digester fed with chicken manure from Shanghai County of Shanghai City, China. The sludge used as starter was rich with anaerobic microorganisms. The concentration of mixed liquor suspended solids(MLSS) average was 111.5 g/L and for reactor was 27.88 g/L. The mixed liquor volatile suspended solids (MLVSS) average was 47.71 g/L and for reactor was 11.93 g/L.

Table 1 Some chemical analysis of wastewater poultry manure(liquid phase)

Before separation(mixture)	Concentration
COD	80000mg/L
After separation(waste water)	
COD	21500 mg/L
BOD	11730 mg/L
NH_3-N	1900 mg/L
pH	7.3

2.2 Chicken manure

Chicken manure was collected from Golden

Bridge Egg Poultry Farm(caged birds), Shanghai, China. Laying hens manure was separated into liquid and solid materials using centrifugal force. The solid phase was treated by aerobic fermentation process to prepare an animal and fish feed. The liquid phase (wastewater poultry manure) is treated by anaerobic digestion process to produce methane as a source of energy for poultry farms. The over all techniques are presented in Fig. 1. And some chemical analysis of wastewater poultry manure from liquid phase as following in Table 1.

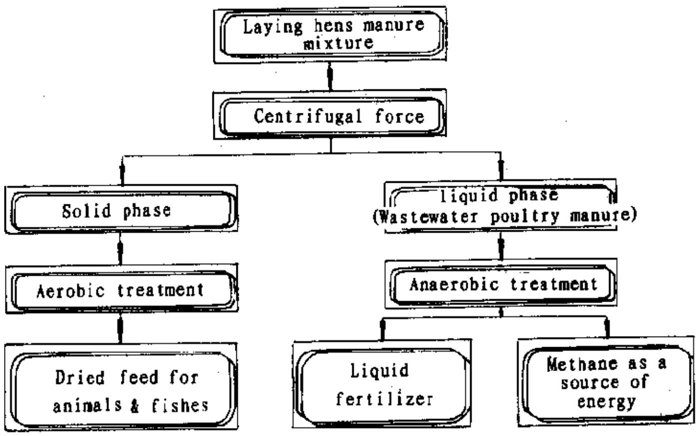

Fig. 1 Technological process for separation of laying hens manure mixture

2.3 UBF reactor

The UBF reactor utilized in the present study consists of bench scale model of up flow anaerobic sludge blanket reactor (UASB), it was constructed from cylindrical plexiglass, and a filter was made of soft plastic with nylon fiber to grow anaerobic seed sludge and prevent washout through circulation of wastewater. The total volume of reactor equals to 4.55 L, the active fermentation volume was 4.0 L while the biogas space was 0.55 L as shown in Fig. 2.

2.4 Control box

A wooden control box with volume of 0.45 m^3 was equipped with the following equipment: (1) gas flow rate gauge; (2) feeding pump; (3) heating source; (4) thermostat: the temperature was held constant 35℃.

2.5 Chemical analysis

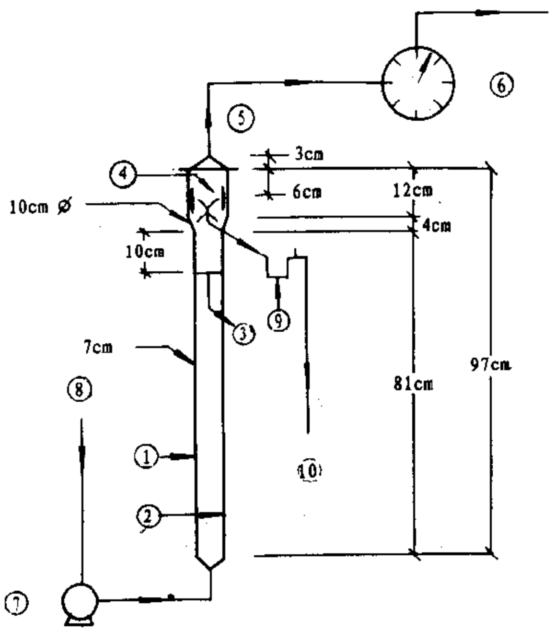

Fig. 2 Sketch of the UBF reactor

1. Digester plexiglass; 2. anaerobic sludge; 3. filter(soft plastic with nylon fiber); 4. gas space; 5. gas out; 6. gas flow rate meter; 7. feeding pump; 8. influent; 9. syphon device; 10 effluent

Total suspended solid(TSS) and chemical oxygen demand (COD) were determined according to the method recommended by the American Public Health Association(1985). Methane content was estimated by using chromatography apparatus model 100 from Shanghai Analysis Instrument Factory.

Hydrogen ion concentration pH was determined directly in a liquid sample using pH meter model S-3(TC) from Shanghai Huxing Electronic Instrument Factory.

2.6 Experimental procedure and operation of the UBF reactor

Depending on the COD concentration, COD loading rate and the forms of the anaerobic sludge in the reactor the process of the operation period can be divided into two stages: the start-up stage and the steady state stage. The start-up stage was carried out in two phases over a period of 58 days, according to the same condition mentioned above and the time for using certain amount of beer with the wastewater chicken manure as nutrient.

2.6.1 Phase I

This period covered 17 days, beginning with addition of anaerobic sludge and a mixture of the wastewater chicken manure with certain amount of beer as nutrient, the COD concentration was 500 mg/L and ended with the volumetric COD loading rate up to 4 kg/(m^3.d) and COD concentration 1567.74 mg/L. In this period, the granular anaerobic sludge began to appear and was washed out and the reactor color changed to dark. The aim of this period is to adapt the sludge for new environmental and operation condition and reactor design. These were accomplished through 17 days as follows:

The reactor fed with liquid of 500 mg/L COD by average flow rate (Q) equal to 8.9L/day and hydraulic retention time (HRT) ranged between 16.3—8.5 h. The duration of this step was 3 days.

The COD concentration was increased to 1178.6 mg/L. The flow rate (Q) also increased by average 11.18 L/day, while the hydraulic retention time (HRT) decreased by average 8.65 h. On the other hand, the duration time during the second step was 6 days.

During the third step, the COD concentration of influent feed material increased to 1392.7 mg/L by duration period 6 days. The average of hydraulic retention time (HRT) and flow rate (Q) were 10.49 h and 9.15L/day, respectively.

The last step of phase I stabilized after two days, while the concentration of COD feed material was 1567.74 mg/L. The hydraulic retention time HRT was decreased by 9.37 h on average, while the flow rate increased by 10.25 L/day on average.

2.6.2 Phase II

This period was covered 41 days, beginning at the point where phase I stopped, and use wastewater chicken manure only, the influent began with COD concentration 2508.5mg/L and LR 6.71kg/(m^3.d). This phase ended with COD concentration 16522.70 and volumetric COD loading rate 18.17 kg/(m^3.d). In this time, the granular anaerobic sludge formed very fast and COD removal efficiency ended at 87.79%. The aim of this period is to adapt the sludge for a quantitative shock loading involving a change in the COD concentration rather than a change in the type of compounds. The start up stage phase II process was done in 7 steps as follows:

On average, the influent COD concentration was 2481.68 mg/L, *Q* was 10.03L/day and *HRT was 9.57 h during the 7 days.*

Increasing the concentration of COD-in to 3294.31 mg/L and *HRT* 10.46 h while *Q* was decreased to 9.18 L/during fermentation period equal to 4 days.

COD-in and *HRT* were increased to 4477.46mg/L and 11.15 h respectively while *Q* was decreased to 8.61 L/day through the 7 days.

The average concentration of COD-in and *HRT* increased to 6723.87 mg/L and 14.77 h respectively, while *Q* was decreased to 6.5 L/day during 3 days.

The COD-in was increased to 8563.48 mg/L and *HRT* was also increased to 17.74 h during 5 days, while *Q* was decreased to 5.4 L/day.

During this stage the COD-in was rapidly increased to 14899.76 mg/L by *HRT* equal to 21.52 h, while *Q* was rapidly decreased to 4.46 L/day through 8 days.

The continuation of flow rate was decreased to 3.89 L/day in 6 days. The *HRT* was increased to 24.68 h and the COD concentration of effluent was increased to 16823.97 mg/L.

The steady state stage period of UBF reactor started after 58 days from the beginning of the start-up stage phase I. The duration period for steady state was 19 days. This process was done in 4 steps as follows:

Both *Q* and *HRT* were recorded as 4.65L/day and 20.64 h respectively. On the other hand, the COD-in concentration was increased to 19678.27 mg/L on average during 3 days.

The duration period was 9 days and the recorded final increase of COD-in was 21391.97 mg/L. While the other parameters *Q* and *HRT* were 4.59 L/day and 20.92 h respectively.

The concentration of COD-in was gradually decreased to 21089.91 mg/L through operation period equal to 3 days. While *HRT* decreased to 13.17 h and *Q* was rapidly increased to 7.0 L/day.

The average loading rate equal to 38.03 kg COD/(m^3.d) and *Q* equal to 7.30 L/day, while the average of COD concentration of the influent raw material was 20715.08 mg/L, and the average of hydraulic retention time "*HRT*" was 13.15 h during 4 days.

The UBF reactor performance was routinely assessed by daily determination of removal efficiency of COD in mg/L hydraulic retention time "*HRT*" in hours, loading rate in kg COD/(m^3.d), pH value and biogas yield. The menthane content of biogas production was periodically tested.

3 Results and discussion

3.1 Removal efficiency during the start up

3.1.1 Removal efficiency during the start up phase I

The relationship between the concentration of feeding material calculated as COD and removal efficiency of the UBF reactor are illustrated in Fig.3 and Fig. 5. It should be noted that, when the strength of feeding material is increased from 500 to 1567.74 mg COD/L, the removal efficiency decreased from 89.94% to 72.37%. On the other hand the flow rate *Q* increased from 5.90L/day to 12 L/day and the *HRT* decreased from 16.27 h to 8.00 h.

The start up stage phase I could be divided into two periods depending on the concentration of COD feed. The first period was 9 days and the COD feed concentration ranged between 500—1178.60mg/L and COD removal efficiency ranged between 70%—89.94% by average equal to 76.35%, while the *LR* ranged between 0.740—3.390kg/(m^3·d). On the other hand, *Q* increased from 5.90 L/day to 12.0L/day, the average of *Q*, COD-in, *LR*, *HQT* were 10.42 L/day, 952.4 mg/L, 2.57kgCOD/(m^3·d), 9.6h respectively. The decreasing removal efficiency may be due to the limitation of contact time between substrate and anaerobic sludge which was used in this stage. This result agrees with Van den Berg *et al*. (Van den Berg, 1985). They found that, substrate removal efficiency decreased with increasing organic loading rate and hence decreased *HRT*. While Gorur(Gorur, 1986) noticed that, soluble COD removal efficiencies on average 87%—96% of UASB and UBF reactor during waste water treatment.

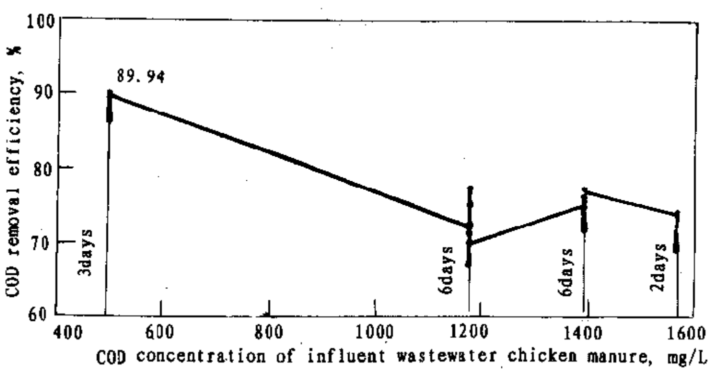

Fig. 3 The relationship between COD influent concentration of wastewater chicken manure and COD removal efficiency during the start up stage phase I

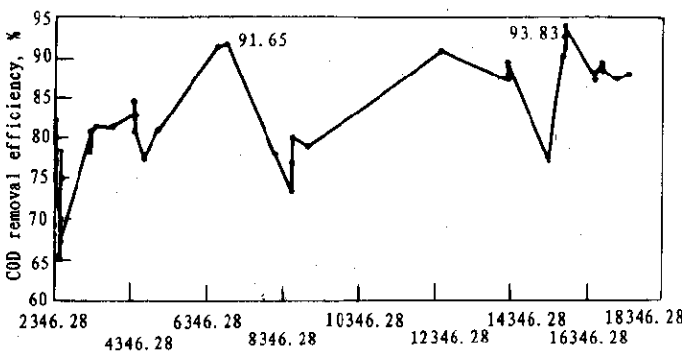

Fig. 4 The relationship between COD influent concentration of waste water chicken manure and COD removal efficiency during the start up phase II

The second period was 8 days starting from the 10th day when the COD feed increased to 1392.7 mg/L and 1567.74 at the end of the period. At the same time the removal efficiency decreased from 75.01% to 72.37%, with average 75.13% while *LR* had values between 4.12 and

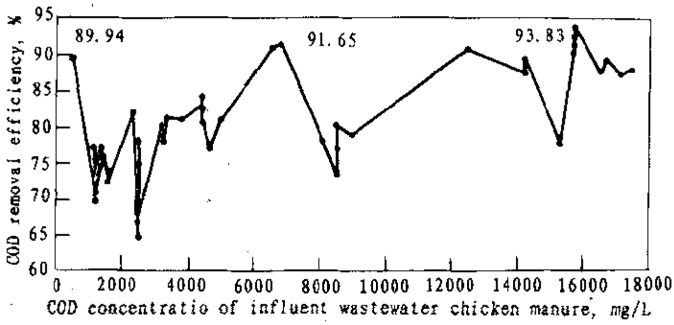

Fig.5 The relationship between COD influent concentration of waste water chicken manure and COD removal efficiency during the start up stage

2.26 kg COD/(m^3·d). Furthermore, the *HRT* increased from 8.73 to 14.8 h and *Q* loaded between 6.5 and 11.00L/day, the average of *Q*, COD-in, *LR*, *HRT* were 9.53 L/day, 1436.46 mg/L, 3.43 kgCOD/(m^3.d), 10.54h, respectively. During this stage the COD removal efficiency decreased from 77.09% to 72.37%. The result average of operation period phase I calculated in Table 2.

Table 2 Results average of operation period of UBF reactor

Content		Start up stage		Steady state stage
		Phase I	Phase II	
Q, L/day		10	6.75	5.50
Operation time, day		17	41	19
COD_{Cr}	Inf., mg/L	1180.19	8825.52	20930.72
	Eff, mg/L	287.87	1266.89	4172.95
	Remove rate, %	76.85	82.47	80.03
HRT, day		10.04	16.45	18.73
Volume loading rate, kg COD/(m^3·d)		2.97	11.69	28.85
pH	Influent	6.65	7.11	7.35
	Effluent	7.55	8.10	8.27
Biogas production, L/day		1.63	15.42	39.34
Biogas production rate	m^3/kg COD	173.93	395.30	437.34
	v/(v.day)	0.392	3.86	9.83

The suitable start up stage depends on many environmental and operation factor, such as : type of digester, concentration of feeding material, loading rate "*LR*", flow rate "*Q*", hydraulic retention time "*HRT*", component of raw material and anaerobic sludge. The aim of phase I period was to adapt the anaerobic sludge to the new environmental and operation factors that had been used addition in reactor design.

3.1.2 Removal efficiency during start up stage phase II

The removal efficiency of COD during the start up stage phase II of UBF reactor are illustrated in Fig. 4 and Fig. 5 also in Table 2. It should be noted that the efficiency had average value 82.47% and two peaks 91.65% and 93.83% at a period equal to 37 and 49 days respectively. The concentration of COD-in during the two peaks were 6798.70 and 15747.75mg/L respectively. At the same points loading rate "*LR*" were 11.05 and 21.65 kg/(m^3·d), while the flow rate "Q" were 6.50 and 5.50 L/day respectively.

The average of COD-in concentration during the star up operation period was 8825.52 mg/L, while the average of *LR*, *Q* and *HRT* were 11.69 kg/(m^3·d), 6.75L/day and 16.45 h respectively. Van den Berg(Van den Berg, 1983) reported that, the rate of start up in advanced anaerobic reactor depended on the type of inoculum, kind of wastewater and the support material used. He observed that, the sewage digester sludge generally required longer time to adapt than effluent from active digester fed by food processing waste.

During the present study the operation period for start up of the UBF reactor was 58 days and wastewater for chicken manure was suitable to start up the reactor and no toxicity could be found.

The aim of phase II was to adapt these sludge for a quantitative shock loading and the change in the types of compounds.

3.2 Removal efficiency during steady state stage

The steady state performance of UBF reactor started when the concentration of COD increased to 19678.27 mg/L while COD removal efficiency fluctuated between 76.55% and 84.36% with average 80.03%. But the average of *LR* was 28.85kg/(m^3·d) while *HRT* was 18.73 h on average during this operation period. The removal efficiency of COD during this stage of UBF reactor is illustrated in Fig. 6. The COD concentration reached 21971.2 mg/L with daily biogas production 57.80L/d with average of this stage for COD concentration 20930.72mg/L. The aim of this stage is to teach COD in concentration around 21000 mg/L, where COD concentration of waste

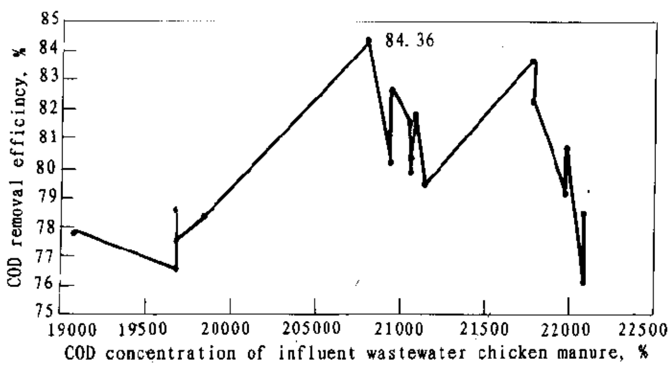

Fig. 6 The relationship between COD infleunt concentration of wastewater chicken manure and COD removal efficiency during the steady state stage

water poultry manure (liquid phase) was 21500 mg/L, the parameters average of this stage are illustrated in Table 2.

3.3 Loading rate "*LR*" and hydraulic retention time "*HRT*" during operation of the UBF reactor

The relationship between *LR* and *HRT* are presented in Fig.7. Once the *LR* increased from 0.74 to 2.26 kg/(m^3·d) during the first thirteen days of operation period the " *HRT*" reached its maximum value twice, once at the first day and other after 12 days. The *HRT* was rapidly decreasing *LR* up to the end of start up stage phase I. During the start up period the *LR* increased from 4.99 to reach 21.65 kg COD/(m^3·d), which equal to 4.34 times the value at the first feeding period. The *HRT* showed a high rate during the period from 29 to 57 days. But for steady state stage the *LR* increased from 19.68 to 43.94 kgCOD/(m^3·d) which equal to 2.23 times the value at the first feed of this stage. The results showed that the UBF reactor had four peaks during the operation period. The highest peak was at 57th day when the *LR* and *HRT* were 14.040 kg/(m^3·d) and 28.24 h respectively. After 57 days, the hydraulic retention time " *HRT*" decreased with the increases of loading rate "*LR*". The value of *HRT* was 11.29 h and *LR* was 42.17 kg/(m^3·d) at the end of the experiment. The result average listed in Table 2. These results are agreed with Van den Berg *et al*. (Van den Berg, 1985) observed the same phenomena in his experiment with brewery wastewater in a UBF reactor.

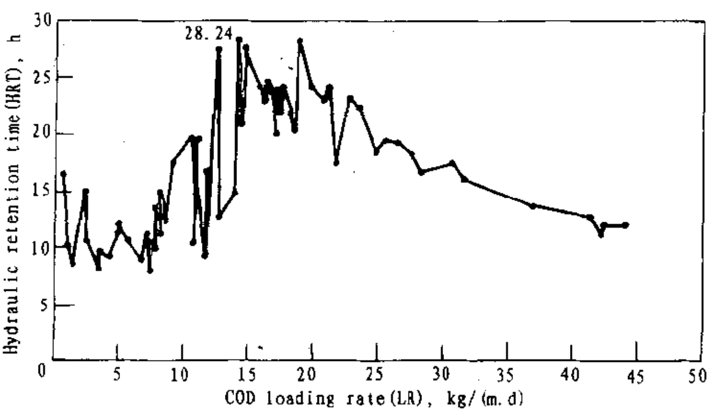

Fig. 7 The relationship between hydraulic retention time (*HRT*) and loading rate (*LR*) during the operation period of UBF reactor

3.4 Biogas production rate

The daily production of biogas throughout the anaerobic digestion process of the UBF reactor are illustrated in Fig.8. And result average calculated in Table 2, the suspended volatile solids produced biogas with a fluctuation rate during the fermentation period, whereas, the gas generation increased from 0.32 to reach 3.48 L/day by an average of 1.63 L/day per 4.0 L active fermentation reactor volume during the start up stage phase I, but the start up stage phase II, the average of biogas production was 15.42 L/d per 4 L.

The early evaluation of biogas, that occured was attributed certainly to the enriching inocula-

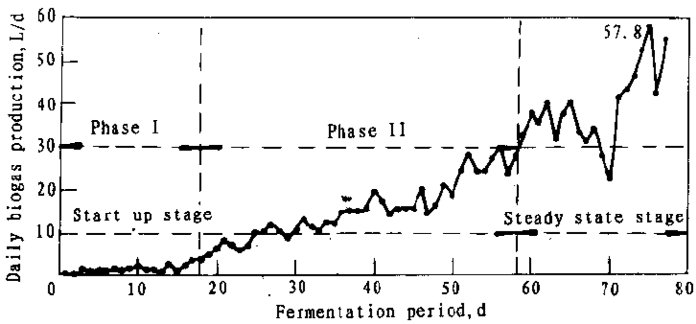

Fig.8 Daily biogas production during fermentation of waste water chicken manure in UBF reactor

tion with partially activated sludge. Such starter provided the material undergoing fermentation with active bacteria agents and their energy and nutritional requirements at the initiation of the digestion process. Furthermore, exposure of the fresh cattle dung and sewage sludge to fermentation, improves its quality as inoculum starter.

During steady state stage operation periods, the rate of biogas production was smoothly increased up to 54.88 L·day per 4.0 fermentation volume, while the COD removal efficiency decreased. The average of daily biogas production during the steady state operation period was 39.34 L/day. These phenomena could be attributed to adaptable microbial in the reactor and bioconversion of the small particles of suspended materials. In this connection, Van de Berg (Van den Berg, 1977) explained that, the highest biogas production, however, since certain methanogenic bacteria have doubling effect. These gave a high efficiency of bioconversion of organic materials and also increases biogas production rate.

The cumulative production of biogas are presented in Fig. 9. During the operation period of the UBF reactor for 77 days. The periodical measurements of methane content of biogas mixture showed 60.80%—65.30% CH_4 while the test ratio was for the other gases, i.e. CO_2, H_2S, and H_2, the highly cumulative gas are attributed to the type of the feeding material as well as to the abundance of mathanogenic bacteria. This result agrees with the results obtained by Hobson and Show(Hobson, 1973), Badjer *et al*. (Badjer, 1979) and Alaa El-Din *et al*. (Alaa, 1984), they reported that composition of the biogas produced by a properly function anaerobic digester should be about 60%—70% CH_4 and 30%—40% CO_2, with small amount of other gases(H_2S, H_2, NH_3, and oxides of N_2). The composition of the biogas is a function of the feed materials.

3.5 Efficiency of biogas production

The average of biogas production efficiency of the UBF reactor to COD consumed was calculated and listed in Table 2. The efficiency of bioconversion of COD consumed to biogas varied according to the rate of COD removal efficiencies and the stage of the digester operation.

The rate of biogas production during the start up stage phase I ranged between 98.96 to 299.41 L/kg COD consumed by average of 173.93 L/kg COD consumed on average 395.30 L/kg COD, and the rates recorded were high throughout the start up stage phase II of operation period,

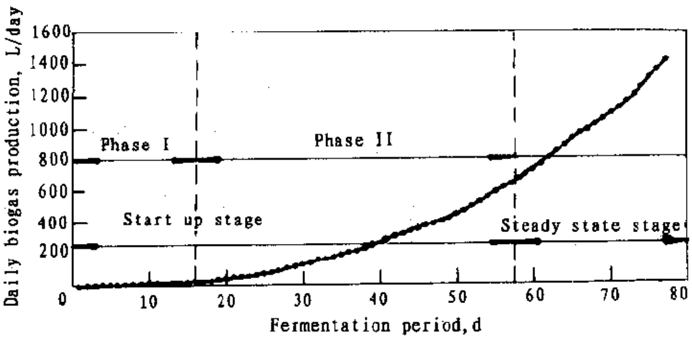

Fig. 9 Total biogas production during fermentation of waste water chicken manure in UBF reactor

the biogas production rate ranged between 200—545. 07 L/kg COD consumed by average of 395.30 m^3/kg COD. On the other hand these rates recorded also throughout the steady state, the biogas production rate ranged between 328. 47—553. 52 L/kg COD consumed on average 437. 34L/kg COD. The efficiency of the UBF reactor was also calculated in relation to the volume of digested material by evaluating the volume of biogas produced per volume of digestion material per day throughout the fermentation periods as well as at maximum production times, i.e. the biogas production rate L/day based on reactor volume. It could be noticed that the production efficiencies ranging between 0.08—0.87 v/(v. day) could be achieved during the start up stage phase I by average of 0.392 v/(v. day). While the range of efficiencies were 0.91—7.00 v/(v. day) at start up stage phase II by average 3.86v/(v. day) and increased to 14.45v/(v. day) at the steady state operation period by average of 9. 83 v/(v. day). This indicates that the reactor is more efficient during the steady state stage. Many investigators evaluated the rate of biogas production for difference models of biogas digesters, among them, Alaa El-Din(Alaa, 1984) reported that, the v/(v. day) for both Indian and Chinese type biogas digesters in winter was 0.05—1.0 v/(v. day), however in summer higher values were achieved. Chinese scientists declared that their units in the field can produce as high as 0.3 v/(v. day) under continuous fermentation. Singh(Singh, 1972), and Indian and Acharya(Acharya, 1963) produces biogas also up to 0.4 v/(v. day) from their biogas digesters. On the other hand, other investigators used poultry manure with their models of biogas digesters, they found that the rate of biogas production were 0.3 v/(v. day) (Jantrani, 1985); 0.8 v/(v. day)(Safly, 1985); 4.0 v/(v. day) (Steinsberger, 1987); and 4.5 v/(v. day)(Huang, 1982).

3.6 Hydrogen ion concentration(pH)

The average of hydrogen ion concentration (pH) in influent and effluent wastewater are presented in Table 2. The pH values ranged between 5.9—8.26 of fresh material, while in the digested material the pH value ranged between 7. 07—8. 6. The depression shown at the influent wastewater (pH) was attributed to the adaptation of microorganisms, organic acids and CO_2 formed from the organic material. When the mathanogenic bacteria is developed and thus consumed the organic acids produces the biogas which show high production rate at the steady state operation stage. McCarty(McCarty, 1964) showed that, the pH of liquid undergoing anaerobic treatment is related to several different acid-base chemical equilibrium. However, at the near neutral pH of interest for anaerobic treatment between 6—8. Stianer *et al*. (Stianer, 1964) reported that, most bacteria are relatively insensitive to external concentration of hydrogen or hydroxyl ions. Many species can grow well at any pH value between 6.0 and 9.0. Barker(Barker, 1956) concluded that the pH range 6.4—7.2 was most effective for methane production and below pH 6.0 and above 8.0 production decline rapidly.

3.7 Granulation process and characteristics

3.7.1 Start up stage

3.7.1.1 Phase I

During this phase the form of new sludge dispersed with growth of poorly settleable filamentous organism. However, towards the end of this phase the washout of biomass occurs. The interface between blanket and bed was clear.

3.7.1.2 Phase II

As a pace load increase, distinct washout of biomass occurs due to excessive bed expansion and presence of flocculant sludge. However, towards the end of this phase, formation for granules take place, and decrease in washout rate, the interface between the blanket and bed is dry clear.

3.7.2 Steady state stage

This phase at the point where the washout rate is less than the yield of newly developed sludge pelletes and presence of the granular sludge. The interface between the blanket and bed was clear, the blanket was distinctly dark.

4 Summary and conclusion

In this experiment carried out to study the possibility of producing a biogas from the poultry manure by using UBF reactor. They results indicates that:

At start up stage phase I covering 17 days the anaerobic sludge was adapted to environmental and operation conditions addition to reactor design and phase II within 41 days had been adapted to a quantitative shock load. Reaching COD concentration of 16522.70 mg/L, *LR* and removal rate 18.17 kg/(m^3·day), 87.79% respectively at the end of this stage. The efficiency of covering COD to a biogas was also studied. The efficiency which reached 93.83% after 49 days from the beginning of start up stage may be due to the activity of innoculum sludge, the quanlity of substrate and/or the kind of UBF reactor.

After 17 days from the beginning of steady state stage, COD concentration reached 21971.29 mg/L, loading rate 41.20 kg/(m^3·day)and biogas production rate to 14.45v/(v·day) with average of this stage for COD concentration 20930.72 mg/L, COD removal rate 80.74% and biogas production 9.83L/d. The aim of this stage is to reach COD-in around 21000 mg/L where COD concentration of waste water poultry manure (liquid phase) was 21500 mg/L. The completion of this stage took 19 days. These results were obtained because the granular sludge has high methane-organic activity, a good settleability, so the reactor could be operated in a stable state at high concentration of COD and high loading rate with high production rate of biogas.

Accordingly, the following recommendations could be considered:

(1) Poultry manure could be used as a substrate to produce a biogas as a clean non-traditional energy; (2) studying the development of the UBF reactor to evaluate the parameters affecting the environment factor such as using temperature less than 35℃; (3) studying the variables affecting *HRT* to reduce it; (4) studying the possibility of using different types of anaerobic filters which could be used to increase the reactor efficiency; (5) studying the effect of reactor to evaluate the suitable reactor volume with maximum efficiency.

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References

Alaa El-Din, MN. Bioenergy report an conservation in Egypt, report presented in Internatioanl workshop on bioenergy recovery an conservation. Boston, Massachusetts, USA: October 13—Nov. 2, 1984

Badjer MD, Bogue DL, Stewart DJ. Neze and Journal of Sciences, 1979; 22:11

Barker HA, Biological fermentation of methane. John Willey and Sons: New York, 1956

Chynoweth DP, Ronisaacson. Anaerobic digestion of biomass. London and New York: Elsevier Applied Science Publishers LTD, 1987; 85:141

Converse JC, GW Evans, KL Robinson, M Gibbson. Methane production from a large-size on farm digester for poultry manure. ASAE St. Joseph, Michigan livestock waste: a renewable resource, 1980; 122

Ghanem II Ibrahim. A study on possibility of using non- traditional energy on poultry farms. MSc. thesis faculty of Agri. Al-Azhar University, Cairo, Egypt, 1992

Gorur SS. Treatment of dilute synthetic wastewater using an up flow sludge blanket filter reactor, MSc thesis, Dept of Civil Eng., Carlton Univ, Ottawa, Canada, 1986

Gramms LC, Polkowski LB, Witzel SA. Trans ASAE, 1971:3

Guiot SR, KJ Kennedy, and L Van den Berg. Proceeding, EWPCA conf. on anaerobic wastewater treatment. Aquatech, 11th international water technology exibition and congress. Amsterdam, 1986; Sep. 15:1

Hills DJ, Ravishanker P. Poultry Science, 1984; 63:1338

Hobson PN, Shaw BC. Water Res, 1973; 7:437

Hobson PN, S Bousfield, R Summers. Methane production from agriculture and domestic wastes, Applied Science Publishers LTD London, 1981:210

Huang JJH, JCH Shin, SC Steinberger. Poultry waste digestion: from the laboratory to the farm, energy conservation and use of renewable energies in the bio-industries, 2nd international seminar, Oxiford and NY, Sep. 6—10:376, 1976

Indian MA, Acharya CN. Biogas plants, Farm bulletin No. 1. Indian Concil of Agri Res, New Delhi, 1963

Jantrania AR, White RK. High solids anaerobic fermentation of poultry manure, Agri Waste Utilization and management, Am Soc Agr Eng St Joseph, Michigan, 1985:73

McCarty PL. Anaerobic waste treatment fundamental, II-environment requirement and control, Public Works, 1964; October 123

Safley LMJr, Vetter RL, Smith D. Managing poultry manure anaerobic digester, Agr waste utilization and management. Am Soc Agr Eng, St Joseph, Michigan, 1985; 491

Shin JCH. Anaerobic digestion of poultry waste and by-product utilization, Proceedings of the national poultry waste management symposium, department of poultry science, Ohio State University, Columbus, Ohio, 1988; 45

Singh RG. Compost Science, 1972; 13:20

Stanier RY, Doudoroff M, Adelberg EA. General microbiology, 2nd Ed. McMillan, London, 1964

Steinsberger SC, Ort JF, Shih JCF. Poultry Science, 1987; 66:634

Standard methods for the examination of water and waste water, 16th Ed Am Public health Assoc, Washington, D.C:, 1985

Van den Berg L. Can J Microbial, 1977; 23:898

Van den Berg L. Use of anaerobic down flow stationary fixed film reactors for waste treatment and methane production, Report division of biological Sciences, national Research Council of Canada, Ottawa, KIA OR6, 1983:52

Ven den Berg L, KJ Kennedy, S Guiot. The down flow fixed film and up flow blanket filter reactor, Proceeding of 4th international symposium on anaerobic digestion hold in Guangzhou, China. 1985; November 11—15:303

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