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A Review on Anaerobic Digestion of Human Excreta for Biogas Generation

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ABSTRACT: The increasing global population and the corresponding rise in energy demand have compelled researchers to explore alternative and sustainable sources of energy. One such promising avenue is the utilization of human excreta for the production of biogas, a renewable energy source with various applications. This research paper presents an abstract for a comprehensive study on the design, operation, and potential benefits of a biogas plant using human excreta as the feedstock.

The paper begins with an overview of the existing challenges associated with traditional waste management systems, emphasizing the environmental and health concerns posed by improper disposal of human excreta. It then introduces the concept of biogas production and highlights its advantages, including renewable energy generation, waste treatment, and the potential for greenhouse gas reduction. It encompasses a detailed analysis of various factors such as feedstock composition, temperature, pH levels, and hydraulic retention time that influence the biogas production process. The study further investigates the critical parameters such as biogas production rate, methane content, and process stability.

KEYWORDS: Composition, Feedstock, Methane, Energy.

I. INTRODUCTION

Biogas shops have gained wide acceptance in numerous countries as a means of perfecting people's quality of life and addressing environmental enterprises. These shops give a way to reclaim colourful organic waste accoutrements, including cow ordure, to produce both energy and ordure. still, there's growing recognition of the eventuality to use indispensable raw accoutrements similar as mortal dirt, as well as other agrarian waste and water hyacinth, in biogas product.

The safe disposal of mortal dirt, especially during darkness, is a pivotal aspect of any hygiene program. Introducing mortal dirt into biogas digesters can serve as an effective result. While there may be artistic taboos associated with the use of natural gas produced from mortal dirt, there are individualities who have embraced this approach on an individual position, if not on a community position. External biogas shops directly fed with mortal dirt have been established in colourful locales, similar as Masoodpur village near Delhi, Sewagram in Wardha, Midnapur in West Bengal, and Puri in Orissa. The gas produced in these shops is intended for cooking purposes in the separate communities.

It's well-known that any naturally being dead organic matter can produce biogas through anaerobic digestion. thus, it's high time to explore the application of colourful organic feedstocks, which are presently wasted coffers, in place of cow soil for biogas product. The relinquishment of similar measures should be prioritized to make better use of available coffers.

In India, biogas technology has been effectively employed for nearly 60 times. The development of biogas shops in the country traces back to the first- ever biogas factory at Ackwarth Leprosy Home in Wadalla, Mumbai, around 1859, which dealt with sewage. In 1937, an mastermind named Shri. Modak worked on biogas product from sewage at Mumbai's sewage treatment factory. still, the reliance on cow ordure as the sole raw material for biogas product has

faced dubitation and limitations over the times. The term "Gober gas factory" came associated with biogas shops in India, leading to misconceptions that biogas can only be deduced from cow soil.

II. HISTORY

Still, we find that in ancient times there was no technical waste disposal system, If we look at the history of mortal civilization. Although the act of excretion is as old as man himself, systems for removing this waste were only developed a century or two ago. As the knowledge of colourfullures, especially microbiology and health lores, developed, numerous problems arose in the tradition. Waste disposal systems have been linked, and in order to break these problems, scientists and specialized tradesmen around the world have developed colourful dirt disposal systems to suit different conditions.

Late Appasaheb Patwardhan, a revolutionary Gandhian hand, took up mortal nightsoil treatment exertion as a charge for his life. He worked feverishly, since 1928, on the matter of mortal nightsoil operation, product within the system, numerous innovative styles for latrines like 'Sopa Sandas' (simple potty), Gopuri public restroom etc. and latterly mortal waste grounded substantially biogas plants. The technological style for a biogas factory, to be used for nightsoil feed should be applicable for the characteristics of mortal night soil. within the original stages. The planning that was set up to be applicable for oxen soil was used for mortal nightsoil with none correction. mortal nightsoil has physical, chemical and microorganism characteristics that markedly differ from those of oxen soil. thus, the parameters, criterion etc. fastened for oxen soil biogas shops do not feel to be valid for mortal night soil. Late Appasaheb Patwardhan innovated night soil grounded substantially biogas shops in Asian country, with the construction of the primary night soil grounded substantially biogas factory at Kankavli in Ratnagiri quarter of geographical area in 1953. It was supported 'Grihalaxmi' style developed by Shri. Jasbhai Patel in 1951 (which was espoused for propagation by KVIC since 1962). Appasaheb Patwardhan worked fresh on 'Grihalaxmi' style and changed this style for the application of mortal night soil as a feed. The design that he cooked, was a water jacketed autoclave with a floating pate Type. He nominated it 'water jacket gas factory' latterly known as as 'Gramgaurav gas factory'. This is frequently the planning that's now appertained to as 'Floating Dome Water Jacketed Digester' style. latterly he made several similar shops throughout the country, making a skeleton of trained social staff within the system.

III. LITERATURE REVIEW

Dr. S. V. Mapuskar. Hereports that the digesters are being operated under stable conditions. With 33% percent more VS loading from FOG and food waste, the daily biogas production is 60% more. The on-site treatment system is capable of reducing the H₂S concentration below 15 ppmv. Using existing infrastructure, co-digesting fats, oil, and grease (FOG), food processing waste, and dairy waste at the existing WWTPs could increase the biogas yield potential to 450 MW of capacity. Emissions of nitrogen oxides (NO₃), precursors for ozone generation, and other compounds from stationary engines that utilize Biogas are of concern. There were 500 food waste generators included in the analysis.

Dedicated to the memory of Engineer Shri Ram Chandra Modak, who was a pioneer in the development of biogas technology in India, the following is an extract from their autobiography. PLANT MALAPRABH BIOGAS (2022) studied how in India, biogas technology is in use very effectively for nearly five decades. **Appasaheb alias S.P. Patwardhan** A pioneer in the field of rural sanitation and bio-methanation technologies appropriate for rural India and other developing countries. Proper treatment of human waste (Nightsoil) is an essential requirement for better village sanitation and promotion of health. One of the first few biogas plants in the world was constructed at Ackwarth Le prosy Home at Wadala in Mumbai in about 1859. Biogas generation was undertaken at Dadar Sewage works at Mumbai by Engineer Shri. Modak in 1937.

Kabita Sharma, et al. Nepal is one of the few countries in the world where cow dung can be used to produce biogas. PROFILE SEE (2015) studied scope of large scale biogas in livestock farming. Biogas plant uses bacteria to break down wet organic matter like animal dung, human sewage or food waste. This produces biogas, which is a mixture of methane and carbon dioxide. Biogas plants can improve sanitation and the residue is useful as a fertilizer. The operator of a biogas system feeds the digester with household by-products such as market waste, kitchen waste, and manure from livestock. Biogas from the plant can be utilised by



the farm for heating water, processing milk or some other purpose. The use of waste to produce biogas is not only limited to the waste from nature such as agricultural waste, or cattle manure; but can also use human waste hereinafter called human excreta.

Dian Andriani et al. (2015) Described a Review of Recycling of Human Excreta to Energy through Biogas Generation. Biogas, the methane rich gas, is the by-product of anaerobic digestion that breaking down the organic material in the absence of air. The 1.2% population growth rate per year in Indonesia can be a promising raw material provider in biogas generation. Considering the high population in Indonesia with potency of gas production from human excreta/ human faeces 106.85 m³ gain 2,350.7 MJ/day. The use of human excreta for biogas at the same time is a potential way in reducing environment problem and in supplying electricity. 10000 people were included in the analysis. Biopower is a renewable energy source that can be produced from a variety of sources, including food waste, municipal wastewater sludge, and internal combustion engines.

A.O. Adebayo, et al. (2015) Sustainable waste management has become a major political issue in many countries and city, and energy recovery and recycling of nutrients and organic matter is aimed. In a review on biogas plant, Effects of Organic Loading Rate on Biogas Yield in a Continuously Stirred Tank Reactor Experiment at Mesophilic Temperature (2015) reported that the Study about biogas production has shown that municipal waste that is available in huge quantity everywhere can be a good source of energy if the government seriously work on it. In this area a lot of scope is available for entrepreneur to start the biogas production plant near the industrial area to fulfill the need of energy requirement. The biogas known as Gobar gas in India. The other name is a marsh, wet gas and swamp gas. Biogas can be produced by fermentation through anaerobic digestion of organic material. Any organic cellulose material from animal or plant that is biodegradable.

M. T. Audu, et al. Fibre cement can be used as a replacement for ferrocement for flexural and tensile members. However, it should be noted that a greater percentage by area of the fibre reinforcement will be necessary to match the strength of a specific percentage wire mesh reinforcement in cement compressive members should keep the reinforcing mesh at a minimum of totally eliminated.

Elangovan, et al. For the funicular shell under test, the analysis's finite element conclusions are in good agreement with experimental findings. The funicular shell's maximum deflection under a load that is five times the permitted by code limit is 97% less than the permitted limit.

The greatest stress that can be created in the shell under five times the maximum load allowed by the code is 98% less than the maximum stress that cement mortar can withstand. For design reasons, the maximum moment can be disregarded because it is quite modest. We feel confident using the room-sized ferrocement funicular shell as roof components in affordable homes and residential structures thanks to the analytical and experimental work that has been done.

IV. COMPOSITION AND COMPARISON OF HUMAN EXCRETA

Mortal faeces are the solid or semi-solid remnants of food that have been further broken down by bacteria in the large intestine but were unfit to be digested or absorbed in the small intestine of humans also, it contains bacteria as well as a negligible quantum of metabolic wastes like bacterially altered bilirubin and dead intestinal mucosal epithelial cells. It's excluded during the faeces process through the anus. analogous to other beast faeces, mortal faeces differ significantly in size, colour, and texture depending on diet, digestive system, and overall health. Health. Normal mortal faeces have a mucus subcaste and are semi-solid in thickness. At the distal (nethermost or end) end, there may sometimes be a many bitsy pieces of firmer, less wet faeces.

Composition	Unit (per wet mass)	Amount
Dry mass (at excretion)	g/kg	216
Total Nitrogen	g/kg	11
Total Phosphorous	g/kg	4
Potassium	g/kg	8



MoistureContent	%	78
Drymattercontent(at excretion)	%	22
pH	-	7-9

A survey of cattle populations in India provides some interesting results. Only about 15 households in the country own more than one cow. So (if everything was perfectly covered) it would be damning that the country's population is unlikely to be able to operate a biogas store. If biogas technology is limited to livestock manure feeding, only wealthy producers will benefit from biogas technology. The poor and weak segments of society will not benefit from biogas. The benefits of biogas technology for these disadvantaged people can only be reaped if we are able to use voluntary feed (except soil for livestock) to produce biogas. It is also necessary to envision the creation of a communal biogas plant.

Source	WaterAmount/day/kg	% Water	% Dry matter	Biogasm ³ /kg dry waste
Cow	20-30(28)	80	20	0.023-0.040
DairyCow	20-30(28)	80	20	0.023-0.040
Buffalo	30-40(35)	83	20	0.023-0.040
Roaster/Hen	0.15-0.20(0.18)	72	28	0.065-0.116
Pig	3.00-4.00(3.40)	67	9	0.04-0.059
Human	0.10-0.40(0.15)	77	23	0.02-0.028

When comparing human emissions with other food biogas feedstocks, several factors must be considered. Human waste, such as sewage, is readily available in cities with good sanitation, but may be restricted in rural or developed areas. Other raw materials such as animal manure, agricultural waste and food waste may be more abundant in farmland. In terms of composition, human feces has a balanced nutrient profile, including nitrogen, phosphorus and potassium, making it a suitable feedstock for biogas production. It also contains a lot of organic matter. Other raw materials may have different properties and their suitability for biogas production depends on their content and carbon/nitrogen ratio. In terms of digestive efficiency, human feces can be digested well in anaerobic digesters as they have the same composition. However, problems arise due to the presence of potential bacteria and drug residues in the human body that must be properly treated for good digestion. Other raw materials such as scraps will be better digested due to their biodegradable properties. Production of biogas from human waste differs in energy potential, but how much biogas can be produced. Other food products such as agricultural residues or energy crops will have more energy due to their higher and higher organic content.

V. ANAEROBIC DIGESTION PROCESS

Anaerobic digestion is the controlled degradation of biodegradable materials under controlled conditions in the absence of free oxygen, at temperatures normally mesophilic or thermophilic anaerobic and facultative bacterial and archaeal species. It contains Biogas and traces of hydrogen (H₂), nitrogen (N₂) and hydrogen sulfide, produced by the biochemical decomposition of organic matter whose main products are methane (CH₄) and carbon dioxide (CO₂). (H₂S). The high level of biodegradable components (carbohydrates, lipids and proteins) found in microalgae biomass makes it a good substrate for anaerobic microbial flora which can be converted into CH₄-rich biogas. The anaerobic digestion process is characterized by biochemical changes caused by different organisms: first substrate organic matter, for example cellulose, hemicellulose and lignin, must be liquefied by extracellular enzymes and then Acidogenic⁴ disease treatment 44. hydrolysis rate depends on . pH, temperature, composition and concentration of intermediate . Soluble organic components include hydrolysates, which are then converted by acidogens into organic acids, alcohols, hydrogen, and carbon dioxide. Acid formation products are converted to acetic acid, hydrogen and carbon dioxide. Methane is produced by methanogenic bacteria from acetic acid, hydrogen and carbon dioxide and other substrates; the most important of these are formic acid and methanol . The process, catalyzed by a consortium (vaccination) of microorganisms, converts macromolecules to complex low molecular weight compounds (methane, carbon dioxide, water and ammonia)

VI. PROCESSES OF BIOGAS PRODUCTION

In the process of anaerobic digestion for biogas formation, the breaking down of components occurs through a series of complex biochemical reactions involving different groups of microorganisms. This natural biological process takes place in an oxygen-free environment, typically within an anaerobic digester. Here's a detailed explanation of how the

components are broken down, leading to biogas formation. The first step is hydrolysis, where complex organic molecules are broken down into simpler compounds. Hydrolytic bacteria play a crucial role by secreting enzymes called hydrolases. These enzymes work on complex carbohydrates like starch and sugar and break them down into smaller carbohydrates like glucose. Similarly, proteins are broken down into individual amino acids and lipids (fats and oils) are hydrolyzed to fatty acids and glycerol. When hydrolysis takes place, more metabolism results are more easily achieved. Acidogenic bacteria are involved in the acidogenic phase. These bacteria metabolize hydrolysates such as sugar, amino acids and fatty acids. Acidogenic bacteria convert these chemicals into organic acids through various enzymatic reactions. For example, sugars are converted to acids such as acetic, propionic, and butyric. This phase also releases carbon dioxide (CO₂), hydrogen (H₂) and volatile fatty acids (VFA) as by-products. The next stage is acetogenic, where acetogenic bacteria further metabolize the organic acids produced in the acidogenic phase. Acetic acid, along with other compounds, acts as a substrate for these bacteria. They convert organic acids into acetate, carbon dioxide and hydrogen. Acetic acid production is an important intermediate step in the production of methane, the main source of biogas. The final stage is methanogenesis, in which methanogenic organisms convert the intermediates of previous stages into methane gas (CH₄). Methanogens use acetate, hydrogen and carbon dioxide before producing their energy and carbon. Through a complex biochemical process, methanogens produce methane as a metabolic by-product. This methane, along with carbon dioxide and trace amounts of other gases like hydrogen sulfide, constitutes the biogas. The biogas produced through anaerobic digestion is collected and stored for various applications. It can be utilized as a renewable energy source. For instance, the biogas can be burned in a gas engine or turbine to generate electricity and heat. Alternatively, it can undergo purification processes to remove impurities, especially carbon dioxide, resulting in upgraded biomethane. Biomethane has properties similar to natural gas and can be injected into the natural gas grid or used as a vehicle fuel. The breakdown of components in anaerobic digestion is a complex and interconnected process, relying on the synergistic activity of different groups of microorganisms. It represents an efficient and sustainable way to convert organic waste materials into valuable biogas, reducing environmental pollution and providing a renewable energy source. substrates of which formic acid and methanol are the most important. The process is catalyzed by a consortium of microorganisms (inoculum) that converts complex macromolecules into low molecular weight compounds (methane, carbon dioxide, water and ammonia)

VII. MAJOR FACTORS AFFECTING BIOGAS PRODUCTION

The efficiency of the biogas plant depends on pH, temperature, loading rate, agitation etc. So these parameters should be changed in the ideal to run the biogas plant well. Most researchers' results are based on temperature, pH value, total waste concentration, etc. showed that factors can affect biogas production. Expect various factors such as feedstock biogas capacity, digester design, inoculum, substrate strength, pH, temperature, loading ratio, hydraulic retention time (HRT), C:N ratio, volatile fatty acids (VFA) related to biogas production.

Temperature

Temperature has a significant impact on biogas plants and anaerobic digestion processes. The temperature of this process affects the overall performance and operation of the plant. There are generally two temperature ranges: mesophilic (25-40°C) and thermophilic (50-60°C). Temperature can affect the activity of bacteria because different groups of bacteria have optimal temperatures for their growth. Higher temperatures accelerate the anaerobic digestion process, resulting in faster degradation of organic matter and more biogas production. Thermophilic digestion exhibits faster kinetics and higher biogas production compared to ambient digestion. However, thermophilic digestion needs to be carefully controlled to maintain a higher temperature for conversion. In addition, temperature plays an important role in the control of diseases and plants. Higher temperatures, especially in thermophilic digestion, help reduce the survival of bacteria and plant seeds in the raw material, increasing the safety of the final product. Temperature can affect the stability process because sudden changes can destabilize the microbial community and inhibit the activity of certain bacteria. Maintaining the desired temperature is essential for continuous and efficient biogas production. Anaerobic digestion temperature affects the design and operation of biogas plants. Hot digestion may require additional heating to maintain temperature, increasing operating costs. On the other hand, mesophilic digestion will be better for areas with high temperature as it requires external heat. In summary, temperature affects the biogas plant and the anaerobic digestion process. Choosing the right temperature is important to optimize biogas production, stabilize the process and meet the specific requirements of the facility, including products such as food, biogas production needs, disease control and thermal management.

Moisture

Humidity has a significant impact on the performance of biogas plants. Adequate moisture is required for microbial activity, substrate degradation, and transport in the digester. It promotes good quality organic substrates and provides nutrients available for use by bacteria. Proper water levels also aid in heat transfer and efficient mixing and use of the substrate. However, excess moisture can cause poor porosity, compaction and handling problems. Therefore, it is important to control the moisture quality in order to promote biogas production and ensure the efficient operation of biogas plants.

pH

pH plays a vital role in the functioning of a biogas plant and has a significant impact on biogas production. The pH level directly affects the microbial activity and enzymatic reactions involved in anaerobic digestion. Different groups of microorganisms have specific pH requirements for optimal growth and metabolic processes. Generally, a neutral to slightly acidic pH range of 6.5 to 7.5 is considered ideal for most biogas plants. Maintaining the appropriate pH range is crucial for the activity of methanogenic bacteria responsible for methane production. Methanogens thrive in a narrow pH range, usually around neutral. The change of these factors prevents the formation of methane and reduces the production of biogas. Very acidic or alkaline conditions favor the growth of acid-producing bacteria, resulting in reduced biogas production. Also, pH affects substrate degradation in the digester. Different types of organic matter require certain pH levels to function properly. Cellulosic materials will prefer a slightly acidic pH, while protein-rich substrates will need a slightly alkaline pH. Maintaining the appropriate pH range for the particular food being digested facilitates degradation and biogas production. Process stability is another important factor affected by pH. Sudden changes in pH can affect the microbial community and affect the overall performance of the biogas plant. Unsustainable processes can reduce biogas production, accumulation of volatile fatty acids and working capacity. Periodic monitoring of pH levels and appropriate adjustments are necessary to maintain optimum pH. pH adjustment techniques such as the addition of alkaline or acidic can help maintain the desired pH. Proper pH control is important to maximize biogas yield, improve process stability and increase the efficiency of biogas plants.

Hydraulic Retention Time

Storage time has a significant impact on the performance of the biogas plant. It refers to the retention time of the organic substrate in the anaerobic digester. Longer storage times allow greater degradation of organic matter, resulting in higher biogas production. It gives the microbes enough time to produce methane-rich biogas by breaking down organic compounds into simpler molecules. However, long storage time, such as the need for greater volume and longer substrate residence time, render the process inefficient, which can render the process ineffective. Effective storage time in a biogas plant depends on many factors, such as the characteristics of the feedstock, the desired biogas yield and the particular process. Considering the specific requirements and objectives of your biogas plant, it is important to find the best balance between storage time and biogas output.

C:N Ratio

For the plant to function properly, it is necessary to maintain the appropriate amount of nutrients so that the C:N ratio of nutrients remains within the desired range. It is often found that microbes use carbon 25-30 times faster than nitrogen during anaerobic digestion. Therefore, to meet the requirements, the bacteria must have a C:N ratio of 20-30:1 and have a maximum amount of degradable carbon. By combining low C content scraps with high N content, the desired 30:1 C:N ratio can be achieved. Some studies have also shown that the C:N ratio varies with hot and cold temperatures. The use of urine waste is particularly important during the winter months when fuel is scarce (Yadvika, 2004). Nutrient imbalance is considered an important factor preventing anaerobic digestion of organic wastes. Integration of organic mixtures is used to improve nutrients and C/N ratio. The combination of fish waste, slaughterhouse waste and waste activated sludge with fruit and vegetable waste helps to balance the C/N ratio. The main benefits are the buffering of organic loading rates and the generation of ammonia from organic nitrogen, thereby reducing the limits of fruit and vegetable waste. A C/N ratio of 20-30 provides sufficient nitrogen for the process. C/N ratios between 22 and 25 seem to be the most suitable for anaerobic digestion of fruit and vegetable wastes, while the optimum C/N ratio for anaerobic degradation of organic wastes is 20-35.

VIII. CONCLUSION

The use of human waste as a raw material for biogas plants has great potential for sustainable energy production and waste management. Anaerobic digestion of human waste produces biogas, a methane-rich renewable energy source. This process not only helps reduce the environmental impact of waste disposal, but also reduces greenhouse gas

emissions. Biogas produced from human waste can be used for a variety of applications, including electricity generation, heating and cooking. In addition, the biogas combustion process produces a valuable residue of biogas that can be used as a valuable fertilizer. However, it is important to ensure that human waste is properly disposed of in accordance with safety and hygiene standards. Adopting good waste management techniques and raising awareness of the benefits of using human waste to produce biogas can lead to a more profitable and profitable future.

REFERENCES

1. Kabita Sharma, et al. "Scope of Large Scale Biogas in Livestock Farming:A case study inBhadrakaliCowFarm"Research gate,ConferencePaper2014
2. Dian Andriana, AriniWrestaa, AepSaepudina, Budi Prawaraa," Areviewofrecyclingofhumanexcretatoenergythroughbiogas generation:Indonesiacase" ScienceDirect2ndInternationalConferenceonSustainableEnergyEngineeringandApplication,ICSEEA2014.
3. Dr. S. V. Mapuskar, "Recycle Human Waste For Health, Wealth and Energy, MALAPRABHABIOGAS PLANT"JyotsnaArogyaPrabodhan,DehuvillageJune1988.
4. Jeff Kuo& Jason Dow, "Biogas production from anaerobic digestion of food waste andrelevant air quality implications" Journal of the Air & Waste Management Association, 67:9,1000-1011,DOI:10.1080/10962247.2017.1316326,2017.
5. A.O.Adebayo,etal."EffectsofOrganicLoadingRateonBiogasYieldinaContinuouslyStirredTank Reactor Experiment at Mesophilic Temperature" Article in Current Journal of AppliedScience andTechnology·August2015
6. OmPrakasha,etal. "AReview onBiogas Plant"Prakashet. al./InternationalJournalofNew TechnologiesinScienceandEngineering Vol.2,Issue4,October2015,ISSN2349-0780
7. S. Esfandiari, et al., "Greenhouse Gas Emissions Reduction through a Biogas Plant: A CaseStudy of Waste Management Systems at FEKA Dairy Farm," in 2nd International Conference onEnvironmentalScienceandTechnology, Singapore,2011.
8. S. Esfandiari, et al., "Greenhouse Gas Emissions Reduction through a Biogas Plant: A CaseStudy of Waste Management Systems at FEKA Dairy Farm," in 2nd International Conference onEnvironmentalScienceandTechnology, Singapore,2011.
9. <https://www.celignis.com/anaerobic-digestion.php>
10. Ms.SampadaKulkarniandMr.RSArunkumar,Casestudyofsustainable sanitationprojectsMalaprabhaTechnologyDehuvillage,Dist.Pune,Maharashtra,INDIA, March 2010.



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