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STUDY OF ANAEROBIC REACTORS OF BIOMETHANATION

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ABSTRACT

Bio-methanation of slurries of manures, dairy waste, organic solid waste of Celluloid nature yields CH_4 using specially designed anaerobic reactors. Continuously stirred tank reactors under go wet digestion (low solid) Ts <20% or dry digestion (high solids) Ts>20%. Depending upon nature of batch reactors are fluidized bed, hybrid, batch, buffed anaerobic filters, blanket reactors are widely used, Anaerobic treatment is collection of biological processes by which micro-organism break down biodegradable materials in absence of O_2. The most of organic carbon is converted to biogas ($CH_4 + CO_2$) while little goes to residual mass.

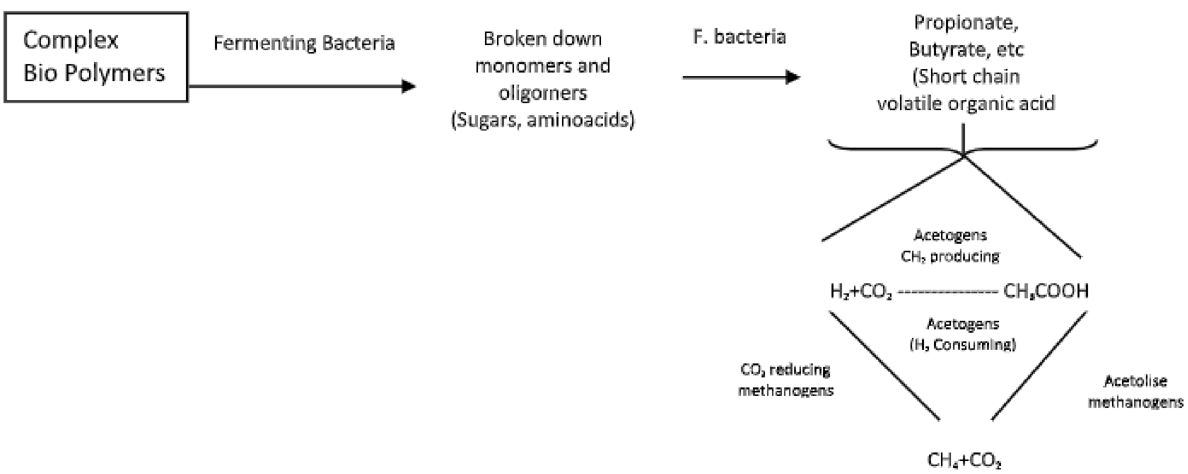
Anaerobic procedure yields 80% of Bio-gas with only 5% of residual slurry as compared to aerobic mode gives both 45% of bio-gas & residual slurry.

KEY WORDS-

Reactor, slurry, biomass, bio-gas, bio-methanation, yield, anaerobic, sludge, COD, effluent, Aeration, microbes.

INTRODUCTION-

Carbon foot print of organic pollutants indicator of bio-gas yields under the set conditions of pH, temperature, retention time of the batch under experimentation. Four stages of Biomethanation are hydrolysis, acido genesis, Acetogenesis, and finally controlled methanogenesis.



Anerobic treatment together requires less energy and involves less operational and maintenance cost and involves energy production, tolerance to high organic loads, application in small & large scale, low nutrient consumption. low production of solid, low land requirement are aided of aided advantages of anaerobic digestion. Bio chemistry and microbiology, unsatisfactory removal of $N_{2,}$ P and phathogens, bad odour and inhibition of micro-organism are main disadvances of it.

(**<u>Source :</u>** Adapted from chericharo and campus (1995), von sperling 1995, Lettings et.aL. (1996)

(de-Lemos chermi charo C.A. (2007) anaerobic reactors biological waste water treatment series Vol. IV IWA publishing.

EXPERIMENTAL LITERATURE AND NOTES:

The ratio of volatile to total solids (Vs/Ts) is indicator of the organic fraction in the substrate solids and its level of digestion

for undigested sludge Vs/Ts = 0.75 – 0.8

for digested sludge Vs/Ts = 0.6 – 0.65

Specific gravity of fixed solids (S_{FS}) is approximately 2.5, while specific gravity of volatile solids (S_{vs}) is approximately one.

Specific gravity of solids = 1/[{Fs/Ts/S_{FS}] + {(Vs/Ts/Svs}]

Specific gravity of Sludge = 1/[(solid fraction in sludge/solid density) + (water fraction in sludge/1)]

Process required for oxidation of the influent organic matter (BOD) along with cell growth endogenous respiration of micro organism. It is used as an electron acceptor in the energy metabolism of the aerobic heterotrophic micro-organism present and O_2 requirement can be computed as

Total O_2 requirement (g/d) = $\frac{Q\ (So-S)}{f}$ f= ratio of BOD to ultimate BOD

The O_2 required for biomass (=1.42 g/d of biomass) produced as a result of substrate utilization that is required to be substrated from the theoretical O_2 requirement

Total O_2 (g/d) = $\frac{Q\ (So-S)}{f}$ - 1.4 Qn X_R

if nitrification has to be considered the O_2 requirement for nitrifievrs need to be added

Total O_2 (g/d) = $\frac{Q\ (So-S)}{f}$ - 1.42 Qn X_R + 4.57 Q (No-N)

No is the influent TKN Conc. mg/L and 4.57 is the conversion factor the aeration equipment must be capable of maintaining dissolved O_2 of level about 2mg/L with mixing solid liquid phases.

SRT relates to the total mass of the solids in the system (use TSS) & MCRT that is the mass of the bacteria in the system (use vss)

MCRT = θC $\frac{VX}{Qn\ Xr + (Qo-Qn)Xe}$

θ= hydrolic retention time (d) = v/q

So = Influent Substrate cone.

S= Efluent substrate cone.

INFERENCES AND NOTES:-

1. Risk of acidification with too high organic looding rate (OLN)
2. Not much activity of digested if temp less than 15^0c

   ideal range

   30-40^{o}c mesophilic

45-60^{o}c thermophilic

3. The time that input material stays in the reactor (days)

   HRT = V/Vs of reactor of input perday is 10-40 days.
4. Higher C/N reduces gas production & lower ratio produces NH_3 as inhibitor (Ideal C/N 16-25.
5. Ideal particle size a < 5 cm increase surface area of material and faster degrade by microbes.
6. Suitable condition for reactor

   solid (dry matter content in feed waste 08%)
   C/N 20 : 1 to 30 : 1
   Temp 25 -35 ^{o}c
   pH 6.8 – 7.2
   SRT 60 – 90 days
7. Chemical Phosphorus – Ca3 (PO_4) Ca_3 (OH) $(PO_4)_2$, ALx (OH)y (PO_4)z Fex (OH)y $(PO_4)_2$, Fe_3 $(PO_4)_2$
8. Some bacteria can use a P compound as energy source. P accumulation organism (POAs), can store excess.

Table-1

Material	C/N ratio	% ratio
Dry Rice straw	67:1	42/0.53
Dry wheet straw	87:1	46/10.53
Corn falks	53:1	40/0.75
Fallen leaves	41:1	41/1
Grass	27:1	14/0.54
Fresh cattle dung	25:1	7.3/0.29
Fresh Pig manure	13:1	7.8/0.60
Fresh human waste	29:1	2.5/0.85

Table – 2

Technology	Crew thickener	Drum thickener	Belt Thickener	Centifuge
DS Content	4-7%	5-7%	5-7%	5-7%
Polymer Consumption	2-6 g/Kg DS	2-6 g/Kg DS	2-6 g/KG DS	1-1.5 g/Kg DS
En. Consumption	Low	Low	Low	High
Maintenance	Low	Low	Low	Low
Capacity and Remark	20-100 m3/h	10-70 m3/h	24-180 m3/h	5-200 m3/h

Table -3
Effect of Solution pH on uptake by plants

Plants	Solution pH	Uptake (mg/h) from $(NH_4)_2$ HPO_4	
		NH_4^+	$H PO_4^{-2}$
Fodder legumes	4.8 6.6 7.4	0.23 0.89 1.26	1.11 0.13 0.06
Wheat	5.3 6.7 7.3	1.40 1.86 2.26	0.92 0.28 0.10

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