

FACULTAD DE INGENIERÍA

Escuela Académico Profesional de Ingeniería Ambiental

Tesis

**Experimental Prototype of Biogas for Domestic
Heating**

Karen Julissa Flores Medina
Yomara Condor Luquillas
Leslie Jannyra Canchari Huaman
Veronica Canales Guerra

Para optar el Título Profesional de
Ingeniero Ambiental

Huancayo, 2024

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FECHA : 16 de Mayo de 2024

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Experimental Prototype of Biogas for Domestic Heating

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Autores:

1. Karen Julissa Flores Medina – EAP. Ingeniería Ambiental
2. Yomara Condor Luquillas – EAP. Ingeniería Ambiental
3. Leslie Jannyra Canchari Huamán – EAP. Ingeniería Ambiental
4. Veronica Canales Guerra – EAP. Ingeniería Ambiental

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Experimental Prototype of Biogas for Domestic Heating

Karen Julissa Flores-Medina
*Department of environmental
Engineering*
Universidad Continental
Huancayo, Peru
71979661@continental.edu.pe

Yomara Condor Luquillas
*Department of environmental
Engineering*
Universidad Continental
Huancayo, Peru
71545167@continental.edu.pe

Leslie Jannyra Canchari Huaman
*Department of environmental
Engineering*
Universidad Continental
Huancayo, Peru
72251059@continental.edu.pe

Verónica Canales Guerra
*Department of environmental
Engineering*
Universidad Continental
Huancayo, Perú
vcanales@continental.edu.pe

Abstract—According to INEI more than 30% of the population lives in high Andean areas of Peru that are affected by frosts reaching levels below zero degrees Celsius and existing heating system costs too much at 0.10 €/kWh. This work developed an experimental prototype to obtain biogas to improve the production processes for domestic heating based on pig manure. For the experimental prototype, recycled materials such as timbo, pipe connections, a car tire with a volume of 20 238.85 cm³ were used to store the biogas produced from 7 kg of pig manure with a ratio of 1-3 (manure-water), in a time of 25 days, achieving to light a stove. The process was automated for production without user intervention through servovalve mixing controls, temperature sensors, methane gas sensors, an outlet pipe for the biol so that it can be used as fertilizer, and will be controlled from the HMI screen by a PLC S7-1200 1214 DC/DC/DC and a TP700 HMI which allows one operator to control the biodigester. The biogas generated will be transferred through a hose to the house to supply the heater.

Keywords—*Biogas, Biol, Thermocouple, Biodigester, Biomass, Biomass, Heating, Sensors, Servovalves*

I. INTRODUCTION

According to the National Institute of Statistics and Informatics (INEI), more than 30% of the population lives in areas affected by frost, which is a recurrent atmospheric phenomenon in the different high Andean areas of Peru, where temperatures drop below zero degrees Celsius [1]. The National Meteorological and Hydrological Service of Peru (SENAMHI) measured temperatures in the Tacna region of -17.5 °C [2][3], while in the Junín region in 2022 the cold reached -10 °C causing the death of cattle in the city of Chupaca, while other animals suffer from pneumonia due to the drop in temperature [4]. Due to the cold in Andean areas, people tend to protect themselves by using coats, blankets and lying down near the stove to receive heat from firewood. This is usually not enough to combat frost while heating systems require a high consumption of expensive electrical energy that approaches 0.10 €/kWh [5].

In Mexico, systems designed to use the temperature generated by the biodigester were developed using biomass as the primary source, which were used to improve the performance of the biodigester through hoses that move hot water which reaches an air conditioner generating a warm environment in the dining area, this is done by using the biogas produced and used as a fuel source for the stove which is controlled by a methane sensor in order not to exceed the limits of methane gas production [6-7].

Biomass is an important source of renewable energy that can replace fossil energy by creating electrical energy and as a source of heat, to estimate the production of biomass in trees is done using parameters such as density, height, diameter of the crown and trunk these are characteristics to measure, but in most situations, it is usually complicated for which linear regressions and Gaussian processes are used for the data set that relate biomass with tree height, [8-9].

In rural areas of Botswana, manure residues are used as a source of energy to take advantage of the potential of biogas for which through experiments at laboratory scale, the yields of manure residues were analyzed by selecting the design of the biodigester through a multicriteria analysis for which KVIC was used having a dimension of 10 to 100 m³, for which 5000 herds were used having a density of matter on site of 1410 kg/m³ considering a biodigester of 20 m³ managing to obtain a potential to produce 45.3 MWh of energy per year [10].

Through experimental advances in different researches biogas has been used as renewable energy for fuel being one of its main uses the generation of electricity, refrigeration, heating and fuel for transportation in South Africa for which it is estimated that 7 hectares of cultivated land are required for the production of biogas to supply a bus, municipal waste is used as raw material to produce biogas to supply up to 600 city buses, which helps to reduce carbon emissions and the waste left in the biodigester, called biol, is used for agriculture as fertilizer [11-12].