Improve the Yield of Methane Gas by Pre-treatment of Biomass (Biomethanated Distillery Waste Water) Using Hydrodynamic Cavitation

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ABSTRACT

Pre-treatment using Hydrodynamic Cavitation can be effectively utilized for enhancing the biodegradability of BDWW along with reduction of COD and increase the yield of methane production from B-DWW. Experimental analysis the effect of pre-treatment of Hydrodynamic Cavitation on B-DWW at various contact time from 50-150 min, at different pressure 5-13 bars, with different dilutions 25-50 % for % COD reduction, for increase in B.I. for increase the yield of methane gas from biomethanated waste water (B-DWW). Experiment shows the effect of pressure, contact time and dilution on % COD reduction, B.I. and % yield of methane gas by BMP.

Experimental analysis shows that with pre-treatment of H.C. of B-DWW (Biomass) shows the increase the % Yield of methane production. That also effect on the % COD reduction and B.I. of B-DWW favors positive results. Pre-treatment of H.C. decrease the particle size, increase pumpability, increase B.I., reduce COD and % yield of Methane gas from B-DWW. The Optimum parameter for H.C. pre-treatment pressure 5 bar, Contact Time 50 min without dilution. Energy balance prove that pre-treatment of B-DWW by using H.C. process is cost beneficial. Hence by experimental analysis Pre-treatment of biomass (B-DWW) are economical and physical treatment process. HC process is increase % yield of Methane as well as cost saving treatment process and also less time consumed.

The biodegradability index increases with increase in the dilution of B-DWW and also increases

with increase in the pressure of cavitation process. It's clear that the % COD reduction increase with increase in the dilution of B-DWW. The % reduction COD reduction also increase with increase in time of cavitation process. As value of % COD reduction increase also increase of % Yield of Methane. As per experimental analysis it's clear that pre-treatment of biomass (B-DWW) can increase the yield of methane gas up to 14 % as above conditions. These values can be change by changing the conditions.

Keywords - *Pre-treatment Biomass, Hydrodynamic Cavitation, B-DWW, Methane, COD, B.I.*

1. Introduction

1.1 Introduction of Biomethanated Distillery Waste Water (B-DWW)

In India Sugarcane industry (Distilleries) are one of the most polluting industries which generating large volumes of high strength wastewater. Waste water produced from distillery containing highly color, COD, BOD, TDS and other organic matter. In India for alcohol production Sugarcane molasses is most useful which is byproduct of sugar industry contains 50 % fermentable sugar. During fermentation of molasses 8 -10L of spent wash generated per liter ethanol production. Distillery spent wash treated by anaerobic digestion produces dark brown sludge which is used as fertilizer and the colored water are discharged after diluting them several folds with water. Due to this fresh water resource which is a precious commodity in most parts of the world is wasted. Distillery spent wash is highly colored with an extremely high chemical oxygen demand (COD) load and contains high percentage of dissolved organic and inorganic matter.

1.1.1 Various Conventional Methods

1. Biological flocculation
2. Nano filtration
3. Activated carbons
4. Bio electrochemical process

5. Ozonation-based process electro oxidation
6. Membrane-based Nano filtration
7. Reverse osmosis.
8. Aerobic and Anaerobic process
9. AOPs (Advanced Oxidation Process)
10. Electro and Chemical Coagulation

1.2 Introduction of Biomass

Biological organic matter derived from living or recently living organisms is called as biomass. The energy contained or stored in biomass is called as the bioenergy. One of the important energy sources available nearly everywhere is biomass and encompasses a large variety of materials including wood from various sources agricultural and industrial residues and animal and human waste. The biomass is organic matter made by living organisms that contain energy stored from the sun. The radiant energy from sunlight is absorbed by plants. This energy is converted into chemical energy in the form of glucose, starch or cellulose, through photosynthesis. The energy contained in the biomass (bioenergy) can be released and used by means of its combustion. The woody biomass is employed by many rural communities all around the world for heating and cooking.

1.3 Lignocellulosic Biomass (LCB)

LCB is the most abundantly available bioresource amounting to about a global yield of up to 1.3 billion tons per year. Lignocellulosic Biomass is mainly composed of three Polymers Cellulose Hemicellulose and Lignin along with minor amounts of other compounds such as proteins, ash and pectin. Plant biomass that is composed of crystalline polysaccharide cellulose, amorphous multi-component polysaccharide hemicellulose and the amorphous phenyl propanoic polymer lignin. Major structural component of both woody and non woody plants and represents a major source of renewable organic matter. It consists of about 35 to 50% cellulose, 20 to 35% hemicellulose and 10 to 25% lignin. Cellulose, hemicellulose and lignin composition vary among different plant species.

1.4 Cavitation

Formation, growth and subsequent the collapse of micro bubbles or cavities occurring in extremely small interval of time (milliseconds) releasing large magnitudes of energy is known as cavitation. Hydrodynamic and acoustic cavitation has been found to be efficient in desired chemical changes. HC generation of required intensity bringing about the desired physical or chemical change with maximum energy efficiency as compared to its counterpart.

1.4.1 Hydrodynamic Cavitation [10]

HC is the one of alternative techniques for the generation of cavitation's is the use of hydraulic devices where cavitation is generated by the passage of the liquid through a constriction such as valve, venturi plate, venturi etc. Hydrodynamic cavitation (HC) which is used in this work to pretreat LCB to release cellulose and hemicellulose. Cavitation is the phenomenon of formation, growth and collapse of bubbles (cavities). Collapsing cavities lead to intense shear and localized very high temperature (~5000 K) and high pressures (~1000 atm). The high pressure and temperature generated by cavity collapse leads to formation of OH radicals.

1.4.2 Advantages of Hydrodynamic Cavitation

1. HC capability to oxidize organic substances.
2. HC is efficient to oxidize organic substances such as volatile organic compounds
3. Less operation costs based on energy efficiency.
4. Hydrodynamic cavitation is much more energy efficient.
5. Less time consumption comparing other process
6. Parameters to be controlled such as PH, TOC, COD, BOD
7. Size of unit is small so required space low.
8. Hydrodynamic is continuous in manner.
9. HC equipment's scale-up ratio required are low

1.4.3 Applications of Hydrodynamic Cavitation

1. Waste water treatment
2. Water disinfection
3. Biological cell disruptions
4. Hydrolysis of fatty oils
5. hydrodynamic cavitation equipment's scale-up ratio required are low
6. Pulp and paper digestion
7. Preparation of nano particle

8. Mixing and uniform dispersion

1.5 Biochemical Methane Potential (BMP)

BMP tests are widely used for characterizing a substrate's influence on the anaerobic digestion process. Biochemical methane potential (BMP) tests are a popular technique to determine the methane potential and biodegradability of wastewater and waste biomass. In BMP test substrate is mixed with an anaerobic bacteria culture normally retrieved from an active digester. Methane and carbon dioxide are produced during the testing period due to the anaerobic degradation of organic contents of the substrate.

Literature Reviews

Pretreated biomass by using hydrodynamic cavitation was more efficient than untreated biomass its increased methane production by about 30% for 5 min of contact time. Hydrodynamic cavitation did not change the chemical composition of the lignocellulose biomass but increased its digestibility which was proven by the higher methane production from the substrate disintegrated for 5 min. Hydrodynamic cavitation increased the temperature of the substrate by 20 °C after 20 min of pretreatment and high digestibility yield of 85% which was higher than the untreated sample by about 70%. **Experimental analysis shows that pretreatment of biomass using Hydrodynamic** cavitation shows the results removal of the COD 60 %, 65%, 70%, 75% for time of cavitation 5, 10, 15, 20 min resp. Results shows HC can adopted as pretreatment for various types of biomass for reduction of COD and increase B.I. which increase the yield of the methane gas production. **Pre-treatment with HC the methane production from the pretreated biomass** increased with an increase in pretreatment time up to 5 min and longer than 5 min only slightly increased the methane generation. Hydrodynamic cavitation as the pretreatment method of wheat straw for biogas production. As per observation a higher methane production by about 14% from biomass cavitated for 2 min. Hydrodynamic cavitation was mainly used for the removal of toxic substances and biomass disintegration before alcoholic fermentation that effect of lignocellulose biomass on methane fermentation. Hydrodynamic cavitation increase the digestibility of biomass which resulted in about 14.4 % higher methane production from the disintegrated substrate cavitated for 2 min. [1]. **Experimental carried out under batch digestion condition the HC treatment** improved the methane yield by 13% treating fresh food waste despite a kinetic degradation rate constant reduction by 52%. HC improved the methane yield by 9% and increased the kinetic degradation rate constant by 60%. HC as a pre-treatment step of the feedstock improved the methane yields up to 17% depending on the food waste characteristics. Hydrodynamic Cavitation pre-treatment didn't change the synthetic organization of the lignocellulose biomass and gives higher methane creation from the substrate crumbled for 5 min than that from the control test. HC treated sample exhibited a compared to ultrasound has rapid hydrolysis rate and digestibility. Experimental Analysis shows that HC and NaOH as a combined pre-treatment were observed in the methane yield 12.7% more biogas was produced after 20 times of passes. **In 2015, studied by Kim et al., shows the effect with HC pretreatment for biofuels** production such as ethanol and biogas production are the significant and higher yield. COD are influencing the production of biogas. As the % of COD reduction goes on increasing the biogas production rate goes on increasing and wastewater or biomass characteristic COD plays an important in biogas production rate.[2]. **Experiment analysis shows the HC pretreatment caused an increase in the** acetogenesis and methanogenesis reactions during the AD process and ultimately resulted in the enhanced biogas generation as well as higher COD reduction. By experimental analysis with HC biogas yield of 68.57 mL/g of volatile solids with a COD reduction of 43.17% was obtained in AD of HC-treated [3]. **In 2008 studied by Chainable et al., the values of COD and TOC** that at 50% dilution has significant effect on the mineralization of distillery wastewater. Reduction of COD is higher at 50% dilution and the total quantum of COD and TOC reduction is lower at 25% and 50% dilution as compared to undiluted wastewater. Experiment shows that by using HC the percentage reduction of COD and TOC with an increase in the inlet pressure 34% reduction in COD and 33% reduction in TOC were obtained at 13 bar pressure as compared to 32% and 31% respectively at 5 bar inlet pressure. HC also effect on Biodegradability Index ratio of BOD/COD treatment the expansion in the proportion with time is practically steady with an estimation of 0.22 at 50 min, 0.23 at 100 min and 0.24 at 150 min. At pressure of 5 bar with zero weakening the proportion increments to the tune of 0.24 turning out to be 0.25and at higher pressure of 13 bar the ratio enhances to a value of 0.29 at zero dilution and is increase to 0.32 at spent wash. [6]. **Rotation generator of hydrodynamic cavitation (RGHC)** the soluble chemical oxygen demand (SCOD) shows the 12.7 % more biogas has been produced by 20 passes through RGHC. Pilot bioreactor plant volume of 400 liters using RGHC for WAS pretreatment leads to better disintegration of the WAS which directly leads to higher biogas production. The energy consumption of the RGHC could be gained from higher biogas production due to better disintegration of the WAS. [7] **Experimental analysis shows that HC technology** is a good candidate among the other pretreatment methods for pretreating the LCB feedstocks and it can be used for large-scale application of this technology has potential to reduce pretreatment process cost. As this process combined with other pretreatment methods biomass pretreatment can increase the overall performance of the pretreatment process. By various experimental study HC process offers a possibility for continuous biomass pretreatment process. HC and hydrogen peroxide pretreatment of sugarcane bagasse showed 95.4% of cellulosic fraction digestibility was reached under optimal conditions. [8] **In the 2017 experimental studied by Zalinski et al., increased** rate and volume of biogas upon AC and HC compared to untreated biomass shows the higher biogas and methane yields were obtained from treated LCB compared to untreated LCB. In 2016, experimental analysis by Patil et al., and by Madison et al., 2017, HC + lime treatment improved enzymatic digestibility and the samples of highest crystallinity corresponded to highest lignin removal. By Teran Hilares et al. in 2017, shows that 90% cellulose and hemicellulose hydrolysis were observed as compared to untreated LCB < 20 % and to increase with treatment time and rpm. [11]. **HC and hydrogen peroxide combined showed 95.4 % of cellulosic fraction** digestibility was reached under optimal conditions at time of contact 9.95 min. Pre-treatment with HC induced biomass disintegration reduces particle sizes and also increases surface areas of feedstocks and bioavailability for anaerobic digestion which produce extra biogas. [11].

3. EXPERIMENTAL ANALYSIS

3.1 Venturi Setup for HC

A single whole venturi and multiple holes on venturi plate or a combination of venture arranged in a sequential manner. The reactor will consist of a closed loop circuit comprising of a holding tank a centrifugal pump controls valve and flanges to accommodate the cavitation's chamber. Pump is connected to the bottom of the tank and discharge from the pump branches into two lines which help in control of the inlet pressure and the inlet flow rate into the main line. In the venturi liquid flow at high velocity entering the tank ensures uniform mixing of the tank contents due to the intense circulation currents generated in the tank.

3.2 Experimental Setup

3.2.1 Specifications / Operating condition of Hydrodynamic Reactor

1. Pipe size- ½ inch.

2. Regulating valves –3 in numbers.

3. Feed Tank size – 10 liters.

4. Pump capacity – 150 LPM.

5. Number of orifice plate-1 number.

6. Number of venturi -1 in number.

3.3 Operating Process

Following is the stepwise procedure to operate the reactor.

1. Take 10 liters of Biomethanated waste water in to the tank collected from Distillery Spent wash of sugar industry.
2. Installed the venturi plate or orifice meter in union joint as shown in figure.
3. Start the pump to regulate the flow of waste water in the reactor.
4. Circulate the Biomethanated waste water in the rector for 10-15 minutes.
5. For operation open the value connected to Orifice or Venturi.
6. The cavitation process carried out 25-150 mins and at pressure 5-13 bars.
7. Analyzed the various parameters of Biomethanated waste water like COD and B.I.

8. Follow the same procedure for No dilution, 25 % Dilution and 50% Dilution of Biomethanated waste water by using distilled water.

3.4 B.I. AND BMP

3.4.1 BMP (Biochemical Methane Potential)

General Principles BMP to determine normalized biogas & CH Determine normalized biogas & CH4 production (mL CH production (mLCH4 / g substrate VS) and the extent of substrate anaerobic and the extent of substrate anaerobic biodegradation (%) biodegradation (%). 1 g COD reduction = 395 mL CH_4 Produce or 1 kg COD reduction = 0.395 m^3 CH_4

3.4.2 B.I. (Biodegradability Index)

B.I. is the ratio of BOD_5: COD and is a parameter for evaluating biodegradability of a wastewater. Biodegradability index (BI) with reference to suitability of wastewater for biological treatment.

3.5 Observations

The B-DWW was subjected to HC pretreatment for which 10 L of Biomethanated wastewater was treated in cavitation reactor and the cavitation was achieved using a circular venturi. Pretreatment process for B-DWW are carried out in lab-based model were conducted at different inlet pressure 5, 13 bar and at different dilutions 25%, 50% of the biomethanated distillery wastewater in the time range of 25-150 minutes. After time of interval 25, 50, 75, 100, 125 and 150 mins the samples were withdrawn from the reactor through a sampling port.

3.5.1 Effect of Inlet Pressure on COD Reduction of B-DWW

Sr No.	Time in Min	% COD Reduction (5 Bar)	% COD Reduction (13 Bar)
01	25	20	22
02	50	28	30
03	75	29	31
04	100	30	32
05	125	31	33
06	150	32	35

Table No. 3.1 Effect of Different Dilution on COD of B-DWW

Table 3.1 shows the effect of HC process on % reduction in COD for the B-DWW at different intervals of time 25, 50, 75, 100, 125 and 150 mins at different pressure of 5 bar and 13 bar. As per table it's clear that the % reduction COD reduction increase slightly with increase in the pressure of cavitation process. The % reduction COD reduction also increase with increase in time of cavitation process.

3.5.2 Effect of Different Dilution on COD of B-DWW

Sr No.	Time in Min	% COD Reduction (At NO Dilution)	% COD Reduction (At 25% Dilution)	% COD Reduction (At 50% Dilution)
01	25	15	20	27
02	50	24	27	35
03	75	26	29	38
04	100	28	31	40
05	125	30	33	42
06	150	32	35	45

Table No. 3.2 Effect of Different Dilution on COD of B-DWW

Table 3.2 shows the effect of HC process on % reduction in COD for the B-DWW at different intervals of time 25, 50, 75, 100, 125 and 150 mins at different dilutions 25 % and 50 %. As per table it's clear that the % reduction COD reduction increase with increase in the dilution of B-DWW. The % reduction COD reduction also increase with increase in time of cavitation process.

3.5.3 Effect of Pressure and dilution on B.I. of B-DWW at 5 bar Pressure

Table 3.3 shows the effect of HC process on biodegradability index for the B-DWW at different intervals of time 25, 50, 75, 100, 125 and 150 mins at different dilutions 25 % with pressure of 5 bar. As per table it's clear that the biodegradability index increases with increase in the dilution of B-DWW. The biodegradability index also increases with increase in the pressure of cavitation process.

Sr. No.	Time in Min	Biodegradability Index (At 5 bar and NO Dilution)	Biodegradability Index (At 5 bar and 25% Dilution)
01	25	0.19	0.20
02	50	0.20	0.22
03	75	0.20	0.22
04	100	0.21	0.23
05	125	0.22	0.24
06	150	0.22	0.24

Table No. 3.3 Effect of dilution on B.I. of B-DWW at 5 bar Pressure

3.5.4 Effect of Pressure and dilution on B.I. of B-DWW at 13 bar Pressure

Sr. No.	Time in Min	Biodegradability Index (At 13 bar and NO Dilution)	Biodegradability Index (At 13 bar and 25% Dilution)
01	25	0.25	0.26
02	50	0.26	0.27
03	75	0.27	0.28
04	100	0.28	0.29
05	125	0.29	0.30
06	150	0.29	0.30

Table No. 3.4 Effect of dilution on B.I. of B-DWW at 13 bar Pressure

Table 3.4 shows the effect of HC process on biodegradability index for the B-DWW at different intervals of time 25, 50, 75, 100, 125 and 150 mins at different dilutions 25 % with pressure of 13 bar. As per table it's clear that the biodegradability index increases with increase in the dilution of B-DWW. The biodegradability index also increases with increase in the pressure of cavitation process. There is no much difference in no dilutions and 25 % dilutions on B. I. of B-DWW. This also for pressure 5 and 13 bar. So, we can choose the condition for the H. C. process without dilution and at pressure value of 5 bar with cavitation time 50 min.

3.5.5 Effect of Pretreatment of B-DWW by Hydrodynamic Cavitation on % Yield of Methane by Using BMP

Sr. No.	Time in Min	% Increase in yield of Methane at 5 bar Pressure	% Increase in yield of Methane at 13 bar Pressure
02	50	11	11.85
04	100	11.85	12.65
06	150	12.65	13.80

Table No. 3.5 Effect of Pretreatment of B-DWW by Hydrodynamic Cavitation on % Yield of Methane by Using BMP

Values of % Increase yield of methane with help of BMP as shown in above table no. 3.5. As per calculation values of % COD Reduction at Pressure 5 Bar 28, 30 and 32 % at 5 Bar Pressure and that of at 13 bar Pressure 30, 32 and 35 % with treatment time 50, 100 and 150 mins by Hydrodynamic Cavitation Process. As per BMP shows that 1 g COD reduction = 395 mL CH_4 Produce. With help of this equation and values of % COD we can Calculate the values of % increase of Methane Yield.

3.5 Energy Balance

We treat the 10 L B-DWW by using HC at 50 min and 13 bar pressure yield shows by the experimental analysis calculating by BMP which is 11.85 %.

Total Biogas produce from 10 L B-DWW = [11.85 * 10] / 100 = 1.185 L

Total energy required for Pump = 1.1 KW * (50/60) hr. = 0.92 KW hr.

Biogas formed per unit energy consumption = 1.185 L / 0.92 KW hr. = 1.28 L / KW hr.

Cost of for 1.28 L Biogas produce from B-DWW by HC = 0.92 * 7.5 Rs Per KW hr.

Total Benefit Biogas produce from 10 L of B-DWW Treated Biomass = 53.3 -7.9 = 45.5 Rs/ 10L B-DWW

Total Benefit Biogas produce from per L of B-DWW Treated Biomass 4.5 Rs / L B-DWW

RESULTS AND DISCUSSION

4.1 Effect of Pressure on % COD Reduction

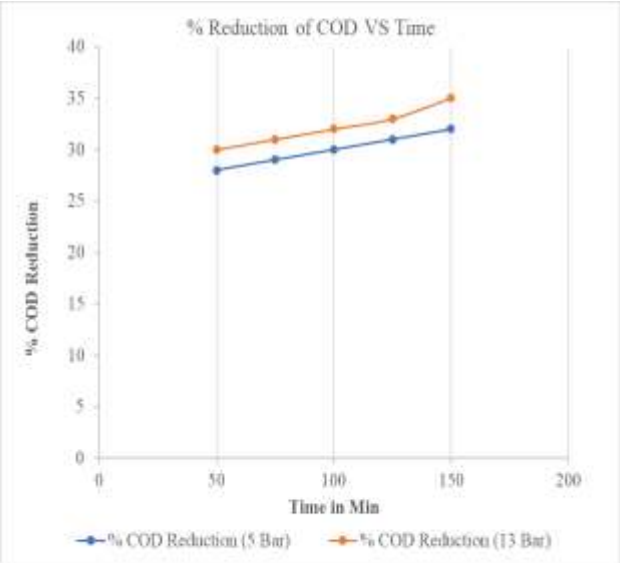

Fig. 4.1 Effect of Inlet Pressure on % COD Reduction of B-DWW

Fig. 4.1 shows the effect of inlet Pressure on % reduction in COD for the B-DWW at different intervals of time 25, 50, 75, 100, 125 and 150 mins at different pressure of 5 bar and 13 bar. The experimental analysis shows the maximum % COD reduction 32-35 at pressure value 5-13 bar. The optimum value for the pressure will be 5 bar because there is no much variation of values of % COD reduction at different pressure values.

4.2 Effect of Different Dilution on % COD Reduction

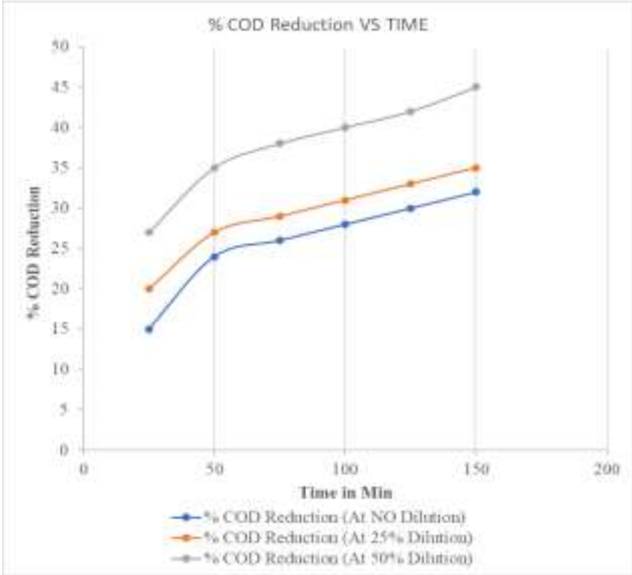

Fig. 4.2 Effect of Different Dilution on COD of B-DWW

Fig. 4.2 shows the effect of Dilution on % COD reduction for the B-DWW at different intervals of time 25, 50, 75, 100, 125 and 150 mins at different dilutions 25 % and 50 %. It's clear that the % COD reduction increase with increase in the dilution of B-DWW. The % reduction COD reduction also increase with increase in time of cavitation process. As per experimental analysis shows the optimum value for the dilutions will be 25-50 %.

4.3 Effect of Pressure and dilution on B.I. of B-DWW at 5 bar Pressure

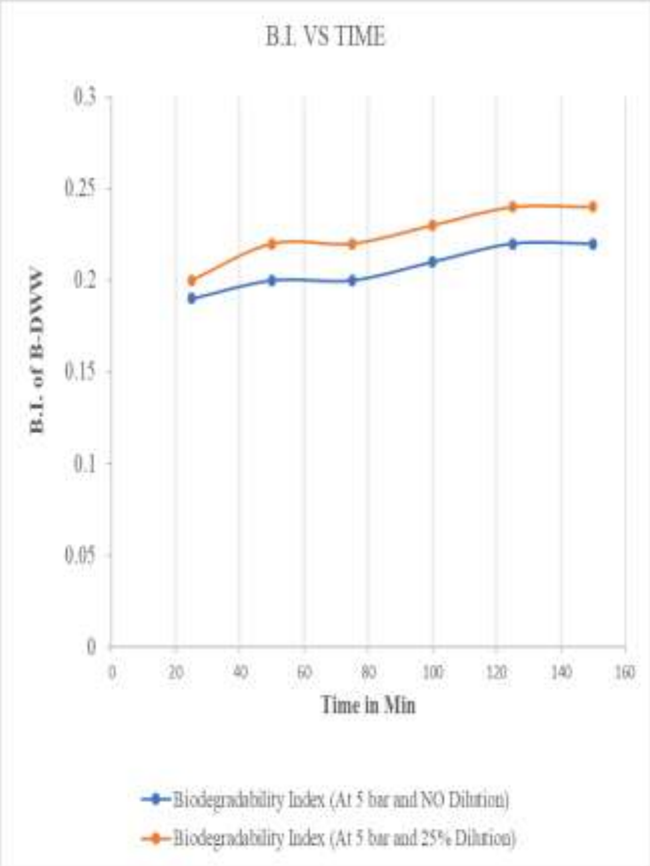

Fig. 4.3 Effect of Pressure and dilution on B.I. of B-DWW at 5 bar Pressure

Fig. 4.3 shows the effect of HC process on biodegradability index for the B-DWW at different intervals of time 25, 50, 75, 100, 125 and 150 mins at different dilutions 25 % with pressure of 5 bar. As per table it's clear that the biodegradability index increases with increase in the dilution of B-DWW. The biodegradability index also increases with increase in the pressure of cavitation process. As per experimental analysis there is no much variation in the B.I. at time 50 min to 150 min and different dilutions. Hence the optimum value for the B.I. 50 min without dilution. As increase in the B.I. the % reduction of COD and decomposition also increase that favors high yield of methane gas generation.

4.4 Effect of Pressure and dilution on B.I. of B-DWW at 13 bar Pressure

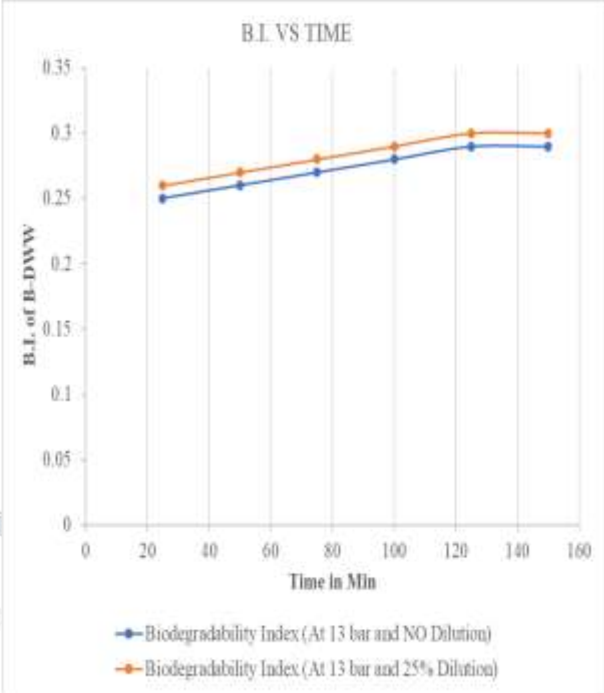

Fig. 4.4 Effect of Pressure and dilution on B.I. of B-DWW at 13 bar Pressure

Fig 4.4 shows the effect of HC process on biodegradability index for the B-DWW at different intervals of time 25, 50, 75, 100, 125 and 150 mins at different dilutions 25 % with pressure of 13 bar. As per table it's clear that the biodegradability index increases with increase in the dilution of B-DWW. The biodegradability index also increases with increase in the pressure of cavitation process. As per experimental analysis there is no much variation in the B.I. at time 50 min to 150 min and different dilutions. Also Compares in pressure that also shows the no much variations for B.I. at pressure value 5 and 13 bars. Hence the optimum value for the B.I. 50 min without dilution at pressure value 5 bar.

4.5 Effect of Pre-treatment of B-DWW by Hydrodynamic Cavitation on % Yield of Methane by Using BMP

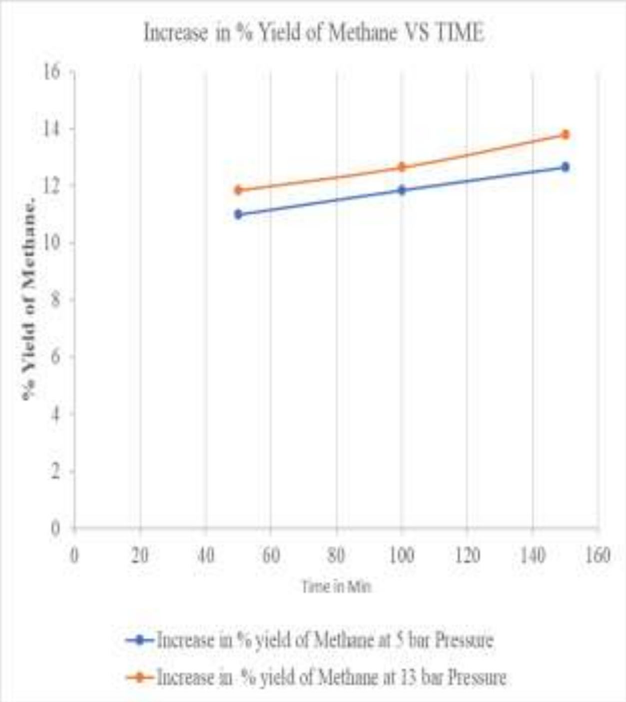

Fig 4.5 Effect of Pre-treatment of B-DWW by H.C. on % Yield of Methane

Values of % Increase yield of methane with help of BMP as shown in above fig. no. 4.5. As per calculation values of % COD Reduction at Pressure 5 Bar 28, 30 and 32 % at 5 Bar Pressure and that of at 13 bar Pressure 30, 32 and 35 % with treatment time 50, 100 and 150 mins by Hydrodynamic Cavitation Process. As per BMP shows that 1 g COD reduction = 395 mL CH_4 Produce, with help of this equation and values of % COD we can Calculate the values of % increase of Methane Yield. As per experimental analysis it's clear that pre-treatment of biomass (B-DWW) can increase the yield of methane gas up to 14 % as above conditions. These values can be change by changing the conditions.

CONCLUSION

We carried out experimental analysis the effect of pre-treatment of Hydrodynamic Cavitation on B-DWW at various contact time from 50-150 min, at different pressure 5-13 bars, with different dilutions 25-50 % for % COD reduction, for increase in B.I. for increase the yield of methane gas from biomethanated waste water (B-DWW). Experiment shows the effect of pressure, contact time and dilution on % COD reduction, B.I. and % yield of methane gas by BMP.

Experimental analysis shows the effect of pre-treatment of HC process on biodegradability index of B-DWW at different intervals of time 50-150 mins, at different dilutions 25 % with pressure of 5-13 bar. The biodegradability index increases with increase in the dilution of B-DWW and also increases with increase in the pressure of cavitation process. There is no much variation in the B.I. at time 50 min to 150 min and different dilutions and that also shows the no much variations for B.I. at pressure value 5 and 13 bars. Hence, the optimum value for the B.I. 50 min without dilution at pressure value 5 bar.

Experimental analysis also shows the effect of Dilution of B-DWW on % COD reduction at different intervals of time 50-150 mins at different dilutions 25 % and 50 %. It's clear that the % COD reduction increase with increase in the dilution of B-DWW. The % reduction COD reduction also increase with increase in time of cavitation process. As per experimental analysis shows the optimum value for the dilutions will be 25-50 %.

The effect of inlet Pressure on % reduction in COD for the B-DWW at different intervals of time 50-150 mins at different pressure of 5 bar and 13 bar. It's clear that the % reduction COD reduction increase slightly with increase in the pressure of cavitation process. The % reduction COD reduction also increase with slightly increase in time of cavitation process. The maximum % COD reduction 32-35 at pressure value 5-13 bar. The optimum value for the pressure will be 5 bar because there is no much variation of values of % COD reduction at different pressure values.

As per calculation values of % COD Reduction 28, 30 and 32 % at 5 Bar Pressure and that of at 13 bar Pressure 30, 32 and 35 % with treatment time 50, 100 and 150 mins by Hydrodynamic Cavitation Process. As value of % COD reduction increase also increase of % Yield of Methane. As per experimental analysis it's clear that pre-treatment of biomass (B-DWW) can increase the yield of methane gas up to 14 % as above conditions. These values can be change by changing the conditions.

All above analysis conclude that with pre-treatment of H.C. of B-DWW (Biomass) shows the increase the % Yield of methane production. That also effect on the % COD reduction and B.I. of B-DWW favors positive results. Pre-treatment of H.C. decrease the particle size, increase pumpability, increase B.I., reduce COD and % yield of Methane gas from B-DWW. The Optimum parameter for H.C. pre-treatment pressure 5 bar, Contact Time 50 min without dilution.

FUTURE SCOPE AND BENEFITS

Benefits of Pretreatment of biomass (BDWW) by using HC process

1. Reduction of organic material size.

2. Reduction of the digested viscosity.

3. Resulting easiness of internal digester mixing.

4. Increase of the digestate homogeneity and better pumpability.

5. H.C. reduce the pumping cost and also reduce the time of operation.

5. Reduction in particle size which increase the surface area and higher rate of degradation.

6. Breakdown lignocellulose.

7. Due to all above increase the digestion of biomass and increase the yield of biogas.

Future Scope

1. Cavitation method can be adopted to treat waste water.
2. To improve the effectiveness of cavitation a series of venturi meter or orifice meter can be connected that can be gives the better results.
3. To improve pH value other substance can be added with it.
4. To improve the efficiency of conventional method cavitation method can be use.
5. By using cavitation method, we can treat the any types of waste water.
6. HC can increase the fermentation by increasing the biodegradability index.
7. HC can pretreatment of the various types of biomass that favors the higher yield of methane.
8. HC can adopt combine with different convectional method for effective treatment of biomass.
9. HC can use to increase the rate of Bioethanol production by increasing the fermentation rate.
10. HC helps to increase rate of degradation by reducing particle size hence it can adopt to increase the yield of Biogas or Methane production.

REFERENCES

1.Aleksandra Krzywicki and Marcin Zalinski, Application of Hydrodynamic Cavitation for Improving Methane Fermentation of Sida hermaphrodite Silage University of Warmia and Mazury in Olsztyn, Department of Environment Engineering, Warszawska and Czestochowa University of Technology, Poland, Energies 2019, 12, 526.

2.David Tran, Hydrodynamic cavitation applied to food waste anaerobic digestion, Scandinavian Biogas Fuels, Department of Thematic Studies Environmental Change, Linkoping University, Engineering Biology Spring 2016, TQTB33.

3.Debabrata Panda, Virendra Kumar Saharan and Sivakumar Manickam, Controlled Hydrodynamic Cavitation: A Review of Recent Advances and Perspectives for Greener Processing, Department of Chemical and Environmental Engineering, Faculty of Science and Engineering, University of Nottingham Malaysia, Semenyih 43500, Selangor, Malaysia and Department of Chemical Engineering, Malaviya National Institute of Technology, Jaipur 302017, India, Processes, 2020, 8, 220.

4.Diane M., Parveen Kumar, Barrett, Michael J. Dewlike and Pieter Stroeve, Methods for Pretreatment of Lignocellulosic Biomass for Efficient Hydrolysis and Biofuel Production Departments of Chemical Engineering and Materials Science, Food Science and Technology and Biological and Agricultural Engineering, University of California, Industrial & Engineering Chemistry Research is published by the American Chemical Society. 1155 Sixteenth Street N.W., Washington, DC 20036, 20 March 2009.

5. Dr. Salim Mokraoui, Introduction to Biomass Energy Conversions, Sustainable Energy Technologies Center (SET) King Saud University, biomass group.

6. Hydrodynamic cavitation as a pretreatment tool for the biodegradability enhancement of distillery waste water, Hydrodynamic Cavitation based degradation of Bio-Refractory pollutants.

7. Martin Petoskey, Brane Siro , Martez Dular , Matej Mlakar , Marjetka Levstek , Marjeta Strazarb , A novel rotation generator of hydrodynamic cavitation for waste-activated sludge disintegration a Laboratory for Water and Turbine Machines, Faculty of Mechanical engineering, University of Ljubljana and Javno podjetje centralna cistilna naprava Domzale-Kamnik d.o.o. (Domžale-Kamnik Wastewater treatment plant), Aškerčeva 6, 1000 Ljubljana SI-Slovenia and Študljanska 91, 1230 Domžale, Ultrasonics Sonochemistry, ULTSON 2776, 6 January 2015.

8. Ramesh Desikan, Kiruthika Thangavelu and Sivakumar Uthandi, Hydrodynamic Cavitation A Promising Technology for Biomass Pretreatment, Department of Vegetable Science, Horticultural College and Research Institute for Women, Department of Bioenergy, Agricultural Engineering College and Research Institute, and Department of Agricultural Microbiology, Tamil Nadu Agricultural University, India, International Journal of Environmental Sciences & Natural Resources, 2572-1119, IJESNR, May 23, 2019.

9. Rely Teran Hilaria and Muhammad Ajaz Ahmedb, Hydrodynamic cavitation-assisted alkaline pretreatment as a new approach for sugarcane bagasse biorefineries, Department of Biotechnology, Engineering School of Lorena, University of São Paulo, CEP 12602-810, Brazil and Department of Civil and Environmental Engineering, KAIST, 373-1 Guseong-dong, Yuseong-gu, Daejeon 305-701, Republic of Korea.

10. Raphael Muzondiwa Jingura and Reckson Kamusoko, Methods for determination of biomethane potential of feedstocks: a review, Chinhoyi University of Technology, P. Bag 7724, Chinhoyi, Zimbabwe, Biofuel Research Journal 14 (2017) 573-586.

11. Sanjay Nagarajan and Vivek V. Ranade, Pre-treatment of Lignocellulosic Biomass using Vortex based Devices for Cavitation: Influence on Biomethane Potential, Multiphase flows, reactors and intensification group School of Chemistry and Chemical Engineering Queen's University Belfast, Belfast BT9 5AG, United Kingdom, Ultrasonics Sonochemistry 72 (2021) 105428, ISCRE25, 20-23 MAY 2018.

12. Sachin Kumar, Julie Baruah Bikash Kar Nath Ritika Sharma, Ramesh Chandra Deka, Recent Trends in the Pretreatment of Lignocellulosic Biomass for Value-Added Products, Department of Molecular Biology and Biotechnology, Tezpur University, Tezpur, India.

13. Sergio Piccinini and Claudio Fabbri, Pretreated biomass improves digestion, Advantages of Controlled Cavitation.

14. Jameson Filer, Huihuang H. Ding and Sheng Chang, Biochemical Methane Potential (BMP) Assay Method for Anaerobic Digestion Research School of Engineering, University of Guelph, 50 Stone Road E., Guelph, ON N1G 2W1, Canada; Water 2019, 11, 921.

15.Wai Yan Cheah and Revathi Sankaran, Pretreatment methods for lignocellulosic biofuels production: current advances, challenges and future prospects, Department of Environmental Health, Faculty of Health Sciences, MAHSA University and Institute of Biological Sciences, Faculty of Science, University of Malaya, 50603, Kuala Lumpur, Malaysia.

Nomenclature

AOP - Advanced Oxidation Processes

AD – Aerobic Digestor

AFEX - Ammonia Fibber Explosion

B-DWW - Biomethanated Distillery Waste Water

BMP - Biochemical Methane Potential

BI - Biodegradability Index (BOD_5: COD ratio)

BOD - Biochemical Oxygen Demand

COD - Chemical Oxygen Demand

DES - Deep Eutectic Solvents

HC- Hydrodynamic Cavitation

IL - Ionic Liquid

LCB - Lignocellulosic Biomass

TOC: Total organic carbon

TWE -Tannery Waste Effluent

VFA - Volatile Fatty Acid

VS – Volatile Substrates