Treatment of Sugar (Distillery) Waste Water Treatment by Hydrodynamic Cavitation Process

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ABSTRACT

Pre-treatment by using hydrodynamic cavitation formation and collapse of micro bubble with venturi as a cavitating device. Hydrodynamic cavitation process the intensity of collapsing bubbles depends on the operating parameter such as pressure. HC carried out at different pressure and checking the waste water characteristics such as Biological oxygen demand, Chemical oxygen demand, Total organic carbon, Color and Biodegradability Index etc. Pre-treatment using Hydrodynamic Cavitation can be effectively utilized for reduction of COD. HC can use with conventional methods for increase the efficiency of selected method in waste water treatment. The effect of pre-treatment of Hydrodynamic Cavitation on DWW at various contact time from 50-150 min, at different pressure 5-13 bars, with different dilutions 25-50 % for % COD reduction. Pre-treatment of H.C. decrease the particle size, increase pumpability, increase B.I., and reduce COD from DWW. The Optimum parameter for H.C. pre-treatment pressure 5 bar, Contact Time 50 min without dilution. It's clear that the % COD reduction increase with increase in the dilution of DWW. The % reduction COD reduction also increase with increase in time of cavitation process.

Keywords - Treatment (Sugar) Distillery Waste Water, Hydrodynamic Cavitation, DWW, COD.

1. INTRODUCTION

Waste water from distillery contain mostly dark brown colored recalcitrant compounds collectively termed as melanoidin polymers which are the product of maillard reaction between the amino acids and carbonyl groups present in molasses. Distillery waste water have very high Chemical Oxygen Demand (COD) and these effluents are environmental hazards when released in water bodies they cause oxygen depletion and associated problems. Spent wash produce from the distillery poses a serious threat to water quality in several regions of the country. After some treatment disposal on land is equally detrimental causing a reduction in soil alkalinity and inhibition of seed germination. Distillery spent wash owing to the presence of melanoidins and color. For production of 1 l alcohol (ethanol) around 8 – 15 l of spent wash generated. Characteristic of waste water generated from the distillery industry is depending up on the quality of molasses and fermentation process.

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

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 06 | June - 2021 ISSN: 2582-3930

7. Reverse osmosis.
8. Aerobic and Anaerobic process
9. Electro Coagulation
10. Chemical Coagulation

Hydrodynamic Cavitation

Produced by pressure variation in a flowing liquid caused by the velocity variation in the system by changing the flow geometry of the flow system. Hydrodynamic cavitation is a promising application in wastewater treatment due to its simple reactor design and capacity in large-scale operation. 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.

Advantages of Hydrodynamic Cavitation

1. HC capability to oxidize organic substances.
2. HC is efficient to oxidize organic substances .
3. Less operation costs based on energy efficiency.
4. Hydrodynamic cavitation is energy efficient.
5. Less time consumption comparing other process
6. Parameters to be controlled 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

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

LITERATURE REVIEWS

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. Hydrodynamic cavitation probably increased the digestibility of the biomass, which resulted in a higher methane production from the disintegrated substrate than that observed in the control experiment and hydrodynamic cavitation could be economically applied on a bigger scale for the methane fermentation. Rapid hydrolysis rate and digestibility with HC treated sample compared to ultrasound.[1]. **By using Hydrodynamic Cavitation process capable of reducing the toxicity of** distillery wastewater as well as the pretreatment increases the biodegradability of the B-DWW. Hydrodynamic cavitation can be effectively utilized for the treatment of complex wastewater such as B-DWW. As HC was used as a pretreatment unit to the AD chemical oxygen demand (COD) reduction were increased. By experimental analysis with HC treatment COD reduction of 43.17% [2]. **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. [3] **Pre-treatment of biomethanated distillery waste water by using hydrodynamic cavitation can be effectively utilized for** reduction in toxicity, COD, TOC and color. At inlet pressure 5 bar suitable for the reduction in toxicity of distillery wastewater and higher pressure have no additional benefits on the reduction of toxicity. The higher pressure 13 bar to be effective for enhancement of the biodegradability index. The biodegradability index is a measure of the extent to which a waste is amenable to biodegradation. BI can be expressed as a ratio of BOD5:COD. For good biodegradability of any wastewater minimum BOD:COD ratio (BI) will be 0.3–0.4. Pretreatment with hydrodynamic cavitation has leads to increase in the ratio with time is almost constant with a value of 0.22 at 50 min, 0.23 at 100 min and 0.24 at 150 min.[4]

Hydrodynamic cavitation process not only reduce the COD and TOC but also decreasing the color of distillery wastewater. For undiluted distillery wastewater a maximum 33% color, for 25% to 50% diluted distillery wastewater color reduction 40% to 47% respectively. At pressure of bar is significant for the reduction of COD and TOC as well as the 6.5 bar pressure is significant for the increasing B.I. HC treatment can be efficiently and effectively carried out for increasing the biodegradability of composite wastewater with decreasing toxicity, color, COD and TOC. Treatment of waste water at pressure of 2.5 bar the reduction of COD becomes 17% and reduction of TOC becomes 18 %. The considerable reduction of COD and TOC occurs at initial 50 min which is optimum treatment time for the reduction of COD and TOC. [5]. **Hydrodynamic cavitation for waste water promising technology for COD reduction as no require chemicals and sludge generation is also very less.** HC process results in sudden drop and increase of pressure in a liquid which creates cavities and bubbles followed by sudden and violent collapse. It results in generation of shock waves leading to generation of hydroxyl free radical. Hydroxyl free radical causes the development of localized forces which have destructive effects on the solids in dispersions, emulsions and slurries affecting particle size and distribution resulting to reduction in COD. Combine hydrodynamic cavitation and AOP process overall efficiency of the COD removal can improved and chemical requirement and sludge generation can reduced. [6]

Characteristics of Distillery Waste Water

Parameter	Value
pH	4 - 4.5
TDS	65000-100000 mg/l
COD	80000 -125000 mg/l
BOD	40000- 50000 mg/l

Table Characteristics of DWW

Operating Process

Following is the stepwise procedure to operate the reactor.

1. Take 10 liters of 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.
8. Follow the same procedure for No dilution, 25 % Dilution and 50 % Dilution of waste water by using distilled water.

4. RESULTS AND DISCUSSION

Effect of Inlet Pressure on COD Reduction

Table 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. Reduction COD reduction also increase with increase in time.

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 Effect of Different Dilution on COD

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 Effect of Different Dilution on COD

Table 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.

CONCLUSION

The effect of pre-treatment of Hydrodynamic Cavitation on DWW at various contact time from 50-150 min, at different pressure 5-13 bars, with different dilutions 25-50 % for % COD reduction. The effect of Dilution of 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 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.

Benefits of Pretreatment of DWW by using HC

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.

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.

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