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Overview of Nanoparticles effects as well as Enhancement of Biogas from Bio methanation of Press mud

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Abstract - *The digestion of press mud with nanoparticles were studied. Our research clearly shows that treating press mud with magnetite nanoparticles increases biogas generation and delivers greater methane yields than regular digestion without nanoparticles. This study showcases the overview of the effects of the nano particles also the enhancement of the biogas from press mud Nanoparticles of trace metals like Co, Ni, metal and Fe_3O_4 were considered during this study to compare their effects on biogas and alkane series produced from the anaerobic digestion of sugarcane press mud. The most effective concentrations of nanoparticle additives were determined supported our previous studies, and were 1 mg/L Co nanoparticles, 2 mg/L Ni nanoparticles 20 mg/L Fe Nanoparticles and 20 mg/L Fe_3O_4 nanoparticles. These concentrations of nanoparticles additives were further investigated and compared to each different during this study and were found to significantly ($p < 0.05$) increase the biogas yield by 2.5, 2.8, 1.9 and 2.1 times as compared with the control, respectively. The methane yields considerably ($p< 0.05$) raised by 3, 3.4, 2.4 and 2.6 times the CH_4 (methane) volume when compared with the other control. The outcome of this research showed that the Ni nanoparticles yielded the most biogas as well as methane percentage when compared with the other nanoparticles used.*

***Keywords*:** Press Mud, Biogas, Fe_3O_4, sugar crystallization, nanoparticles.

1.INTRODUCTION

Press mud is by-product of sugarcane. It is a solid residue which is generated from sugarcane juice prior to sugar crystallization. In India, press mud is commonly used as manure. It is a soft, spongy, lightweight, amorphous material that ranges in colour from dark brown to black. Sugar factory press mud normally comprises 65–80 percent moisture, 5–9 percent ash, and 20–28 percent volatile solids, with 73–75 percent organic content on solids. Its chemical structure is affected by a range of elements such as sugarcane type, soil condition, fertilizer application, the factory's clarifying process, ambient conditions, and so on.

1.1 Composition & Characteristic of Press Mud:

Compound & Parameter	Percentage (average)
Cellulose	11.4
Hemi Cellulose	10.0
Lignin	9.3
Protein	15.5
Wax	8.4
Sugar	5.7
Na	0.22
Moisture	76.3
Volatile Matter	76.6

Sugars	6.4
Wax	7.2
C/N ratio	14

The research on nanoparticles and nanomaterials on biogas enhancement from sugarcane press mud is presented in this publication. It also investigates the possible influence of nanotechnology on microorganisms in the field of biogas, namely in biogas improvement This effort's main purpose was to establish a critical knowledge of nanomaterials by defining them according to European Commission's recommendations, characterizing feedstock, and demonstrating the influence on biogas improvement and its efficiency.

A nanoparticle is a small molecule that spans in size from 1 to 100 nanometres. Nanoparticles, which are imperceptible to the naked eye, can exhibit entirely unique physical and synthetic features to their larger material companions. According to the European Commission, the molecular size of at least half of the particles in the number size distribution should be 100 nm or less. Most nanoparticles are made up of a few hundred iotas. "A unique, coincidental, or synthetic material including particles in an unstable state, as a whole or as an agglomeration, and containing at least one outside measurement in the size range 1 nm - 100 nm for 50% or more of the particles in the number size distribution." The various explanations are inconsistent with their interpretation of the nature of synthesis or synthesis of nanoparticles. Current level of information available on the presence of nanomaterials and products containing nanomaterials on the market is not enough. As the definition of European Union is based on the distribution of spatial size particles of an object expressed in numerical metrics (EU Commission, 2011), almost always powder can be considered nanomaterial. However, the EU has already announced it review of its definition established in 2011: modified definition in light of new information and science and technology advancements. Reviews are appropriate mainly focus on what the 50% size limit should be increased or decreased (EU Commission, 2011).

2.MATERIALS, METHOD, AND PROCEDURE:

Fresh press mud samples was collected from a Sugar Mill from Maharashtra, and it was homogenized with water and ensured that the slurry total solid content was only 9%. All the parameters were checked before feeding the slurry to the anaerobic digester. All the parameters were monitored continuously for 90 days. The experiments were done with the Labio 50 ltr Model of Arka Brenstech Private Limited. The total solids, volatile solids and the ash content were regularly determined after every 10 days during the 90-days experiment. The digester was based on CSTR technology and batch feeding was done to this Labio which consists of a Biodigester, Feeding hopper, Agitator, Temperature maintenance system, Gas liquid separation unit, Gas collection unit, pH meter, Temperature meter, pH correction unit. Biogas meter and Analyser was used externally. The temperature was maintained steady, and it was at 38 Deg C. Biogas was measured on daily basis using the biogas meter.

Investigations have been conducted on a regular basis. using 50 L anaerobic digester and in batch operation mode. CO, Ni, Fe and Fe3O4 nanoparticles were used to study the effect of the nanoparticles on the efficiency of biogas production and compared with the other control. As mentioned, the concentrations were 1, 2, 10 and 20 mg/L. The digester was fed with sugarcane press mud slurry on a daily basis and after 30 mins interval daily at same selected time the nanoparticles were added separately to the anaerobic digester. Regular performance was noted down.

3.NANOPARTICLE'S IMPACT ON BIOGAS PRODUCTION:

All the nanoparticles when added to the digester improved the immediate startup of biogas production and reduced the lag commissioning

period. The highest biogas startup was achieved when the press mud was treated with 2 mg/L Ni nanoparticles and was approximately 1350 ml biogas as an average in the first 6 days of HRT while 1 mg/L Co nanoparticles, 20 mg/L Fe nanoparticles and 20 mg/L Fe_3O_4 nanoparticles yielded 1200 ml, 1150 ml and 1240 ml respectively. However, the average gas production in the initial 6 days of the control slurry was only 340 ml. Similarly, the data was collected for 30 days HRT and it was found that the highest biogas yield was achieved using the addition of 2 mg/L Ni and 20 mg/L Fe_3O_4 which was around 2800 ml biogas. Furthermore, it was shown that the addition of 2 mg/L Ni nanoparticles resulted in the maximum biogas output for 40 days of hydraulic retention time, which was 102,594 ml biogas when compared to other additives. Furthermore, the biogas yields with 1 mg/L Co nanoparticles and 20 mg/L Fe_3O_4 nanoparticles added to the substrates were found to be insignificantly different, with 95,666- and 97,254-ml biogas yields, respectively. On the other hand, the addition of 20 mg/L Fe nanoparticles yielded 84,389 ml biogas, while the control yielded the lowest biogas production ($p<0.05$), and was only 53,490 ml. Moreover, the addition of 1 mg/L Co nanoparticles, 2 mg/L Ni nanoparticles, 20 mg/L Fe nanoparticles and 20 mg/L Fe_3O_4 nanoparticles significantly increased the overall biogas volume by 2.5, 2.8, 1.9 and 2.1 times as compared with the control, respectively. With the addition of 2 mg/L Ni and 20 mg/L Fe_3O_4 nanoparticles, the maximum daily methane production was achieved. Highest methane yields of 56,000 and 57230 ml CH_4, respectively in comparison with the addition of 1 mg/L Co nanoparticles, 20 mg/L Fe nanoparticles which yielded 52,248, 23,120 ml CH_4 respectively. When compared to the control, the methane yields increased significantly (p 0.05) by 3, 3.4, 2.4, and 2.6 times the methane volume.

4.METHANE CONCENTRATION:

The methane contents of the nanoparticle treatments compared with the control can be clearly seen in the above-mentioned details. The press mud treated with Fe_3O_4 nanoparticles attained the highest methane contents during the startup of biogas production and was 40% as an average of first 6 days of the hydraulic retention time. It had the largest peak of methane concentration from day 25 to day 28 of the hydraulic retention time and contained more than 78 percent methane. Other nanoparticle additions did not achieve such high methane concentrations.

5.EFFECT OF NANOPARTICLES ON THE ORGANIC MATTER OF THE PRESS MUD:

The Total solids and the volatile solids were determined every ten days and was noted to track the exact decomposition of the organic matter through the 90 days of the experiment. The highest decomposition of the total solids in press mud samples were observed when the press mud was treated with 2 mg/L Ni nanoparticles and 20 mg/L Fe3O4 nanoparticles up to a final total solid concentration of 5% each respectively. Furthermore, the additives mentioned achieved the highest volatile decomposition which was almost 5.5% and 5.8% respectively at the end of the experiment.

6.RESULTS AND DISCUSSIONS:

The positive effect of nanoparticles on press mud showed and confirmed with the experiments that the Ni and Fe_3O_4 nanoparticles yielded the highest biogas as well as the methane concentration when the same was compared to the CO and Fe nanoparticles, where the statistical analysis sowed insignificant difference of the methane yield with the addition of 2 mg/L Ni nanoparticles and 20 mg/L Fe3O4. It was also found that the highest methane production with 20 mg/L Fe_3O_4 magnetic nanoparticles increased by almost 100% which is much higher than the methane yielded by Feng et al. at the dosage of 20 g/L increased by 48%. These results indicated that the Fe_3O_4 magnetic nanoparticles led to enhanced anaerobic digestion, and consequently to higher methane production and organic matter degradation. The presence of

Fe+2/Fe+3 ions, supplied into the digester in the form of nanoparticles that could be absorbed as the growth element of anaerobic microbes, is primarily responsible for the better performance in press mud digestion.

7. CONCLUSIONS

The use of trace metals in the form of nanoparticles reduced not only the lag phase but also the time necessary to attain maximal biogas output and methane concentration. Nanoparticles have also demonstrated that many stimulating effects on the methanogenic activity during the startup phase of the anaerobic digestion of press mud slurry process through the hydraulic retention time while the experiment ended. At the same time Ni nanoparticles produced the highest significant biogas production as well as methane concentration compared to CO, Fe and Fe_3O_4 nanoparticles and the control during the further experiments.

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