Characterization of Activated Sewage Sludge And Biogas Production By Anaerobic Digestion Method

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Abstract- *The biogas production from the activated sewage sludge by anaerobic digestion method and analysis of activated sewage sludge characteristics are investigated in this study. The anaerobic digester is filled with the cow dung and water with the ratio 1:3 and stabilized. Latter the ASS is fed with organic loading rate 998.78 kg COD/m^3/day for 20 and 560 kg COD/m^3/day for 15 days respectively. The maximum yield of biogas for the organic loading rate of 560 kg COD/m^3/day is 78.38 L/day on 18th day and for the organic loading rate 998.78 kg COD/m^3/day is 65.38 L/day on 7th day is observed. In the experimental work, anaerobic digestion of activated sewage sludge is carried out. It has been observed that biogas production and contaminants reduction will be more for the OLR of 560 kg COD/m^3/day and the reduction of Total organic content, total solids, volatile solids, chemical oxygen demand, nitrogen, phosphorous for the of 560 kg COD/m^3/day is 85%, 69%, 69.8%, 85.78%, 4.4%4.2% .The effluent from the anaerobic digester is tested for the heavy metals. The obtained results are within the desirable limits for the land disposal.*

Keywords- Activated sewage sludge, anaerobic digestion, Cow dung, Biogas.

I. INTRODUCTION

Sewage water containing the excess amount of organic contents which causes several environmental issues. By discharging the sewage directly into the revers or any water bodies results in the formation of eutrophication algal boom etc. In order to overcome this effects the treatment of waste water or sewage treatment plant are adopted.

The anaerobic/oxic /anoxic (A^2/O) process are implemented in many municipal waste water treatment along with the activated sludge process. Sewage Sludge is a by-product from the sewage treatment plant process. As the number of waste water treatment facility increases there is increases the sludge production. Because of this the excess production of sludge from the activated sludge process and its disposal and treatment is one of the severe Problem and environmental issues in the waste water treatment process.

In sludge treatment process the recovery of energy by the anaerobic digester can be obtained. So, part of the waste water treatment plant energy demand can be fulfilled by the sludge digestion and energy generation from biogas. This biogas produced mainly based on the initial characteristic of the sewage sludge such as as total solids(TS), volatile solids (TS), total organic content (TOC), nitrogen (N) etc.Sewage sludge treatment involves several methods such as biological anaerobic digestion, thermal process and incineration.

From the literature reviews, anaerobic digestion is one of the best method to treat sludge. Anaerobic digestion (AD) is a process in which the easily degradable waste solids are metabolised and produce biogas along with some other gases through biological reactions

Anaerobic digestion helps in stabilization of sludge. Latter the resulted digested sludge can be used for the landfill/ agriculture as a manure.

II. MATERIALS

The present work comprised mainly the anaerobic digester which contains digester tank, Gas holder, inlet value and outlet value. The main aim of the work is to analysis the sewage sludge character and biogas production. Hence the anaerobic digester are organized in such a way that to get maximum biogas Yield by creating anaerobic condition.

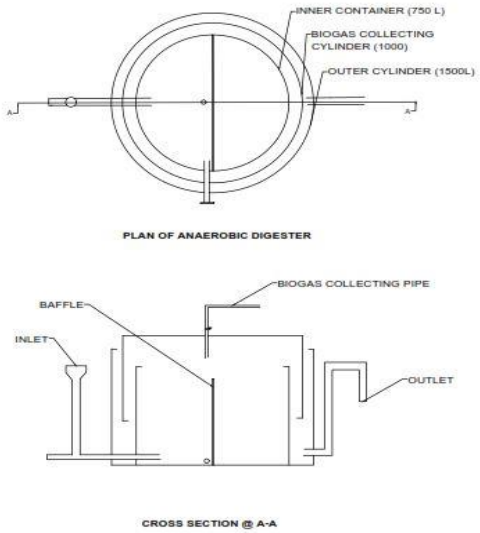
A Collection of activated sewage sludge

Sampling materials is selected in such a way that it should not react with the raw activated sewage sludge. Here for the intended work plastic container and bottles were used to collect activated sewage sludge. As the activated sewage sludge is hazardous to the health percussions have taken by using the hand gloves and mask, because the collections are done manually. Here we followed the grab sample method, were the sample consists of several grab sample over a period of time i.e. 15 days.

Anaerobic digester

Anaerobic digester, as the name itself indicate there is an anaerobic condition inside the digester tank. It which biochemical decomposition of complex organic compounds in the sewage sludge and helps to release the energy rich biogas and nutrias effluents through biochemical processes. Here, anaerobic digester are made up of plastic which is non-reactive, so that it should not change the activated sewage sludge quality. Anaerobic digester consists of digestion tank, gas holder, and inlet and outlet pipe.

Anaerobic digester



Schematic Plan and Cross Section of Anaerobic Digester

III. METHODOLOGY

Initially to know the condition of the activated sewage sludge laboratory tests are conducted for the initial characteristics of ASS. To enhance the biogas production, beginning the digester is filled with the 1:3 ratio of cow dung and water respectively. The gas produced during this period is released and allow it for stabilization. The reason for this is to give microbial load to the ASS degradation.

After complete stabilization, 2 liters of activated sewage sludge or with organic loading rate of 560 kg COD/m^3/day is mixed with the water in the ratio 1:4 and feed to digester every day at the same time for about 20 days. The biogas daily produced is calculated in terms of litters. After 20 days of feeding digester is allowed to complete stabilization and effluents are collected and laboratory test are carried out to know the decrease of impurities in the effluent.

The same procedure is carried out for four liters of sewage sludge with organic loading rate 998.78 kg COD/m^3/day for about 15 days.

IV. RESULTS AND DISCUSSION

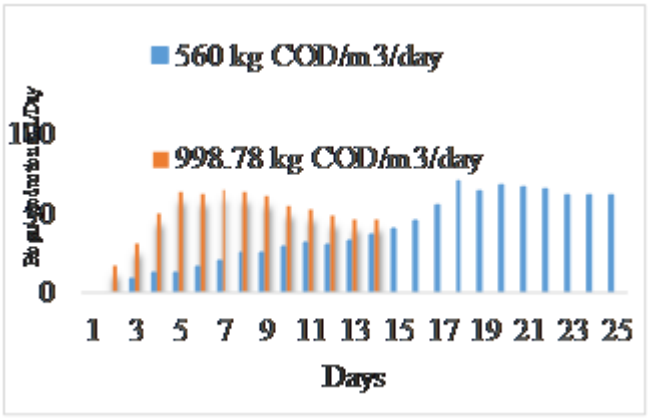
The activated sewage sludge obtained from the sewage treatment plant of JNNCE, Shivamogga is analyzed for the various parameters. Analysis showed that ASS is rich enough to produce the biogas, which means organic content is more. Hence it is subjected to the anaerobic digester to produce the biogas and calculated the amount of biogas produced. After the completion of digestion process the effluents are tested for the various parameters and found the drastic reduction in the Activated sludge. The cow dung used for the experiment in order to give the microbial load to the anaerobic digester is also analyzed before its stabilized condition.

Parameter	ASS for OLR 560 kg COD/m^3/day Before Treatment	ASS for OLR 560 kg COD/m^3/day After treatment	ASS for OLR 998.78 kg COD/m^3/day Before treatment	ASS for OLR 998.78 kg COD/m^3/day After treatment
Total solids (mg/L)	1860	574.94	1783.0	836.84
Volatile solids (mg/L)	1620	488.448	1460.0	560.33
Chemical oxygen demand(mg/L)	1,40,000	19899.5	1,23,598	24589.7
Volatile fatty acids(mg/L)	210	224.60	209	298.54
Water content (%)	66	47	62	52

The Characteristics of Activated Sewage Sludge before and after its treatment.

A. Biogas production

In the entire experiment, the different organic loading rate 560 kg COD/m^3/day for 20days and 998.78 kg COD/m^3/day for 15days respectively



Variation of Biogas Production with respect to the days for the Organic Loading Rate.

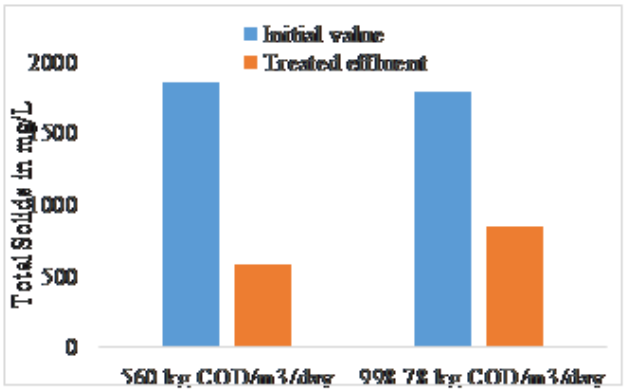
OLR kg/ m^3/day	Day on which biogas yield is maximum	Maximum yield of biogas in L/day
560 kg COD/m^3/day	18	70.38
998.78 kg COD/m^3/day	7	65.38

The optimum Biogas produced for the different Organic Loading Rate

For the OLR 560 kg COD/m^3/day loaded for 20 days, the biogas production increases day by day and the observation showed that the optimum yield is 70.38 L/day on 18th day. Later the yield of gas decreases and produced in between 60 to 65 L/day. For the OLR 998.78 kg COD/m^3/day loaded for 15 days, the biogas production increases suddenly and later its get decreased and produced in between 45 to 50 L/day.

B. Total Solids

Total solids is the summation of suspended and dissolved solids. TS is directly proportional to the production of the biogas.

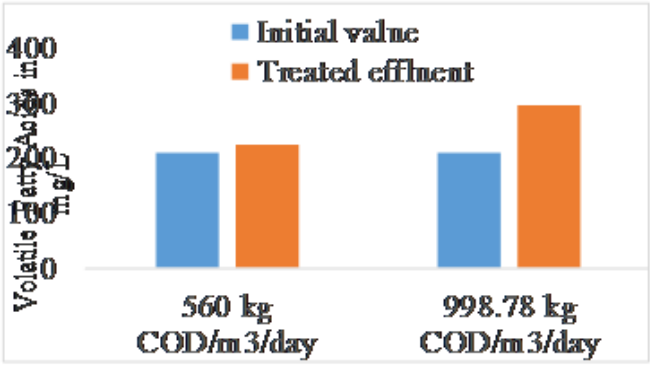


Variation of Total Solids with respect to the ASS and treated effluent

For the organic loading rate 560 kg COD/m^3/day the reduction of volatile solids is 69.8% and for the 998.78 kg COD/m^3/day the reduction of total solids is 61.62%. The reduction of TS is more for the OLR 560 kg COD/m^3/day where the biogas obtained is also more when compare with the OLR 998.78 kg COD/m^3/day

C. Volatile Fatty Acids

Volatile fatty acids are essentially used by the microorganisms for their growth and VFA are the main source of energy. Around 70% of total energy is obtained from this. Volatile solids place a vital role for the methane generation and fermentation in the anaerobic digestion.



Variation of Volatile Fatty Acids with respect to the ASS and treated effluent for the organic loading rate 560 kg COD/m^3/day and 998.78 kg COD/m^3/day.

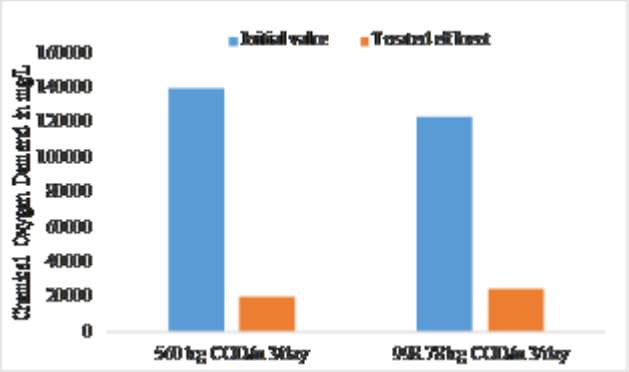
As the rate of degradation of organic compound increases the VFA will also increases which results in increasing the biogas production. Here for the OLR 560 kg COD/m^3/day the biogas production increased because of increase in the VFA and the increasing percentage is 6.9% from initial to final. Whereas, for the OLD 998.78 kg COD/m^3/day the percentage of increasing in VFA is 47% which is affected to the biogas production. This is because of

the increasing in the VFA will shift the pH scale to acidic medium and effect to microbial community.

D. Chemical Oxygen Demand

Chemical oxygen demand is indicative measure of oxygen required to complete the reaction for the measured solution. It is also measured by means of organic strength of the sludge. It is expressed in terms of mg/L.

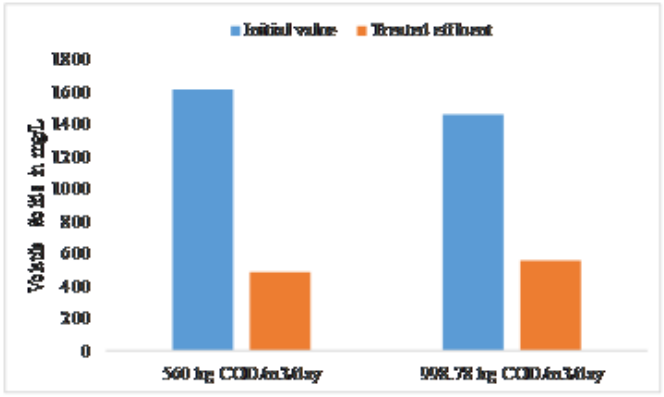
In anaerobic digestion, during the hydrolysis and acetogenesis process this COD is converted as VFAs which is the main source of energy for the microorganism. Here for the OLR 560 kg COD/m^3/day the reduction in COD is 85.78% and for the OLD 998.78 kg COD/m^3/day the percentage of reduction in COD is 80%. With increasing in COD there is decrease in the biogas production as because of conversion of COD into VFA will shift the pH value to ACIDIC and effects to the microbial community.



Variation of Chemical Oxygen Demand with respect to the ASS and treated effluent for the organic loading rate 560 kg COD/m^3/day and 998.78 kg COD/m^3/day.

H. Volatile Solids

Volatile solids are the solids obtained after loss of dry solids by ignition (at 550˚C). The ratio of VS/TS will give the concentration of volatile organic substances in order to support the rapid hydrolysis in anaerobic digestion method. Volatile solids considered as the main component for the production of methane in the biogas production.



Variation of Volatile Solids with respect to the ASS and treated effluent for the organic loading rate 560 kg COD/m^3/day and 998.78 kg COD/m^3/day.

The volatile solids reduction for the OLR rate 560 kg COD/m^3/day and 998.78 kg COD/m^3/day is 69.8% and 61.62% respectively. The reduction of this will recommend the further reaction required for the biomethanation in the anaerobic reactor. In the present work it is observed that the reduction of volatile solids is more for the OLR 560 kg COD/m^3/day.

I. Analysis of heavy metals for the disposal of treated effluent to the land disposal

Parameters in (mg/L)	Indian Limits (mg/L)	Treated effluent for OLR 560 kg COD/m^3/day	Treated effluent for OLR 998.78 kg COD/m^3/day
Cadmium (Cd)	3 – 6	< 0.05	< 0.05
Chromium (Cr)	800	-	-
Nickel (Ni)	100	< 2	< 2
Copper (Cu)	135 – 200	< 0.25	< 0.25
Iron (Fe)	75 – 150	3.3	3.3

Comparison of Heavy Metals Content in the Treated Effluent with .the "Indian Limits".

From the results, it clear that the heavy metals content in the treated effluent is negligible when compared with the "Indian limits" for the land disposal of treated ASS.

V. CONCLUSION

- Development of methodology and to treat the activated sewage sludge.
- Yield of biogas obtained from anaerobic digester is maximum for the OLR 560 kg COD/m^3/day.

- Even though the reduction is not completely possible we got the maximum reduction of unwanted materials for the 560 kg COD/m^3/day of OLR.
- AS the effluent is within the desirable limits we can dispose them on land.

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