Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2017, 4(2):52-57**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Electronic Monitoring System for Hydrogen Produced from the Oxidation of Human Urine (Mhydros)

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Abstract In this research was developed a monitoring system of hydrogen produced by the electrochemical reaction using urine as an energy source, this system can measure in percent the flow of hydrogen gas produced by the pressure of the reaction system and the current applied through the electrolysis process: In this system was used: sensor AMS HPS-100, current sensor ACS712 - 20A, Flow sensor AWM42150VH, Atmospheric pressure BMP180 sensor, card Arduino development Uno R3 and Seeeduino CAN BUS Shield card values were measured hydrogen concentration up to 45% with an uncertainty of 0.5%, flows between 5- 15 mL / min with errors up to 2% and 0.0-2.0 amperes flows.

Keywords Hydrogen, sensors, electrochemical cell and urine

Introduction

Air pollution emissions is the cause of: the greenhouse effect, acid rain, variation of climatological regimes, etc., which seriously affect Humanity situation presented by the indiscriminate Energy production from fossil fuels [1-4].

An alternative energy source to reduce the atmospheric emissions that cause the adverse effects of the atmosphere without limiting the efficiency is the use of hydrogen, however the obtaining from the conventional way (using water) requires large amounts of energy that make its application unviable To replace hydrocarbon fuels. Urine is a raw material of interest for the generation of hydrogen because of the low oxidation potential, in addition urine is one of the pollutant of the water, since it is normally discharged to the water sources [5-7].

There are commercial monitoring equipment and are made up of gas detectors that are characterized mainly by the following analysis: a series of sensors with sensitivity to several gases working under specific environmental conditions, a data logger that processes and records the information in a unit Storage and a display allows you to view information, some have a battery system for independent operation, all these elements are coupled to a device that can be fixed or mobile, these instruments do not possess the required selectivity, range and working conditions For the measurement of specific chemical elements such as hydrogen gas, there are also equipment for these measurements with a high cost and are difficult to acquire, being a limitation for the purchase of these products. When reviewing the projects developed on this topic, the following results of works that deal with this topic are discussed:

Hydrogen is the smallest known molecule, is a tasteless, colorless and odorless gas, being less dense molecules which tends to dissipate quickly after being released, is an extremely flammable gas, reacts with oxygen in the air to produce water, has the highest concentration of energy per unit volume compared to known fuels, has a high permeability through various materials [8], these reasons require developing measurement systems with robustness and accurate to enable tracking this gas unconventional in experimental systems.

A special property of hydrogen is its thermal conductivity being 0.187W/mK at normal temperature and pressure is significantly higher compared to other gases, this property is used to design specific sensors for this gas.

In this work, an electronic system was designed, assembled and implemented to monitor online and in real time the percentage of hydrogen produced by a reactor that oxidizes the human urine and uses the electrons obtained to produce hydrogen in chemical equilibrium, the system measures the percentage Of hydrogen using an HPS-AMS-100 sensor, the gas flow produced by the reactor and the required current by the reactor.

Materials and Methods

Hydrogen Generator:

The rector is an electrolytic cell with separate anode and cathode developed by the research group "*Estudio de Sistemas Contaminantes*". The average flow generated in the cell is 5.5 mL of H2 per minute, at ambient conditions, applying an average current of 2 amps.

Sensor AMS HPS-100:

An HPS-100 sensor manufactured by AMS selective for hydrogen used in automotive applications, with operating range (0-100% v / v), with a sensitivity of 0.5% (v / v), reliability and CAN communication interface was used. [9]

The calibration of the sensor was performed in the laboratory with hydrogen and nitrogen of high purity (Linde Group, 99.99%), adjusting the flow rate with a manual flow meter, then the gases were mixed by a flow divider, finally compared with the Percentage reported by the sensor, this procedure was performed under ambient conditions. It was verified that the sensor has a correct response and has a sensitivity of 0.5% (v /v) volume.

Current sensor ACS712 – 20A:

Electronic device developed by Allegro MicroSystems which allows current measurement based on the Hall effect, internally amplified and adapts the magnetic signal generated by the current, generating an output voltage proportional to its [10].

Calibration was performed using a digital multimeter with a resolution of 0.01 A, 20 samples were taken calculating the mean square error with reference to the actual value, with an error of 0.05 A.

Flow sensor AWM42150VH:

Electronic device developed by Honeywell, allows measurement of airflow compatible with hydrogen, internally has a silicon chip on which the flow passes transferring heat measuring and generating a voltage output proportional differential [11-15].

Calibration is performed through five tests with a manual flow meter. The output values showed an error of 2% on average and allowed measures in a range of 0-30cm^3/min

Atmospheric pressure sensor BMP180:

Atmospheric pressure and temperature are obtained locally through BPM180 sensor manufactured by Bosch. It is based on piezoresistive component, an ADC and an internal microcontroller, transmits digital data via the I2C protocol to Arduino card with a resolution of ± 2.0 hPa for pressure and ± 2.0 ° C for the temperature in the range 0 -65 °C.[16]

Development board Arduino Uno R3:

It is a free hardware platform based on Atmel AVR microcontroller 8 bits. It energizes and communicates with the USB port, an AD converter has 10-bit resolution, 6 analog inputs.

card Seeeduino CAN BUS Shield:

Modular plate which is connected at the top of the Arduino card, and employing the MPC2551 microcontrollers MCP2515 allowing interaction between electric levels to the CAN protocol.

Methodology - Assembly System :

General System Diagram

The system is represented by Figure 1 and consists of the following parts: electrolytic cell, measuring sensors, communication interface, central display card and software.

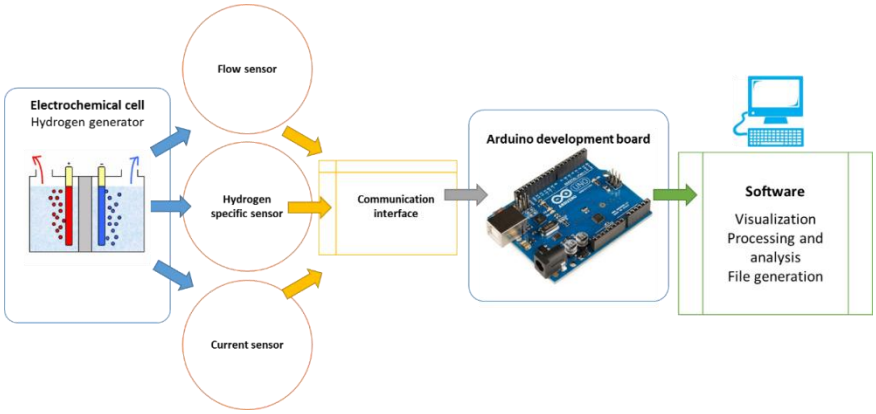

Figure 1: General System Diagram

Electrochemical cell

The reactor is an electrochemical cell that uses urine as an energy source, applying electrolysis as an electrochemical principle. The system is closed with two half-cells which are in electrical contact and material by means of an electrical bridge and a proton exchange membrane, the reactor operates between 3,0-12,0 V, 2,0 amp average, hydrogen is generated at the cathode and a latex hose 10 cm and 0.7 mm diameter driving into the filter with adsorbent materials to prevent corrosion and moisture flow.

Driving flow and corrosion and moisture filter

The output of the electrolytic cell was connected via a hose latex of 0.7 mm diameter, the corrosion and moisture filter, the filter has a length of 4 cm, containing a solid $NaHCO_3$ and NaOH granular 50:50, is responsible for neutralizing corrosion and trap moisture in the flow cell outlet, the filter output sensor holder connected via a hose latex of 0.7 mm diameter tube.

Porta-sensor

One sensor holder was constructed with a PVC pipe half inch and 10 cm long, at the left end with a stopper and 0.5 mm connector. In this hydrogen sensor in the measuring position approximately 35% of the flow, then the right end was connected to tubing differential pressure constriction started as Figure 2.

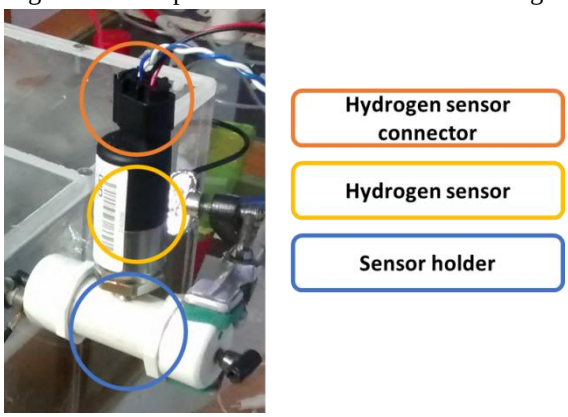

Figure 2: Hydrogen sensor and holder Sensor

Measurement of hydrogen concentration

It was performed with the HPS-100 sensor manufactured by AMS, which transmitted the data to the CAN- Bus Seeeduino Shield card on the card **Arduino Uno** for the creation of a data packet.

The concentration sensor hydrogen HPS-100 is connected via 4-wire VCC, GND CANH and CANL to the central unit, this communicated with the Seeeduino card for the CAN protocol at 500 kbps to transmit transmission data collected, transmitted a frame of 8 bytes in hexadecimal encoding, which represent the concentration, internal temperature and sensor status.

Flowmeter

It was performed by heat transfer AWM42150VH flow sensor, which generates a voltage signal digitized by a digital converter module ADS1115 analog. the output value with respect to environmental conditions are

adjusted by measuring the pressure and local temperature through BMP180 sensor modules communicate with the Arduino board via the I2C protocol, common connections SDA and SLC and are energized by the 3.3V and GND pin card.

Current measurement

The ACS712-20A module connected via 3-wire DC, SIGNAL and GND, connected to the analog input of the Arduino Uno digital card, this module is connected in series with the electrolytic cell, which conducts current through an internal integrated route, containing a sensitive sensor magnetic field produced by the current according to Figure 3.

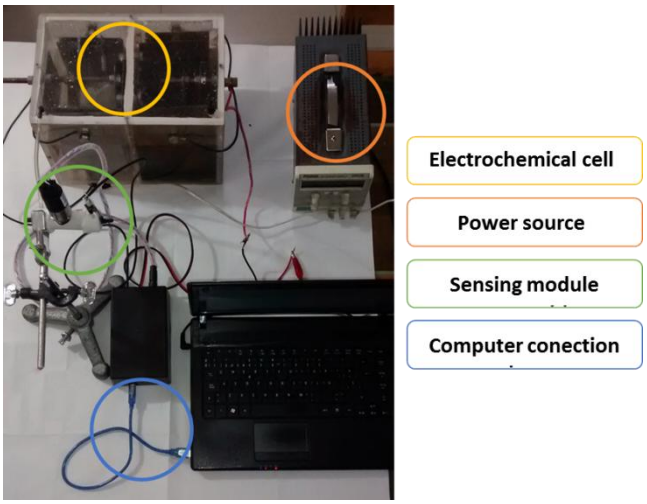

Figure 3: Complete assembly of sistema

Communication and Programming

Data transmission

The Arduino Uno board created a data frame of 60 bytes, which are transmitted by the USB connection to the computer through the serial asynchronous transmission protocol at a rate of 115200 baud.

Software

The data frame became valid for the user display by MHYDROS software developed in the MATLAB platform for Windows, the software will show a graph in real time every second was updated presenting the specific values of the measured values at the time data experiment.

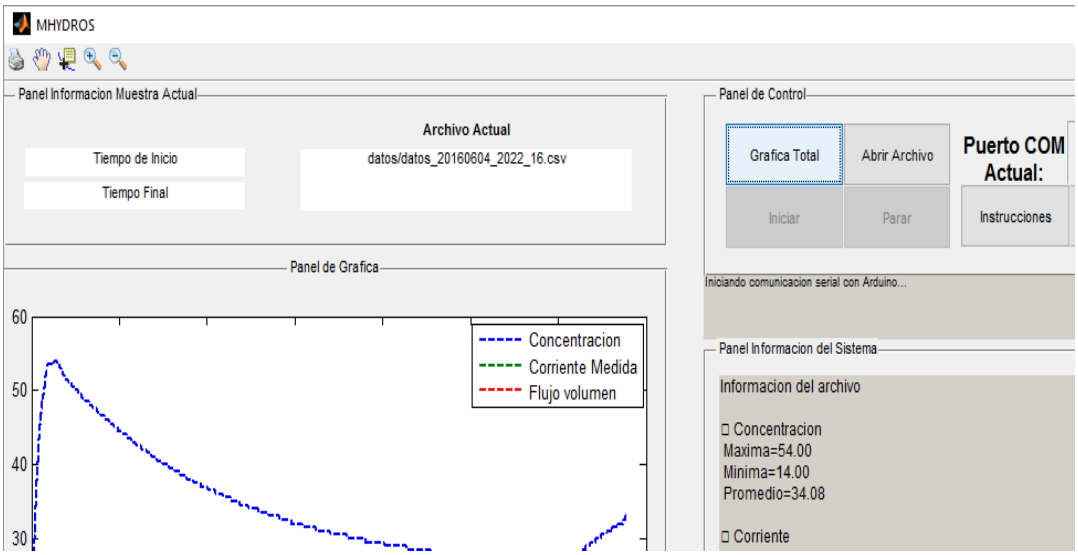

Figure 4: Main window of visualization software

The application developed automatically generated a comma separated file backup for each measurement containing the following values: time, concentration, flow and current.

Results and Discussion

three measurements were performed at the outlet of the cathode of the electrolytic cell for 20 minutes connected to a current source set to 10V @ 2A, values obtained in the experiments are shown in Figure 5 and Table 1, it was observed that after 6 minutes the hydrogen concentration is set to a constant value a flow and continuous current.

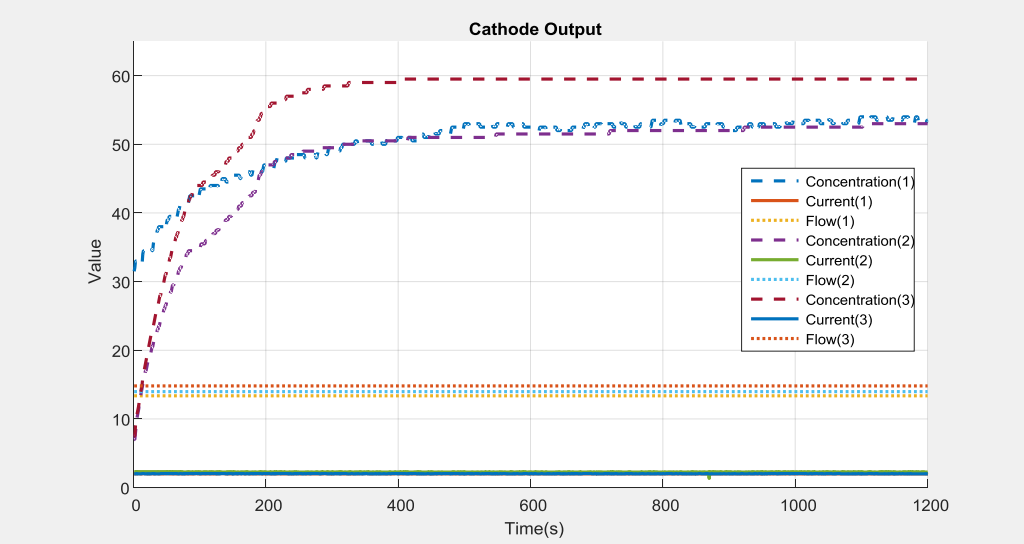

Figure 5: Output values measured

Table 1: Average values reactor output

Experiment No.	Time (min)	Average Concentration	Average Flow ($\left(\frac{cm3}{min}\right)$	Average Current (A)
1.	20	50.84 ± 0.5	13.36 ± 2	2.015 ± 0.05
2.	20	49.35 ± 0.5	13.97 ± 2	2.004 ± 0.05
3.	20	56.30 ± 0.5	14.80 ± 2	2.020 ± 0.05

The hydrogen concentration value had an uncertainty of 0.5% which matches the manufacturer's specifications manual. an error of 2% measured flow due to the resolution of the adc and calculation from the differential pressure was obtained has an uncertainty of current 0.05A due to the resolution of the arduino card, experimentally verified using introduced a flow meter and a digital multimeter, is I can improve range of flow measurement by changing the measurement principle because the output streams generated at the cathode are small, the software allowed us to visualize in real time the changes made in the electrochemical cell, allowing optimization hydrogen generation.

Conclusions

The system enabled to monitor MHYDROS the hydrogen produced by the MIOIL reactor and found to using urea dissolved in the anode and cathode water percentages of 45% hydrogen, flows de13.5cm3 / min and with an applied current of 2A were detected with variations of 2% indicating that the system works reliably and robustly, allowing determine define variables associated with the efficiency of the electrochemical process.

Acknowledgment

The authors thank to the University of Nariño, VIPRI Research System.

References

[1]. Dinga Gustov P. Hidrogen. The ultimate fuel and energy carrier. En: Int J. Hydrogen Energy. Vol.14,No.11, pp777-784. 1989.
[2]. Informe Final "Desarrollo nuevos prototipos en fuentes no convencionales de energía". Grupo Energía Alternativa, Universidad de Antioquia. 1997
[3]. Mundo Electrónico Colombiano. Octubre-diciembre. 1999
[4]. Informe Final "Desarrollo prototipos y Evaluación plantas piloto". Grupo Energía Alternativa, Universidad de Antioquia. 1998.
[5]. Cuidoelagua.org. ¿Qué son las Aguas Residuales?, disponible en: [http://www.cuidoelagua.org/empapate/aguaresiduales/aguasresiduales.html].
[6]. Contaminación Agrícola de los recursos hídricos, Depósito de documentos de la FAO, disponible en: [http://www.fao.org/docrep/w2598s/w2598s03.htm#TopOfPage].
[7]. Enfermedades por contaminación, Profesor en línea, disponible en: [http://www.profesorenlinea.cl/ecologiaambiente/Contaminacion_Enfermedades.htm].
[8]. Castells Xavier, Jurado Lorena, El hidrogeno y las pilas de combustible, Madrid: Ediciones Díaz de Santos, 2012.
[9]. AMS, HPS-100 Datasheet AMS, Unterpremstaetten, 2016.
[10]. Allegro MicroSystems, Fully Integrated, Hall Effect-Based Linear Current Sensor IC with 2.1 kVRMS Isolation and a Low-Resistance Current Conductor Allegro MicroSystems, 2013.
[11]. Honeywell Inc, AWM42150VH, Honeywell Inc, Morristown , 2016
[12]. Honeywell, «Installation Instructions for the AWM40000 Series Mass Gas-Flow Sensors,» Honeywell, Freeport - Illinois, 2005.
[13]. Honeywell, «Mass AirFlow Sensor,» Honeywell Sensing, 2015.
[14]. Honeywell, «Mass Flow Sensors: Mass Flow versus Volumetric Flow and Flow Rate Unit Conversions,» Honeywell Inc, Golden Valley, 2012.
[15]. Honeywell, «Gas Media Compatibility and Correction Factors,» Honeywell Inc, Golden Valley, 2012.
[16]. Bosch Sensortec, «BMP180 Digital pressure sensor,» Bosch Sensortec, Reutlingen, 2013.