Bio-Hydrogen Production from the Dairy Waste Water using Anaerobic Sequence Batch Reactor

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Abstract— Energy is an urging need of the daily life is going on depleting while the demand for is increasing with this time bio-hydrogen technology provides an alternative source of energy and hails as an typical appropriate technology that meets the basic need for cooking fuel in rural India. The main objective of the study is to produce the bio hydrogen from dairy waste water with in oculums by anaerobic sequncing batch reactor, which can be used to improve the conditions favourable for H2 production. A study was undertaken to know the possibility of producing bio-energy from wastes generated in industry. Dairy wastewater was evaluated for biological hydrogen production in conjugation with wastewater treatment in a suspended growth sequencing batch reactor (AnSBR). The horse manure is used as inoculum.The minimum and maximum level of hydrogen is produced from different HRT loading rates such as 72 HRT, 96 HRT,120 HRT, and 168 HRT loading. The reactor was designed with 34.3cm diameter and 57.4cm height, the gas escape valve is 1.5cm, substrate fill valve is 13.3cm are provided. The reactor was coated with AMBER, which is used to restrict the absence of light energy in AnSBR.

Key words: Bio-hydrogen; Chemical oxygen demand (COD); Biological oxygen demand (BOD); Dairy wastewater; Horse Manure; Bio-energy; Anaerobic sequencing batch reactor (AnSBR)

I. Introduction

A. General

Biogas is produced by anaerobic digestion with anaerobic bacteria or fermentationof organic matter. It can be produced from regionally available raw materials such as recycled waste and is environmentally friendly. Additionally, it is a renewable energy source, like solar and wind energy.

Biogas typically refers to a gasproduced by the breakdown of organic matterin the absence of oxygen. The biodegradable materials such as manure,sewage,green waste, municipal waste, material, and crops. It is primarily methane(CH_4) and carbon dioxide(CO_2) and may have small amounts of hydrogen sulphide(H_2S), moisture and siloxanes.

The gases hydrogen, methane, and carbon monoxide (CO) can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel it can be used for any heating purpose, such as cooking. It can also be used in a gas engine to convert the energy in the gas into electricity and heat.

B. Bio-Hydrogen

In a compound state, hydrogen is most commonly found on the earth in the form of water, or H_2O. It is a non-pollutant gas in the environment. Potentially, as a motor fuel, the main source of hydrogen is natural gas and methanol. Hydrogen fuel may contain low levels of carbon monoxide and carbon dioxide, depending on the source.

The extensive use of fossil fuel has also created an environmental issue where emission of carbon dioxide during combustion of fossil fuels has caused a global warming effect. For these reasons, researches are looking at alternative fuels that combat both the mentioned problems. Hydrogen is one of the most abundant elements in the universe in its ionic form. It is an odorless, colorless, tasteless and non-poisonous gas.

Hydrogen gas is a clean energy source with a high energy content of 122 kJ g-1. Unlike fossil, fuels hydrogen does not cause any CO_2, CO, SO_x and NO_x emissions producing water as its only by-product .

Hydrogen can be produced using diverse, domestic resources, including nuclear, natural gas and coal, biomass, and other renewable sources. The latter include solar, wind, hydroelectric, or geothermal energy. This diversity of domestic energy sources makes hydrogen a promising energy carrier and important for energy security.

The annual production of hydrogen is estimated to be about 55 million tons with its consumption increasing by approximately 6% per year. Hydrogen can be produced in many ways from a broad spectrum of initial raw materials.

Nowadays, hydrogen is mainly produced by the steam reforming of natural gas, a process which leads to massive emissions of greenhouse gases. Close to 50% of the global demand for hydrogen is currently generated via steam reforming of natural gas, about 30% from oil reforming from refinery/chemical industrial off-gases, 18% from coal gasification, 3.9% from water electrolysis, and 0.1% from other sources.

C. Current uses of Hydrogen Energy

It is primarily used to create water. Hydrogen gas can be used for metallic ore reduction. Chemical industries also use it for hydrochloric acid production. The same hydrogen gas is required for atomic hydrogen welding (AHW).

Hydrogen is also used for methanol production. Tritium is generated in nuclear reactions. It is a radioactive isotope used to make H-bombs. It can also be used as a luminous paint radiation source. Tritium is used in biosciences as an isotopic label.

Rocket fuel is the main use of hydrogen for energy. The National Aeronautics and Space Administration(NASA) is the largest user of hydrogen as a fuel.NASA began using liquid hydrogen in the 1950s as a rocket fuel, and NASA was one of the first to use fuel cells to power the electrical systems on space craft.

Electrical generators use the gas as a rotor coolant. The element is relied upon in many manufacturing plants to check for leaks. Hydrogen can be used on its own or with other elements. Other applications include fossil fuel processing and ammonia production. Ammonia is part of many household cleaning products. It is also a hydrogenating agent used to change unhealthy unsaturated fats to saturated oils and fats. Hydrogen is also used for methanol production. Tritium is generated in nuclear reactions. It is a radioactive isotope used to make H-bombs. It can also be used as a luminous paint radiation source. Tritium is used in biosciences as an isotopic label.

Welding companies use the element for welding torches. These torches are utilized for steel melting. Hydrogen is required as a reducing agent in chemical industries. Chemical industries use them for metal extraction. For example, hydrogen is needed to treat mined tungsten to make them pure.

D. Advantages of Hydrogen Energy

1) Readily Available

Hydrogen is a great source of energy for a number of reasons, the biggest one being that it is so readily available. While it may take some work to access, there is no element in the universe as abundant as hydrogen.

2) No Harmful Emissions

Another advantage to using hydrogen energy is that when burned, its leaves almost no harmful byproducts. In fact, when used in NASA‘s spaceships, the burned hydrogen gas leaves behind clean drinking water for the astronauts.

3) Environment Friendly

Hydrogen is also non-toxic, which makes it a rarity among fuel sources. Nuclear energy, coal, and gasoline are all either toxic or found in hazardous environments. This makes hydrogen ideal for use in a number of ways other fuel sources can‘t compete against

4) Renewable

Unlike non-renewable sources of energy which can‘t be produced again and again as they are limited; hydrogen energy can be produced on demand. Hydrogen is available in plenty. All we need is fossil fuels to break the water molecules to separate it from oxygen.

5) Non-toxic

It does not cause any harm or destruction to human health. This aspect makes it preferred compared to other sources of fuel like nuclear energy, natural gas,which are extremely hazardous or daunting to harness safely.

E. Disadvantages of Hydrogen Energy

Hydrogen energy is not quite the perfect, super clean and cheap energy source that so many companies and governments would love to get their hands on. It‘s volatile in gas form, and while that makes it able to accomplish huge tasks, it also makes it sometimes hazardous to work around and use.

1) Storage

Hydrogen is also hard to move around. Whereas oil can be sent through pipelines, and coal can be carried in the back of dump trucks, super-light hydrogen is hard to transport in a reasonable fashion. It is very expensive to move anything more than small amounts of it, making it impractical for most functions.

2) Highly Flammable

Hydrogen in itself is a very powerful source of fuel. We all know the effects of hydrogen bomb that was dropped on Hiroshima and Nagasaki in Japan. It‘s highly inflammable and always in news for the potential risks associated with it.

F. Dairy Wastewater

Dairy is one of the industries producing wastewater rich in organic matter and thus leading to creation of odorous and high COD containing water. It contains complex organics such as polysaccharides, proteins and lipids, which on hydrolysis form sugars, amino acids, and fatty acids.

The dairy industry handles large volumes of milk, and the major waste material from processing is the water. The water removed from the milk can contain considerable amounts of organic milk products and minerals.

The dairy industry involves processing raw milk into products such as consumer milk, butter, cheese, yogurt, condensed milk, dried milk (milk powder), and ice cream, using processes such as chilling, pasteurization, and homogenization. Typical by-products include buttermilk, whey, and their derivatives. Dairy industries have shown tremendous growth in size and number in most countries of the world. These industries discharge wastewater which is characterized by high chemical oxygen demand, biological oxygen demand, nutrients, and organic and inorganic contents. Such wastewaters, if discharged without proper treatment, severely pollute receiving water bodies.

1) Dairy Processing

Dairy processing plants can be divided into two categories: Fluid milk processing involving the pasteurization and processing of raw milk into liquid milk for direct consumption, as well as cream, flavored milk, and fermented products such as buttermilk and yogurt. Industrial milk processing involving the pasteurization and processing of raw milk into value-added dairy products such as cheese and casein, butter and other milk fats, milk powder and condensed milk, whey powder and other dairy ingredients, and ice cream and other frozen dairy products.

2) Dairy Processing Activities

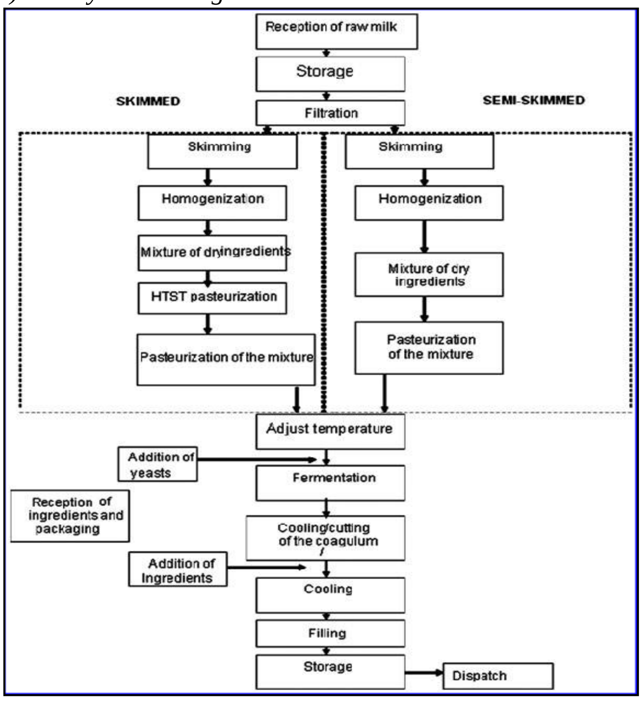

Fig. 1.1: Process Flow diagram of Dairy Activities

3) Wastewater Generation

The dairy wastewater is collected from Salem district cooperative milk production Ltd, Salem. All the process of dairy is completed finally it will be allowed to the treatment plant. The dairy industry is one of the most polluting of industries, not only in terms of the volume of effluent generated, but also in terms of its characteristics as well.

A chain of operations involving receiving and storing of raw materials, processing of raw materials into finished products, packaging and storing of finished products, and a group of other ancillary operations (e.g., heat transfer and cleaning) will produce wastewater.

In the dairy industry, some amount of wastewater gets produced during starting, equilibrating, stopping, and rinsing of the processing units. However, a majority of wastewater gets produced during cleaning operations, especially between products changes when different types of products are produced in a specific production unit and clean-up operations. Dairy processing effluents are generated in an intermittent way and the flow rates of these effluents change significantly.

The quality and quantity of the product content in the dairy wastewater at a given time changes with the application of another technological cycle in the processing line. The treatment plant wastewater is allowed to the irrigation purpose it will be affect the crop growing and also the soil conditions.

II. MATERIALS & METHODS

A. Wastewater Collection

Dairy wastewater collected from Salem District Union Cooperative Milk Production Limited, Salem, India will use as substrate. The wastewater can be considered as complex in nature due to the presence of proteins, carbohydrates, and lipids content.

After collection, the wastewater was transferred immediately to the laboratory and stored at 4°C, and the wastewater was not corrected for trace elements deficiency.

B. Physical-Chemical Characteristics of Wastewater

The following methods were adopt for estimating different Physical-Chemical characteristics of the dairy wastewater from Salem District Union Co-operative Milk Production Limited, Salem.

1) PH Value Definition:

A measure of the acidity or basicity of a solution i.e. the negative of the logarithm of the hydrogen ion concentration.

The pH of samples was estimated using the electrometric method (APHA, 1998 & IS3025).Take 100ml of the wastewater sample in a clean beaker and allow standing for an hour. Wash the electrodes with distilled water and wipe it dry. Immerse the electrodes in the beaker containing dairy wastewater sample diluted in the water and record the meter reading.

2) Total Solids

Total solids content is the entire residue left after complete evaporation of water from milk. This includes fat protein, lactose and mineral matter. These solid constituents exist in milk in a mechanical mixture.

It is determined by using the procedure put forward by APHA (1998). Weigh an evaporation dish to the nearest 0.1 mg and accurately measure a known volume (as much as will fit without spilling) of the sample into an evaporation dish and place in the 105 ° C oven. After all of the wastewater as evaporated, let the dish cool in a desiccators, weigh the dish plus the remaining solids and record.

The process is repeated till a concurrent value is arrived

$$TS\left(\frac{mg}{l}\right) = (((W1 - W2) \times 1000)/\text{sample volume (ml)}.$$

W_1 = Weight of dried residue + dish after 24 hrs at 105° C (mg)

W_2 = Weight of dish (mg)

3) Volatile Solids

Solids, frequently organic, which volatilize at a temperature of 550 ºC.

After measuring the total suspended solids, fire the residue obtained in TS determination in a 550ºC muffle furnace for 1 hour, (APHA 1998) in a silica crucible. Weigh the crucible plus the remaining solids after cooling it by keeping in desiccator.

This method was continued until a concordant value is obtained.

$$VS\left(\frac{mg}{l}\right) = (((W1 - W2) \times 1000)/\text{sample volume (ml))}$$

W_1 = Weight of crucible +filter+ residue after 24 hrs at 105° C (mg) W_2 = Weight of crucible +filter+ residue after 1 hr at 550° C (mg)

4) Chemical Oxygen Demand (COD)

Introduction

The COD of the samples were analyzed following the Dichromate method (APHA, 1998). The diluted sample was reflected for two hours in strongly acid solution of concentrated H_2SO_4 with Ag_2 SO_4 (5.5g Ag_2 SO_4 plus H_2SO_4) with a known excess of potassium di-chromate ($K_2Cr_2O_7$).

After digestion, the remaining unreduced $K_2Cr_2O_7$ was titrated with ferrous ammonium sulphate (FAS) to determine the amount of $K_2Cr_2O_7$ consumed. A blank was also run

5) Biological Oxygen Demand (BOD)

The BOD test is carried out by diluting the sample with de-ionized water with added nutrients, saturated with oxygen, inoculating it with a fixed aliquot of seed, measuring the dissolved oxygen and sealing the sample (to prevent further oxygen dissolving in). The sample is kept at 20° C in the dark to prevent photosynthesis (and thereby the addition of oxygen) for five days, and the dissolved oxygen is measured again.

The difference between the final DO and initial DO is the BOD. The apparent BOD for the control is subtracted from the control result to provide the corrected value.

Undiluted

BOD = Initial DO – Final DO

Diluted

BOD = [(Initial DO – Final DO) – (BOD of the blank) × Dilution Factor

C. Design of Anaerobic Sequence Batch Reactor

A lab-scale anaerobic sequencing batch reactor (AnSBR) with suspended growth configuration was designed and fabricated in the laboratory using ‗Borosil‘ glass material with a working volume of L (gas holding capacity, 0.75 L; liquid volume, 3.25 L) as depicted in given figure.

The sequence batch chamber has the volume of 4L, dimensions of chamber (Reactor) is 14cm dia and 34.3 cm height. It has the two openings of 1cm at the side of the tank for influent feeding and decanting the dairy waste water. The gas escape valve of 1.5cm is also given at the top of the chamber and also provide pH probe and temperature probe of 1.5 cm.

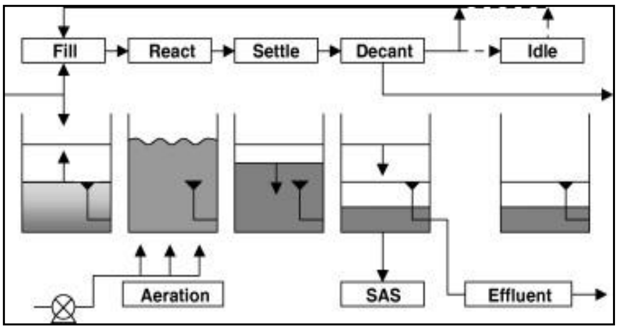

Fig. 2.1: The details of the experimental set up

The sequence of the AnSBR is composed of Fill React Settle Decant per cycle. This cycle is continuously repeated so that HRT and SRT can be separated. Hydrogen production and the degradation of organic wastewater are achieved continuously during the React period. There are several parameters for AnSBR operation and the estimation of hydrogen productivity, including HRT, OLR, F/M ratio, HPR, and hydrogen yield.

1) Fill

During the fill phase, the basin receives influent wastewater. The influent brings food to the microbes in the activated sludge, creating an environment for biochemical reactions to take place. Mixing and aeration can be varied during the fill phase to create the following three different scenarios:

a) Static Fill– Under a static-fill scenario, there is no mixing or aeration while the influent wastewater is entering the tank. Static fill is used during the initial start-up phase of a facility, at plants that do not need to nitrify or denitrify, and during low flow periods to save power. Because the mixers and aerators remain off, this scenario has an energy-savings component.

b) Mixed Fill– Under a mixed-fill scenario, mechanical mixers are active, but the aerators remain off. The mixing action produces a uniform blend of influent wastewater and biomass. Because there is no aeration, an anoxic condition is present, which promotes denitrification. Anaerobic conditions can also be achieved during the mixed-fill phase. Under anaerobic conditions the biomass undergoes a release of phosphorous. This release is reabsorbed by the biomass once aerobic conditions are reestablished. This phosphorous release will not happen with anoxic conditions.

c) Aerated Fill– Under an aerated-fill scenario, both the aerators and the mechanical mixing unit are activated. The contents of the basin are aerated to convert the anoxic or anaerobic zone over to an aerobic zone. No adjustments to the aerated-fill cycle are needed to reduce organics and achieve nitrification. However, to achieve denitrification, it is necessary to switch the oxygen off to promote anoxic conditions for denitrification.

By switching the oxygen on and off during this phase with the blowers, oxic and anoxic conditions are created, allowing for nitrification and denitrification. Dissolved oxygen (DO) should be monitored during this phase so it does not go over 0.2 mg/L. This ensures that an anoxic condition willoccur during the idle phase.

2) React

This phase allows for further reduction or "polishing" of wastewater parameters. During this phase, no wastewater enters the basin and the mechanical mixing and aeration units are on. Because there are no additional volume and organic loadings, the rate of organic removal increases dramatically. Most of the carbonaceous BOD removal occurs in the react phase.

Further nitrification occurs by allowing the mixing and aeration to continue the majority of denitrification takes place in the mixed-fill phase. The phosphorus released during mixed fill, plus some additional phosphorus, is taken up during the react phase.

3) Settle

During this phase, activated sludge is allowed to settle under quiescent conditions—no flow enters the basin and no aeration and mixing takes place. The activated sludge tends to settle as a flocculent mass, forming a distinctive interface with the clear supernatant.

The sludge mass is called the sludge blanket. This phase is a critical part of the cycle, because if the solids do not settle rapidly, some sludge can be drawn off during the subsequent decant phase and thereby degrade effluent quality.

4) Decant

During this phase, a decanter is used to remove the clear supernatant effluent. Once the settle phase is complete, a signal is sent to the decanter to initiate the opening of an effluent discharge valve. There are floating and fixed-arm decanters.

Floating decanters maintain the inlet orifice slightly below the water surface to minimize the removal of solids in the effluent removed during the decant phase. Floating decanters offer the operator flexibility to vary fill and draw volumes. Fixed-arm decanters are less expensive and can be designed to allow the operator to lower or raise the level of the decanter.

It is optimal that the decanted volume is the same as the volume that enters the basin during the fill phase. It is also important that no surface foam or scum is decanted. The vertical distance from the decanter to the bottom of the tank should be maximized to avoid disturbing the settled biomass.

D. Methods Of Biohydrogen Production

1) Hydrogen gas production from water by algae

Algae split water molecules to hydrogen ion and oxygen via photosynthesis. The generated hydrogen ions are converted into hydrogen gas by hydrogenase enzyme.

Chlamydomonasreinhardtii is one of the well-known hydrogen producing algae. Hydrogenase activity has been detected in green algae, Scenedesmusobliquus, in marine green algae Chlorococcumlittorale, Playtmonassubcordiformisand in Chlorella fusca.

However, no hydrogenase activity was observed in C. vulgaris and Duneliellasalina.

2) Hydrogen gas production by dark fermentation

Many anaerobic organisms can produce hydrogen from carbohydrate containing organic wastes. The organisms belonging to genus Clostridium such as C. buytricum, C. thermolacticum, C. pasteurianum , C. paraputrificum M-21 and C. bifermentants are obligate anaerobes and spore forming organisms.

Clostrida species produce hydrogen gas during the exponential growth phase. In batch growth of Clostridia the metabolism shifts from a hydrogen/acid production phase to a solvent production phase, when the population reaches to the stationary growth phase.

Investigations on microbial diversity of a mesophilic hydrogen producing sludge indicated the presence of Clostridia species as 64.6%. The dominant culture of Clostridia can be easily obtained by heat treatment of biological sludge. The spores formed at high temperatures can be activated when required environmental conditions are provided for hydrogen gas production

E. Operation of AnSBR

The reactor was fabricated using leak proof sealing along with proper inlet and outlet arrangements. Feed will introduce from top of the reactor, and operate in suspended mode employing magnetic stirrer mechanism for keeping biomass in suspension during operation.

The reactor will operate in sequencing/periodic discontinuous batch mode with a total cycle period of 24 h (hydraulic retention time (HRT)) consisting of 15 minutes of FILL, 23 hours of REACT (anaerobic), 30 minutes of SETTLE and 15 minutes of DECANT phases.

Hydraulic retention time (HRT) is defined in a continuous system.

$$HRT = V_r / Q$$

Where, Vr is the working volume of the reactor and Q (L/d) is the flow rate of influent.

HRT can be expressed in units of d‖ or hr‖.Organic loading rate (OLR) is a function of HRT and substrate concentration, and it is expressed in units of g COD or sucrose/L reactor.d‖, as definedby

$$OLR = S \times Q / V_r \quad \text{(or)} \quad OLR = S / HRT$$

Where S is the influent substrate concentration (g/L). In an experiment, the substrate concentration can be determined when HRT and OLR are specified.As for the food-tomicroorganism ratio (F/M ratio), food‖ means the organic substrate contained in the influent and ―microorganism‖ can be represented by the mixed liquor volatile suspended solids (MLVSS).

$$F/M \text{ ratio} = S \times Q / V_r \times M \text{ (or) } F/M \text{ ratio} = OLR / MLVSS$$

Where, MLVSS (M) is the biomass concentration in the reactor (g/L). Hydrogen production rate (HPR) (L H_2/L reactor.d) can be obtained from the data of biogas collected during one day and knowing the reactor size. After the biogas volume is recorded periodically, hydrogen content is obtained through gas chromatography and hydrogen volume is determined by

$$HPR = V_g \times CH_2 / V_r \times t$$

Where Vg is a total biogas volume in certain time, CH_2 is hydrogen content (%) in biogas, V_r is a working volume of the reactor, and t is a time period of hydrogen production. Hydrogen yield (Yield) represents the mass of hydrogen (mol) per unit mass of substrate (mol) loaded into the reactor. Therefore, the molar mass of hydrogen produced is divided by the molar mass of substrate loaded, as given in

$$\text{Yield} = \frac{V_g \times CH_2 / 24.2 \text{ (L/mol)}}{S_{mol}}$$

Where, ($V_g \times CH_2$) is the volume of hydrogen produced, and S_{mol} is a molar mass of substrate loaded. designed with 34.3cm diameter and 57.4cm height, the gas escape valve is 1.5cm, substrate fill valve is 13.3cm are

F. Fabrication Details of the Reactor

Total volume of the reactor = 80 L
Height of the reactor = 57.4cm
Diameter of the reactor = 34.3cm
Gas escape valve = 1.5cm
Effluent removal probe and other probes = 1 cm

1) Inoculum

Horse manure is a solid waste,Manure isorganic matterused asorganic fertilizerinagriculture. Manures contribute to the fertility of the soil by adding organic matter andnutrients, such asnitrogen, that are trapped bybacteriain the soil. Higher organisms then feed on thefungiand bacteria in a chain of life that comprises thesoil food web.

Horse manure contains bacteria and other pathogens that can be harmful to horses as well as humans. Parasitic roundworms, such as strongyles, are potential health problems for horses that ingest them.

Pathogens such as Escherichia coli, Listeria monocytogenes, Salmonella spp. and Clostridium tetani can be present in horse manure and are pathogenic to humans. Protozoan pathogens such as Giardia spp. and Cryptosporidium spp. can be found in horse manure and are known to cause waterborne human disease. Careful composting will help to reduce these pathogen

III. EXPERIMENTAL WORK

A. H_2 Producing Horse Manure

Anaerobic horse manure acquired from an operating laboratory scale up flow anaerobic sludge blanket (AnSBR) reactor treating chemical waste water was used as parent inoculums prior to inoculation dewatered sludge acquired from AnSBR .

B. Dairy Waste Water

Dairy waste water Total dissolved solids (TDS),809 mg/l; Total suspended solids (TSS),24 mg/l; Volatile suspended solids (VSS), 3mg/l; COD 5360 mg/l; BOD @27°c; and PH 4.78). Dairy wastewater collected from Salem District Union Cooperative Milk Production Limited, Salem, India will use as substrate. The wastewater can be considered as complex in nature due to the presence of proteins, carbohydrates, and lipids content. After collection, the wastewater was transferred immediately to the laboratory and stored at 4 °C, and the wastewater was not corrected for trace elements deficiency.

C. Design and Operation of Reactor

First all the connections should be sealed by using M-seal in reactor.Which is used to any air content does not enter inside of the reactor. The bottom of the reactor is placed on the magnetic stirrer. Which is used to settle down the slit particle at the bottom of the reactor. The left side of the reactor consist barine bottle and displacement jar are attached by using hose. The reactor contain 4L storage capacity. The horse manure is mixed with 2.25 ml waste water and then filled in the reactor. All the openings of hose are tighten with the use of air tight clip. The arrangement is placed in the absence of oxygen surrounding of thereactors.

Fig. 3.1: Operation of [AnSBR] anaerobic sequencing batch reactor

IV. RESULT & DISCUSSION

The Dairy wastewater parameters are analyzed in our laboratory as per IS 3025 (Withdifferent parts) parameters are listed below.

A. Characteristics of Dairy Wastewater

Dairy wastewater contains milk solids, detergents, sanitizers, milk wastes, and cleaning water. It is characterized by high concentrations of nutrients, organic and inorganic contents. Salting activities during cheese production may result in high salinity levels.

Wastewater may also contain acids, alkali with a number of active ingredients, and disinfectants, as well as a significant microbiological load, pathogenic viruses, and bacteria. Other wastewater streams include cooling water from utilities, storm water, and sanitary sewage.

B. Characteristics of Horse Manure

Horse manure is a solid waste,Manureis organic matter used as organic fertilizer in agriculture.

Manures contribute to the fertility of the soil by adding organic matter and nutrients, such as nitrogen, that are trapped by bacteria in the soil. Higher organisms then feed on the fungi and bacteria in a chain of life that comprises the soil food web.

S.NO	PARAMETERS	VALUES
1.	BOD @27^{O}C	1040 mg/l
2.	COD	5360 mg/l
3.	TDS	809 mg/l
4.	TSS	24 mg/l
5.	VSS	3 mg/l
6.	pH@27^{O}C	4.78
7.	EC	1254Micromhos/cm
8.	Chloride	232.3 mg/l
9.	Oil & Grease	22 mg/l
10.	TKN	0.01 mg/l
11.	VFA	73 mg/l
12.	Phosphorous	109.04 mg/l

Table 4.1: Characteristics of Dairy Wastewater

Time (min)	Gas Production (AnSBR)ml
0	0
15	65
30	45
45	40
60	45
75	55
90	55
105	55
120	55
135	65
150	45
165	55
180	65
195	60
210	65
225	45
240	45
255	25
270	25
285	35
300	20
315	15
TOTAL	980

Table 4.2: Gas production in a Cycle for 72h HRT

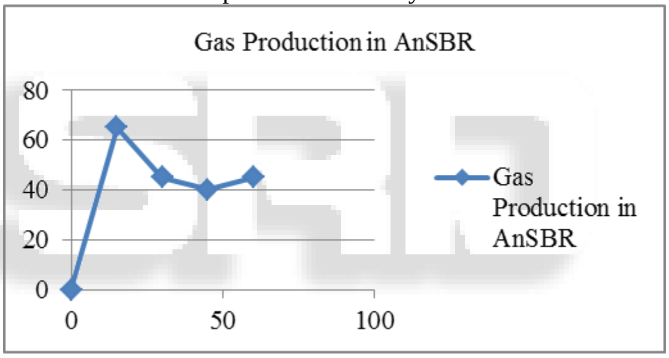

Fig. 4.1: Rate of Gas Production in a Cycle for 72h HRT

If the above figure is discussed about the rate of gas Production in a cycle for 36h HRT under sequence time period. If the above graph is plotted between Time(min) and Gas Production in AnSBR(ml) from 72 hour HRT loading. .The minimum amount of Hydrogen gas produced in the time of 315 minute from 48 hour HRT loading.The maximum amount of Hydrogen gas produced in the time of 120 minute from 72 hour HRT loading.

Time (min)	Gas Production (AnSBR)ml
0	15
15	45
30	55
45	35
60	65
75	55
90	45
105	45
120	55
135	65
150	60
165	65
180	55
195	20

210	20
225	15
240	20
255	25
270	25
285	25
300	15
315	0
TOTAL	810

Table 4.3: Gas Production in a Cycle for 96h HRT

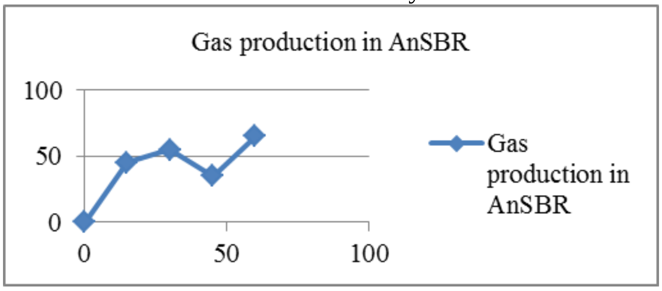

Fig. 4.2: Rate of Gas Production in a Cycle for 96h HRT

If the above figure is discussed about the rate of gas Production in a cycle for98 hr HRT under sequence time period. If the above graph is plotted between Time (min) and Gas Production in AnSBR (ml) from 96 hour HRT loading.The minimum amount of Hydrogen gas produced in the time of 315 minute from 96 hour HRT loading. The maximum amount of Hydrogen gas produced in the time of 120 minute from48 hour HRT loading.

Time (min)	Gas Production (AnSBR)ml
0	0
15	25
30	35
45	35
60	35
75	25
90	30
105	25
120	55
135	55
150	35
165	25
180	20
195	15
210	15
225	10
240	25
255	25
270	20
285	10
300	15
315	0
TOTAL	535

Table 4.4: Gas Production in a Cycle for 120h HRT

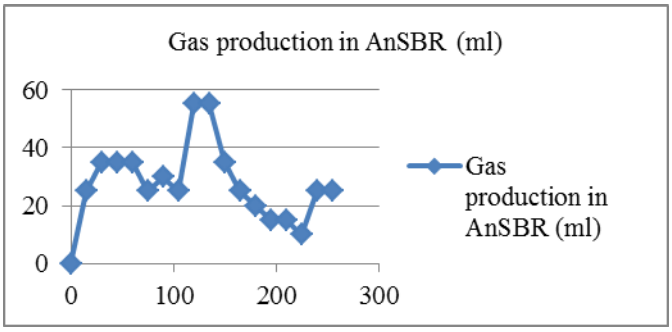

Fig. 4.3: Rate of Gas Production in a Cycle for 120h HRT

If the above figure is discussed about the rate of gas production in a cycle for 96h HRT under sequence time period. If the above graph is plotted between Time (min) and Gas Production in AnSBR (ml) from 108 hour HRT loading. The minimum amount of Hydrogen gas produced in the time of 315 minute from 96 hour HRT loading. The maximum amount of Hydrogen gas produced in the time of 105 minute from 108 hour HRT loading.

Time (min)	Gas Production (AnSBR)ml
0	0
15	20
30	30
45	25
60	25
75	20
90	25
105	20
120	50
135	50
150	30
165	20
180	25
195	20
210	20
225	15
240	20
255	20
270	20
285	15
300	15
315	0
TOTAL	475

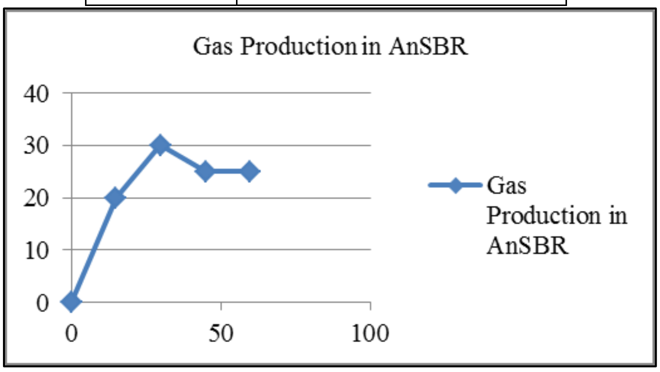

Figure No: 4.4 Rate of Gas Production in a Cycle for 168h HRT

If the above figure is discussed about the rate of gas production in a cycle for 96h HRT under sequence time period. If the above graph is plotted between Time(min) and Gas Production in AnSBR(ml) from 120 hour HRT loading. The minimum amount of Hydrogen gas produced in the time of 315 minute from 96 hour HRT loading. The maximum amount of Hydrogen gas produced in the time of 105 minute from 120 hour HRT loading

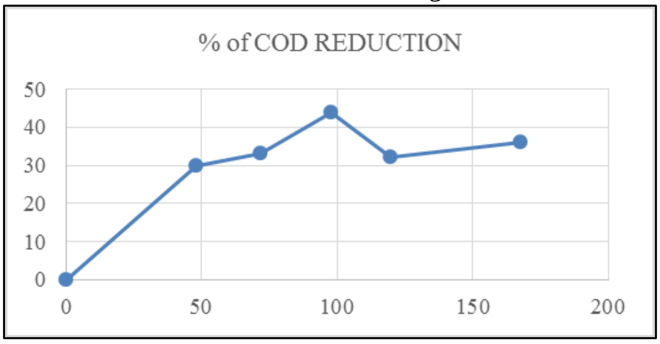

Fig. 4.5: Elimination of Organic Reduction

If the above figure is discussed about the Elimination of Organic Reduction under sequence time period. If the above graph is plotted between HRT,h loading and Percentage of COD Reduction. The minimum amount of COD content reduced in 24 hour HRT loading rate. The maximum amount of COD content reduced in 96 hour HRT loading rate.

1) Discussion

The wastewater collected from SALEM District Cooperative Milk Production, KARIPATTY, at before screening point. The reactor was designed based on that wastewater physical-chemical characteristics such as BOD = 1040 (mg/l), COD = 5360 mg/l, TDS = 809 mg/l, Conductivity =1254 Micro mhos/cm. The diameter of the reactor is 14cm and height is 34.3cm, the gas escape valve and other probes are 2cm.

The horse manure is collected from our near by areas. The reactor was designed based on that horse manure physical - chemical characteristics such as TS = 17,400 mg/l, VS = 7,550 mg/l, DS = 10,100 mg/l, SS = 7000 mg/l.

the hydrogen gas has been produced from different HRT loading rate such as , 48 HRT, 72 HRT, and 96 HRT loading. Then the graph is plotted to the above loading rates and find the maximum and minimum level of hydrogen gas production.

The final graph is used to find the maximum and minimum level of percentage of COD Reduction in different HRT loading

V. Conclusion

The study demonstrated the feasibility of H_2 generation from dairy wastewater treatment by anaerobic fermentation in suspended growth bioreactor using horse manure is an inoculum. However, the process of H_2 generation was found to be dependent on the HRT applied. The pretreatment steps adopted for enumerating the H_2 production from anaerobic inoculum were found to be effective. Dairy wastewater was evaluated for biological hydrogen production in conjugation with wastewater treatment in a suspended growth sequencing batch reactor (AnSBR). Using inoculum (Horse Manure) is considered to be a practical, cost-effective and promising approach to achieve H_2 production in large scale. The characteristics of horse manure and dairy waste water have to be determine. To find the minimum and maximum level of hydrogen is produced from different HRT loading rates such as 72HRT,96HRT,120 HRT and 168HRT loading. The dairy waste water parameter have to be determine. The described process has a dual benefit of H_2 production with simultaneous wastewater treatment in an economical, effective, and sustainable way.

References

[1] APHA,1998.Standard method for the examination water and wastewater, 20th American Public Health Association, American Water Works Association, Water pollution Control Federation, Washington, DC.

[2] Bruna Soares Fernandes, Guilherme Peixoto, Fernanda Rui Albrecht,Nora Katia Saavedra del Aguila, Marcelo Zaiat ―Potential to produce biohydrogen from various wastewaters‖ at Energy for Sustainable Development 14 (2010) 143–148.

[3] Burak dem˙irel, Paul scherer, Orhan yen˙igun, and Turgut t. Onay ―Production of Methane and Hydrogen from Biomass through Conventional and High-Rate Anaerobic Digestion Processes‖ at Critical Reviews in Environmental Science and Technology, 40:116–146, 2010.

[4] Chiu-Yue Lin, Chyi-How Lay, Biswarup Sen, Chen-Yeon Chu , Gopalakrishnan Kumar, Chin-Chao Chen, Jo-Shu Chang ―Fermentative hydrogen production from wastewaters: A review and prognosis‖ at international journal of hydrogen energy xxx (2012) 1e11

[5] Gadhe Abhijit, Sonawane Shriram and Varma Mahesh ―Kinetic modeling of biohydrogen production from complex wastewater by anaerobic cultures‖ at Research Journal of Chemistry and Environment Vol.17 (12) December (2013).

[6] HaijunYang, Peng Shao, Tingmao Lu, Jianquan Shen,⁎, DufuWang,Zhinian Xu, XingYuan―Continuous bio-hydrogen production from citric acidwastewater via facultative anaerobic bacteria‖ at International Journal of Hydrogen Energy 31 (2006) 1306 – 1313.

[7] Hema Krishna R, Venkata Mohan S and Swamy A V V S ―Bio Hydrogen Production from Pharmaceutical Waste Water Treatment by a Suspended Gro Reactor Using Environmental AnaerobicTechnology‖. American Chemical Science Journal 3 (2): 80-97, 2013