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# PRODUCTION OF BIOGAS FROM DAIRY WASTE WATER

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**Abstract:**

Pollution caused by dairy effluents is a serious problem throughout the world. The major source of waste water is from dairy industry. The effluent from dairy processing unit affects the environment. As a solution our aim is to produce bio-gas from diary wastewater. There are various treatment technologies, among them anaerobic treatment technology is simple and encouraged due to the following advantages such as low cost of construction, pH stability, low maintenance and repair. The biogas is a renewable fuel which can be made using a relatively well known technology. The hazardous pollutants of dairy wastewater can be reduced by anaerobic digestion. For the production of bio-gas we use a batch reactor of capacity 2L. Diary wastewater as a substrate and cow dung as an inoculum is mixed in a definite proportion and fed into the digester. The required physio-chemical parameters (pH, COD, T.S, and V.S) which influence the bio-gas production are studied before and after the digestion process. After the biogas production COD level was reduced up to 36%.

**Key Words:** Anaerobic Digestion, Biogas Generation, Diary Wastewater, Cow Dung & COD

## 1. Introduction:

The production and use of biogas is usually seen as a promising option for clean and sustainable energy generation that can meet global energy needs and provide multiple environmental benefits, such as significant reductions in emissions of gases causing the greenhouse effect. The biogas can be produced from the anaerobic digestion of almost all types of organic materials for the primary agricultural and various industrial and domestic organic waste streams. Among the industrial activities, the dairy industries stand out as major generators of organic waste. The dairy industry, like most other agricultural industries, generates large flows of resistant wastewater, characterized by high biological oxygen demand (BOD) and chemical demand of oxygen concentrations (COD), representing its high content of organic matter. Dairy industry is one of the major food industries in India, and India ranks first among the maximum major milk producing nation. Dairy is an industry where milk is processed and various milk products are manufactured. The dairy factory is a major source of food processing waste water. The discharge of industrial effluents by dairy industry has a great impact on environment, because besides the high concentration of organic matter, the effluents have high levels of oil and grease, and are characterized by the presence of suspended solids and odour caused by the decomposition of casein. In this scenario, the adoption of anaerobic digestion processes in the dairy industry effluent treatment plants stand out as the biological method more suitable for the treatment or pre-treatment of generated waste effluents. Anaerobic digestion has been widely used as a treatment technology that is applicable to high strength wastewater without energy consumption, stabilization of the organic matter and the production of biogas which can be used as a renewable source of energy in the industry itself. Objective of the study is to investigate the potential production of biogas from the dairy wastewater and to investigate the effect of various parameters on the biogas production.

## 2. Characteristics of Dairy Wastewater:

The colour of dairy waste water is usually white and they are alkaline in nature. Due to the fermentation of milk sugar to lactose, the dairy wastewater becomes acidic rapidly and also by the use of detergents in washing it becomes acidic. The pH decreases immediately due to fermentation, this leads to formation of casein. Heavy black sludge and strong butyric acid odours are produced due to decomposition of casein. The pH value varies from 6.5-8. By the use of caustic soda for cleaning, it increases the sodium content in waste.

## 3. Effects of Dairy Effluent:

Due to rapid decomposition of dairy wastewater, it reduces the dissolved oxygen level of receiving water and lactose which is a major constituent of waste which promotes the growth of sewage fungus. When water is highly contaminated by dairy waste water, it becomes breeding place for flies and mosquitos carrying dangerous diseases. The high odorous black sludge is produced due to decomposition of casein precipitation which is found to toxic to aquatic life. They promote eutrophication, impart turbidity and releases strong foul smell. Based on biodegradability and solubility of waste, the effect on environment varies. The processing of dairy waste water has organic components which are highly biodegradable.

## 4. Anaerobic Digestion:

Anaerobic digestion is a process of decomposition of organic matter in which it is broken down into simple chemical compounds under the absence of oxygen. Anaerobic microorganisms digest the organic materials to produce methane and carbon dioxide under the absence of oxygen. The small amount of hydrogen sulphide and ammonia, as well as trace of other gases is produced during the biogas production in the anaerobic digestion plant.

The process includes four stages they are,

- ✓ Hydrolysis

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- ✓ Acidogenesis
- ✓ Acetogenesis
- ✓ Methanogenesis

**5. Materials and Methods:**

This paper deals with the feasibility study of biogas production from dairy wastewater. Studies were carried out in laboratory scale anaerobic digesters under ambient condition.

**A) Methodology:**

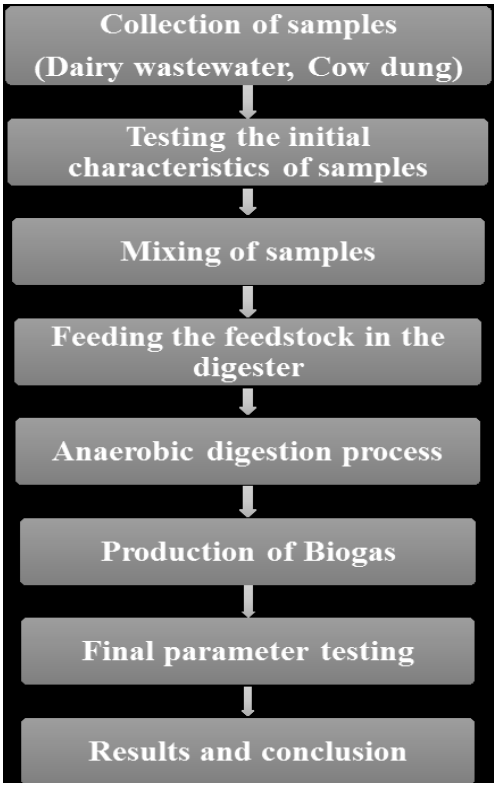


Figure 1: Methodology

**B) Materials:**

**Substrate:** The dairy wastewater was collected from Numax food Pvt .Ltd located in Annur, Coimbatore.

**Inoculum:** The cow dung was collected and it is used as inoculum for digestion. It contains large amount of microorganisms and it was diluted with dairy waste water in 1:2 ratio (w/v).Where one part of cow dung is taken with two parts of diary waste water.

**6. Experimental Setup:**

The experimental setup consists of digester, gas collector and gas measuring jar connected in series. The capacity of the digester and gas measuring jar is 2 liters. The capacity of gas collector is 10 liters and filled with brine solution. A known ratio of influent containing a mixture of dairy wastewater and cow dung was transferred into a 2 liter glass digester. The air tight rubber stoppers were used to seal the bottles. From the top of the digester, the gas collection tube was connected to the gas collection jar filled with brine solution which in turn was connected to the gas measuring jar. No external temperature adjustment was made for increasing the production of methane and the system was operated under ambient conditions.

**7. Experimental Procedure:**

Anaerobic digester was fabricated in the laboratory using glass material with a working volume of 1.5L. The digester was fabricated with a leak proof sealing along with proper inlet and outlet arrangements. Dairy wastewater which was used as a substrate and cow dung as inoculum was mixed in the ratio of 2:1. The seed consists of enormous amount of microorganisms which are responsible for the stabilization of the substrate so as to obtain methane gas. No pH adjustment was made in the digester. The following were studied under ambient conditions. The amount of biogas generated was monitored and rewarded on daily basis.

**8. Experimental Analysis:**

The influent for the digester was analyzed based on standard methods for examination of water and wastewater. The following parameters were tested

- ✓ pH
- ✓ Total solids
- ✓ Volatile solids
- ✓ Chemical oxygen demand (COD)
- ✓ Carbon nitrogen ratio (C/N)

Initial characteristics of the substrate, inoculum and influent were shown in table 1.

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Table 1: Initial characteristics of substrate, inoculum and influent

| Characteristics | Substrate | Inoculum | Influent |
|---|---|---|---|
| pH | 7.5 | 5.92 | 7 |
| Total solids, mg/l | 2532 | 4300 | 1520 |
| Volatile solids, mg/l | 1702 | 1100 | 1340 |
| COD, mg/l | 1184 | 3360 | 2432 |
| C/N ratio | 23.2:1 | 20:1 | 21:1 |

**9. Results and Discussions:**

Dairy wastewater and cow dung were added to the reactor. The contents of the reactor were analyzed for pH, total solids, volatile solids, COD and carbon nitrogen ratio. The inoculum was allowed to acclimatize and the biogas production was monitored.

**A) Characteristics of Reactor Content:** The reactor contents were analyzed for its characteristics as per standard methods of analysis and the results are shown in table 2. All the experiments were carried out in ambient temperature.

Table 2: Characteristics of reactor content

| Characteristics | Effluent |
|---|---|
| pH | 6.46 |
| Total solids, mg/l | 1290 |
| Volatile solids, mg/l | 890 |
| COD, mg/l | 760 |
| C/N ratio | 15:1 |

**B) Biogas Production in Process:** After the substrate and inoculum were added into the reactor, gas production was observed. No nutrients and growth factor were added. It was observed that the gas production started on 17th day. However, when tested it did not burn. After a period of two weeks the gas was tested and started burning with the blue flame indicating the presence of methane. Gas production was recorded thereafter. Table 3 shows the cumulative volume of biogas.

Table 3: Cumulative volume of biogas 275*ml was taken as initial value

| Days | Cumulative volume |
|---|---|
| 14 | 275* |
| 15 | 275 |
| 16 | 275 |
| 17 | 275 |
| 18 | 315 |
| 19 | 420 |
| 20 | 430 |
| 21 | 440 |
| 22 | 450 |
| 23 | 460 |
| 24 | 460 |
| 25 | 485 |
| 26 | 510 |
| 27 | 530 |
| 28 | 550 |
| 29 | 575 |
| 30 | 605 |
| 31 | 625 |
| 32 | 650 |
| 33 | 680 |
| 34 | 700 |
| 35 | 730 |
| 36 | 760 |
| 37 | 800 |
| 38 | 840 |
| 39 | 870 |
| 40 | 895 |
| 41 | 910 |
| 42 | 930 |
| 43 | 950 |
| 44 | 965 |
| 45 | 990 |

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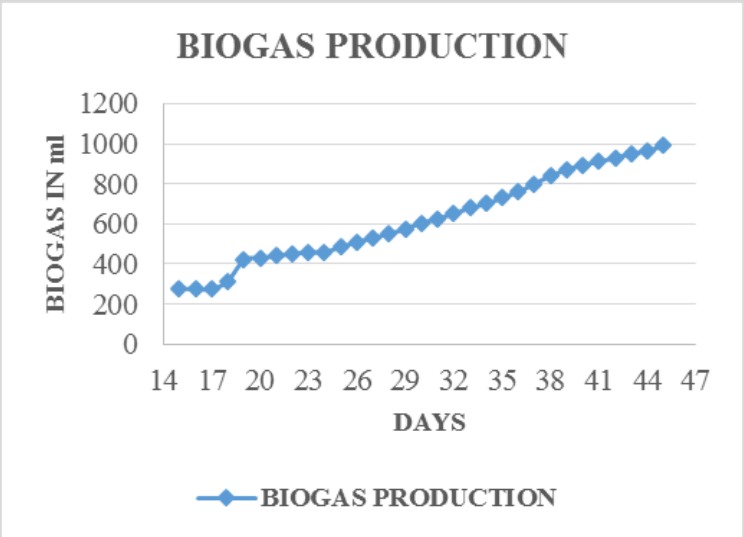


Figure 2: Cumulative biogas production

**10. Summary:**

Studies were carried out in laboratory scale anaerobic digesters to evaluate the potential of biogas production by dairy wastewater. Experiments were conducted in anaerobic reactors of 2L capacity with a working volume of 1.5L, connected to gas collection jar and gas measuring jar. Dairy wastewater was collected from Numax food Pvt. Ltd. Dairy wastewater was used as substrate and Cow dung was used as inoculum. Dairy wastewater and cow dung was added in proportion 2:1. The contents of the reactor was mixed intermittently to provide intimate contact between substrate and inoculum. The biogas produced was determined by liquid displacement method.

**11. Conclusion:**

The biogas production in the anaerobic digester and treatment of dairy wastewater was studied under ambient conditions and investigated experimentally.

- ✓ Experimental setup of anaerobic digester system demonstrated the feasibility of dairy wastewater with bio-methane production.
- ✓ After initial acclimatization, methane gas started yielding which was evident from the blue flame.
- ✓ Biogas production was collected, monitored and measured by water displacement method.
- ✓ Cumulative biogas production was 715cm3 for the dairy waste of 1litre which was kept at a hydraulic retention time of 45 days.
- ✓ The percentage removal of COD and VS were 36% and 33.5% were determined.

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