Maestría en Ingeniería en Diseño de Bioprocesos

Prototype for gases monitoring from biological systems

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Prototype for gases monitoring from biological systems

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Master in Bioprocess Design Engineering

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1. Introduction

Currently bioprocess monitoring has evolved slowly from chemical engineering. The real-time knowledge of a set of key variables in bioprocess is of utmost importance. Therefore, online monitoring methods that provide specific knowledge for optimal operation of the process are required.

Sensors in bioprocesses must have certain characteristics such as: low response times, resistance to volatile compounds and humidity, prolonged working time and sterility. In the case of gas sensors can be placed in the system exhaust. Measurement of the composition of the waste gas allows to know the metabolic state of the organism.

Gas composition is a relevant biological variable in organic waste treatment by anaerobic digestion (AD). Hydrogen, methane and carbon dioxide are produced during the stages of AD. Gases monitoring improve the system operation. In many cases the gases measurement is based mainly on the use of a gas chromatograph, which is an expensive equipment [1],[2].

2. Objectives

2.1. General objective

To build a gas monitoring system for bioprocess applications that considers the physicochemical characteristics of the samples.

2.2. Specific objectives

- To design and to build a gas sensor system using a data acquisition card based on an 8-bit microcontroller and MQ sensors.
- To design and to build the gas sampling and measurement chamber considering the physicochemical parameters of the sample.
- To develop a human machine interface (HMI) for online information acquisition of gases produced in a biological reactor.

3. Methods

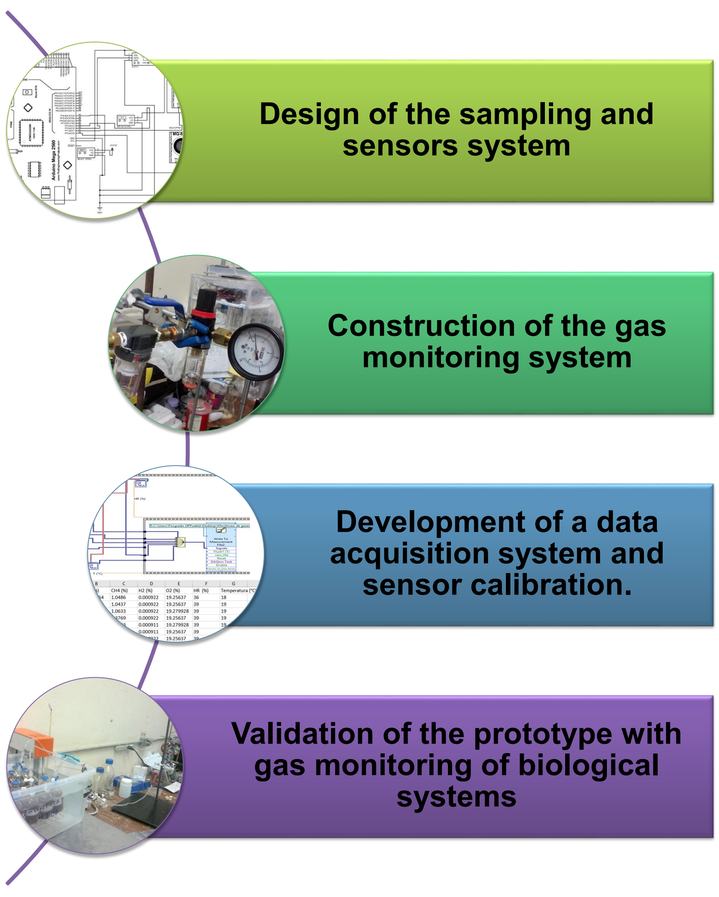

Figure 1. Methodology used in this research.

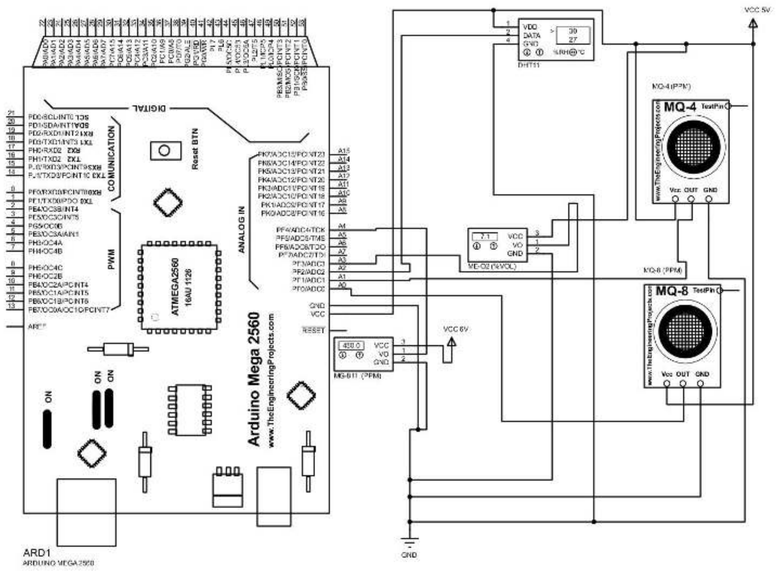

Figure 2. Circuit diagram made in Proteus 8.

- **Methane production:**

$$CH_3COONa + NaOH \Leftrightarrow CH_4 + Na_2CO_3$$

- **Carbon dioxide production:**

$$CaCO_3 + 2HCl \Rightarrow CaCl_2 + H_2O + CO_2$$

- **Hydrogen production:**

$$2Al + 6H_2O \Rightarrow 2Al(OH)_3 + 3H_2$$

$$Al(OH)_3 + NaOH \Rightarrow Na^+ + [Al(OH)_4]^-$$

$$Al_2O_3 + 2NaOH + 3H_2O \Rightarrow 2Na^+ + 2[Al(OH)_4]^-$$

- **Oxygen production:**

$$2KMnO_4 + 3H_2O_2 \Rightarrow 2MnO_2 + 3O_2 + 2H_2O + 2KOH$$

Figure 3. Chemical reactions used to calibrate gas sensors

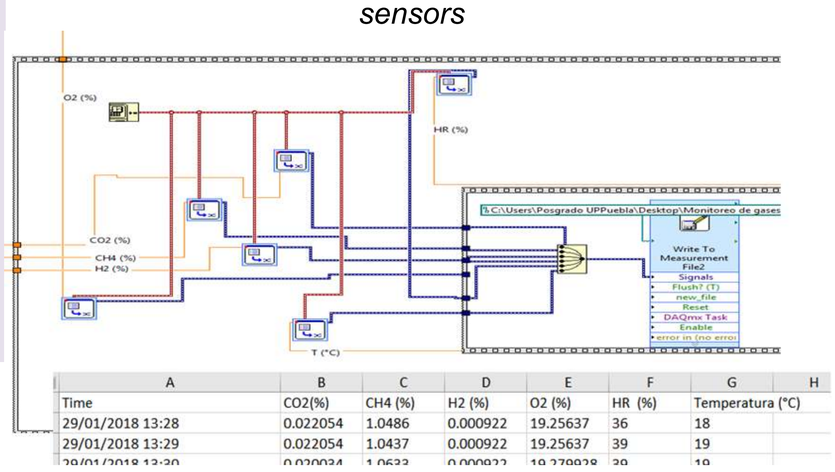

Figure 4. Data acquisition system in LabVIEW 2014 program

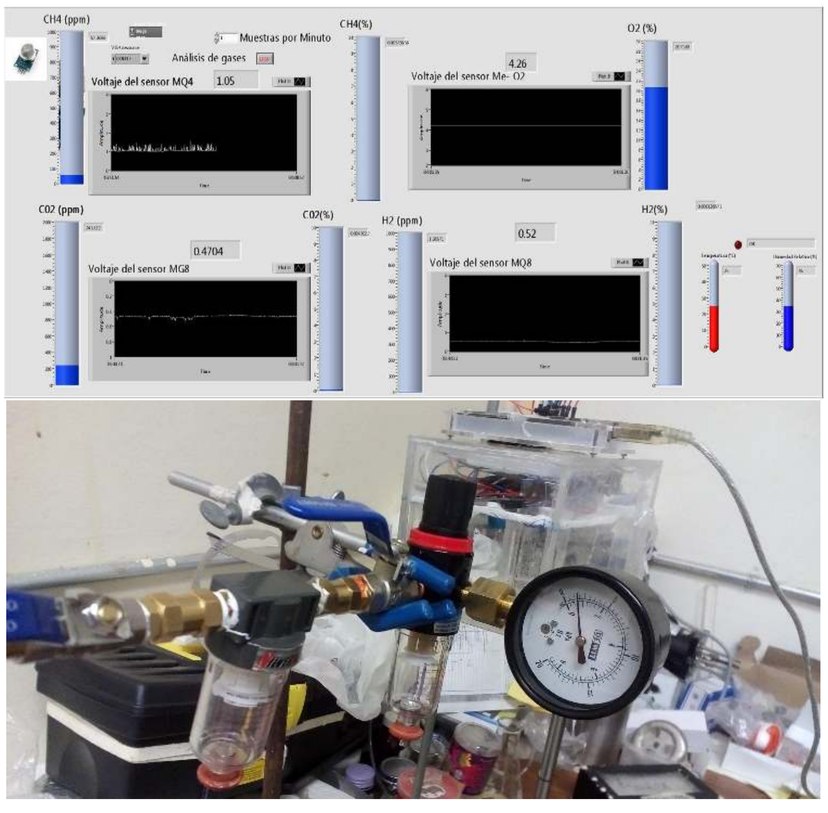

Figure 5. Gas monitoring system and its interface

4. Results

Anaerobic digestion monitoring, experimental analysis and pressure measurement were performed during thirty three days. Figure 6 shows experimental assembly and Figures 7-8 show the experimental results .

Figure 6. Online monitoring of horse manure anaerobic digestion

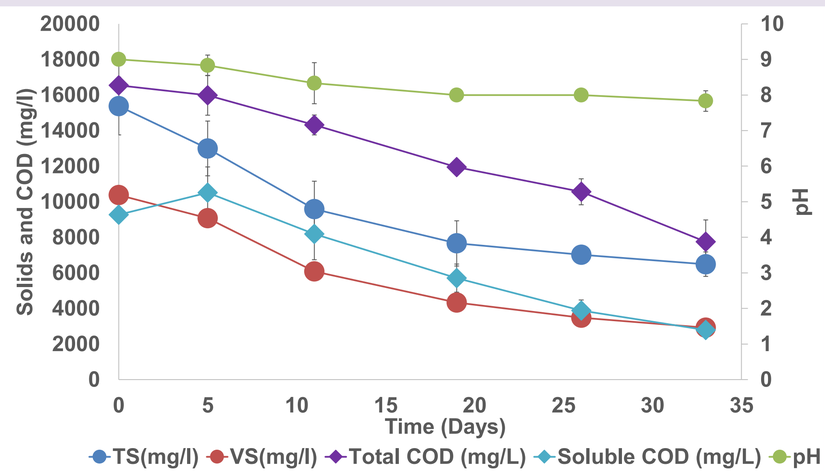

Figure 7. Total (TS) and Volatile Solids (VS), Chemical Oxygen Demand (COD) consumption.

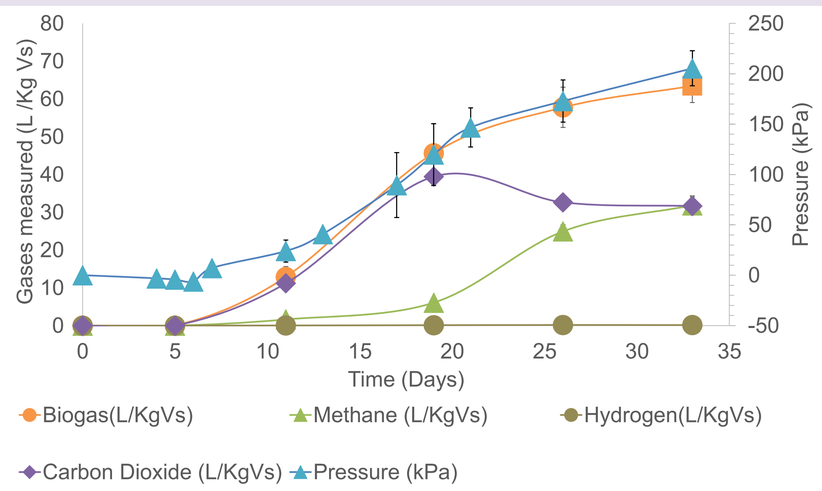

Figure 8. Gases measured.

5. Conclusion

The prototype is capable of measure oxygen, carbon dioxide, methane and hydrogen gases per minute, obtaining data and storing them in Excel using the interface developed in LabVIEW 2014. This project is 80% of progress.

Acknowledgements

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References

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