

BIOGAS GENERATED FROM FOOD WASTE USING SYSTEM OF INTEGRATED BIOREACTORS CONFIGURATION RIG (PILOT PLANT)

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Abstract:

The main objective in this study was to promote waste utilization to clean energy for both our various home uses, institutions and the society at large precisely Municipal Owerri IMO STATE. Municipal waste management system within Municipal Owerri has been developed since 2019. All Central Municipal waste has been segregated and data collection. According to the data information, food waste has been produced within Municipal Central Area with average of 77,015 kg/year or 211 kg/day. From food waste to Energy concept has been concerned. The high potential to utilize food waste for biogas production by using System of Integrated Bioreactors Configuration Rig Anaerobic Digester pilot plant proved that Biogas can be effectively generated. The biogas pilot plant capacity for food waste loading 211 + 74 kg/day incorporation of appropriate Mixing and Flow Features in Bioreactor Design provided leading to high yield in Biogas Production the basis of effective digestion of Food waste. Data collection has been done with average biogas production was 18- 27 m³/day. The food waste utilization to clean energy as biogas within Municipal Owerri IMO STATE can be empowered and promoted along with waste reduction and waste utilization if Government adopts it for their usage or our Institutions etc. Biogas production from food waste has been shown as a demonstration site for clean energy production and help to protect the public environment and save money for any investor's incorporation.

Keywords: Biogas, Food waste, waste utilization

Introduction:

Municipal solid waste (MSW) is a serious problem facing in all areas of Owerri, IMO STATE, including Educational Institute (Babayemi et al., 2020). The increasing of municipal solid waste generation each year leads to environmental problems (Obasi et al., 2019). In 2010, the municipal solid waste generated in Centre Owerri was around 41,532 tons per day or 15.1 million tons per

year (Chanaka. et al., 1995). As part of an integrated waste management system, anaerobic digestion reduces the emission of landfill gas into the atmosphere and serves as renewable energy source process producing methane and carbon dioxide rich biogas suitable for energy production helping to replace fossil fuels. Also, shows the nutrient-rich solids left after digestion can be used as fertilizer (Obasi et al., 2023); where:

(1) Central Municipal Waste Owerri IMO STATE has a significant environmental impact due to municipal solid waste (MSW) and try to reduce this impact with possible save the university resources and money (Table 1). The MSW Management in Central Municipal Waste Owerri IMO STATE has been developed since 2002 and first revised in 2005 to meet the Green policy of the STATE. The three main parts in the system consists of waste segregation, waste collection and waste utilization (Chawla, et al., 2017).

(2) The MSW were separated into 5 difference types for segregation including organic waste, recycled waste, non-recycled waste, toxic waste and workshop waste and use green, yellow, blue, red and grey bin for waste collection (Cruazon, et al. 2017). The waste utilization is focused on organic waste, recycle waste and workshop waste. The recycle waste and workshop waste have been sold by using recyclable waste bank system, while some organic waste has been done for organic fertilizer and food waste for animal feed. The truck from farm will pick food waste once a week. To reduce bad smell from rotten food waste by using food waste utilizing concept was discussed. In Korea (3) due to lack of sufficient space in the highly populated city area for a landfill site, the anaerobic digestion facility was developed. The processes about 3 tons of food waste per day, 230 m³ of biogas, 100 kg of humus and 2 tons of waste-water are produced (Chitra, et al. 2022). However, it was noted that the gas rated varies significantly depending on the type of organic matter added to the digester The objective of this study is to promote waste

utilization to clean energy by using anaerobic digester pilot plant to produce a useful fuel product (biogas) from food waste (Monod, et al., 2020).

Methodology:

Food waste from Central Municipal Waste Owerri IMO STATE food center was collected every day from September 2011 to August 2012 then processed. System of Integrated Bioreactors Configuration Rig (Pilot Plant) Anaerobic digester was employed for Biogas collection. Anaerobic digester pilot plant was started up and operated. Biogas fuel from food waste was recorded. All data have been collected. The statistical analysis has been done by using SPSS

program.



Integrated Bioreactors Configuration Rig (Pilot Plant) has following features as shown below:

- An overhead tank which feeds substrate to coupled bioreactor systems by gravity.
- Isolation of bioreactor systems into experimental modules capable of independent operation and observation
- An ergonomic design with a centralized system control for bioreactor operation
- A dedicated gas collector and metering device for each bioreactor operation
- A mechanism for flushing and cleaning the bioreactor vessels

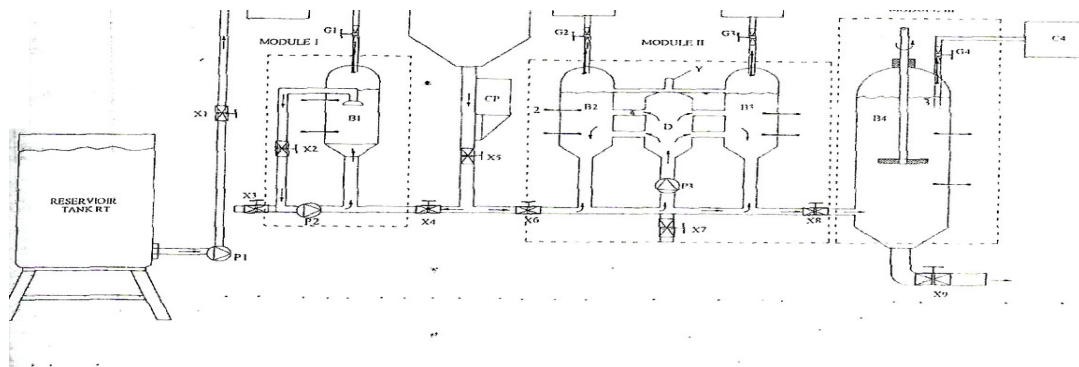


Figure 2. System of Integrated Bioreactors Configuration Rig (Pilot Plant)

Figure 3. Experimental Set-Up of the Integrated System Of Reactors

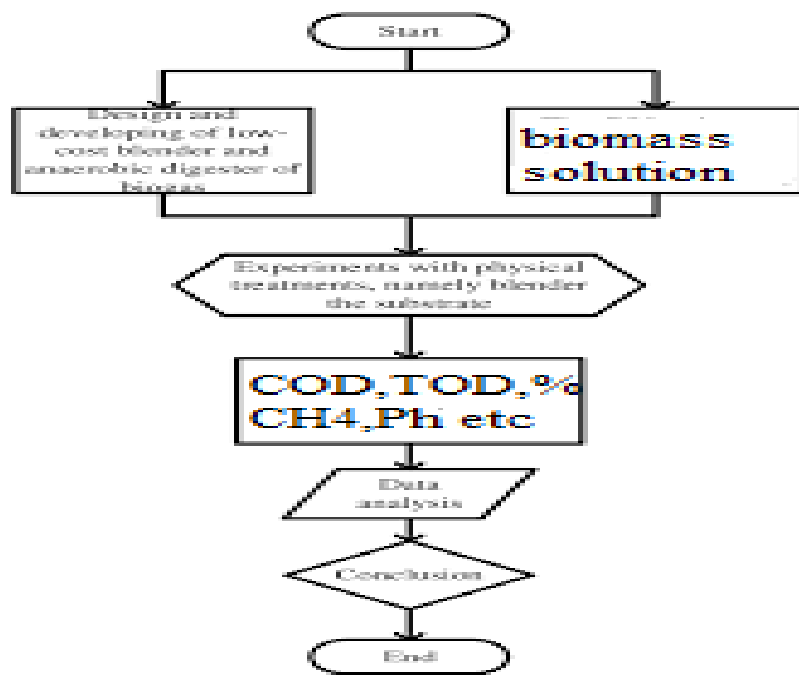


Plate 3: Municipal Waste after Processing in Different Proportions

2018-2023

year	Organic waste (kg)	Recycle waste (kg)	Workshop Waste (kg)	Toxic Waste (kg)	Non Recycle waste (kg)	Total Waste (kg)
2018	96.688	90.145	7.120.00	9,380.0	128,895.00	332,228.0
2019	229.760	155.714	427.50	19,158.0	201,385.00	606,445.0
2020	189.767	88.031	612.00	17,631.0	239,553.00	535,594.0
2021	169.291	67.369	72.50	12,000.0	280,651.00	529,384.0
2022	126.933	151.708	71.50	17,8030	283,079.00	579,594.0
2023	117.463	186.755	769.0	21,880.0	225,663.00	552,530.0
Average	154.983	123.287	1,512.00	16,309.0	227,537.40	522,630.0
%	30.54	24.48	0.30	311.50	43.40	100.0

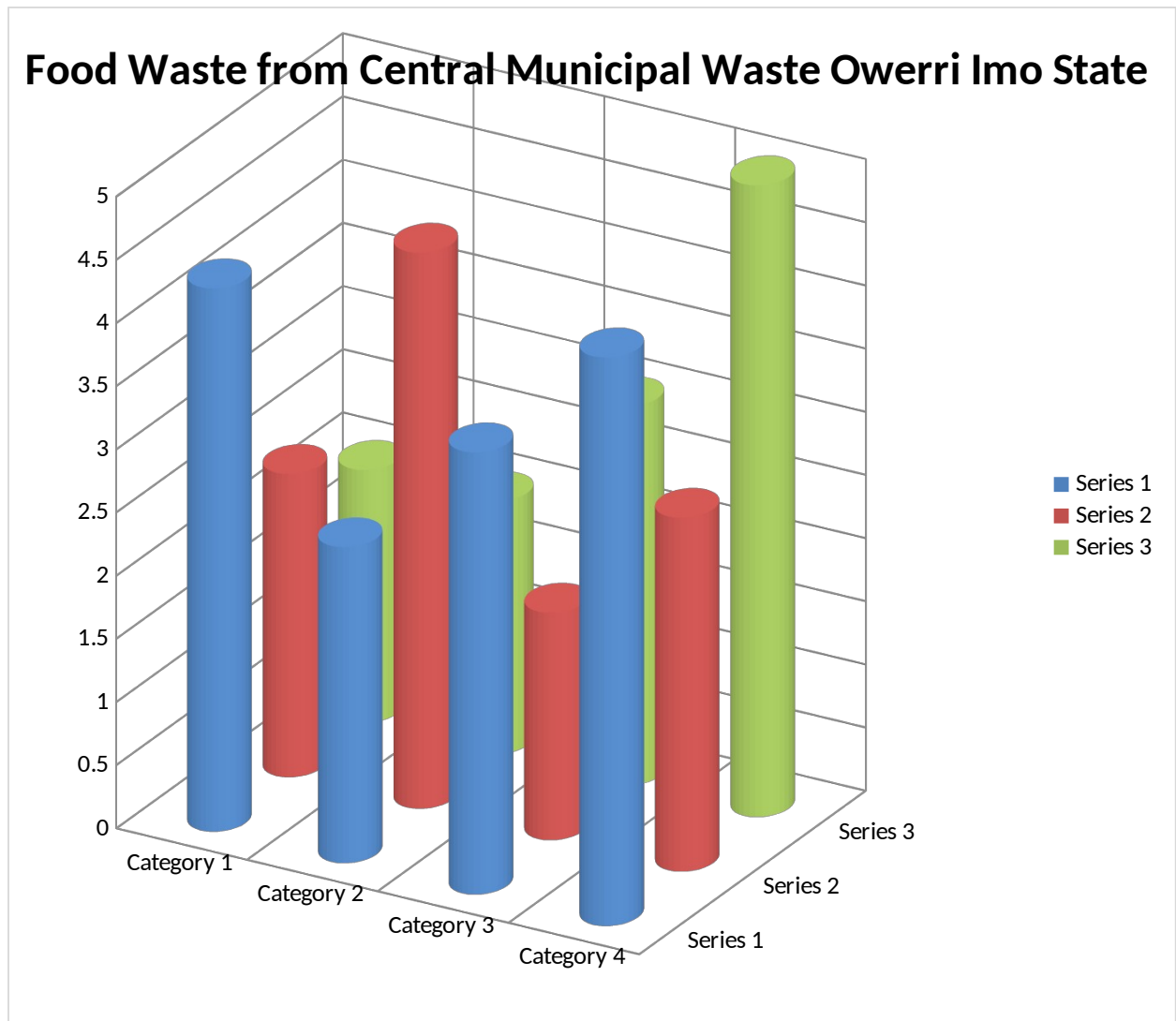
Table 2. Food waste from Central Municipal Waste Owerri IMO STATE during

Sep 2022- Aug 2023

Kg/Day	Sep. 22	Oct. 22	Nov. 22	Dec. 22	Jan. 23	Feb. 23	March 23.	April 23.	May 23.	Jun. 23	July 23	Aug. 23
Min	104	65	75	100	105	55	50	46	50	105	110	120
Max	300	135	245	175	210	140	90	90	176	304	290	290
Aug	147	101	138	148	145	99	60	61	110	225	180	185

The result in one day of food waste is varying from 45 to 305 kg (211 kg +74 Kg) depending on education season. This data was used to design anaerobic digester to produce biogas. The anaerobic digester pilot plant was installed and operated near Central Municipal Waste Owerri IMO STATE (Plate1 Plate,2, Plate 3, Figure 1), (Figure 2), (Figure 3) and (Figure 4)

**Figure 4: GRAPH FROM INTEGRATED BIOREACTORS CONFIGURATION RIG
(PILOT PLANT) GENERATED**



At start up, shredded food waste mixed with the effluent from an active biogas plant is filled into anaerobic digester to start up the anaerobic process. A continuous system was operated every day and found to be successful in producing gas. Based on supply 35-58 kg food waste/day, the biogas was produced around 4.34-9.37 m³/day at startup period (Figure 3). The CH₄ and CO₂ content in biogas are varying at 51 to 54% and 35 to 40%, respectively. The biogas pilot plant has been developed since 2023 with capacity for food waste loading 211 + 74 kg/day. The average biogas production is 18- 27 m³/day. This biogas fuel uses for hot water supply in Central Municipal Waste Owerri IMO STATE. The beneficial of food waste utilization by using Integrated Bioreactors Configuration Rig (Pilot Plant) in Central Municipal Waste Owerri IMO STATE s not only to

promote waste reduction and waste utilization within university, but also, help to promote clean energy utilization, to protect the public health and environment and maintaining a safe environmentally responsible workplace and save the food waste utilization to clean energy as biogas within Municipal Owerri IMO STATE can be empowered and promoted along with waste reduction and waste utilization if Government adopts it for their usage or our Institutions etc. Biogas production from food waste has been shown as a demonstration site for clean energy production and help to protect the public environment and save money for any investor's incorporation

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