Article ECORFAN Journal
ARCHITECTURE June 2015 Vol.2 No.2 123-132

Habitat improvement in Chipilo of Francisco Javier Mina. Puebla: Use of biogas as an alternative energy in the productive activity of dairy cattle animal house

ARTILES-LÓPEZ, Dora María*†, DUEÑAS-BERRA, Laura Yanela and SANTIAGO-AZPIAZU, Gloria Carola

Benemérita Universidad Autónoma de Puebla, México

Received January 8, 2014; Accepted June 12, 2015

Abstract

The proposal is part of the project results funded by PRODEP "Family Treatment Plant as Stable energy attachment Bio digester". Rural housing in Mexico is still a production unit, where productive activities are development, the main livestock and agriculture. There are areas with a clear dairy vocation also complement this productive activity with the cultivation of fodder to produce their own food, in the state of Puebla traditionally a farming community of milk and dairy products is Chipilo of Francisco Javier Mina, Auxiliary Board of the Municipality San Gregorio Atzompa, located twelve kilometers from the city of Puebla. The estabularia livestock produces organic wastes, which become a source of unhealthy and pollution due to various reasons, among which we can mention: the number of existing stables, lack of infrastructure and inability of the ecosystem to absorb wastes and lack of clean the waste management technologies to mitigate this problem. The above clearly shows that environmental problems caused by such activity are important and it is essential to generate specific solutions that help minimize them. The research objective was proposed, provide a suitable technological solution for waste treatment with power generation to "stable housing," and in this way contribute to the reduction of environmental impacts from cattle excreta and it also has the production of renewable energy for various uses (heating, DHW heating, cooking, lighting and power).

Citation: ARTILES-LÓPEZ, Dora María, DUEÑAS-BERRA, Laura Yanela and SANTIAGO-AZPIAZU, Gloria Carola. Habitat improvement in Chipilo of Francisco Javier Mina. Puebla: Use of biogas as an alternative energy in the productive activity of dairy cattle animal house. ECORFAN Journal-Spain 2015, 2-2: 123-132

* Correspondence to Author (email: doraartileslopez@yahoo.com.mx)
† Researcher contributing first author.

© ECORFAN Journal -Spain

Introduction

The state of Puebla has an area of 34,290 square kilometers (km2), therefore ranks 21 among the 32 states nationwide, with a total of 217 municipalities, one of these areas is San Gregorio Atzompa, with an area of 15.31 square kilometers (km2), which ranks 211 with respect to the other municipalities in the state, there are a total of 9128 cattle according to the Agricultural Census 2007, its main economic activities of agriculture and livestock.

The study site is located in the municipality of San Gregorio Atzompa, identified as the Auxiliary Board Chipilo of Francisco Javier Mina, with a population of 3493 inhabitants, is distinguished by being a recognized dairy producer in the country.

There are several rural communities in the state, dedicated to livestock; this determines the problem of unplanned expansion of the city, causing gaps in services, areas of planting and breeding, one of which is the Auxiliary Board Chipilo of Francisco Javier Mina.

Chipilo community, housing is common to find the stable as a basic for raising domestic livestock and there are several stables that are part of the dairy industry space. This Auxiliary Board, the lack of a real plan of development, lack of services and housing growth itself, have caused it to be of vital importance, considering the treatment of organic waste generated by livestock for their use.

In this situation, there is needed to take advantage of this organic waste to generate electricity and heat, to generate a positive impact on the ecosystem not only appropriate but also for productivity for the same resources.

Treatment digesters (bio-digestion) is an option for the use of these organic wastes as through biodegradation and production treatment plant fuel, electricity and fertilizer will occur, attempting to achieve a cycle of sufficiency in livestock.

The stable as a basic construction for the development of livestock, allows the realization of various activities related to it. Much of the production process; It is subject to the use of electricity, so it is important consumption in activities such as:

- Water supply.
- Lighting.
- Fences voltage (electrical).
- Milking.
- Ventilation
- Machinery.
- Electric heater (Cleaning-Agua Caliente).

The use of biogas can be viable for energy saving in the stable, for carrying out their activities and become a viable energy attachment.

For the design and installation of the treatment plant based on bio-digestion must have five basic factors into consideration:

- The availability of water for mixing with the manure.
- The number of cattle that owns the family (3 cows min).

ISSN-On line: 2444-3204
ECORFAN® All rights reserved.

- The operation and maintenance of the technology by the family.

- Variable space.

- HOLD time

The spatial variable depends on the liquid volume and gas volume in the digester, is related to the daily load to be determined by the type and quantity of cattle.

The retention time is related to the ideal temperature required for the anaerobic digestion of the methanogen bacteria, and which may have a heating system or depend on the temperature of the environment; so you should consider an optimal temperature range in the range 10-30 °.

The ideal Family prototype, it is considered that is producing milk, because it can use the whey, to replace part of the water required for the bio-digester mixture and because the fertilizer resulting from this treatment to excreta, it generates a particularly good for growing alfalfa fertilizer.

In Chipilo most families are eligible for installation in a plant biodigester; considering a design and suited to the needs and characteristics of the region installation is needed, the digester has three main limitations and big challenge in terms of climatic adaptation, because, for the production of the plant, the temperature must be greater than 5 ° C.

This becomes a design challenge and adaptation, because in the region where the village is located, the climate and thus the temperatures tend to be somewhat extremes and changing.

Due to the government's promotion of sustainability (not full and deep) and goals set in the five federal strategic axes, where environmental sustainability and sustainable rural development is contemplated; There are some programs within the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) and the Secretariat of Environment and Natural Resources (SEMARNAT), which allow the processing of a state subsidy for the implementation and construction of a biodigester treated plant.

To take care of the management of waste generated by production activities and seek environmental quality, media obtained to preserve the ecosystem, allowing its sustainable use and prevent pollution, to recover what has deteriorated.

Within the range of energy, Agenda 21 considers that this has a particular development according to the community in which it develops and must meet the following conditions: the standard of living of it, you can become commercial power and to promote energy efficiency. In addition to playing the requirements to be economically viable, socially acceptable and environmentally resonance.

While there are still some discrepancies as to what are the cornerstones that make the sustainability, in this research the Socio Cultural, political, environmental, productive and technological areas.

One of the most important and necessary to resume a particular design limits is the appropriation of the proposed technology, the family will be the same user; considering also to promote political and environmental sustainability area to return as stated in the Energy Sector Program (2013-2018) for renewable energy projects:

ISSN-On line: 2444-3204
ECORFAN® All rights reserved.

Positive environmental impact relative to the axes of air pollution, waste pollution and use of clean power generation resources.

Ensure the economic, technical and environmental medium and long-term feasibility.

Financing and contracting to allow achieving planned goals and objectives in a balanced manner in the project.

This means that the project should be triad of public policy, government programs and social responsibility that allow energy savings, seeking efficiency according to the National Energy Strategy (ENE, 2014-2018).

Biodigester Treatment Plant, seeks to achieve the cogeneration of electricity, understood according to the Public Service Act of Energy (2012), indicating that can be achieved when using fuels produced in processes for the direct or indirect power generation as long as electricity is devoted to meeting the needs of the associated cogeneration facilities, allowing the energy and economic efficiency of the process increases.

Rural housing in the study context

Speaking to housing should always be considered in relation to the environment where it is located, that is their habitat, as this will determine their main characteristics, understood as habitat, organization and change in space, generated on a physical and social environment, influenced by the cultural activity of man, according to the National Housing Commission in 2012.

In Mexico they have conceptual differences between the urban and the rural area, especially in government policies and programs, where distinction according to the following indicators is done:

Population and degree of urbanization.

Rural: smaller localities to 5000 inhabitants, Semi-Rural: localities in 5000 to less than 15 thousand inhabitants Urban: districts with more than 15,000 inhabitants.

Administrative Political Division.

Organic Law, Municipality and Town, where a definition of urban municipalities (more than 15 thousand inhabitants), semi-urban (2500-15000 inhabitants) and rural (less than 2500 inhabitants) is given.

However, since this classification is considered arbitrary, because it characterizes the overall concept of the rural habitat, they are considered for this work the following indicators:

a) Characteristics of settlement:

Land use, in general for agricultural activities and integration of productive activities within the housing classification. Distribution and nature of the settlement.

b) Administrative Classification:

Within the Administrative Policy Division and within the entity according to the Organic Law, Municipality and Town.

c) Productive Activities:

Type of activities performed (primary, secondary and tertiary).

d) Relationship with the urban area:

Degree of interaction and distance from urban areas (at least 5 km).

ISSN-On line: 2444-3204
ECORFAN® All rights reserved.

e) Culture and Traditions:

Existence in the area or region of the presence of culture and traditions that characterize the dwelling, seen as the relationship with the environment, marked by customs and visible in the development of local activities.

Rural housing is part of the built environment of a place, giving expression to the palpable influence in their community activities which contrasts with the city cultural heritage.

To (Orozco y Rojas, 2000: 3), the term of rural housing is the housing unit as a complex of buildings and areas used by the Group for its constant activity; consider housing as housing unit, production and culture.

The researchers in this study considered rural housing construction that allows the living to its occupants, in conformity with their customs and cultures, allowing them to maintain their lifestyle, subsistence services and adequate facilities, for quality of life and benefits.

When you consider milk production as part of the farm, it is no longer considered only lodging, rest and feed cattle; but also facilities that enable the proper functioning of the two main activities are labor and milking.

Being so for the proper definition and characterization of the dairy farm, it will be considered as a set of facilities that allow not only the housing of livestock with their physiological activities, but also facilitate the development of milk production.

Methods and tools for the study

In developing research methodological instruments that combined theoretical and conceptual research with empirical and quantitative tools with other qualitative applied.

The research project was structured into the following phases:

Phase 1 (theoretical research): Collection and analysis of specialized information on the topic. Development of the conceptual framework of rural housing in response to habitat and production space. Characterization of the current production process and environmental pollution it causes. Conceptualization and practice the use of cleaner production in best available techniques.

Techniques of documentary research (bibliographic records / hemerographic, worksheets, TABLES, Tables, Matrix SWOT) Field Techniques (Sheets Observation, Reporting tables (observation / typological survey, Maps / Maps, visual memory, Interview, Questionnaire / survey)

Phase 2 (empirical research): Fieldwork research to characterize the social, built and natural area study with the participation of stakeholders through local workshops to exchange and evaluation of experiences.

Application of empirical methods and field techniques: participant observation, inference, interviews, questionnaire / survey.

This stage provided methodological tools as tokens of each of the properties, which is summarized and plotted the location of the property in relation to the external environment, the functional relationship and space physics of the house and the barn, the materials they are built The existing infrastructure, waste management, stable capacity.

Phase 3 (concluding stage): Collaborative work from the documentary analysis and field work context studied analysis and synthesis. Technological proposal develops draft level.

ISSN-On line: 2444-3204
ECORFAN® All rights reserved.

So a general design methodology and calculations based raises, but without standardized solutions, looking to each case study has a framework of guidelines and bases to go by, but that allows for the necessary adaptations and changes that meet the particular characteristics of stable housing

Analysis and design criteria

Within the Chipilo Community of Francisco Javier Mina, the unit of study is the stable housing, which is characterized by the following variables:

- Socio-demographic aspect.

Population and the urbanization process in order to have the data fidelity, national indicators will be taken in the demographic composition of the site and its density.

- Economic aspect.

Highlighting the economic activities in place, services and housing characteristics in relation to units of production, income and production rates; besides resuming forms of organization and niche marketing.

- Institutional Legal and political aspect.

Law regulations, national policies, development priorities and public institutions that serve rural areas.

- Environmental aspect.

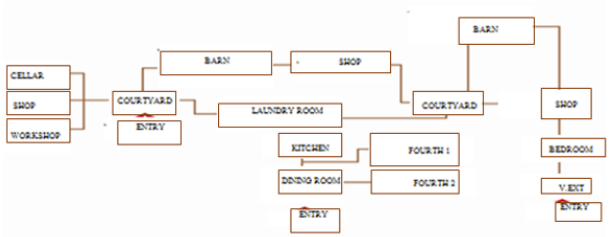
Taking into account three important aspects of the study site, water supply, solid waste disposal and drainage system.

- Architectural appearance.

According to the design variables (functional, physical space, constructive, expressive and environmental).

The field survey stable housing in 18 properties with a total of 40, with preparation of the sketch of the floor plan, the plant and cuts set to see the volume, functional and spatial relationship of the house and the barn was performed and operation.

In the location within the field survey, it is considered as part of the indicators for the design of digester orientation and prevailing winds, and the analysis of climate as a major hub structure to achieve the temperature of the digester.



Scheme 1 Housing-Stable Operation of Chipilo community. Source: Authors

Within the activity of intensive dairy farming wastes are broadly related to the production process, so for the classification of waste the stages of production as is defined: feeding, cleaning pens, milking area and aging and waste generated in each.

Since the existence of different types of digesters and context-specific analysis, we decided to design the fixed dome digester low rate.

The geographic location affects biodigestion, especially for its altitude, in relation temperatures reached. In the Chipilo village of Fco. Javier Mina, it has an altitude of 2139 meters. In general it can be said that the average people of Chipilo according to the study of climate, through the Koppen-García system by Dueñas (2013) environment, temperature has a mild sub-humid climate, with an average annual temperature 17.1 ° C.

ISSN-On line: 2444-3204
ECORFAN® All rights reserved.

With high enough temperature and oscillation extremes.

It is making necessary to conserve the temperature inside the digester, and it is appropriate that is buried, in order to maintain the temperature in the range of 30 ° - 40 ° C, to generate digestion.

Should be considered in the daily mix, the field survey was done in the community, in the stables Dung prefer using shovel and wheelbarrow, having a storage place for it and its removal through trucks; which directly allows the realization of the dung-water mixture in the ratio 1: 1.

Retention time (while remaining the mixture within the digester) is what determines the quality of products especially biogas, if it has a proportion of less methane at 50% this is no longer flammable, as specified by Guardado (2006). Uniting the type of climate (temperature) with the type of manure (cattle) and by reviewing past experiences of others, it is considered ideal a retention period of 56 days for the region where it is proposed, with the least consider a retention period of 40 days.

The information collected and analyzed, allowed classifying the stables according to their common characteristics, serving mainly variables:

- Number of cattle heads. What determines manure management and the volume necessary to the digester?

- Free Space area that can be used for the construction and installation of the digester.

- Energetic Demand. The electrical energy required for the process through the description of equipment used in each of the stables.

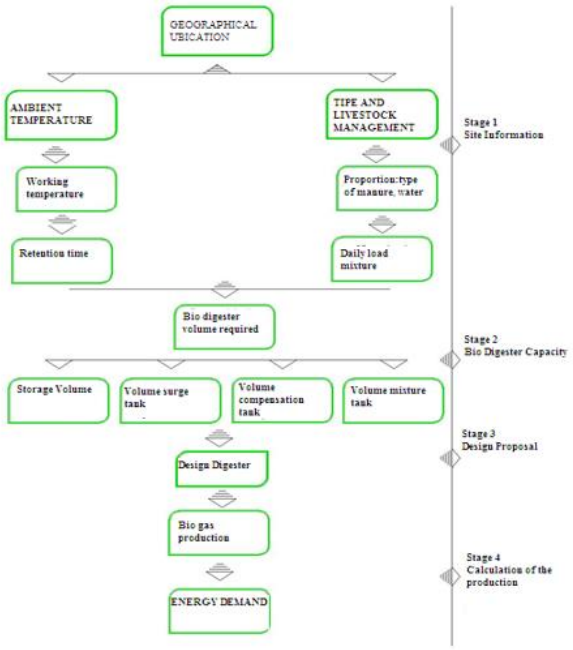
Their study results in three prototypes for the classification of stable homes:

I. prototype barns are grouped with a range of 50 -100 heads of cattle, with more than 100 m2 space, with energy demand for milking bucket, lighting, water pump and alternative use of biogas for heating and Grill Of gas. It has well water supply mainly. The drain is considered to drain outlet and piped drainage ditch according to the age of the construction.

Prototype II. With a range of 40- 70 head of cattle out of a perimeter drainage ditch at the premises and piped drainage considering the position of construction and age, just about free area for the design of the digester, less than 100 m2. Energy demand for productive activity is considered with milking on the site, lighting stable, Prototype III pump. Grouping ranging from 80-200 cattle, with an open area of over 100 m2, with demand for onsite energy, lighting, water pump, gas grill, milk kitchen, boiler and machinery milking. Only one of them has urea treatment of animal waste and a functional electrical generator but can be improved for the needs of the barn. Mostly water supply is well and public water supply, drainage in most lands is cased, though there are open ditches.

The design of the digester was made according to Scheme 2, to understand what are the steps and factors to consider in the design of the treatment plant biodigester; consists of four steps necessary to obtain adequate information, perform calculations and drawings, helping to make it accessible and easy to understand and apply, omitting in this work the math for information about the number of pages, but may be revised in handbook Design guide for biodigester treatment plant in cowshed housing, (2015) the authors.

ISSN-On line: 2444-3204
ECORFAN® All rights reserved.



Scheme 2 Design for fixed dome biodigester. Font. Authors (2013)

To calculate the criteria described by Guardado (2007) Design and Construction of Simple Biogas treatment plants will resume.

The project calculation and design according to the methodology defined for a stable housing Prototype I, with 50 head of cattle, resulting in the following proposal is made:

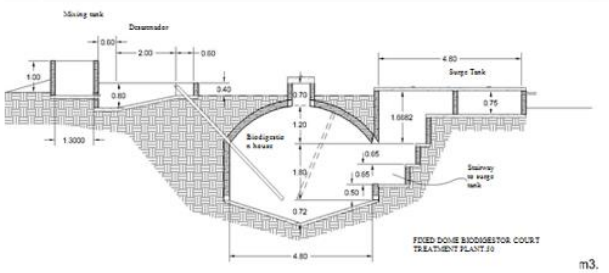


Figure 1 Court Biodigestor Type Nicarao Treatment Plant 50 m3, based on Guardado (2007) .Made by authors (2013).

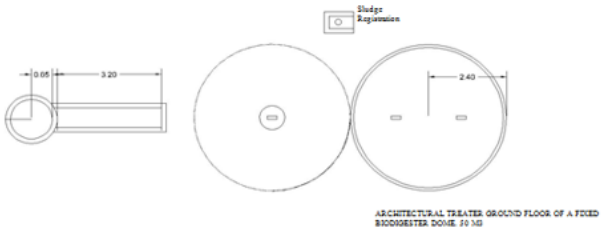


Figure 2 Basic Plant Treatment Plant Biodigestor based on Guardado (2007) Type Nicarao of 50m3. Made by authors (2013).

Figure 3 Fixed dome plant. Web image. F. Cut Problems biogas technology. Cuba, CUBASOLAR (No. 36, December 2006).

To calculate the biogas production, there are different ways of doing this work Guardado (2007) and Marti (2008), being more attached to the proposal, in Guardado special because considered very important as is the proportion dung water 1: 1.

It should be noted that in the production of biogas temperature, water type and quality of manure, are decisive factors in achieving a greater or lesser production of biogas.

The, albeit limited, practical and straightforward use biogas production serves as an aid in the production process stable, mitigating expenses LP within the stable housing. If you have dairy, this promotes greater savings, to be used as fuel biogas stove in the dairy, as could occur in other cases within the community.

ISSN-On line: 2444-3204
ECORFAN® All rights reserved.

To produce electricity with biogas several options, and most feasible:

1. Full generator, factory purchased by a dealer.

2. Armed Genset, comprising combustion engine generator, alternator and control panel.

3. Generator.

The generator factory, requires less work for its implementation in the treatment plant biodigester fixed dome, but has a higher cost, require further adjustment for installation and monitoring. Such generators are justifiable given when we are talking about large amounts of cattle in barns equipped and high production volumes.

Instead the generator assembly, from the union of the different proposals parties; can make the necessary adaptations for the needs of housing-stable, is less expensive, allows reuse items that are regional in scope and the ability to perform most of the self-construction process, with the help of a specialist in auto mechanics.

Costs vary serving providers; it is suggested to do research in each case beginning with suppliers in the region and to consult a specialist in automotive mechanics for assembling generator set.

Greater chance of success in the implementation of a digester will itself has a strict observance of the requirements to be met for the design, construction and use, and the performance of a maintenance program for the same.

Final thoughts

The literature enlightens us about the landscape diversity of projects implemented biodigesters in the world. Comparison and synthesis allow a better idea about the proposal and implementation of a digester and generate power from the self.

Family, designed as an energy attachment, design adaptation to environmental, social and economic conditions of the study context, allow biodigester treatment plant operational best practices that include procedures to reduce the generation of pollutants from the use of excreta of animals in the production of energy use in stable activities and housing.

Design factors to consider in any digester are: the type and amount of excreta or organic to use waste as this determines the type of digester and volume thereof, for which type of treatment is required The availability of water to the mixture, and the usable space available to the user for operation and maintenance.

For the case study, including the design requirements for the digester, it was considered prioritize location due to the somewhat extreme weather site structure, being necessary to adopt strategies for the conservation of the temperature required for the process; also it considered the operation of housing-stable in each case, their type, the amount of livestock and energy demand required for the operation of the production process.

In the community of Francisco Javier Mina (Chipilo), commonly found in the home, the barn as a basic space for raising domestic livestock, there are also several stables that are part of the dairy industry.

ISSN-On line: 2444-3204
ECORFAN® All rights reserved.

So technology biodigesters it is a viable and sustainable alternative, allowing its use as an appropriate low-cost technology.

Referencies

CONAVI (2012). Glosario. México, Recuperado en: http://www.conavi.gob.mx/meta-anual-seguimiento-tren-vivienda.

Artiles D; Dueñas, L; Hofbauer, A; Santiago, G; Morales; J (2015). Design guide for biodigester treatment plant in cowshed housing. Recuperado de: dialnet.unirioja.es/descarga/libro/573220.pdf. Editores. ECORFAN

Estrategia Nacional de Energía (ENE, 2014-2018)

Guardado C. (2006). Tecnología del Biogás, Manual del Usuario. Habana Cuba: Cubasolar. Recuperado de http://www.cubasolar.cu

Guardado, C. (2007). Diseño y construcción de plantas tratadoras de biogás sencillas. Habana Cuba: Cubasolar. Recuperado de: http://www.cubasolar.cu

Martí H. (2008). Guía de diseño y manual de instalación de biodigestores familiares. Bolivia: GTZ.Recuperado de :http://www.mienergiagratis.com/proyectos/59.pdf

Ley de Servicio Público de Energía (2012).

Orozco F. R., Rojas O. E. (2000).La vivienda rural y su ambiente cotidiano. Revista Científica Luna Azul. Recuperado de: http://lunazul.ucaldas.edu.co/index.php
Programa Sectorial de Energía (2013-2018)

ISSN-On line: 2444-3204
ECORFAN® All rights reserved.