ANAEROBIC CODIGESTION PROCESS AND PRETREATMENT

[1]Madhanmohan T, [2]Santhosh J

[1]PG Student, Department of Civil Engineering, Periyar Maniammai University, Vallam, Thanjavur.

[2]Assistant Professor, Department of Civil Engineering, Periyar Maniammai University, Vallam, Thanjavur.

ABSTRACT

It is believed and throughvarious experimental studies, it is identified that the anaerobic digestion is one of theviable technologies to convert solid waste in to energy form Further the anaerobic digestionisdevelopedinthewayofco-digestionprocesseswhereasingleorvarioussubstratesadded togetherthroughthisco-digestionprocess,C/Nratioandbufferingcapacityisbalancedfor digestion.Moreover,thegasproductionwillbeincreased.Hence,thisstudyfocustowardstheutilizationofkitchenwaste,slaughterhousewaste andPoultrylitterassubstrateforco-digestionprocess.Thecharacteristicsofsubstrates andinoculumandinfluentwereanalysed. Continuous monitoring was done to measure the gas production. Similarly,theotherenhancingtreatmenttechnique modes wasadoptedaspre-treatment for substrates in thermal, chemical and thermochemical. The treated substrates were allowed for digestion and the gas production wereobserved. It is observed that the kitchen waste, slaughter house waste and poultry litter The experimental study observed the efficiency of gas production is more in pre-treated substrates. The digester without pre-treatment for 13days gas production observed 53 ml similarly for chemical treatment 210 ml for thermal treatment 70 ml and thermochemical treatment 65 ml.

1. INTRODUCTION

Anaerobic digestion (AD) is one of the simplest and well-studied technologies for stabilizing organic wastes. Among the treatment technologies available for treating organic solid wastes(OSW), AD is very suitable because of its limited environmental impacts and high potential for energy recovery Such positive aspects coupled with the recent concerns on rapid population growth, and global warming have promoted further research on the AD process development and improvement in order to enhance biogas production, achieve faster degradation rates and reduce the amount of final residue to be disposed AD is a biological process that converts complex substrates into biogas and dig estate by microbial action in the absence of oxygen through four main steps, namely hydrolysis, a biogenesis, acetogenesisand methanogens. Most researchers report that the rate-limiting step for complex organic substrates is the hydrolysis, due to the formation of toxic by-products (complex heterocyclic compounds) or non-desirable volatile fatty acids (VFA) formed during the hydrolysis whereas methanogenesisis the rate-limiting step for easily biodegradable substrates Extensive research has been conducted on pretreatment methods to

accelerate the hydrolysis step

In addition of pretreatment is one of the enhancing method to speed up the reaction of anaerobic digestion and increasing the efficiency of gas production level. It also reducesthe fermentation time period too.

Food waste and vegetable waste collected from college canteen and hotel and poultry litter were collected from poultry farming and then slaughter house waste were collected from meat selling shops and then inoculums were kept from cow farming.

1.1 Objectives ofthe Study

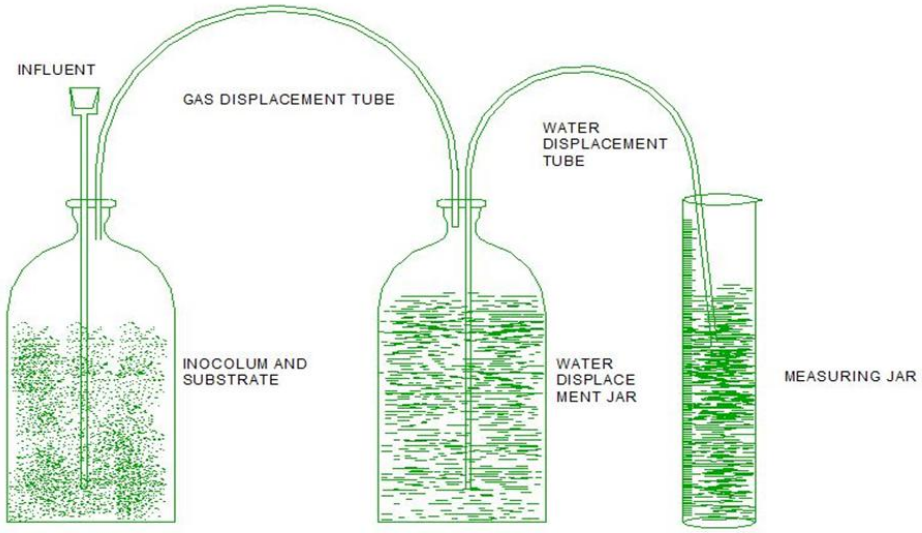
To increase the efficiency of methane by co-digestion similarly, the other enhancing treatment technique will be adopted as pre-treatment for substrates in thermal, chemical and thermochemical methods

1.2 Experimental work

A lab scale reactor was set to have 0.5 litres of capacity. Initially we fed cow dung as an inoculum for about 15 days. After that food waste, vegetable waste, poultry litter and slaughter house waste were fed in equal proportion about 0.2 litres. The thermal, chemical and thermochemical treatments also were having the same proportion of feed with the same inoculum and substrates. For keeping the reactor alive, we underwent some tests which all are completely about chemical characteristics such as pH, COD, Total solids and Volatile solids.

1.3 Reactor working principle

A reactor was set to have anaerobic conditions. It works with wastes of easily biodegradable. This can result in production of gas which was observed and measured by water displacement method. The container of 0.5 litres capacity behaves as the reactor while the jar filled of water works with the water displacement method. The measuring jar of 100 ml capacity was placed behind the jar of water. All three were connected. The digestion on wastes which we fed causing production of gas which was displaced through tubes and collected at measuring jar which can sow the quantity of gas produced.



GAS MEASUREMENT IN WATER DISPLACEMENT METHOD

1.4Digestion and co digestion

Anaerobic digestion is a process by which micro-organismsbreak down biodegradable material in the absence of oxygen. Anaerobic digestion can be used to treat various organic waste and recover bio energy in the form of biogas, which consist mainly of CH_4 and CO_2.

It is considered to be a process of digestion process but with multiple biodegradable substrates in a single anaerobic digestion system.

Two or more substrates Major amount of a main basic substrates + Minor amount of additional substrates.

1.5 Objectives of the study

The main objective is to increase the efficiency of methane by co-digestion. Similarly, the other enhancing treatment technique will be adopted as pre-treatment for substrates in thermal, chemical and thermochemical methods

1.6 Substrate and inoculums

Here the substrate was vegetable waste, food wastes, slaughter house waste and poultry litter waste. The above said wastes were fed in equal proportion which comprises to give substrate of this reactor along with inoculum. On discussing inoculum, we took cow dung as it helps in developing microorganisms for digestion. It was taken in a moist and humid state. The time which the reactor was set to be with inoculum is about 15 days.

1.7Analysis of the characteristics of substrate, inoculum and influent

- The characterisation have been done for both substrate and inoculums materials
- They arepH, chemical Oxygen Demand, Volatile Solids, Total solids.

Fig.1 characterization of waste

Table no 1 – Influent, inoculum and substrate character analysis

S.No	Tests	Type of waste					
		Food waste	**Vegetable waste**	**Slaughter waste**	**Cow dung**	**Poultry waste**	**Influent**
1.	pH analysis	4.84	5.57	5.92	7.49	5.78	6.47
2.	Total solids in %	51.1	23.16	29.75	0.48	82.6	65.24
3.	Volatile solids(based on total weight) in %	23.95	11.31	12.06	16.52	15.41	19.26
4.	Volatile solids(based on total solids) in %	17.90	8.58	10.09	14.28	9.62	12.14
5.	COD mg/l	230	260	2343	470	1240	1456

Fig.2 pH and Total solids of Substrates

Experiment 1 (Co digestion process without pre-treatment)

In this analysis, we just go without any pre-treatment. The inoculum was initially tested for its total solids and was set to be undisturbed with the reactor. The wastes we fed was food waste, vegetable waste, poultry litter waste and slaughter house waste. Initially different inoculum characters was analysed and finally set to proper.

Table no 2 - Daily observation of gas production (without pre-treatment)

S.No	Duration (days)	Cumulative methane production(ml)
1.	Day1	70
2.	Day2	125
3.	Day3	30
4.	Day4	40
5.	Day5	35
6.	Day6	25
7.	Day7	15
8.	Day8	30
9.	Day9	53
10.	Day10	35
11.	Day11	23
12.	Day12	16
13.	Day13	-

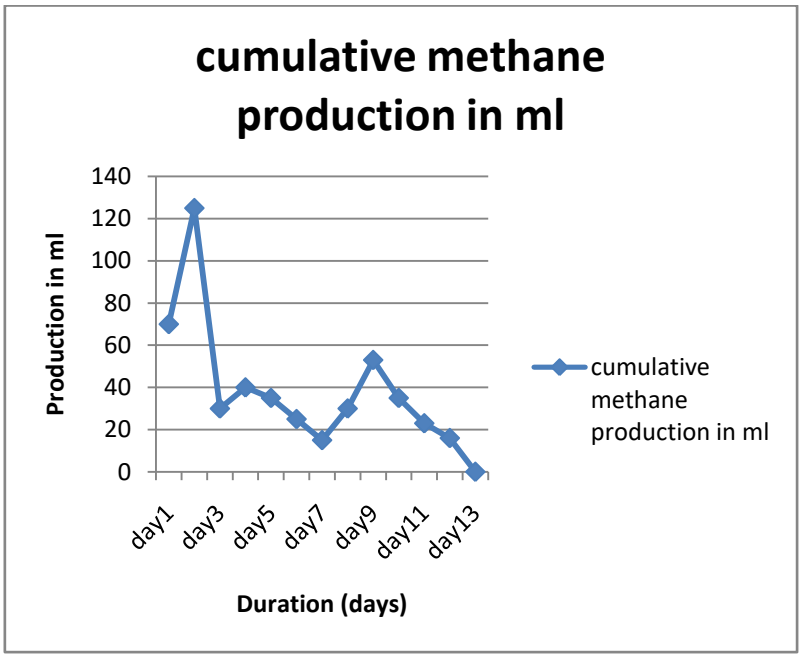


Fig.3 Results without pre-treatment

Experiment 2 – Alkali treatment

In this method of treatment of substrate, we added alkali to maintain the chemical characteristics. We tried in two proportions. Adding 0.3mg/l of NaOH to the substrate and 0.6mg/l of NaOH to the substrate. As a result of these proportions, adding 0.3 mg/l of NaOH to the substrate gives higher production of gas.

Table no 3 - Daily observation of gas production (Alkali treatment)

S.No	Duration	Cumulative % of methane in 0.3mg/l	Cumulative % of methane in 0.6mg/l
1.	Day1	42	60
2.	Day2	9	48
3.	Day3	30	50
4.	Day4	45	65
5.	Day5	60	69
6.	Day6	55	80
7.	Day7	45	210
8.	Day8	46	45
9.	Day9	60	38
10.	Day10	55	40
11.	Day11	62	39
12.	Day12	49	21
13.	Day13	-	-

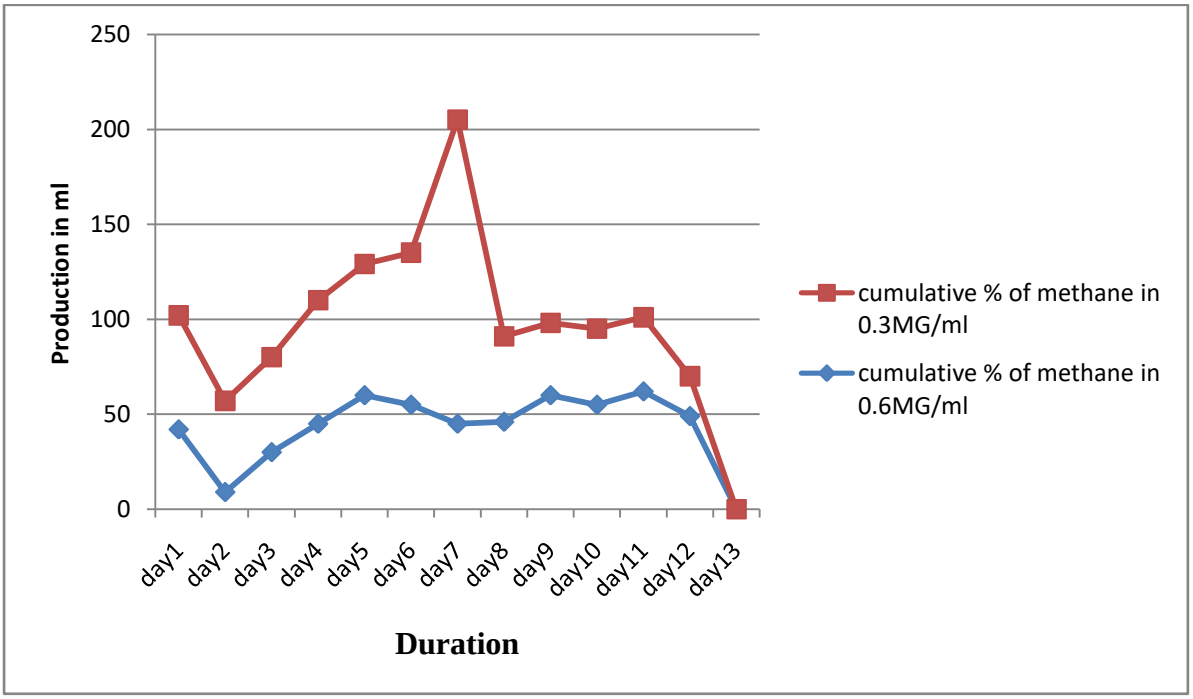


Fig.4 Results with alkali treatment

Experiment 3 – Thermal treatment

In this method of treatment of substrate and inoculum, we treat them both with heat. On daily basis it was heated at 100° C and as well as 70°C for one hour every day. The inoculum and substrate were heated with the help of water bath. As the results came, the reactor underwent treatment of heat about 70°C was given higher production of gas.

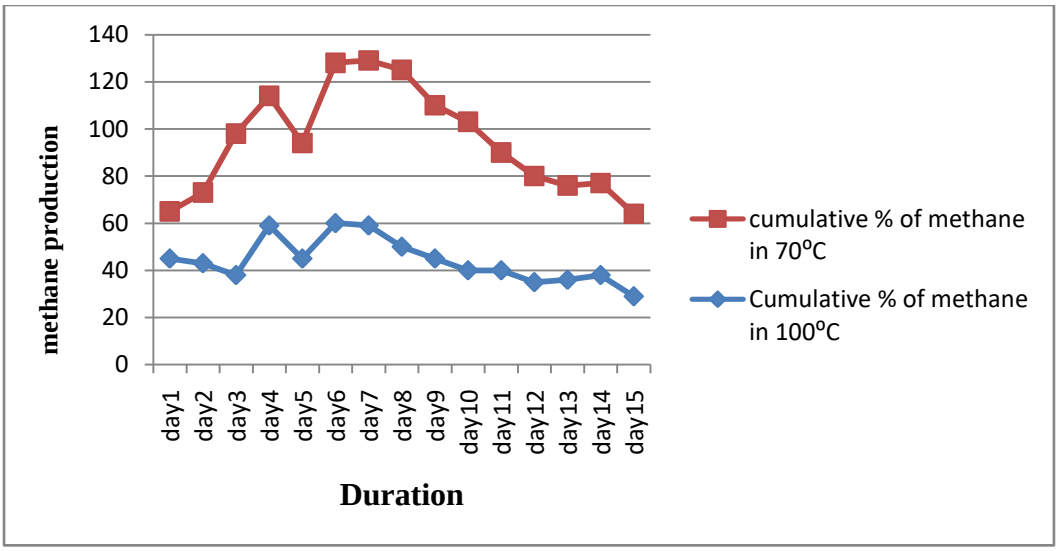


Fig.5 Results with thermal treatment

Table no 4 - Daily observation of gas production (Thermal treatment)

S.No	Duration	Cumulative % of methane in 100^0C	Cumulative % of methane in 70^0C
1.	Day1	45	20
2.	Day2	43	30
3.	Day3	38	60
4.	Day4	59	55
5.	Day5	45	49
6.	Day6	60	68
7.	Day7	59	70
8.	Day8	50	130
9.	Day9	45	65
10.	Day10	40	63
11.	Day11	40	50
12.	Day12	35	45
13.	Day13	36	40
14.	Day14	38	39
15.	Day15	29	35

Experiment 4 – Thermochemical treatment

This method of treatment is quite different as we treat both the substrate and inoculum with chemical as well as thermal processes. As far as we gone through 0.3mg/l and 0.6mg/l of NaOH proportions as well as 100°C and 70°C proportions, we go with mingling the both. Proposing a reactor of Alkali 0.3mg/l in concentration and of heat 70°C, a reactor of 0.3mg/l of alkali concentration and of heat 100°C. also having reactors proposing 0.6mg/l of alkali concentration followed by 70°C and 100°C of heat in control. Upon all these four reactors, the reactor having 0.3mg/l of alkali concentration with 100°C of heat produces higher quantity of gas.

Table no 5 - Daily observation of gas production (Thermochemical treatment)

3.Thermo Chemical treatmentS.No	Duration	Cumulative % of methane in 0.3mg/l at 70 °c	Cumulative % of methane in 0.3mg/l at 100°c	Cumulative % of methane in 0.6mg/l at 70 °c	Cumulative % of methane in 0.6mg/l at 100°c
1.	Day1	55	65	58	69
2.	Day2	53	60	62	64
3.	Day3	54	63	57	60
4.	Day4	50	57	50	56
5.	Day5	47	54	47	50
6.	Day6	40	50	40	45
7.	Day7	32	47	35	40
8.	Day8	28	40	28	33
9.	Day9	24	33	23	28
10.	Day10	15	25	17	20
11.	Day11	11	17	10	13
12.	Day12	8	12	4	9
13.	Day13	-	-	-	-

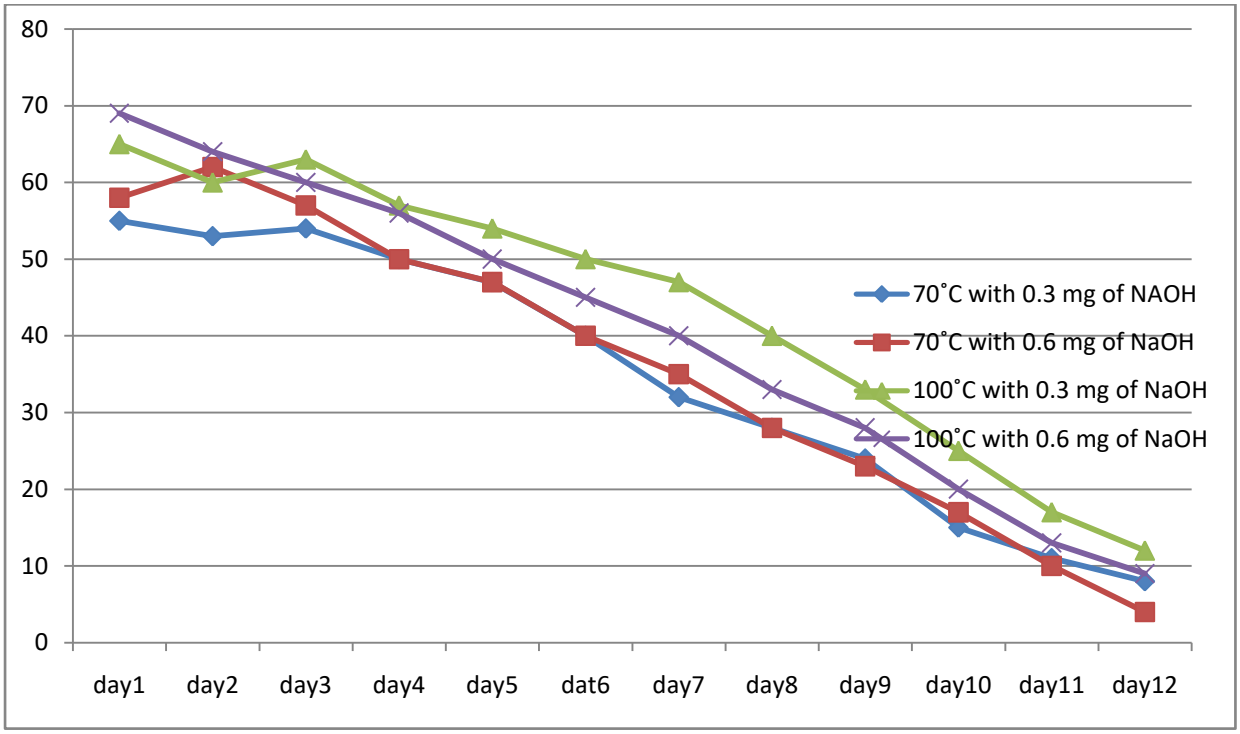


Fig.5 Results with thermochemical treatment

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RESULT AND DISCUSSION

The most remarkable characteristic of this waste was the high content of organic matter, expressed as total COD and the fractions VS/TS). The percentages of VS in TS and VDS in TDS are 67.0% and 63.0%, respectively. Anyway, the large amount of suspended solids (more than 80.0%) and the relatively low content of dissolved matter make pre-treatment necessary, in order to enhance the chemical oxygen demand (COD) solubilisation. As a result, a higher efficiency of the anaerobic digestion process must be achieved.

And to comparing to normal treatment and pre-treatment. Alkali treatment processing of substrate gives higher production of gas. As well as Thermal treatment also gives good efficiency at 70^{o}C of heat.

The pH value at the waste material is 6.47 and the inoculum were fed in to 15 days fermentation. The ratio of water and solid is 1:1 and the food waste vegetable waste , slaughterhouse and poultry litter were added in to equal proportion and substrate and inoculum both were heated up to 100^{o}c and 70^{o}c for this waste composition in 70^{o}c giving more efficiency of gas production value .

CONCLUSION

It is observed that the kitchen waste, slaughter house waste and poultry litter The experimental study observed the efficiency of gas production is more in pre-treated substrates. The digester without pre-treatment for 13days gas production observed 53 ml similarly for chemical treatment 210 ml for thermal treatment 70 ml and thermochemical treatment 65 ml

The findings of this study shows chemical treatment is giving good efficiency of gas.

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