

FACULTAD DE INGENIERÍA

Escuela Académico Profesional de Ingeniería Mecatrónica

Tesis

**Design of an automatic system of an accelerated
biogas biodigester for rural areas in Peru**

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Para optar el Título Profesional de
Ingeniero Mecatrónico

Huancayo, 2021

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Abstract— This research presents the design and control of a biodigester with mechatronic systems for control and a closed system of controlled compression to reduce the times in the generation of biogas. The development of the project shows that the application of level sensors, electro valves, and exhaust ducts are feasible in each tank through a control panel in order to monitor each process. The acceleration stage to obtain biogas consists of a closed system type cylinder-piston, to perform a controlled compression reducing fermentation times, additionally it was considered that the drive of this cylinder is mechanical type due to the limited access of electrical energy in rural areas.

The control and design of the proposed system will provide multiple improvements in homes in rural Peruvian areas that require solutions based on better use of natural resources with the waste generated by livestock, use of energy reducing pollution to their environment, creating access to energy generation, and the possibility of reducing diseases due to the consumption of polluting fuels during the preparation of their food.

Keywords— Biodigester, renewable energies, automation, mechatronic systems, methane.

I. INTRODUCTION

Worldwide, the increase in population has increased the problem of energy demand, optimizing the use of natural resources, and the reduction of greenhouse gases, which is solved by the development of renewable energy sources, being a sustainable means of anaerobic digestion [1] [2]. Methane gas is one of the most damaging to the atmosphere and contributes to the greenhouse effect, which is produced by the manure of living beings, with the greatest presence of cattle [3]. In a systematic review of the management and greenhouse gases in livestock systems, they conclude that the methane gas produced by the excrement of cattle becomes the second potential emitter that contributes to the damage to the environment [4].

The use of biodigesters addresses several solution issues such as the use of organic waste that through fermentation is generated biogas and biofertilizers [5]. Waste management in livestock farming should be a priority issue, seeking to determine future strategies to mitigate the effects of climate change on the uptake and proper use of methane [6]. There are several cases of methane

measurement, one of them is by algorithms through a design of a covariance system of eddies during times of low turbulence [7] also in a study on improving biogas production is done by phototrophic biofilms produced with natural sunlight rich in *Rhodospseudomonas faecalis*, this bacterium can carry a photoautotrophic metabolism that is to say that it fixes carbon dioxide optimizing production biogas [8], among others. The development of new technologies in biogas plants increases the efficiency of biogas production [9].

Europe is currently the world's leading producer of biomethane for the use of natural gas, electricity, and vehicle fuel [10], according to annual reports from the European Gas Association, there are significant increases especially in biomethane production [11]. In Latin America, the country with the most biogas development in Brazil unlike countries such as Peru, Ecuador, Chile, among others [12].

In Peru, the Ministry of Agriculture and Irrigation presents in the Diagnosis of Prioritized Breeding for the Livestock Plan 2017 – 2021 that in 2015 there were 824 thousand agricultural producers of which at least have one bovine, of which 87% are in the mountains and with 44% of them with a socioeconomic condition between poor and extremely poor, however, the average number of cattle per producer in Peru is 11 head per family [13], for example, the Cajamarca region is the one that leads in the production of beef [14], this same region is the one that has the first highest level of incidence of poverty from 2011 to 2018 [15]. In addition, the limited access to electricity and use of polluting fuel contribute significantly to the situation of poverty in rural areas in Peru [16].

Likewise, the last national census carried out in 2017, 70.1% of households in rural areas cook with polluting fuels, that is, the use of firewood, charcoal, direct burning of both and crop residues, which are harmful to health, such as lung cancer, acute respiratory infections, eye problems and adverse consequences to pregnancy [17].

This paper seeks to present an economically sustainable alternative for the acceleration of biogas generation as a sustainable alternative fuel in rural areas of Peru.

II. MATERIALS AND METHODS

The proposed design has 3 stages for the production of biogas by cattle excrement in rural areas. In the first stage, there is the first deposit where the mixture of excrement with water is made. This