Pelleting Machine for Biogas Slurry as an Organic Manure : A Review

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Abstract - *Biogas slurry is one of the best organic manure to rejuvenate soils since it is a rich source of both plant nutrients and organic matter. When slurry properly processed and applied can increase the physical, chemical and biological properties of the soils besides supplying essential nutrients to the crop plants. Biogas slurry is available where the biogas plants are installed. Biogas slurry is by-product obtained from the biogas plant after digestion of dung or other biomass. Biogas slurry manure supplies essential nutrients, enhance water holding capacity (WHC) and soil aeration and accelerate root growth. Biogas slurry consist of more than 92 % moisture content which makes it difficult to handle. Pelletization of biogas slurry can improve storability, reduce transportation costs, and make these materials easier to handle by using existing handling and storage equipment. The main goal of this paper is to deliver technique of pelletization of biogas slurry which makes ease in handling, transport and storage.*

Keywords: Anaerobic digestion process, Biogas plant, Biogas Slurry, Pelletization, etc...

1. INTRODUCTION

The biogas plant is an important source of organic manure. The slurry, which come out of a biogas unit as by-product, constitutes good quality of manure free from weed seeds, foul smell and pathogens and contains high amount of plant micronutrients as compared to farm yard manure (FYM). Biogas plant is the best option for households having feed material, to become self- dependent for cooking gas and highly organic enriched bio-manure. It provides the solution to protect the households from the problems of indoor air pollution and while saving on cost of refilling of LPG cylinders.

Government of India has taken up a target of installing 2,10,000 biogas plants in the year 2018-19 in which 47,500 biogas plant installed. The average estimated biogas generation capacity of these biogas plants is about 6.46 lakh cubic meter per day. These biogas plants are giving an estimated annual savings of about 70.90 lakh numbers of LPG cylinders equivalent and simultaneously producing about 88.4 lakh tonnes of organic enriched bio-manure per year, which is equivalent to about 31,100 tonnes of urea per annum.

The review paper is focused on pelletization technology for biogas-spent slurry as an organic manure. A comprehensive review of literature is an essential aspect of any scientific investigation and profile an insight into the theoretical frame work as well as methods, procedure and meaningful interpretation of findings. The different techniques for development of pelleting machine, performance and economical assessment.

2. LITERATURE REVIEW

2.1 Biogas Slurry as an Organic Manure

The biogas slurry has 93 % water and 7 % of dry matter, of which 4.5 % is organic matter and 2.5 % inorganic matter. Biogas slurry is considered a good source of organic fertilizer as it contains considerable amounts of both macro such as Nitrogen (N), Phosphorous (P) and Potassium (K) and micronutrients such as Zink (Zn), Manganese (Mn), Copper (Cu) and Iron (Fe) that are necessary for plant. Use of biogas slurry is providing a sustainable way for agriculture, environment and farming communities. [1]. Kumar *et al.* (2015) had done analysis on average composition of biogas slurry is 1.5 % N, 1.1 % P and 1 % K.

Table -1: Average Nutrient Content of Biogas Spent Slurry

Sr. No.	Nutrients	Content
1	Nitrogen (N)	1.8%
2	Phosphate (P_2O_5)	1.0%
3	Potash (K_2O)	0.90%
4	Mn	188 ppm
5	Zn	144 ppm
6	Fe	3550 ppm
7	Cu	28 ppm
8	C/N ratio	10-15
9	Organic matter	65%

2.2 Pelletization Technology for Biogas Slurry

Pelletization of biogas slurry can improve storability, reduce transportation costs, and make these materials easier to handle by using existing handling and storage equipment. Evaluation effect of extrusion and raw material parameters on quality parameters of pellet is necessary to determine optimum conditions for designing and constructing a suitable pelleting machine for producing manure pellets. According to shortage organic material in field, use of biogas slurry increases the agricultural production yield. On the other hand, biogas slurry are naturally higher moisture content materials having high bulk density and, therefore, the application of biogas slurry in form of pelletization would increase their utility.

The pellet production is able to convert raw material into a compressed form with advantages in transportation, handling and storage. For production of composted livestock manure into pellets, there are two types of machine available in the market. [2]. Zafari and kianmehr, (2012) had done experiment on extruder type machines have a barrel into which the raw material is forced by a screw. The material is then compressed into the die installed at the end of the machine, producing the pellet.

[3]. Ghadernejad et al. (2012) suggested the pelleting process has advantages of high adaptability of raw material, wide application of moisture ratio, low power consumption per ton of material and high production, thus making it suitable for application in rural area where straw wastes are extensively disposed. In this study, a pelletization process investigate production of organic manure in pellets form. The main aim of this project is to reduce the area for storage of biogas slurry become easy in transportation and reduce the transportation cost. Presently, biogas slurry is the main source to reduce the use of chemical fertilizer as organic manure. It can fulfil these requirement in the search for simple technology of pelletization using locally available materials like biogas spent slurry and clay soil as binder. Pelletization process is one of the promising technologies, which has been investigated by several researchers. Pelletization process is used to solve the problems of storage of waste available on biogas plant.

[4]. Kumar et.al (2010) studied biogas manure generation (BMG) from mixed kitchen waste. The study was mainly based on biogas manure quality which was produced after the digestion of kitchen waste. After the 40 days semi-liquid biogas slurry was obtained. This semi-liquid slurry was used for the manure analysis. Total six composite samples of biogas slurry were analysed on oven dry basis. An average percentage of nutrient in these samples were found to be 2.02 % nitrogen, 0.69 % phosphorus and 1.11 % potassium respectively.

[5]. Nasir et al. (2010) evaluated the potential of biogas slurry as a fertilizer in contrast with farmyard manure. Six different treatments were applied to check the efficiency under field conditions. Two different levels of biogas slurry were used to evaluate its efficiency in relation with its quantity. The treatment T_3 (biogas slurry was applied @ 20 t/ha) showed next better results as compared with rest of treatments. It increased the plant height, cob yield, grain yield, 1000-grain weight and NPK level significantly as compared with control and plants treated with farmyard manure.

[1]. Kumar et al. (2015) studied about the biogas plant with anaerobic digestion providing a facility to generate manure and energy generation. The digested biogas slurry (DBGS) is rich in macro and micronutrients that provide essential plant nutrients for longer period. Biogas slurry may be considered as a good quality organic fertilizer for sustainable agriculture. By applying the digested biogas slurry in the field for long term, basis help in reducing fertilizer demand and provide an eco-friendly way of maintaining productivity and soil health. Results summarizing nutrient potential of digested biogas slurry and relation with synthetic fertilizers in India, as a potential source.

The design of screw is necessary for production of pellets from biogas plant waste to convert it an efficient manure. There are several types of pelleting technique available in present context. The screw extruder machine gives better quality pellets. [6]. Chickwado, (2013) carried out experiment on the process for the compaction of waste material to convert it in to a solid form. It replaces the historical method of the batch wise compaction of waste by piston or hydraulic pressing. The pelletizing machine consists of a screw (or worm), rotating inside a cylindrical cage (barrel). The material to be pressed is fed between the screw and barrel and propelled by the rotating screw in a direction parallel to the axis. The configuration of the screw and its shaft is such that the material is progressively compressed as it moves on, towards the discharge end of the cylinder Screw type pelleting technology consist of driving motor, screw, die, hopper, and power transmission system. Chain drive were used to transmit power from motor to the screw. The raw material was fed to the hopper, which convey it to screw by gravity. The material was pushed, it got compresses and binded material comes out of die in the form of pellets.

[7]. Orisaleye et al. (2009) designed and developed a prototype pelleting machine for affordability. The machine consisted of a screw conveyor, die, barrel and hopper. It can be driven by an electric motor or a prime mover as shown in Fig -1. The best pellets were formed using 750 cm^3 of either starch or water. The average specific energy consumption when 750 cm^3 of starch binder was used was 0.69 kWh/kg while it was 0.93 kWh/kg when water was used as preconditioner. The density of the pellets varied between 0.7 and 1 g/cm^3. This machine can be manufactured at a local machine shop for small scale livestock farmers in developing countries.
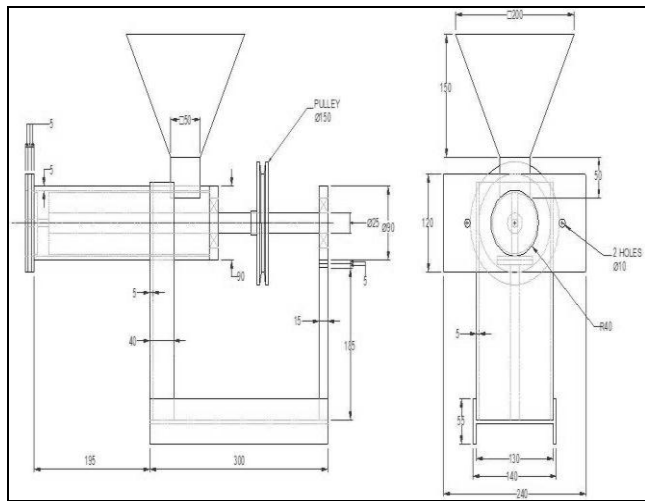
Fig -1: Pelleting Machine

[8]. Oduntan (2013) reports on the design of fabrication and testing of a machine for cottage level production of pellets from cassava mash. The result derived from the calculated design parameters were used for the fabrication. The testing of the pelleting machine was determined in terms of throughput of the machine, against the moisture content of the mash (18, 20 and 22% w.b.), die size (4, 6 and 8 mm) and the auger speed (90, 100 and 120 rpm). Test results showed that the pellets with the best quality attributes were obtained from cassava mash at 18% moisture content (w.b.) through the 4 mm die at 90 rpm and a maximum throughput of 54 kg hr^{-1}.
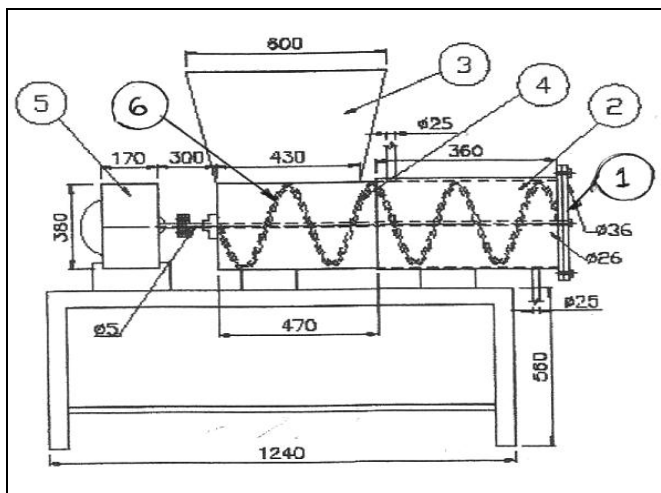

Fig -2: An Orthographic View of Pelleting Machine

1: Die plate, 2: Heat exchanger barrel, 3: Hopper, 4: Main barrel, 5: Gear box, 6: Screw

[9]. Burmamu (2015) Studies on the development of manually operated pelleting machine for small scale industries. The machine was then tested with 3 kg of mixture of fish feed where 2.65 kg of the feed was recovered which gave the efficiency of 88.3%. Pelleting machine was recommended for both rural and urban fish producers since it is portable and can be operated manually.

2.2 Performance Evaluation of Pelleting Machine

[9]; [10]; [11]. Burmamu *et al.* (2015) Ojomo *et al.* (2010), and Aremu, *et al.* (2014) and tested pelleting machine on the basis of operational parameters of raw material and operational parameters of pelleting machine. The machine performance was carried out in term of pelleting efficiency, throughput capacity, pelleting capacity, percentage recovery or percentage pelleted, and percentage un-pelleted.

2.4 Properties of Pellets

[12]; and [13]. Sengar *et al.* (2012) and Demirbas *et al.* (2004) studied on physical properties of pellets like length, diameter, weight, Volume, Moisture Content, Density, Porosity, durability, radial compressive strength, shatter index resistance of water penetration and stability of pellets. For the chemical analysis key nutrients such as Nitrogen, Phosphate and Potash content of the pellets is determine.

2.5 Techno-economic Feasibility of Pelletization Process

For the success and commercialization of any new technology, it is essential to know whether the technology is economically viable or not. Therefore, an attempt should be made to evaluate economics of the pelleting machine. The capital cost, variable cost, fixed cost, total cost, revenue and net profit are the basic components for an economic analysis of any business.

3. CONCLUSIONS

The fresh biogas slurry which contains 90 to 93 % moisture therefore, it is difficult to handle and transport, and therefore it becomes bulky and creates a problem of use. Generally, farmers use the digested slurry to leave in the nearby area of plant, transport it as such in the field, and leave in irrigation channel. This tends to high transport cost because of high moisture content and uneven distribution of digested slurry in the field. In many cases, the biogas slurry from the digester cannot be directly used as a fertilizer and thus needs to be stored. This storage is mainly necessary because fertilizers should only be applied in specific periods of the growing season, while biogas slurry is generally produced continuously. To minimize the losses of nutrients, easy transportation, decrease the cost of handling and reduce the volume of the biogas slurry by compression in pellet form. For above mentioned problem, the effective solution is to apply pelletization technology. In this review paper concluded that , this project is to reduce the area for storage of biogas slurry become easy in transportation and reduce the transportation cost. It can fulfil these requirement in the

search for simple technology of pelletization using locally available materials like biogas spent slurry

REFERENCES

[1] Kumar, S., Malav, L.C., Malav, M.K. and Khan, S.A. 2015. "Biogas slurry: source of nutrients for eco-friendly agriculture".

[2] Zafari, A. and Kianmehr, M. H. 2012. "Livestock manure management and pelleting". *Agricultural Engineering International: CIGR Journal*, 14(3): 78-84.

[3] Ghadernejad, K. and Kianmehr, M.H. 2012. "Effect of moisture content and particle size on energy consumption for dairy cattle manure pellets". *Agricultural Engineering International: CIGR Journal*, *14*(3): 125-130.

[4] Kumar. A., Kumar. A., Kumar. R. and Sudarshan J. S. 2010. "Biogas Manure (bgm) from mixed kitchen waste: A trial study. *Journal of Environmental Research and Development.* 5: 164-171.

[5] Nasir, A., Khan, F.H., Riaz, M. and Khan, M.A. 2010. "Comparative study of biogas slurry with farmyard manure as fertilizer on maize crop". 22(4): 297-301.

[6] Chikwado, U. K., 2013. "Development and performance test of poultry feed mixing and pelleting machine". *International Journal of Science and* Research, 4(6): 1161-1166.

[7] Orisaleye, J., Ojolo, S. and Fashina, A. 2009. "Design and development of a livestock feed pelleting machine". *Journal of Engineering Research*, 14(1).

[8] Oduntan, O.B., Koya, O.A. and Faborode, M.O. 2014. "Design, fabrication and testing of a cassava pelletizer". *Research Agricultural Engineering*, 60: 148-154.

[9] Burmamu, B.R., Aliyu, B. and Tya, T.S.K., 2015. "Development of a manually operated fish feed pelleting machine". *International Journal of Research in Engineering and Advanced Technology*, *2*(6), pp.23-32.

[10] Ojomo, A.O., Agbetoye, L.A.S. and Ologunagba, F.O. 2010. "Performance evaluation of a fish feed pelletizing machine*. Asian Research Publishing Network (ARPN),* **5**: 88-97.

[11] Aremu, A.K., Kadiri, A.O. and Ogunlade, C.A. 2014. "Development and testing of screw type kenaf (Hibiscus cannabinus) pelletizing machine". *Journal of Agricultural Technology*, 10(4): 803-815.

[12] Sengar, S.H., Mohod, A.G., Khandetod, Y.P., Patil, S.S. and Chendake, A.D. 2012. "Performance of briquetting machine for briquette fuel". *International Journal of Energy Engineering*, 2(1): 28-34.

[13] Demirbas, A. and Sahin Demirbas. 2004. "Briquetting properties of biomass waste materials". *Energy Sources*, *26*(1): 83-91.

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