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Journal of Research and Development

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The works must be unpublished and refer to topics of industrial development, project model, computer application, research production, systems development, research networks, application design, programming and development proposals and other topics related to Humanities and Behavioral Sciences.

Presentation of the Content

In the first chapter we present, *Low-cost method for quantification of hydrogen and methane in continuous flow bioreactors* by ROJAS-ESCOBAR, Silvino, GONZÁLEZ-CONTRERAS, Brian, JARAMILLO-QUINTERO, Patricia and GUEVARA-GARCÍA, José Antonio with adscription in the Universidad Autónoma de Tlaxcala, as a second article we present, *Transformation of kinetic energy to electrical energy through a static system to recharge electronic devices*, by PRADO-SALAZAR, María del Rosario, BARBOZA-BRIONES, José Gabriel and ÁVALOS-SÁNCHEZ, Tomás, with adscription in the Universidad Tecnológica de Jalisco, as the following article we present, *Numerical Simulation of the Combustion Chamber for a New Reference Combustion Calorimeter*, by GONZÁLEZ-DURÁN, J. Eli E., ZAMORA-ANTUÑANO, Marco A., LIRA-CORTES, Leonel and MÉNDEZ-LOZANO, Nestor, with affiliation at the Instituto Tecnológico Superior del Sur de Guanajuato, Universidad del Valle de México, Centro Nacional de Metrología CENAM, as next article we present, *Methodology for pattern determination in electroencephalographic signals*, by ESQUEDA-ELIZONDO, José Jaime, TRUJILLO-TOLEDO, Diego Armando, PINTO-RAMOS, Marco Antonio and REYES-MARTÍNEZ, Roberto Alejandro with adscription in Universidad Autónoma de Baja California, as next article we present, Oral health in patients with diabetes mellitus type 2 from the faculty of dentistry in San Francisco de Campeche 2016, by ROSADO-VILA, Graciella, ZAPATA-MAY, Rafael, SANSORES-AMBROSIO, Fatima and VIDAL-PAREDES, Jorge, with adscription in Universidad Autonoma de Campeche.

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Low-cost method for quantification of hydrogen and methane in continuous flow bioreactors

Método de bajo costo para la cuantificación de hidrógeno y metano en bioreactores de flujo continuo

ROJAS-ESCOBAR, Silvino†, GONZÁLEZ-CONTRERAS, Brian, JARAMILLO-QUINTERO, Patricia and GUEVARA-GARCÍA, José Antonio*

Universidad Autónoma de Tlaxcala

ID 1st Author: *Silvino Rojas-Escobar* / **ORC ID:** 0000-0003-3312-9604, **CVU CONACYT ID**: 705186

ID 1st Coauthor: *Brian, González-Contreras* /

ID 2nd Coauthor: *Patricia, Jaramillo-Quintero* /

ID 3rd Coauthor: *Antonio, Guevara-García* / **ORC ID**: 0000-0002-5097-1345, **Researcher ID Thomson:** Z-3856-2019, **CVU CONACYT ID**: 204020

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Abstract

Bioreactors of industrial scale for gaseous biofuels constitute a field of research worldwide. Automation at a profitable technical and economic level has not been possible because of fluctuating biological systems. The quantification of biogas in continuous flow is difficult to implement by Gas Chromatography and it is very expensive in account of special sensors. In this work, we developed a system with MQ8 hydrogen and MQ4 methane sensors, used in the detection of industrial leaks, for the determination of gas concentration. The sensors were installed on Arduino cards and programmed to plot the concentration in real time. Calibration curves were made for these sensors making use of a standardized mixture of gases, in hermetic jars of known volume. The result is exponential and reproducible, and when using real biogas samples, no problems of interference with other gases are observed. The prototypes are very low cost with respect to the GC equipment and can be installed at the gas outlet of bioreactors with a mechatronic system that allows the monitoring of the composition in real time, which will allow to obtain microbial kinetics in semi-continuous flow in a very economical way.

Sensors, Hydrogen, Methane, Economical, Bioreactors, Continuous Flow

Resumen

Biorreactores de escala industrial para biocombustibles gaseosos es un campo de investigación a nivel mundial. La automatización a un nivel técnico y económico redituable no ha sido posible por tratarse de sistemas biológicos fluctuantes. La cuantificación de biogas en flujo continuo es difícil de implementar por Cromatografía de Gases y muy caro a partir de sensores especiales. En este trabajo se desarrolló un sistema con sensores MQ8 de hidrógeno y MQ4 de metano, utilizados en la detección de fugas industriales, para la determinación de la concentración. Los sensores se instalaron en tarjetas Arduino y se programaron para trazar la concentración en tiempo real. Se realizaron curvas de calibración para estos sensores utilizando una mezcla estandarizada de gases, implementando la medición en frascos herméticos de volumen conocido. La respuesta es exponencial y reproducible, y al utilizar muestras de biogás reales, no se observa problemas de interferencia con otros gases. Los prototipos son de muy bajo costo con respecto al equipo de CG y pueden instalarse a la salida de gas de los biorreactores, con un sistema mecatrónico que permita el seguimiento de la composición en tiempo real, lo cual permitirá obtener cinéticas microbianas en flujo semi-continuo, de manera muy económica.

Sensores, Hidrógeno, Metano, Económico, Biorreactores, Flujo Continuo

Citation: ROJAS-ESCOBAR, Silvino, GONZÁLEZ-CONTRERAS, Brian, JARAMILLO-QUINTERO, Patricia and GUEVARA-GARCÍA, José Antonio. Low-cost method for quantification of hydrogen and methane in continuous flow bioreactors. Journal of Research and Development. 2019 5-16: 1-6

* Correspondence to Author (Email: joseantonio.guevara@uatx.mx)
† Researcher contributing as first author.

Introduction

A new way of acquiring equipment is rapidly expanding in the scientific community, this is the so-called DIY (Do It Yourself), which provides at least two great benefits: 1) Flexibility, whereby scientists can build just what they need to automate their particular laboratory processes, rather than buying a standard configuration; 2) Economic advantage: commercial equipment that can cost USD $100,000 or more, scientists can build it for USD $5,000 or less, depending on the desired performance, controls and sensors (May 2019). The same goes for electronics. Instead of building complicated circuits from scratch on a "board," scientists can turn to open source tools, such as the Arduino (2019) programmable circuit board, to design, build and code the necessary controls. In addition, scientists frequently provide detailed guides to assemble created devices and instructions to automate and customize it.

In this way, equipment as sophisticated as an *Evolver*, a millifluidic module that allows the routing of multiplexed media, the cleaning, transfering from vial to vial and automatic coupling of microbiological strains (Wong et al. 2018) is now available at a low cost, or a *Microplate Reader*, which is a microplate reader for multiplexed spectrophotometric measurements that performs complete absorbance spectra and fluorescence emission detection, optogenetic stimulation *in situ* and facilitated programming via touch screen for automated analysis (Szymula et al. 2018); or building a 3D printer for multiple uses (Silver 2019).

Experimental bioreactors for hydrogen and/or methane gas production can be operated in batch or continuously, for periods of 2 to 6 months, with hydraulic retention times ranging from hours to several days, with monitoring of the kinetics of biomass growth and gas production, pH and temperature control, and the most frequent analysis of organic load, volatile organic acids, COT, NT, COD, BOD, and, of course, the composition of biogas (Montiel Corona et al. 2015). The automation of these processes is a gigantic challenge. In particular, the analysis of biogas composition is carried out by Gas Chromatography (GC), a device that must be turned on and stabilized for a couple of hours, and another couple of hours, passing gas, before shutting it down; so it cannot be used continuously.

Currently, commercial gas sensors are available for online use, integrated into expensive fully automated bioreactors, or separately, but with impractical concentration intervals and no possibility of communication and automation.

On the other hand, there are low-cost semi-industrial gas sensors, which are coupled to Arduino plates, the purpose of which is leak detection, so they are calibrated to respond to low concentrations.

In particular, our interest is focused on the MQ4 sensor, for methane, and the MQ8, for hydrogen, from Zhengzhou Winsen Electronics Technology Co., Ltd. (the technical characteristics are summarized in Table 1).

This paper addresses the adaptation and calibration of these sensors to be used in the determination of the H2 and CH4 gas content in the biogas production line of continuous experimental bioreactors which are still in the research and development stage.

The objective was to investigate the sensitivity of these sensors to gaseous mixtures of different composition to determine the existence of a differentiated response and the type of behavior observed; proceeding then to the adaptation of the sensors to the bioreactor and to its calibration, to reach the goal of generating low cost technology for the determination of biogas composition in line and in continuous flow.

	Sensor	
	MQ4	MQ8
Detecting concentration scope	200-10000 ppm CH_4, natural gas	100-10000 ppm Hydrogen (H_2)
Sensing Resistance	10KΩ- 60KΩ (1000 pm CH_4)	10KΩ- 60KΩ (1000 ppm H_2)
Using Tem	-10℃-50℃	-10℃-50℃
Circuit voltage	5V±0.1 AC OR DC	5V±0.1 AC OR DC
Heating voltage	5V±0.1 AC OR DC	5V±0.1 AC OR DC

Tabla 1 Características Técnicas de los sensores MQ4 y MQ8 empleados en esta investigación[1].
Source: Technical Data. Hanwei Electronics; www.hwsensor.com

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Methodology

Devices for MQ4 and MQ8 sensors. Glass jars of 1L capacity were adapted with a screw cap with two holes both sealed with silicone, one through which the cables connecting the sensor are introduced and another that was conditioned with a rubber setpoint where the gas samples enter, assisted with a syringe of 3 mL capacity to which three-way valves were adapted for easy handling (Figure 1a). Connections, tubing, 3-step wrenches, latex balloon, 1, 3, 5, 60 mL syringes.

Arduino programmable circuit board. It consists of a board based on the ATmega328P microcontroller. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack connector, terminals for ICSP connection and a restart button. The Arduino-Uno board was connected to the computer using the USB port, while the analog input A_0, the output of the 5V source and the GND were connected to the sensor as shown in Figure 1b.

Excel interface. This was used as a data acquisition system.

Laptop. A Gateway NV59C laptop with core PLX-DAQ V2 (2014) was used, which is a complement to Excel i5.

C*ylinder with 3-component mixtu*re: 50% hydrogen/40% methane/CO_2 balance; with Gravimetric Analysis traceable to the CENAM weight frame. INFRA brand. 1 m^3, 2015 Psig.

INFRA N_2 cylinder

Bioreactor for biogas generation. We used a glass jar with a screw cap of 6.6 L capacity with three-way valves adapted for gas collection. Hydrogen production was carried out using sludge from a biological wastewater treatment plant.

The sludge was previously treated by thermal shock. As a substrate, waste from the dairy industry was used, in a procedure described above (Rojas Escobar et al. 2018). On average the reactor produces 1.7 L biogas/week.

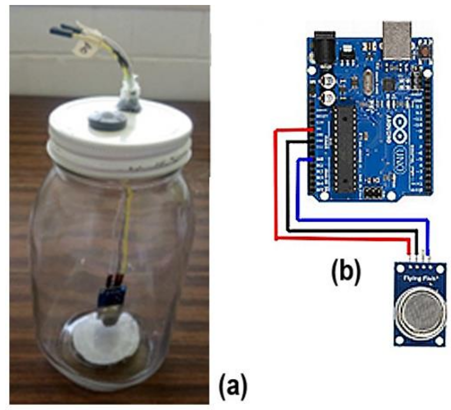

Figure 1 Images corresponding to the experimental devices: (a) Biogas composition monitoring chamber; (b) Arduino card and sensor connection

Experimental development

Using the arduino environment, the programming for the measurement of hydrogen and methane gas concentration was performed, respectively, using the analog input A_0, sending the signal to the Laptop through the Arduino serial communication interface at intervals of one second for each reading.

This program was compiled and its execution began. To achieve a real-time graph, the connection to the interface for Excel PLX-DAQ V2 was made for data acquisition. The programs and the Excel workbook are available upon request to the authors.

A 3 mL syringe was fitted with a three-way valve, a balloon was adapted to one of the valve's outlets as a means of temporary gas storage, a dermal needle was placed on the third outlet.

The balloon was filled with the mixture of hydrogen gas, methane and commercial CO_2, purchased from the INFRA company, the dermal needle was introduced through the rubber setpoint in the monitoring chamber and 0.5 mL doses of gas were applied, obtaining the data in an Excel sheet and graphing simultaneously for interpretation (Figure 2).

This procedure was repeated with methane gas and with biogas from the reactor, with both MQ4 and MQ8 sensors.

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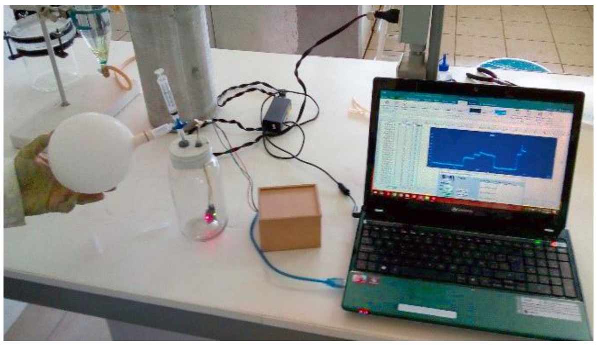

Figure 2 Experimental device for calibration of the MQ4 and MQ8 sensors. The cylinder behind the sensor bottle is that of the mixture of H_2, CH_4 and CO_2

Results

MQ8 sensor behavior. In order to observe the sensitivity and behavior of this sensor, doses of different volumes were injected into the monitoring chamber, determining the range of working concentrations.

Subsequently, to establish whether the sensor can be used continuously, in the permanent presence of H_2, and to see if there is a differentiated response at different concentrations, the injection of gaseous mixture dose was performed every 30 seconds and consecutively increasing the injected volume. In Figure 3 there is a differentiated response, but that it does not return to the baseline after each pulse, in addition to the fact that the accumulation of H_2 in the chamber causes a saturation effect in the sensor.

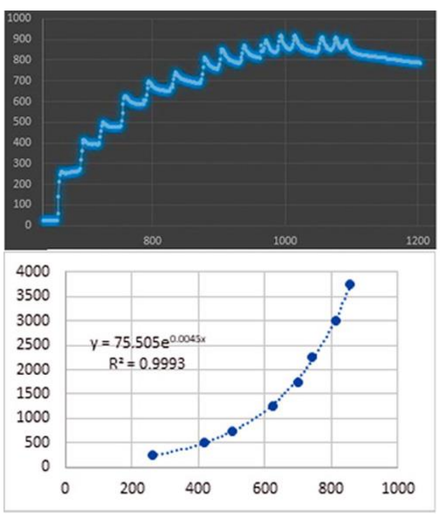

Figure 3 Above: Response of the MQ8 sensor to 3 consecutive doses (0.5, 1.0, 1.5, 2.0, 2.5) of the gas mixture (50% H2 + 40% CH_4 + 10% CO_2) every 30 s. The x axis is the time (s), the y axis are arbitrary units. Below: Graph of response to sensor concentration. The x-axis are arbitrary units, the y-axis is ppm of H_2

The response graph of the MQ8 sensor is exponential, with an R^2 = 0.9993 for the first 8 points (maximum concentration of H_2 before saturation = 3750 ppm). The following points are aberrant, due to saturation. This result is conclusive in the sense that the response and sensitivity are excellent, but the sensor cannot be used under conditions of permanent exposure to H_2.

After these experiments, the conditions for the sensor to return to the baseline and the optimal time to perform gas measurements were tested.

Saturation of the monitoring chamber with N_2 gas was tested, immediately after a pulse of mixed gas to return to the baseline, but it was not possible; instead, after opening the bottle and ventilating with air for approx. 10 minutes, the sensor returned to its baseline (see Figure 4).

Finally, the device was used to determine the proportion of H_2 in the biogas produced by a hydrogen generator bioreactor.

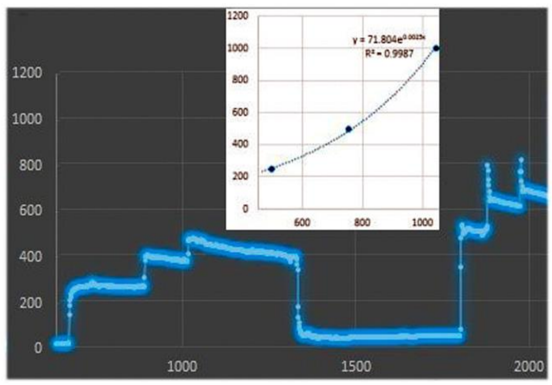

Figura 4 Use of the MQ8 sensor to determine the concentration of H2 in a biogas sample. The first three pulses are from the bioreactor gas sample, then there is a period of 10 minutes before the injections of the gas mixture (50% H_2 + 40% CH_4 + 10% CO_2). The x axis is the time (s), the y axis are arbitrary units. The calibration calibration chart is shown on the insert

Figure 4 shows the result of one of these tests. 1 mL of biogas was injected three consecutive times, then the bottle was opened to return to the baseline and then three 0.5 mL injections of the gas mixture were made for calibration.

With this procedure, the calibration was R^2 = 0.9987 and the concentration calculated in the biogas was 23% H_2. This concentration is like the ones found in biogas produced in similar bioreactors (Montiel Corona et al. 2018).

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MQ4 sensor behavior. The previous tests were repeated with the MQ4 sensor. Similar to the MQ8 sensor, the MQ4 is a sensor that saturates at a certain concentration. It returns to the baseline faster than the MQ8, but, in the same way, its continuous exposure to biogas containing methane was not possible.

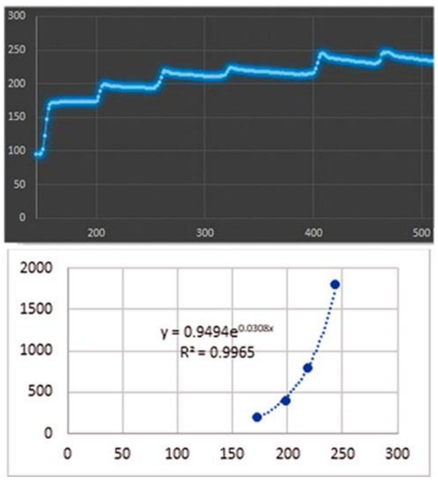

Figure 5 Above: Response of the MQ4 sensor to 2 consecutive doses (0.5, 1.0, 1.5) of the gas mixture (50% H_2 + 40% CH_4 + 10% CO_2) every 30 s. The x axis is the time (s), the y axis are arbitrary units. Below: Graph of response to sensor concentration. The x axis are arbitrary units, the y axis is ppm of CH_4

Figure 5 shows the calibration of the MQ4 sensor with the gas mixture. After calibration, 1.5 mL of biogas was injected three consecutive times, to determine the concentration. In the case of methane, the composition yielded 52%.

In this way, it was determined experimentally that the reactor is producing more methane gas (52%) than hydrogen (23%), therefore, methanogenic bacteria predominate over the hydrogen and it will be necessary to apply an extra thermal shock to eliminate methanogenic bacteria. A result obtained in less than an hour, which would have been previously obtained after several days, after sending the corresponding samples to a laboratory with a GC devise.

It is important to mention that H_2 gas interference tests were performed on the MQ4 sensor and for methane gas on the MQ8 sensor. No test response of the sensors was observed, so it can be ensured that there is no influence of other gases in the mixture, according to the signal of both sensors.

It is noteworthy that much of the research for the production of methane and hydrogen is based on the design of the fermenter (Izurieta 2019), on the use and/or combination of different types of substrates (González & Suárez, 2019; Luque 2019) , or the optimization of the substrate components (García 2019); however, there is no reference to the optimization of the gas measurement system, a situation that is of paramount importance to minimize process costs and timely monitoring of the process.

Conclusions

This paper presents for the first time the use of the MQ8 methane and MQ4 hydrogen sensors, of semi-industrial use for leak detection, for the determination of the composition of these gases in line and semi-continuous in production bioreactors of biogas. In both cases, a differential response to the concentration was observed exponentially, with R^2 of up to 0.9993, in a suitable concentration range before saturation of the sensor. In the case of MQ8, the frequency of the biogas pulses it can receive is up to 10 minutes, to return to the baseline; this prevents the sensors from being used continuously but opens the possibility of performing compositional analysis every 10 minutes, throughout the day, which is impossible with a GC devise. This work also contributes with key technology to the growing community of open source hardware oriented to biotechnology, the progress of which is facilitated by the ability to create prototypes, low-cost electronics, optoelectronics and microcomputers in a fast way.

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To the members of the support team in Computing and Electronics: M.C. Alberto Nava Saldaña and students Doris B. Tlapalamatl García and José Manuel Arroyo Cruz.

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Transformation of kinetic energy to electrical energy through a static system to recharge electronic devices

Transformación de energía cinética a energía eléctrica a través de un sistema estático para recargar aparatos electrónicos

PRADO-SALAZAR, María del Rosario†, BARBOZA-BRIONES, José Gabriel and ÁVALOS-SÁNCHEZ, Tomás

Universidad Tecnológica de Jalisco, Calle Luis J. Jiménez No. 577, 1º de Mayo , 44979 Guadalajara Jal

ID 1st Author: *María del Rosario, Prado-Salazar* / **ORC ID:** 0000-0002-6366-1944 y **CVU CONACYT ID**: 100541

ID 1st Coauthor: *José Gabriel, Barboza-Briones* / **ORC ID:** 0000-0002-3268-6065, **CVU CONACYT ID**: 457555

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Abstract

This project aims to produce electricity using a static bicycle, which has been made some modifications to take advantage of both tires. Along with these have been placed two dynamos which, having friction with the tires, transform mechanical energy into electrical energy, enough to recharge a cell phone. Parallel to this, it stops consuming electricity from the supply network which represents an energy and economic savings, if it is taken to large numbers of cell phones. By using this type of alternative power generation, we are also not emitting greenhouse gases into the atmosphere, which is also helping our health and the environment. This research is able to provide electrical power to cell phones in a friendly way with the environment, entertaining and healthy to keep in shape when charging our electronic devices, being a center of attention for students, since the circuit system allows to deliver 5 V and 0.7 A in direct current in approximately 15 minutes, achieving the load of 15% of a cell battery

Renewable energy, Electric generator, Kinetic energy

Resumen

Este proyecto tiene como objetivo producir energía eléctrica utilizando una bicicleta estática, a la cual se le han realizado unas modificaciones para poder aprovechar ambas llantas. Junto a estas han sido colocados dinamos los cuales, al tener rozamiento con las llantas, transforman la energía mecánica en energía eléctrica, suficiente para poder recargar un teléfono celular. Paralelo a esto, se deja de consumir energía eléctrica de la red de suministro lo cual representa un ahorro energético y económico, si es llevado a grandes cantidades de celulares. Al utilizar este tipo de generación de energía alterna, también estamos dejando de emitir a la atmósfera gases de efecto invernadero, lo cual es también ayuda a nuestra salud y medio ambiente. Esta investigación es capaz de proporcionar energía eléctrica a teléfonos celulares de una forma amigable con el medio ambiente, entretenida y saludable al mantenernos en forma al cargar nuestros aparatos electrónicos, siendo un centro de atención para los alumnos, ya que el sistema circuito permite entregar 5 V y 0.7 A en corriente continua aproximadamente en 15 minutos, logrando la carga del 15% de una batería celular.

Energía renovable, Generador eléctrico, Energía cinétic

Citation: PRADO-SALAZAR, María del Rosario, BARBOZA-BRIONES, José Gabriel and ÁVALOS-SÁNCHEZ, Tomás. Transformation of kinetic energy to electrical energy through a static system to recharge electronic devices. Journal of Research and Development. 2019 5-16: 7-11

† Researcher contributing as first author.

Introduction

The incessant search for new ways of generating clean electricity on the planet is one of the many objectives that humanity and specifically the scientific society has in order to find in the short and medium term. The purpose of this exploration of clean sources is to reduce dependence on non-renewable sources, such as mainly the burning of fossil fuels, which contribute greatly to global warming and climate change.

This project describes a prototype to transform kinetic energy into electricity by using an exercise bike. The transformed electrical energy can be used to recharge electronic devices for example cell phones, tablets, and some other low-power gadgets.

This alternative allows to stop using the electricity supply network, intrinsically reducing the emission of greenhouse gases, in addition to promoting the physical activity of those who use the prototype.

Said static equipment allows to take advantage of the energy produced by our pedalling which, by installing a pair of dynamos on both tires of the bicycle, will generate twice as much electrical energy compared to single-dynamo systems.

Background

Since the middle of the last century and what we have taken from the current one, the search for clean alternatives for the generation of electric energy that are equally cheaper and more accessible to society, has been an important part of the agenda of countries, industry, and humanity To mention any and to be the subject of our research, there is already the generation of electric energy through the use of kinetic energy through a common instrument, such as the bicycle.

In rural communities in Central America and southern Mexico, they use the bicycle to extract water from the subsoil. This was carried out through the support of the Ministry of Environment and Natural Resources (SEMARNAT) and the Mexican Institute of Water Technology (IMTA) who provided the supplies and installation manuals to the communities.

In Guatemala, the Mayan Pedal Foundation together with the then Mechanical Engineering intern, Jon Leary, implemented an irrigation system by installing several bicycles, which were pedalled by the same people in the community.

This "technology" really improved the daily lives of the locals, without the need to resort to expensive electrical devices or mechanisms that harm the environment (Mayan Pedal, 2010).

Students of Mechatronics Engineering at the National Autonomous University of Mexico (UNAM), Abraham Carmona, Andrés Ortega and Abraham Sánchez, developed as part of their degree project a sustainable design which proved to be very practical for those who used it.

The purpose of its design was to generate electricity that could be used to recharge a cell phone. The result was that they could load such equipment and have a surplus which was used to turn on the bicycle's LED lights. The main disadvantage was that the electrical equipment, being a bicycle that fulfilled its main function of mobility, were exposed in a city where the crime rate is very high.

In Córdoba, Argentina, D`Agostino implemented within a sports club, especially in the area of indoor cycling, a system to take advantage of the potential energy generated there by constant pedalling. He showed that by using installed capacity and replacing old electronic equipment with more energy efficient ones, the club could reduce its electricity consumption by 39%.

As a final background, the work carried out by students of Environmental Technology Engineering of the Technological University of Jalisco, Pablo Álvarez, Mirlo Jiménez & Sara Arellano, who presented the project “Pedal your Energy” which consisted of the implementation of a bicycle static by placing a dynamo on the rear tire, obtaining an average load production of 15% over a period of 15 minutes.

Problem Statement

Talking about climate change has become a topic of day-to-day conversation, not only in research centres, governments or international organizations, but also in the general population.

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Apart from this serious problem, the causes that cause it are analysed and one of these reasons is largely the emissions to the atmosphere generated by the burning of fuels only for the production of electrical energy. This phenomenon can originate naturally, however, anthropogenic pollution accelerates these instabilities in the climate through the phenomenon of the greenhouse effect, which gradually intensifies the temperatures in the atmosphere, bringing with it natural disasters never seen before. Electricity generation is among the activities that emit the most emissions into the atmosphere along with deforestation, the use of motorized transport and the generation of waste. The main resource used to produce electricity has been the use of non-renewable resources such as fossil fuels. Nuclear power and hydraulics have been an important part in the generation of electricity. Currently, other forms of clean generation are being added, such as the use of renewable natural resources such as solar energy and wind energy.

Overall objective

Transform kinetic energy to electrical energy to recharge electronic devices by using an exercise bike installed in the Workshop of Applied Chemistry of the Technological University of Jalisco.

Justification

The search for new and innovative technologies is a challenge that every scientist and engineer is willing to accept. We see that every day countless machines, artefacts and products are being produced that come to solve health problems, processes, food, etc. However, very rarely hear of innovative proposals that come to solve specific problems in environmental matters.

The possibility of being able to resume the "Pedal your energy" project will allow us to generate a new bicycle prototype with a mirror system that seeks to produce twice as much electrical energy as what was produced with the original system. If successful, it will be an opportunity to be able to implement within our university campus, which has within its environmental objectives, reduce the consumption of electric energy, in addition to which the student community can be made aware by observing that there are other alternatives to produce your own electric power.

Methodology

The first stage of this project was dedicated to conducting an investigation of the state of the art, to determine its viability. During the investigation several references were found on electric power generating bicycles, however, none of them showed an identical system.

In the second stage, the pertinent modifications to the "Pedal your energy" prototype were carried out (figure 1). The transformation consisted of incorporating a tire in the front where a second dynamo was installed.

Figure 1 "Pedal your energy" prototype

The part of the levers was also modified by changing the single star to a triple star, which is used in bicycles with changes. This in order to place a chain that is connected to the front tire (figure 2). This modification allows that with the same pedalling that drives the rear tire, drive the front tire in the same way.

Figure 2 Modified Final Prototype

With the two dynamos installed on both tires, a greater potential will be obtained, with reference to what only one generates. Both are connected to a card that allows you to convert alternating current into direct current, which has a pair of USB inputs, which allow you to connect electronic devices.

The last stage was to perform the functional tests of the prototype. Five tests were carried out on different days in triplicate, placing the same downloaded cell phone (IPhone 6 plus).

Results

For the realization of the tests, the support of students of the Chemistry Department of Environmental Technology area was requested in order to be able to appreciate differences between the amount of percentage of load produced and the weight of the participant, since as mentioned previously, the load potential will depend on the mass and speed with which the person pedalled.

Competitor	Time (min)	% Load
A	20:06	20
B	17:15	16
C	19:55	20
D	13:09	11
E	10:19	10

Table 1 Power generation for a single cell

Table 1 shows the data obtained in the pedalling tests. Participants A and C are of the masculine gender of robust complexion and have a more advanced physical condition, they pedalled harder for longer compared to participants B, D and E who are women who have a thin complexion and less condition. According to the information presented in table No. 1 we can determine that the pedalling time is directly proportional to the load generated.

A second experiment was carried out where two electronic devices were connected at the same time, for loading, the data generated is presented in table 2.

Competitor	Weather	% Cellular Load 1	% Cellular Load 2
A	15:05	16	15
C	14:35	17	16

Table 2 Power generation for two cell phones

In this case, only the participants with the best physical condition, and of the male gender, were considered, obtaining as a result that if it is possible to charge two cell phones at the same time, with a similar percentage of charge.

Greenhouse Gas Emissions to the atmosphere

According to FORBES data, a full-load cell phone consumes 9.5X10-3 kW / h (3.46 kW / h per year) (Takahashi, 2017). The averages obtained in both prototypes allow us to give up the supply network at 1.4345X10-3 kW / h (.524 kW / h per year) by pedalling an average quarter of an hour per day.

Using the Emissions Calculator for the National Emissions Registry (RENE) of the SEMARNAT, a total of .304 tCO2e per year would cease to be emitted into the atmosphere. This value may seem minimal, however, when multiplying by the 64.7 million cell phones that existed in Mexico in 2017, the amount of non-emitted emissions would be 19.6 million tCO2e per year.

Conclusions

Once the tests and data collection of both prototypes were carried out, it was observed that, since there was no storage system, there was a loss of energy, at the time of pedalling.

However, two cell phones were connected at the same time for charging. This is how it can be affirmed that the initial hypothesis is proven, because, if twice the energy is being produced in the same period of time, only that it is not properly channelled to a single electronic device but is distributed in Two equal parts. This final check allows us to observe that trying to channel a third device would give us a failed result because we would incur the initial situation where the result was loss of energy and not gain. It is worth mentioning that during the modifications to the “Pedal your energy” prototype, it was always prioritized to use reusable parts of other bicycles so that the production cost was as low as possible. However, the realization of the prototype with new parts in its entirety would have a high cost, and the benefit would be relatively low, this because the cost of KW / h is low.

Proposals

As mentioned previously, the main objective was to channel the transformed energy to a single point, which was not achieved because a previous storage system was required. This implementation might be able to charge a faster phone always depending on the time and energy generated.

Similarly, it is proposed to use a more efficient transformer than dynamos, which could be an alternator, as long as you are aware that the cost will be higher, and the performance may be less profitable.

Finally, the system used was unique and the benefit relatively little, however, this project can be applied together, where the energy is channelled to a superior storage system that allows it to be used in other areas such as lighting, electricity supply, etc.

Acknowledgement

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Article

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Numerical Simulation of the Combustion Chamber for a New Reference Combustion Calorimeter

Simulación Numérica de la cámara de combustión para un nuevo calorímetro de referencia

GONZÁLEZ-DURÁN, J. Eli E.[1] †*, ZAMORA-ANTUÑANO, Marco A.[2], LIRA-CORTES, Leonel[3] and MÉNDEZ-LOZANO, Nestor[2]

[1]Instituto Tecnológico Superior del Sur de Guanajuato, Educación Superior 2000, Benito Juárez, C.P. 38980 Uriangato, Gto.
2Universidad del Valle de México, Campus Querétaro, Blvd. Juriquilla no. 1000 A Del. Santa Rosa Jáuregui, C.P. 76230, Querétaro, Qro.
3Centro Nacional de Metrología CENAM, km 4.5 Carretera a los Cués Municipio El Marqués 76246 Querétaro, México.

ID 1st Author: *J. Eli, González-Durán* / **ORC ID**: 0000-0002-6897-9716, **Researcher ID Thomson:** G-7998-2019, **CVU CONACYT ID:** 331544

ID 1st Coauthor: *Marco, Zamora-Antuñano* / **ORC ID**: 0000-0002-9865-3944, **Researcher ID Thomson:** Z-8102-2019, **CVU CONACYT ID:** 292501

ID 2nd Coauthor: *Leonel, Lira-Cortes* / **ORC ID**: 000-0002-9851-0740, **Researcher ID Thomson:** B-4154-2013, **CVU CONACYT ID:** 120309

ID 3rd Coauthor: *Nestor, Méndez-Lozano* / **ORC ID**: 0000-0001-5622-9283, **Researcher ID Thomson:** M-8257-2019, **CVU CONACYT ID:** 350543

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Abstract

The Centro Nacional de Metrología is developing a reference calorimeter to measure the superior calorific value of natural gas in collaboration with the Instituto Tecnológico de Celaya. We present the study of the combustion chamber for two formulations a steady state (already published) against the transient state. The study of the combustion chamber is performed employing computational fluid dynamics (CFD) through FLUENT®. For this work, specific parameters were set to define and simulate the combustion process involving the exchange of energy, momentum and mass transfer. In this work, we present simulations performed in steady and transient state, for which was used the Eddy Dissipation Model (EDM). Is shown the simulation of two geometries for the combustion chamber; one cylindrical body a hemispherical lid and the other elliptical, which was proposed to increase the area to heat transfer to the surrounding medium, water in our case. The criterion for selection is the chamber that achieves the lowest temperature for waste combustion gases at the exit. Achieved by the cylindrical chamber with a hemispherical lid in the first 4 seconds with a difference of 0.4 °C lower than the elliptical chamber.

Superior calorific value, Reference calorimeter, Computational Fluid Dynamics

Resumen

El Centro Nacional de Metrología está desarrollando un calorímetro de referencia para medir el poder calorífico superior del gas natural en colaboración con el Instituto Tecnológico de Celaya. Se presenta el estudio de la cámara de combustión para dos formulaciones, una en estado estacionario (ya publicada) contra otra en estado transitorio. El estudio de la cámara de combustión se realiza empleando Dinámica computacional de fluidos (CFD) a través de FLUENT®. Para éste trabajo, se utilizaron parámetros específicos para definir y simular el proceso de combustión que involucra el intercambio de energía, transferencia de masa y momento. En éste trabajo se utilizó el modelo Eddy Dissipation Model (EDM) para las simulaciones realizadas. Se muestra la simulación de dos geometrías para la cámara de combustión; una de cuerpo cilíndrico con tapa hemisférica y la otra elíptica, la cual se propuso para incrementar el área de transferencia de calor a los alrededores. El criterio para la selección, es la cámara que logre la temperatura más baja de los gases residuos de la combustión a la salida. El cual lo obtuvo la cámara cilíndrica en los primeros 4 segundos con una diferencia de 0.4°C, más bajo que la cámara elíptica.

Poder calorífico superior, Calorímetro de referencia, Dinámica Computacional de Fluidos

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* Correspondence to Author (Email: je.gonzalez@itsur.edu.mx)
† Researcher contributing as first author.

Introduction

Today natural gas is the third model most widely used fuel in the world. Measuring the amount of heat that would be released by the complete combustion in air of a specified quantity of gas (on a molar, mass or volume basis), in such a way that the pressure *p*, at which the reaction takes place remains constant and all the products of combustion are returned to the same specified temperature, *T*, as that of the reactants, all of these products being in the gaseous state, except for water formed by combustion, which is condensed to the liquid state (ISO 15971:2010, 2008), or superior calorific value (SCV) is essential for billing purposes. Therefore, to perform this task, there are different methods (P. Ulbig, 2002), among them are those that operate under direct combustion calorimetry as the apparatus Cutlass hammer (P. Ulbig, 2002), on the other hand, there are instruments commercial falling in indirect methods and which are the most used. Such devices can calculate the SCV of natural gas by chromatography, supported with ISO 6976 standard (ISO 6976, 1996), the ISO 6976 contain the SCV´s of several pure gases. However, these values for pure gases are based on measurements made in the 1930s and 1970s, and uncertainty involved in the ISO for methane is specified to amount to 0.12 % (two times the standard deviation) (P. Schley, et al., 2010).

Methane is the main constituent of natural gas, measure the value of its SCV is essential because it is used in calorimetry of gases as reference material for calibration to measure SCV by chromatography.

Today several institutions around the world such as (P. Schley, et al., 2010), (Haloua, Filtz, & et.al, 2009) and (A. Dale, et al., 2009), have developed their own devices which operate under the same principle as the calorimeter by (F.D. Rossini, 1931) called Class 0 mass-basis calorimetry by ISO 15971 and its main feature is the accuracy of measuring the SCV of pure gases that can be achieved whit this type of equipment, i.e. uncertainties from about 0.05 % (95% confidence level) (P. Schley, et al., 2010). With the aim to try to get this kind of uncertainty and avoid to use reference materials, a project was initiated jointly by the laboratory calorimetry of CENAM and the ITC to develop a reference calorimeter to measure the heating value of natural gas, based on the principle of (F.D. Rossini, 1931) for combustion calorimetry.

We show in Fig. 1 the main components that comprise these kinds of calorimeters are:

1) The “burner,” which provides and mixes the oxidizer and fuel which generates the flame. The “combustion chamber” and “heat exchanger,” which maximize the heat transfer from the burned gases to the surrounding, generally water.

2) The “calorimeter vessel,” which can contain any fluid, water in this work. Its function is to receive and measure the energy generated by the flame and the burned gases, as well as to maintain a uniform temperature in the fluid contained. The burner, combustion chamber, and heat exchanger are immersing in the calorimeter vessel.

3) The “jacket,” which is a further vessel enclosing the calorimeter vessel and having a temperature either uniform and constant or at least known as regards space and time (Dickinson, 1914).

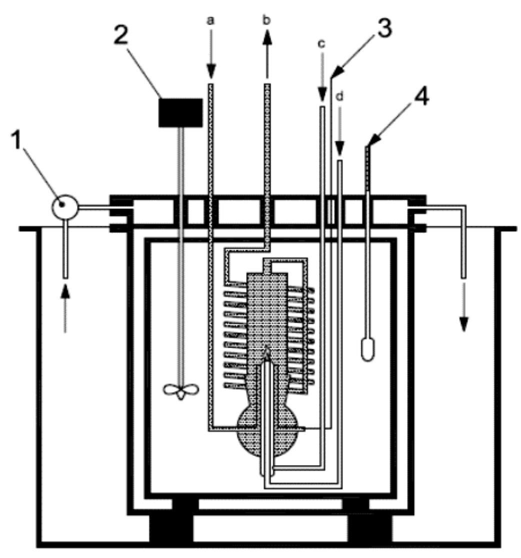

Figure 1 Schematic diagram of class 0 calorimeter. (1) water pump; (2) stirrer motor; (3) spark ignition electrode; (4) thermometer; (a) secondary oxygen; (b) combustion products, (c) primary oxygen plus argon; (d) fuel gas; (CV) calorimeter vessel; (J) jacket; (CH) combustion chamber; (B) burner; (H) heat exchanger.
Source: (ISO 15971:2010, 2008)

The principle under which the calorimeter operates is called Isoperibolic. It consists of a rise of temperature from the calorimeter vessel, containing a stirred liquid, which is watching while the jacket temperature is keeping constant (Dickinson, 1914).

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In Annex C from (ISO 15971:2010, 2008) is presented in more detail operation of called reference calorimeters which objective is to measure the quantity of energy involved in the complete combustion of a specific amount of a hydrocarbon fuel gas (P. Schley, et al., 2010). For a Rossini-type calorimeter, this is achieved by allowing the energy liberated in the reaction to be transferred to a well-stirred bath where is measuring its temperature rise. Do complete isolation of the jacket of a calorimeter is not possible in practice, so then a calorimeter is usually surrounded by a thermostatically controlled jacket, and allowance is made for the various sources and sinks of energy. In calorimetry, this is usually called an isoperibolic principle (P. Schley, et al., 2010).

The combustion chamber is one of the most critical components of the calorimeter because it aims to maximize the heat transfer to the surroundings, water for this work. Hence the Centro Nacional de Metrología (CENAM) and Instituto Tecnológico de Celaya (ITC). In an attempt to increase the heat exchanged through the walls of the combustion chamber, was propose an elliptical chamber and was compared against cylindrical published in the literature by (P. Schley, et al., 2010), (Haloua, Filtz, & et.al, 2009) and (A. Dale, et al., 2009). To test the hypothesis was performed a transient state simulation of temperature distribution into the combustion chamber and the temperature of outside gases to compare the performance of both combustion chambers.

Numerical model

The conservation equations were used for reactive flows in the steady and transient state, for the development of this work was used FLUENT® by ANSYS®. Therefore, the code solves the equation of conservation for chemical species, where the fraction of local mass of each species is predicted through the solution of the equation of convection-diffusion for the species. The conservation equation takes the following general form:

$$\frac{\partial}{\partial t}(\rho Y_i) + \nabla \cdot (\rho \vec{v} Y_i) = -\nabla \cdot \vec{J}_1 + R_i + S_i. \qquad (1)$$

Where R_i is the net rate of production of species i by chemical reaction and S_i is the rate of creation by addition from the dispersed phase.

In Eq. 1 $\vec{J}_1$ is the diffusion flux of species that arises from the gradients of concentration and temperature, Y_i is the mass fraction of species *i*. The code uses Fick's law to model mass diffusion due to concentration gradients, under which the diffusion flux can be written as:

$$\vec{J}_1 = -(\rho D_{i,m} + \frac{\mu_\tau}{Sc_\tau})\nabla Y_i - D_{T,i}\frac{\nabla T}{T}. \qquad (2)$$

In the Eq. (2), $D_{i,m}$ is the coefficient of diffusion for the species i into the mixture, and $D_{T,i}$ is the thermal diffusion coefficient. Sc_τ is the Schmidt turbulent number (where $\mu_\tau / \rho D_\tau$ is the turbulent viscosity and D_τ is the turbulent diffusivity). Due to the model used for combustion, the net speed of production of species in the Eq. 1 is assumed to be controlled by the turbulence with a two-step reaction mechanism:

$$CH_4 + 1.5O_2 \rightarrow CO + 2H_2O$$
$$CO + 0.5O_2 \rightarrow CO_2$$

Due to the used non-premixed combustion model, the code resolves the total enthalpy of the energy equation:

$$\frac{\partial}{\partial t}(\rho H) + \nabla \cdot (\rho \vec{v} H) = \nabla \cdot (\frac{k_t}{c_p}\nabla H) + S_h. \qquad (3)$$

The terms of conduction and diffusion of species combine to give the first term of the right hand of the Eq. 3, where H is the total enthalpy, ρ is density and v is the velocity while the contribution of the viscous dissipation S_h appears in the non-conservative form, where k_t is the thermal conductivity and c_p is the heat capacity. And therefore the total enthalpy is defined as:

$$H = \sum_j Y_j H_j. \qquad (4)$$

Where Y_i is the mass fraction of species j and

$$H_j = \int_{T_{ref,j}}^{T} cp_j dT + h_j^0(T_{ref,j}). \qquad (5)$$

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Where the enthalpy of formation is $h_j^0\left(T_{ref,j}\right)$ of species j at reference temperature $T_{ref,j}$.

The fluid flow is described using the equation of conservation of momentum as described below:

$$\frac{\partial}{\partial t}(\rho\vec{v}) + \nabla\cdot(\rho\vec{v}) = -\nabla p + \nabla\cdot(\boldsymbol{\tau}) + \rho\vec{g} + \vec{F}. \qquad (6)$$

Where p is the static pressure, $\boldsymbol{\tau}$ is the tensor of efforts, $\rho\vec{g}$ and $\vec{F}$ are the gravitational body force and the external body forces respectively (ANSYS FLUENT 14.0, 2011). Simulations were made using Fluent®. Nonlinear equations along with boundary conditions were solved using an iterative numerical method using the finite volume method (Versteeg & Malalasekera, 1995).

Methodology

After reviewing and analyzing the combustion chambers used by (P. Schley, et al., 2010), (Haloua, Filtz, & et.al, 2009) and (A. Dale, et al., 2009); it is seen to be the cylindrical body with hemispherical lid. Therefore, was proposed one elliptical combustion chamber, under the hypothesis that by increasing the area, the temperature of the waste gases of combustion is reduced. The restriction to evaluate the chambers was to have the same height and diameter, so was achieved increase by 10 cm^2 the elliptical combustion chamber against another one.

To select the best chamber was established that the waste gases of combustion should have the lowest temperature and that to transfer as much energy to its surrounding environment, in our case water. Fig. 2 and Fig. 3 shows the combustion chamber from literature with heat exchanger and the elliptical chamber.

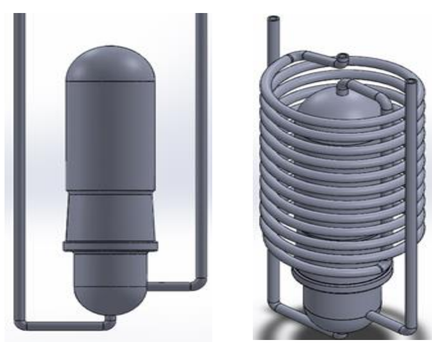

Figure 2 Combustion chamber published in the literature.
Source: Own Elaboration

Figure 3 Combustion chamber from this work.
Source: Own Elaboration

For this work we realized all the simulations in FLUENT® (ANSYS FLUENT 14.0, 2011), an iterative numerical approximation solved the nonlinear governing equations together with the boundary conditions by finite volume method (Versteeg & Malalasekera, 1995). In the solution of the transport equations and turbulence model, in this work, we used the algorithm PISO (Pressure-Implicit with Splitting of Operators) for coupling the pressure and speed.

Grid generation is done using (ANSYS ICEM CFD 14.0, 2011). For the meshes, an unstructured mesh with tetrahedral elements was used, due to the complex geometry, Fig. 4 and Fig. 5 shows the result of this discretization. In this work, two fluid domains and one solid domain were established. The first fluid domain represents the zone which provides fuel and oxidant, mixes both and generates flame and burned gases. Coupled to it, we have one solid domain, which represents the burner and the heat exchanger made of glass whose thermophysical properties, such as density, thermal conductivity, and heat capacity were obtained from (Incropera & DeWitt, 1999). The second fluid domain represents the water contained inside the calorimeter vessel, which receives all the heat due to combustion and burned gases.

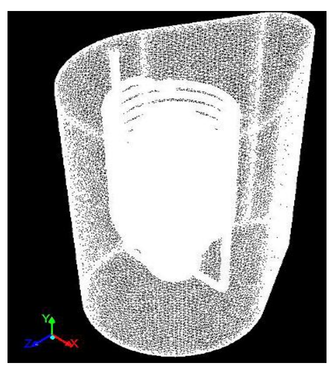

Figure 4 Picture shows discretization of calorimeter with burner, heat exchanger and combustion chamber. From as (P. Schley, et al., 2010), (Haloua, Filtz, & et.al, 2009) and (A. Dale, et al., 2009) with 1 133 433 nodes

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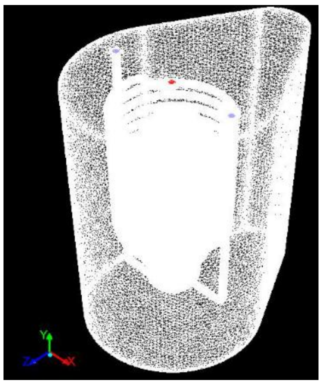


Figure 5 Picture shows discretization of calorimeter with burner, heat exchanger and combustion chamber from this work. with 1 403 244 nodes
Source: Source: Own Elaboration

In this work, we carried out simulations in transient and steady state at 3D for proposed combustion chambers, the elliptical and cylindrical with hemispherical lid. The flow fuel is 76 cm^3min^{-1} for methane, and the oxidant is oxygen, and its flow is three times the fuel flow.

The molar fractions established were of 0.96 for methane and 0.9 for oxygen with an input temperature of 23.5 °C for both flows, furthermore, the initial temperature for all the system of 23.5 °C.

For simulations carried out in this work, the combustion chamber, the burner and heat exchanger are inside of the calorimeter vessel, represented by a water volume of geometry similar to those published in the literature by (Rauch, et al., 2008) and (Haloua, Filtz, & et.al, 2009). The walls of the vessel calorimeter were established at 25 °C to simulate the isoperibolic environment (see Fig. 6).

We established the boundary conditions and initial condition above mentioned for the following cases: constant and variable density water and the last par transient case, shown in the results of this work.

Results analysis

Our aim in this work was determining the best kind of geometry to the reference calorimeter to develop. We used computational fluid dynamics to evaluate the performance of the chamber proposed (elliptical) and compare against published in the literature, to improve the chambers published by other authors. Our hypothesis was if we increase the area of heat exchanged we will improve the performance.

To achieve the above exposed, we designed virtual models by computer-aided design, which were discretized to be evaluated in FLUENT, data input, boundary and initial conditions were the same. We carry out the analysis in the transient state. The restriction established was diameter and height equal. We use the lowest temperature obtained of exhaust gases like a parameter to choose the best chamber.

Taking account, the results obtained in the transient state, we figure out that the cylindrical chamber with hemispherical lid has better performance that elliptical one. The area that we have to increase to improve heat exchange is where exhausted gases are accumulated in the chamber.

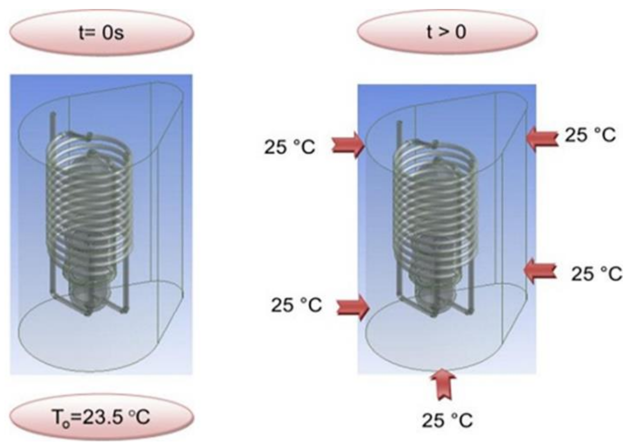


Figure 6 Analyzed diagram by numerical simulation with initial and boundary conditions.
Source: Own Elaboration

Results

For the case at steady state, we made two additional formulations; one keeping the constant density of water whose detailed work is presented in (Gonzalez, Estrada, & Lira, 2015) and the second was established a ratio with density-temperature for the water in the calorimeter vessel.

For the first case Table 1, shows that average temperature of the gases at the exit is lower in the elliptical chamber by 0.49 °C, as the average water temperature which is calculated based on the volume of water contained in the calorimeter vessel. The maximum temperature represents the temperature reached by the water in the calorimeter vessel by heat transfer from the burner. In the top of the burner are presented the higher temperatures.

	Elliptical chamber	Cylindrical chamber
Average temperature of the exit gases	27.71 °C	28.20 °C
Average temperature water	26.45 °C	26.80 °C
Maximum water temperature	68.43 °C	80.23 °C
Minimum water temperature	24.93 °C	24.95 °C

Table 1 Evaluation results of the combustion chamber with the constant density of water
Source: Own Elaboration

For this case, water with the constant density, the behavior of heat transfer through water is like a thermal conductivity case instead of a convective case, hereby from Table 1, we can see that the cylindrical chamber transferred more heat to water surrounding, because the maximum temperature in the water is higher than the another chamber.

The minimum water temperature is 25 °C as the boundary condition established. It is because we not used a stirrer in all simulations.

In the second case, to take account variable density of water, we take information of density and temperature from (Incropera & DeWitt, 1999), we generate a polynomial relation that we input to the code through functions, and these results are showing in Table 2. Here it is seen a difference of 0.27 °C, for the residual gases from the combustion chamber concerning each other; almost half regarding the analysis of -the constant density-. Generally, temperatures obtained to the burner exit and in the water are lower, concerning for to the results of constant density. Due in this case we consider the effect of buoyancy forces, we got lower temperatures than the last case, mentioned above.

	Elliptical chamber	Cylindrical chamber
Average temperature of the exit gases	28.48 °C	28.75 °C
Average temperature water	26.41 °C	25.29 °C
Maximum water temperature	37.24 °C	45.40 °C
Minimum water temperature	25.00 °C	20.00 °C

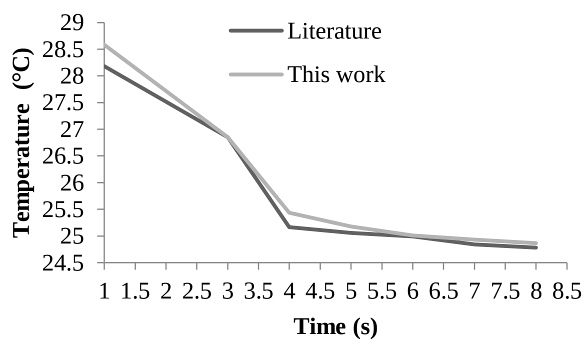
Table 1 Evaluation results of the combustion chamber with the constant density of water
Source: Own Elaboration

The difference among both formulations shown in Table 1 and Table 2 is due to the variable density because, for this case with the polynomial functions introduced, we are closer of the convective model than another case where density is constant.

Maximum water temperatures for the case with variable density were lower than constant density, due which the case of constant density, the code simulate like a phenomenon of pure conduction, with variable density we are modeling the behavior of water with a heat transfer mode by convection.

To the transient state, one aim of this work was to monitor the temperature of residual gases of combustion under transient formulation.

Therefore Graphic 7 shows the values of the mean temperature in the first 8 seconds, where under the legend "this work" shows the evolution over time of the behavior of the chamber proposed for this work and "literature" from (P. Schley, et al., 2010), (Haloua, Filtz, & et.al, 2009) and (A. Dale, et al., 2009), to identify the chamber with the cylindrical body and hemispherical lid.



Graphic 7 Graph of the temperature last the first 8 seconds from the residual gases of the combustion to the exit of the heat exchanger. For the elliptical chamber the legend "this work" is used and for the cylindrical chamber with hemispherical cover the legend "literature".
Source: Own Elaboration

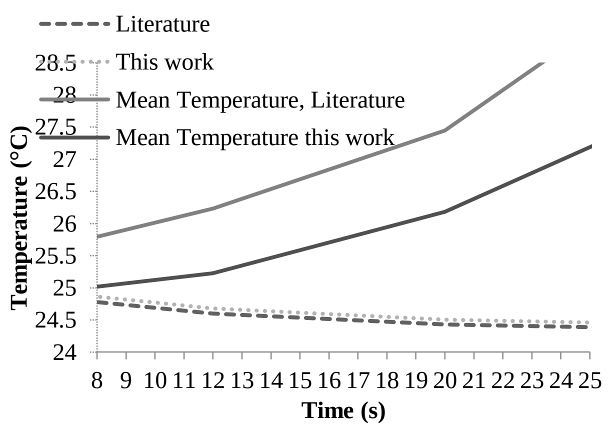
For the first 4 seconds is important analyze how temperature to the exit is high, probably could be have a negative effect to the moment to calculate the SCV. We could reduce this temperature by the stirrer, increasing its rotary velocity. From Graphic 7 we can analyze performance from both chambers, with the slope.

The cylindrical chamber has a quick rate of temperature decrescent. It is mean that heat exchanged to water is more significant than the elliptical chamber. We only show 8 seconds because it is where the changes in temperature are abrupt.

Graphic 8 shows evolution temperature from second 8 to the second 25. For this time interval analyzed, the maximum difference is 0.08 °C at the second 12 and continues going down a rate of 0.003 °C / s. Additionally Fig. 6 shows the comparison from mean temperature from the water bath for this work against literature as (P. Schley, et al., 2010), (Haloua, Filtz, & et.al, 2009) and (A. Dale, et al., 2009) and we can see the difference in temperature 8 second, this due to the performance of the combustion chamber cylindrical.

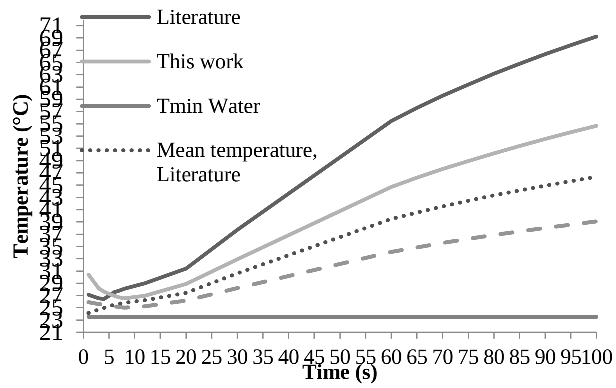
From Graphic 8 we can see that combustion chamber from literature as (P. Schley, et al., 2010), (Haloua, Filtz, & et.al, 2009) and (A. Dale, et al., 2009) is more efficient than proposed in this work, this taking account the slopes among both chambers because the mean temperature from literature as (P. Schley, et al., 2010), (Haloua, Filtz, & et.al, 2009) and (A. Dale, et al., 2009) is growing up more and quicker than elliptical. So performance is better than the elliptical chamber.

As we can see in Graphic 8 the temperature of residual gases from combustion is practically constant, approximately 24.3 °C. This temperature is higher than 23.5 °C, and under the definition of superior calorific value from (ISO 15971:2010, 2008), the exhaust gases should return to initial temperature. However, we can reach the temperature using a stirrer, which is not taking account for simulations in this work.



Graphic 8 Graph of the temperature of the residual gases of the combustion to the exit of the heat exchanger from 8 to 25 seconds. For the elliptical chamber the legend "this work" is used and for the cylindrical chamber with hemispherical cover the legend "literature"
Source: Own Elaboration

From Graphic 8 can see how the mean temperature inside of water bath from the cylindrical body is higher than elliptical because heat exchanged by the combustion chamber is better than the elliptical. Thus temperature in exit gases is lower than exit gases from elliptical chamber.



Graphic 9 Graph of the evolution of the maximum temperature inside the calorimeter vessel, mean temperature and minimum temperature for 100 seconds of simulation
Source: Own Elaboration

Graphic 9 shows that the maximum temperature inside the calorimeter vessel is higher in the chamber published in the literature because of cylindrical chamber exchanges more energy to the water surrounding it, unlike the elliptical chamber. The value of the minimum temperature of the water in the calorimeter vessel under legend T_{min} is also displayed.

As we can see minimum temperatures are constant for the 100 seconds shown, this meant that in that time not all the water inside has a homogenous temperature.

Then is necessary develops and locate a stirrer that can assure a uniform temperature inside of the vessel calorimeter.

Figure 10 and Figure 11 are pictures that show the temperature gradients for elliptical chamber in the second 100, through a cut plane.

We can see in both pictures a white zone which indicate temperature higher than 30°C, so we can see the contour of burner, combustion chamber, and helicoidal heat exchanger with several turns. By the side of the circles of heat exchanger we can see two tubes vertical, these represent the inlet and outlet of methane and oxygen.

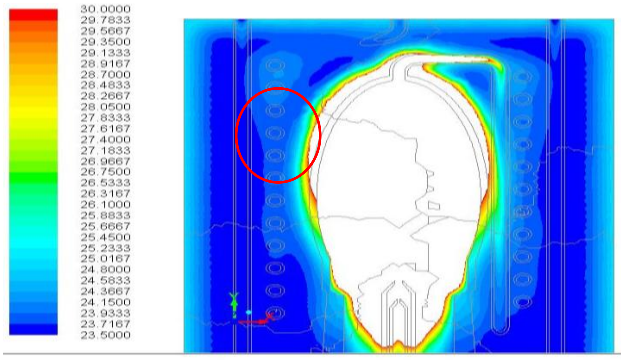


Figure 10 Temperature distribution (in °C) for elliptical chamber at 100 seconds of simulation in a transient state
Source: Own Elaboration

In Figure 10 can be seen that in the last turn, from heat exchanger for elliptical chamber has a higher temperature than the same heat exchanger used for the cylindrical chamber (red circle), as shown in Figure 11. which is observing that the distribution of temperature gradients is different for both chambers and that may be due to the accumulation zone of residual gases of the combustion. We can also observe as the elliptical chamber has higher temperature zones at the top the calorimeter vessel, which implies that the temperature of the residual gases is slightly larger than that of the chamber generated by the cylindrical body. As the Fig. 5 and Fig. 6 shown. Where is possible analyse than the lowest temperature last 100 seconds of simulation is for combustion chamber with the cylindrical body.

In Figure 11 we can see that gradients temperature are more uniform than the elliptical chamber. It is possible since temperature around tubes of the inlet of oxygen and methane conserve the lowest temperature, this for the cylindrical chamber. However, according to Figure 10, we can see like tubes of inlets for methane and oxygen are perturbed by a temperature at least 1°C more than the cylindrical chamber.

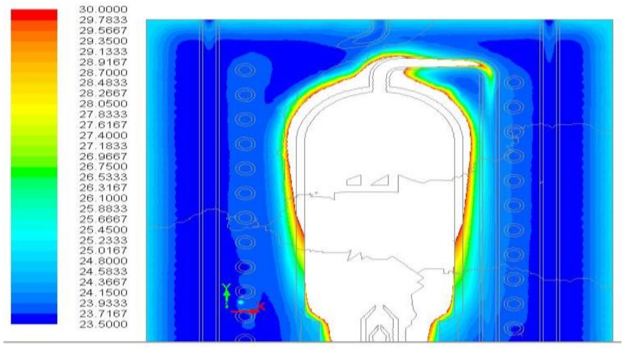


Figure 11 Temperature distribution (in °C) for cylindrical chamber at 100 seconds of simulation in a transient state.
Source: Own Elaboration

From Figure 11 we can see the temperature distribution, and it shows a critical zone between the burner and heat exchanger. This zone is locating at the end of de chamber, the little tube that turns to the side and takes the combustions gases to the heat exchanger, this part is close to the tube that exit from the vessel. If they are very close to each other the temperature of gases at exit can be higher than required by definition of Superior Calorific Value. We figure out through simulations an optimum distant among these parts.

Conclusions

In this work was shown two numerical simulations in a transient state of two combustion chambers for possible employment in the reference calorimeter to measure SCV of natural gas. The goal of the work was to test the hypothesis that increasing the heat transfer area by an elliptical chamber proposed by this work the temperature of the residual gases would be lower than used by the authors (P. Schley, et al., 2010), (Haloua, Filtz, & et.al, 2009) and (A. Dale, et al., 2009) of the cylindrical body and hemispherical lid. With the aim to select the most appropriate combustion chamber for the reference calorimeter developing by CENAM.

The lowest temperature of the residual gases of combustion was obtained by cylindrical chamber with hemispherical lid with a maximum difference of 0.40°C in the first second, and a temperature in the rest of the simulation which was descending at rate of 0.003 °C /s for which the second 100 the difference is 0.005°C. Therefore, in the transient state, the performance of the chamber cylindrical with hemispherical lid is better than elliptical chamber proposed by this work. The above can be possible because the residual gases of the combustion accumulate in the top of the combustion chamber and therefore this area is larger in the hemispherical lid than in the elliptical chamber. Then to improve heat exchanged from residual gases of combustion, we need to increase the area at the top of the combustion chamber, due it is here where they are accumulated.

The graph in Graphic 9 show the maximum value of temperature for the elliptical chamber, and it is lower than the cylindrical chamber. It is possible because by increasing the area, its mass increases, therefore at that time the mass of the chamber absorbs heat before to be transferred to the surrounding water.

Due to the established criteria and the fact that is less complicated and have more repeatability to build a chamber with a cylindrical body and hemispherical lid, this geometry was selected for the chamber to be used in the calorimeter under development by the CENAM and ITC.

Acknowledgments

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Methodology for pattern determination in electroencephalographic signals

Metodología para la determinación de patrones en señales electroencefalográficas

ESQUEDA-ELIZONDO, José Jaime †*, TRUJILLO-TOLEDO, Diego Armando, PINTO-RAMOS, Marco Antonio and REYES-MARTÍNEZ, Roberto Alejandro

Universidad Autónoma de Baja California, Facultad de Ciencias Químicas e Ingeniería

ID 1st Author: *José Jaime, Esqueda-Elizondo* / **ORC ID**: 0000-0001-8710-8978, **CVU CONACYT ID:** 90966

ID 1st Coauthor: *Diego Armando, Trujillo-Toledo* / **ORC ID**: 0000-0003-1482-8581, **CVU CONACYT ID:** 232755

ID 2nd Coauthor: *Marco Antonio, Pinto-Ramos* / **ORC ID**: 0000-0003-4748-6012, **CVU CONACYT ID:** 1790582

ID 3rd Coauthor: Roberto Alejandro, Reyes-Martínez / **ORC ID**: 0000-0003-2210-2692, **CVU CONACYT ID:** 214730

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Abstract

A methodology for the selection and determination of electroencephalographic (EEG) signal patterns is presented at the case study level, which can later be used as on-off control signals in other applications. Electroencephalographic signals are acquired through the use of a brain-computer interface (BCI). These systems capture electrical signals from the cortex of the brain and transfer them to a computer so that they can be analyzed by algorithms and some action is taken. In this case, the EEG signals are acquired through the wireless 14-channel Epoc+ platform. The methodology used consists first in acquiring signals from the user sample in three scenarios: in relaxation, thinking about turning on and off. Subsequently, the wavelet transform of each of the channels is obtained for each of the cases and the most significant coefficients are taken into account. Then, through digital signal processing algorithms, descriptive parameters are obtained for the on and off cases, which are used as patterns to describe each of the actions. With this information, a comparison between the incoming signals and the previously stored patterns is made to execute one of the established commands.

Patterns, EEG, Case of study

Resumen

Se presenta como caso de estudio, una metodología para la selección y determinación de patrones de señales electroencefalográficas (EEG), que pueden ser empleados como señales de control encendido-apagado en otras aplicaciones. Las señales electroencefalográficas se adquieren mediante el uso de una interfaz cerebro computadora (Brain Computer Interface, BCI). Estos sistemas capturan las señales eléctricas de la corteza del cerebro y las transfieren a una computadora, para que se puedan analizar mediante algoritmos y se toma alguna acción. En este caso se adquieren las señales EEG mediante la plataforma de 14 canales Epoc+. La metodología empleada consiste primero en adquirir señales de la muestra de usuarios en tres escenarios: en relajación, pensando en encender y en apagar. Posteriormente, se obtiene la transformada wavelet de cada uno de los canales para cada uno de los casos y se toman en cuenta los coeficientes más significativos. A continuación, mediante algoritmos de procesamiento digital de señales se obtienen parámetros descriptivos para los casos de encender y apagar, los cuales se utilizan como patrones para describir cada una de las acciones. Con esta información se hace una comparación entre las señales entrantes y los patrones previamente almacenados para ejecutar uno de los comandos establecidos.

Patrones, EEG, Caso de estudio

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* Correspondence to Author (Email: jjesqueda@uabc.edu.mx)
† Researcher contributing as first author.

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Introduction

In late years, there have been developed some brain-computer interfaces (BCI) that acquire the electrical signal from the brain cortex. With this BCI Systems is possible to interact with some devices through the processing of the electroencephalographic signals. These systems include the hardware and software needed to acquire and communicate the EEG signals with a computer or microprocessor (Ramadan & Vasilakos, 2017a).

The measurement of the electrical activity of the brain is called electroencephalogram (EEG) and is taken by electrodes placed on the scalp of the subject. These electrodes measure the electrical activity of the brain cortex and are placed using a standardized scheme (Al-Fahoum & Al-Fraihat, 2014).

With digital signal processing algorithms is possible to extract features that can describe some thinking patterns and that can be used to control some devices (Al-Fahoum & Al-Fraihat, 2014). The quality of the patterns is defined by the feature extractions techniques used. There are many kinds of techniques that are widely used nowadays.

Feature extraction allows extracting more useful or descriptive information hidden in a signal by reducing unnecessary or redundant information. Using digital signal processing algorithms is possible to reduce noise, interference, and artifacts before the feature extraction process begins. Once the feature extraction is done, the classification process can be done (W Azlan & Low, 2014) (Krishnan & Athavale, 2018).

In this paper, we show a methodology, applied to two datasets, that can be used for determining useful patterns for controlling systems applications.

We show how we use coherence and entropy as the base in order to determine these patterns. We also comment on some of our experiences in this experiment.

The intention of this paper is to give a kind of guideline to pattern election for beginners.

Methodology

There are some EEG platforms available, like Open BCI, Epoc+, Neurosky, among others. In this case, The EEG signals, are taken with the Epoc+ via the Emotiv Pro software, which is supplied by the Emotiv company (Ramadan & Vasilakos, 2017b)(Esqueda Elizondo, José Jaime, Rosique Ramírez, Súa Madaí, Pinto Ramos, Marco Antonio, Trujillo Toledo, 2018) (Esqueda Elizondo, José Jaime, Chávez Guzmán, Carlos Alberto, Jiménez Beristáin, Laura, Bermúdez Encarnación, 2018). This software communicates the headset with the PC and saves the EEG signal in a *.edf* format or it can convert it to a *.csv* format, so it can be used in other platforms like (in this case) Matlab.

Test Signals

Three EEG one-minute signal register of two people of 22 and 24 years (A and B), thinking first in neutral or relax, then in right and finally in left was taken. The signals were recorded seated with their eyes open, one register at the time. This data set was used in (Esqueda Elizondo José Jaime, Hernández Manzo Diana, Bermúdez Encarnación Enrique, Jimenez Beristáin Laura, 2016).

Signal Preprocessing

First, the signal is filtered with a 5th order sync digital filter and also with notch filters at 50 Hz and 60 Hz. These filters are built in the Epoc+ headset. After that, we remove the mean for each channel in order to eliminate de isoelectric line for all the channels. Then the value obtained is multiplied by 0.51µV, that corresponds to the Analog do Digital Converter resolution, in order to convert the signal to volts. This procedure is shown in figure 1.

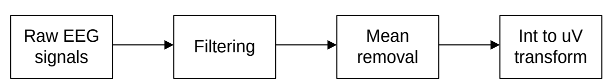

Figure 1 Signal preprocessing. *Source: self-made.*

Entropy

Entropy is a computational complexity sensitive tool that assesses the signal dynamics in a time series data. Neural systems are neither completely a random process nor a completely regular one, the measurements of the complexity should have low values for a completely random or a completely regular system (David et al., 2016).

Entropy can be used as a simple non-linear feature extraction technique. In this paper Shannon, Log Energy and Normalized Entropies are used.

Coherence

Coherence is a frequency function, presented in normalized units, that indicates how much the power spectral density of one signal *x(t)*, corresponds to the other one *y(t)*. Coherence is a quadratic correlation coefficient that estimates the consistency of the amplitude and phase related between two signals in a frequency band. When the coherence value is 1, this means that the signal *x(t)* totally corresponds to signal *y(t)*, and they are the same signal. Coherence is given by the equation:

$$\Gamma^2(f) = \frac{|S_{xy}(f)|^2}{S_{xx}(f)S_{yy}(f)}; \quad 0 \leq \Gamma(f) \leq 1. \qquad (1)$$

Where *Sxy(f)* is the crossed Power Spectrum Density of signals *x(t)* and *y(t)*, *Sxx(f)* is the self-Spectrum of the signal *x(t)* and *Syy(f)* is the self-Spectrum of the signal *y(t)*. Any pair of signals can be coherent in some frequency bands and not in another one. In contrast with the amplitude measurements, coherence measures the synchronization between two signals based principally on the phase consistency. This represents that if two signals have different phase (as in the common linear simple circuits). A high coherence value (near to 1) is presented when the phase difference tends to stay constant. For each frequency, the cohere measures when the signals are related one to each other with a linear and time-invariant transformation (Srinivasan, Winter, Ding, & Nunez, 2007).

Feature extraction

Once the signal is preprocessed, the feature extraction stage can be done. For the feature extraction Entropy, Coherence and the entropies of the Discrete Wavelet Transform are used. First, a visual inspection is made for identifying some possible patterns.

Then, some segments of the signal containing those possible patterns are taken and then the Entropy and Coherence functions are obtained in order to verify that they have similar levels. This is indicative that they have similarities.

Then, a four-level Discrete Wavelet Decomposition is done in order to obtain the detailed coefficients (Dx) and the approximated coefficients (Ax). Next, the Entropy of the coefficients Dx and Ax are obtained, according to the scheme presented by (Djemal, Alsharabi, Ibrahim, & Alsuwailem, 2017) and shown in figure 2.

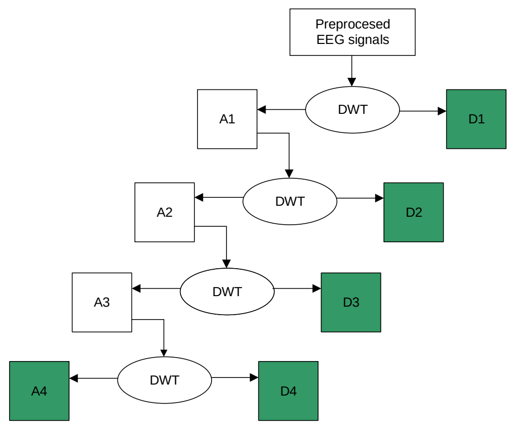

Figure 2 4-level Discrete Wavelet Transform decomposition. *Source:* (Djemal et al., 2017)

Selecting possible patterns

In this case of study, the analysis begins with the preprocessing of the EEG signals shown in Figure 1. First, an entropy analysis is done in order to detect similar entropy values using a 128 samples window, that is equivalent to one second. Whit this analysis we detect EEG data segments that have similar entropy values. Figure 3 shows the Shannon entropy analysis for a one-second window of an EEG signal. This signal corresponds to the electrode O1 of the left test. Then we take these segments of these particular electrodes or channels and the coherence is obtained. Next, the Shannon, Log Energy and Normalized Entropies of the pair of analyzed segments are obtained in order to verify their relationship. This process is shown in figure 3.

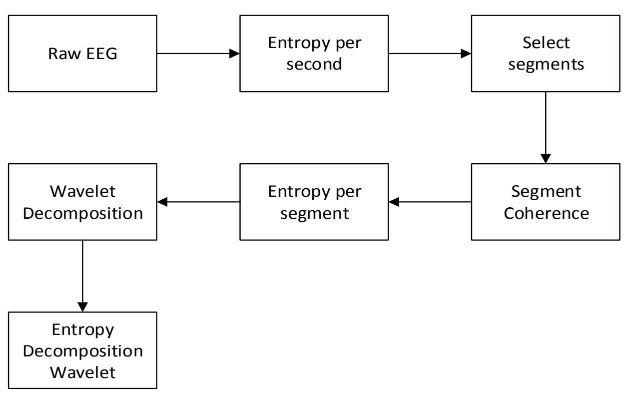

Figure 3 Block diagram of the process
Source: Self-Made

Experiments in user A

First, the dataset of user A was preprocessed and then the one-second entropies were obtained for all the one-minute test.

Figure 4 shows similar Shannon entropies obtained in an EEG signal. The similar values are circled in colors.

Table 1 and 2 show the Shannon, Log Energy, and Normalized Entropies obtained with the two one second segments of the electrodes AF3 and O1 of the subject D, obtained during the left test and O2 and T8 during the right test, respectively. We can notice that are similar values are obtained.

Figure 5 and Figure 6 show the coherence of a pair of these two segments. We observe that they have high coherence in almost all the signal bandwidth. All of the signal processing was done in Matlab Version 9.0.0.341360 (R2016a).

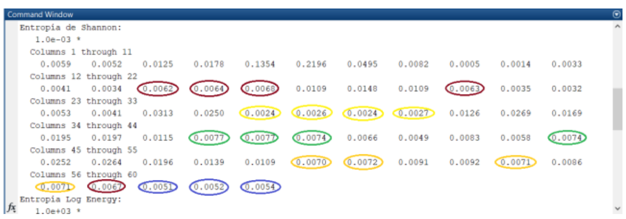

Figure 4 Similar Shannon entropies detected in an EEG signal
Source: Self-Made

Channel Time	Entropy (Shannon)	Entropy (Log Energy)	Entropy (Norm)
AF3 8s & 33s	6.0682e-05 5.9660e-05	-2.2483e+03 -2.2509e+03	0.0089 0.0088
O1 14s & 15s	0.0062e-4 0.0064e-4	-2.5391 -2.5344	0.0023 0.0024

Table 1 Subject A, left test and entropy values
Source: Self-Made

Channel	Entropy (Shannon)	Entropy (Log Energy)	Entropy (Norm)
F4 8s &23s	0.2732e-03 0.2717e-03	-2.0248e+03 -2.0255e+03	0.00213 0.0213
T8 18s & 21s	5.7666e-05 5.1997e-05	-2.2552e+03 -2.2694e+03	0.0086 0.0081

Table 2 Subject A, right test and entropy values
Source: Self-Made

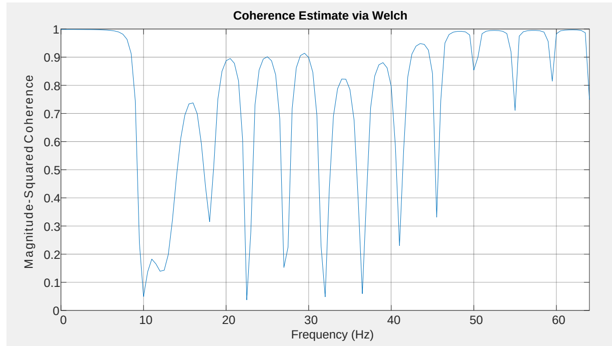

Figure 5 The coherence of two segments of channel AF3, Subject A, left test
Source: Self-Made

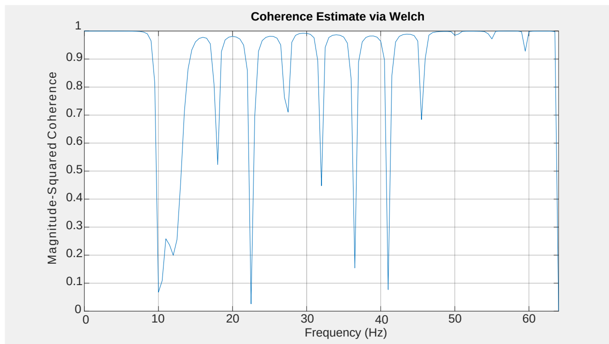

Figure 6 The coherence of two segments of channel F4, Subject A, right test
Source: Self-Made

Then, if the estimated coherence is acceptable, the four-level Wavelet decomposition of each segment can be obtained, as it is shown in Figure 2. Once the wavelet decomposition is obtained, the Shannon, Log Energy and Normalized Entropies of the detailed coefficients dA3, dA4 and the approximation coefficient A4 are calculated. Tables 3, 4 and 5 show the Shannon, Log Energy and Normalized entropies calculated from the Discrete Wavelet Decomposition, obtained for the same electrodes and segments as in Tables 1 and 2. With this information, the entropy of the segments, coherence and the entropy of the DWT coefficients, the consistency of the pattern can be validated, if the entropy values obtained are similar.

In Table 3 we observe that the Shannon entropies are different, but Log Energy and Normalized entropies for the Detail coefficients are closer.

In Table 4, we observe again that Shannon and Normalized entropies are quite different, but the Log Energy ones are similar.

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Electrode	D3 (Entropy)		
AF3	Shannon	Log Energy	Norm
8 sec.	5.8756e-09	-430.9594	1.2347e-05
33 sec.	1.3581e-08	-398.1880	2.4502e-05

Table 3 Subject A, entropies for detail coefficient A3 for the left test
Source: Self-Made

Electrode	D4 (Entropy)		
AF3	Shannon	Log Energy	Norm
8 sec.	2.6990e-09	-204.8071	7.3692e-06
33 sec.	8.9709e-09	-198.3364	1.4654e-05

Table 4 Subject A, entropies for detail coefficient A4 for the left test.
Source: Self-Made

Table 5 shows the entropies calculated for the approximation coefficients A4 for the AF3 electrode in the left test. We observe that all the entropies are similar and these entropies are different from the ones obtained using only the one-second data segments.

Electrode	A4 (Entropy)		
AF3	Shannon	Log Energy	Norm
8 sec.	5.6674e-05	-131.9524	0.0028
33 sec.	5.6309e-05	-132.0304	0.0028

Table 5 Subject A, entropies for approximation coefficient A4 for a left test
Source: Self-Made

Experiments in user B

In this section, the analysis for subject B is presented. Electrode P7 was chosen because it presented similar entropy values and coherence. Some of the entropies obtained for two segments are shown in Table 6. The coherence of this pair of segments is shown in figure 7. It is observed that is not a very good one, except for the band near 30Hz.

Table 7 shows the entropies of the detailed coefficients A3. It is observed that the values are not close enough, except for the Normalized, that are similar.

Channel Time P7	Entropy (Shannon)	Entropy (Log Energy)	Entropy (Norm)
23 s	4.7741e-05	-2.2812e+03	0.0077
52 s	9.8571e-05	-2.1871e+03	0.0117

Table 6 Entropies for subject B, right test
Source: Self-Made

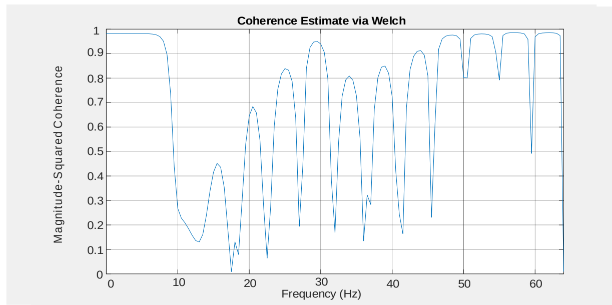

Figure 7 The coherence of two segments of electrode P7, Subject B, right test
Source: Self-Made

Electrode	D3 (Entropy)		
P7	Shannon	Log Energy	Norm
23 sec.	1.4247e-08	-405.1969	2.3961e-05
52 sec.	2.2473e-08	-386.3170	3.4070e-05

Table 7 Subject B, entropies for detail coefficient A3 for the right test
Source Self-Made

Table 8 presents the entropies for the detail coefficients A4 or the P7 electrode. None of them are close enough. Table 9 shows the entropies for the approximation coefficients for A4 and as in Table 8, the entropies are not similar.

Electrode	D4 (Entropy)		
P7	Shannon	Log Energy	Norm
23 sec.	8.7090e-09	-200.0164	1.2708e-05
52 sec.	5.0026e-08	-186.9553	3.8515e-05

Table 8 Subject B, entropies for detail coefficient A4 for the right test
Source: Self-Made

Table 9 shows the entropies for the Approximation coefficients A4 of the DWT of the P7 segments. It is noticed that the entropies obtained do not completely match each other. In this case, we can conclude that these segments are not trustworthy. It would be necessary to look for another electrode or segment, for the search of patterns.

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Table 10 shows the entropies of the segments obtained for the electrodes T8 and F3 for the left test of subject B. It is observed that almost all of them have similar values, except for Shannon entropy for T8. The coherence for the segments of both electrodes is presented in figures 8 and 9. The coherence obtained is regular in both cases, in spite of the close entropy values shown in Table 10.

Electrode P7	A4 (Entropy)		
	Shannon	Log Energy	Norm
23 sec.	4.4841e-05	-134.2122	0.0025
52 sec.	9.5113e-05	-127.3002	0.0038

Table 9 Subject B, entropies for approximation coefficient A4 for the right test
Source: Self-Made

Electrode Time	Entropy (Shannon)	Entropy (Log Energy)	Entropy (Norm)
T8 55s & 56s	5.2676e-05 5.4524e-05	-2.2680e+03 -2.2633e+03	0.0082 0.0083
F3 7s &36s	2.7070e-05 2.7018e-05	-2.3600e+03 -2.3600e+03	0.0055 0.0055

Table 10 Entropies Subject B for the left test, electrodes T8 and F3
Source: self-Made

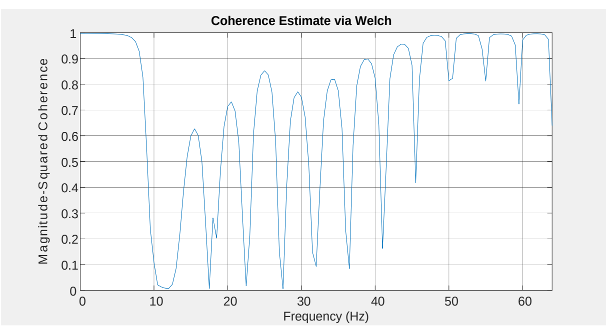

Figure 8 The coherence of two segments of channel T8, Subject B, left test
Source: Self-Made

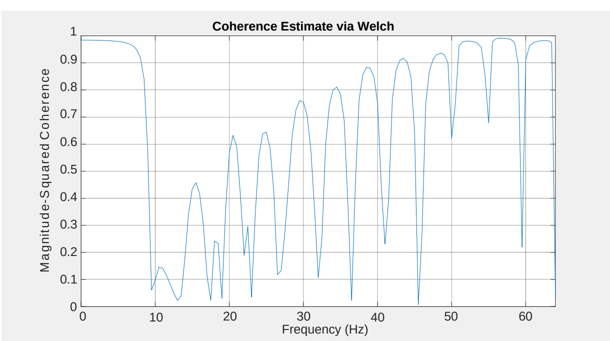

Figure 9 The coherence of two segments of channel F3, Subject B, left test
Source: Self-Made

Table 11 shows the entropies for the detail coefficients D3 of the segments of electrode T8. Closer entropy values were obtained for the Log Energy and the Normalized entropies. Table 12 shows the entropies obtained for the Detail coefficients D4 for electrode T8. These entropies values are discrepant. The closer ones are Log Energy.

Electrode	D3 (Entropy)		
T8	Shannon	Log Energy	Norm
55 s	7.4101e-09	-413.338	1.6802e-05
56 s	5.1398e-09	-415.282	1.4026e-05

Table 11 Subject B, left test and entropy values for A3 detail Coefficients
Source: Self-Made

Table 13 shows the entropy values obtained for the Approximation coefficients A4 for the same segments of electrode T8. It can be observed that Log Energy and Normalized Entropies got closer values.

Electrode	D4 (Entropy)		
T8	Shannon	Log Energy	Norm
55 s	3.8904e-09	-209.176	7.9733e-06
56 s	1.1585e-08	-201.639	1.5977e-05

Table 12 Subject B, left test and entropy values for D4 detail Coefficients

Electrode	A4 (Entropy)		
T8	Shannon	Log Energy	Norm
55 s	4.9823e-05	-133.215	0.0026
56 s	5.1920e-05	-132.824	0.0027

Table 13 Subject B, left test and entropy values for cA3 approximation Coefficients

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Conclusions

We observe that the methodology presented is useful to determine the confidence of the possible pattern. Sometimes, using the entropies and cohere functions directly to the preprocessed signal does not reflect the real significance of the possible pattern.

Working with the entropies of the coefficients of the Discrete Wavelet Transform is useful to validate the possible pattern.

In this case, the Log Energy and the Normalized entropies gave closer values, so they had better performance.

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Oral health in patients with diabetes mellitus type 2 from the faculty of dentistry in San Francisco de Campeche 2016

Salud oral en pacientes con diabetes mellitus tipo 2 de la facultad de odontología en San Francisco de Campeche 2016

ROSADO-VILA, Graciella†, ZAPATA-MAY, Rafael, SANSORES-AMBROSIO, Fatima and VIDAL-PAREDES, Jorge

Universidad Autonoma de Campeche, Faculty of Odontology and Faculty of Nursing, San Francisco de Campeche, México

ID 1st Author: *Graciella, Josefa, Rosado-Vila* / **ORC ID**: 0000-0002-8688

ID 1st Coauthor: *Rafael Zapata-May* / **ORC ID**: 0000-0002-3750

ID 2nd Coauthor: *Fátima, Sansores-Ambrosio* / **ORC ID** 0000-0001-5403-4802

ID 3rd Coauthor: *Jorge, Vidal-Paredes* / **ORC ID**: 0000-0002-4474-3733

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Abstrat

Introduction: Insulin is a hormone secreted by the pancreas that has the function of controlling blood sugar concentration. The most common type of diabetes is type 2 which occurs 90 to 95% of cases. The most frequent alterations at the stomatological level are periodontal disease, gingivitis, caries, xerostomia (dry mouth syndrome), so there is a need to investigate how susceptible patients are to suffer from this disease and to be able to take the necessary preventive measures. had similar plaque levels. RESULTS: The sample studied corresponded to a total of 100 patients, 49 female (49%), and 51 male (51%). The average age of the sample was 54.89 years ± 10.85 years with a range of ages between 40 and 70 years. The most representative age group was the group of 40 to 50 years with 39%, followed by the group of 51-60 years with 37% and the group of 61-70 years with 24%. In the Gingival index it was found that 45% of the patients presented mild gingivitis, 13% moderate gingivitis and 21% severe gingivitis.
Keywords: diabetes, periodontal disease, gingivitis, prevalence.

Diabetes, Periodontal Disease, Gingivitis, Prevalence

Resumen

Introducción: La insulina es una hormona segregada por el páncreas que tiene la función de controlar la concentración de azúcar en la sangre. La diabetes más común es la tipo 2 en el 90 o 95 % de los casos. Las alteraciones más frecuentes a nivel estomatológico son la enfermedad periodontal, gingivitis, caries, xerostomía y síndrome de boca ardiente, por lo que surge la necesidad de investigar que tan susceptibles son los pacientes que sufren esta enfermedad y poder tomar las medidas preventivas necesarias. Resultados: La muestra estudiada correspondió a un total de 100 pacientes, 49 del sexo femenino (49%), y 51 del sexo masculino (51%). La edad promedio de la muestra fue de 54,89 ±10.85 años con un rango de edades entre 40 y 70 años. El grupo etáreo más representativo fue el grupo de 40 a 50 años con 39%, seguido del grupo mayor a 51-60 años con 37% y el grupo menor de 61-70 años con 24%. En el índice Gingival se encontró que, el 45% de los pacientes presentó gingivitis leve, el 15% gingivitis moderada 13% y el 21% gingivitis severa.

Diabetes, Enfermedad Periodontal, Gingivitis, Prevalencia

Citation: ROSADO-VILA, Graciella, ZAPATA-MAY, Rafael, SANSORES-AMBROSIO, Fatima and VIDAL-PAREDES, Jorge. Oral health in patients with diabetes mellitus type 2 from the faculty of dentistry in San Francisco de Campeche 2016. Journal of Research and Development. 2019. 5-16: 28-37

† Researcher contributing as first author.

Introduction

This work was carried out with the purpose of being able to investigate more about the oral health status of type 2 diabetic patients. Diabetes is an autoimmune and metabolic disease characterized by selective destruction of the beta cells of the pancreas causing an absolute insulin deficiency. Insulin is a hormone secreted by the pancreas that has the function of controlling blood sugar concentration. Insulin stimulates body tissues to absorb the glucose they need as fuel. The most common diabetes is type 2 in 90 or 95% of cases. The most frequent alterations at the stomatological level are periodontal disease, gingivitis, caries, xerostomia and burning mouth syndrome, so there is a need to investigate that so susceptible are the patients who suffer from this disease and be able to take the necessary preventive measures. This research focused on the oral status in type 2 diabetic patients with emphasis on the CPOD index, the gingival index, the presence or absence of removable and fixed prostheses. What is the oral health status of patients with type 2 diabetes mellitus who go to the dental faculty clinics at the Autonomous University of Campeche in the City of San Francisco de Campeche?

Theoretical Framework

According to the world diabetes association, more than 371 million people have diabetes, this number is increasing in each country, half of the world's population does not know that they have diabetes In Mexico the National Prevalence 14.3% in the population aged 20 to 69, about 9 million people with diabetes INEGI statistics nationwide in the state of Campeche. During 2011, according to the SSA, the percentage of hospital discharge in men is 4.4% and in women 2.1 percent.

Diabetes is a disorder in the way in which the human body uses the glucose we obtain when ingesting food, producing an elevation of blood glucose levels known as hyperglycemia. The human body needs energy to fulfill its functions and to be able to carry out our daily activities. We obtain this energy from the food we consume. By digestion, food is degraded and as a final product they are converted into glucose, which is the main energy source of the cells. The pancreas is a gland located behind the stomach.

Among its many functions is the task of producing insulin, a hormone generated by beta cells that are located in the Islets of Langerhans, the function of insulin is to make it possible for glucose to enter the cells. Under optimal conditions, the production of insulin in the body depends on the accumulation of glucose in the blood, thus, when the glucose rises, the production of insulin is activated. Diabetes occurs when: • The amount of insulin produced by the pancreas is not enough to meet the body's needs. When the insulin that is produced does not have the effect that it should regularly have. When the pancreas stops producing insulin completely. Types of diabetes: According to the International Classification of Diseases the types of diabetes are: Type 1 diabetes: Formerly known as juvenile and / or insulin-dependent diabetes, it is a condition of autoimmune origin, this means that beta cells, responsible for producing insulin, are unknown and destroyed by the immune system itself responsible for protecting the body against viruses, bacteria and diseases.

This process of self-destruction is gradual, and the symptoms begin when a large part of the cells have already been eliminated. It has been possible to identify that this can begin several years before the person with diabetes is diagnosed. If so, it is believed that it happens due to hereditary factors and that it manifests itself from a trigger that ends up manifesting itself in diabetes, but the precise reason why this condition occurs is still unknown. This type of diabetes is 10 times less frequent than type 2. It is typically characterized by its early onset, before 20 years of age. Type 2 diabetes: Before adult and / or non-insulin-dependent call. This type of diabetes begins when the liver produces excess glucose and at the same time, tissues (mainly muscle) decrease the use of insulin, which causes high blood glucose levels.

This is called "insulin resistance" (it is a defect in the use of insulin) or also because insulin production is no longer sufficient and is triggered by different reasons such as: Obesity, sedentary life, poor diet in most In cases the hereditary factor is decisive. It is a little symptomatic disease, so its diagnosis is made in about 50% of cases by laboratory tests requested for another cause and not by clinical suspicion.

The scarce classic symptomatology determines that with high frequency it is diagnosed late and in the presence of chronic complications. Gestational diabetes: It occurs during pregnancy in a woman who did not previously have diabetes. In this case, it is also insulin resistance. During pregnancy the body undergoes very intense hormonal changes and in gestational diabetes these hormones produce the inverse effect to insulin, raising blood glucose. Most often this condition disappears at the end of pregnancy, but there are cases in which diabetes remains and is considered as type 2 diabetes. Other Specific Types: Hyperglycemia occurs as a result of pancreatic disorders associated with medications or chemicals, endocrinopathies, disorders of insulin receptors, infections or other genetically associated syndromes and others.

Approach

In type 2 diabetes 2 alterations are associated: a decrease in the action of insulin, with an alteration of the function of the beta cell that is initially able to respond with an increase in insulin production (hence the levels of these are elevated or normal in order to compensate for the deficit of their action) but later insulin production is becoming insufficient. However, in type 1 diabetes, the alteration occurs at the level of beta cells, so insulin levels are very low, which is why the levels of C-peptide (which is secreted with insulin) are normal or high in Type 2 and type 1 diabetes are usually very low.

According to the Official Mexican Standard NOM-015-SSA2-19994: For the prevention, treatment and control of Diabetes the diagnosis of diabetes is established if it meets any of The following criteria: Presence of Classic symptoms and casual blood glucose> 200mg / dl., Fasting Plasma Glycemia> 126 mg / dl., Blood glucose> 200 mg / dl, two hours after oral loading of 75 g. of dissolved glucose in water.The clinical characteristics, signs and symptoms of the patient with diabetes vary, depending on the specific type of the disease, but in general they include: polyuria, polydipsia, polyphagia, weight loss and asthenia.

The symptoms of type 2 diabetic can be classified as: Acute: Acute metabolic complications in Type 2 Diabetes Mellitus, mainly include the presence of 2 fundamental clinical conditions: As a non-ketosic hyperosmolar diabetic CDHNC and hypoglycemia secondary to the treatment of diabetes with insulin-secreting drugs and / or insulin. Chronic: Chronic complications of type 2 diabetes mellitus can be broadly subdivided into 2 categories: Ophthalmopathy microvascular complications. nephropathy and neuropathy.

The Macrovascular coronary heart disease, cerebrovascular and peripheral vascular disease. criteria of a patient with a good control of diabetes mellitus healthy and balanced nutritional regime, medications in the indicated doses-Insulinotherapy, exercise regularly, check blood glucose levels regularly, a blood glucose value within the limits of 80-130 mg / dlcriteria of a patient with poor control of diabetes mellitus fatigue and weakness, numbness of hands and feet, blurred vision, dry skin, frequent need to urinate, insatiable thirst, dental mobility, high blood glucose of 200,300 or more than 1000 md / dl.

The association between diabetes and inflammatory periodontal diseases has been extensively studied for more than 50 years. It is known that the prevalence of type 2 DM increases with age, as there are older populations, the global prevalence increases. International investigations agree that as age increases, individuals move from a lifestyle marked by physical activity. and caloric restriction to another characterized by sedentary lifestyle and high caloric intake.

This predisposes to suffer said disease. In addition, type 2 DM increases its frequency with age due to a loss of the mass of beta cells in a genetically labeled pancreas. According to the bibliography consulted, the age group that brings together the largest number of patients with Diabetes are adults between 40 and 59 years old, followed by the group from 60 to 79 years old and the group from 20 to 39. On the other hand, in relation to gender, the total number of patients with Diabetes is similar between the two genders. The determination of the risk of dental caries is difficult due to the existence of complex interactions between multiple factors.

DM increases the risk when combined with poor oral hygiene, cariogenic diets (it is not determined on the basis of sugar content, but several factors must be considered), among others.In patients with DM, when they have hyperglycemia, it is observed a salivary viscosity, a factor that predisposes to caries due to viscous saliva is less effective in carbohydrate clearance. The risk of dental caries changes throughout the person's life, as the risk factors from which DM does not escape change. As age increases and there is a deficiency in oral hygiene, there is an increased accumulation of dentobacterial plaque, which reduces the diffusion coefficient of acids formed by fermented microorganisms.

This facilitates the demineralization process and raises caries risk, especially in people with a high number of cariogenic microorganisms. When age increases the prevalence of periodontitis is higher. This is due to the effect of other factors over time and not a consequence of aging. It is greater in the diabetic patient due to decreased resistance to infection, vascular changes, altered oral bacterial flora, among others. .Studies of diabetes and periodontal diseases.

The relationship between diabetes and periodontal disease has been the subject of more than 200 articles published in English in the last 50 years, varying the clinical and radiological criteria used to assess the prevalence of periodontal disease, the extent and severity; evolution of the standards for the degree of glycemic control, and methods to assess the change in complications associated with diabetes. In addition, researchers and clinicians should be careful when comparing the results of different studies, since research has focused on varied populations and has often included a relatively small number of subjects or controls lacking. Symptoms of gingivitis: Red and swollen gums. Bleeding gums are not healthy. Even if your gums only bleed when you brush too hard, any bleeding symptoms are not normal. White or yellow pus around the gums. Teeth that are longer and gums that have receded from the teeth. A general evaluation of the available data suggests that diabetes is a risk factor for gingivitis and periodontitis. In a classic study of diabetes and gingivitis reported more than 30 years ago, the prevalence of gingival inflammation was higher in children with type 1 diabetes than in children without diabetes who had similar plaque levels.

Ervasti and colleagues observed greater gingival bleeding in patients with poorly controlled diabetes than in control subjects who do not have diabetes or in people with well-controlled diabetes. Subjects with type 2 diabetes also had greater gingival inflammation than control subjects who did not have diabetes, the highest level of gingivitis was found in patients with poor glycemic control. The appearance of type 1 diabetes in children has been associated with an increase in gingival bleeding, while improving control of blood sugar levels after initiation of insulin therapy resulted in decreased gingivitis.

The use of an experimental gingivitis protocol, a longitudinal study Recent showed faster and more severe gingival inflammation in adult patients with type 1 diabetes than in control subjects without diabetes, despite qualitative similar and quantitative bacterial plaque characteristics, suggesting a hyper-inflammatory gingival response in people with diabetes. Possible signs of periodontal disease or periodontitis include tooth sensitivity, chewing pain, bleeding or red gums, and bad breath. Treatment: The treatment of severe periodontal disease can include a deep cleaning procedure called scraping and root brushing, in which the dentist removes tartar above and below the gum line and smoothes the rough points of the roots Dental, where the causative bacteria of plaque have to accumulate.

Most of the evidence also suggests that diabetes increases the risk of developing periodontitis. In a classic cross-sectional study, type 1 diabetes is associated with a five-fold prevalence of periodontitis in adolescents. A recent case-control study confirmed that insertion loss is more frequent and extensive in children with diabetes than in children who do not have diabetes. In addition, epidemiological research supports an increase in the prevalence and severity of insertion loss and bone loss in adults with diabetes. A multivariate risk analysis showed that subjects with type 2 diabetes have increased the chances of have periodontitis compared to subjects without diabetes, after adjusting for confounding variables such as age, gender and oral hygiene measures.

A dental prosthesis is an artificial element intended to restore the anatomy of one or several teeth, also restoring the relationship between the jaws, while returning the vertical dimension, and replacing the teeth Diabetic patients are more prone to loss Dental therefore are candidates for oral prostheses either Mucosoportadas or adjusted. The literature reflects controversial aspects regarding the role of certain factors as well as their possible way of acting. Among the most important local factors in the development of oral lesions appear to be traumatic ones, poor oral hygiene and dry mouth in diabetic patients.

The first ones include burns, nibbled mucosa, maceration, local candy abuse, local effect of tobacco and the action of prostheses, which, being poorly adapted, cause continuous microtrauma on the supportive mucosa that they cover. Incorrect hygiene of the prosthesis and oral cavity promotes the accumulation and proliferation of microorganisms causing the imbalance of the oral microflora and may allow the action of opportunistic microorganisms such as Candida albicans.

The prostheses can be: Dentosoportadas: Those that are supported by the abutment teeth, or remnants, of the patient, which are natural teeth that it still retains. The teeth can retain their structure completely, or they can be (in the vast majority of cases) teeth previously carved by the dentist. Dentosoportadas are fixed prostheses. Mucosoportadas: Those that are supported on the alveolar process, in contact with the gum which is a fibromucosal tissue. Fully Mucosupported prostheses are the typical "dentures" (complete acrylic resin prostheses). Auto-supports: Those that combine the two types of supports mentioned above, that is, they are supported both in the patient's remaining teeth and in the alveolar process. They are metal prostheses, partial resin prostheses, and mixed prostheses. Implanted supports: Those that are supported by surgical implants (implanted prostheses).

Justification

A diabetic patient is considered high risk due to his systemic condition in a dental practice compared to a systemically healthy patient. Recent studies also indicate that there is a vicious cycle between diabetes and advanced gum disease.

People with diabetes are not only more susceptible to advanced gum disease, but they can affect blood glucose control and contribute to the progression of diabetes. Studies indicate that people with diabetes are at an increased risk of oral health problems such as gingivitis gum disease in its initial stage and periodontitis advanced gum disease. People with diabetes are at a higher risk of periodontitis because they are generally more susceptible to bacterial infections and are less able to fight the bacteria that invade the gums.

Therefore, this study aims to know what is the main risk factor that these patients run in order to be able to emphasize the preventive measures they may have and make patients with diabetes mellitus aware of oral diseases that are very easy in their situation to obtain and that can lead to aggravate your systemic situation by the fact of not having a healthy oral health status.

Methodology

It is a non-experimental, descriptive, transversal, projective, non-probabilistic sample selected for convenience, not blinded and without controls. Time Delimitation The time covered by the study was from January to September 2014. Study design: Cross-sectional study: The total of 100 patients with type 2 diabetes, 49 women and 51 men who attended the study were included in the sample. stomatology consultation in the clinics of the faculty of dentistry of the UAC in the study period.2014

Characteristics Clinical signs

0 Absence of inflammation None
1 Slight swelling Slight color and texture change
2 Moderate inflammation Moderate brightness, redness, edema and hypertrophy, blood on probing
3 Severe inflammation Tendency to spontaneous bleeding. ulceration

The following table summarizes the gingival index according to Loe and Silness.
MEASUREMENT SCALE: categorical.

Periodontitis conceptual definition: Periodontitis It is a disease that can initially occur with gingivitis, and then continue with a loss of collagen insertion, gingival recession and even bone loss, in the case of not being treated, leave the tooth without bone support.

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The loss of such support implies the irreparable loss of the tooth itself operational definition: categories: 0- Absence, 1- mild, 2- moderate, 3-Severe The data were collected in the clinical file of the faculty of dentistry of the UAC, once carried out the corresponding procedures with the authorities of the campus. The review was carried out each of the previously selected medical records of patients with type 2 diabetes mellitus. In each patient history a methodical inspection of symptoms and treatments performed on the patient was performed .To obtain data, the CPOD odontometer was used. The statistic is descriptive; the measures of central tendency and dispersion appropriate for each variable according to their distribution are described and the summary data is presented in tabular and graphical form.

Results

The sample studied corresponded to a total of 100 patients, 49 female (49%), and 51 male (51%). The average age of the sample was 54.89 ± 10.85 years with a range of ages between 40 and 70 years. The most representative age group was the group of 40 to 50 years with 39%, followed by the group older than 51-60 years with 37% and the group less than 61-70 years with 24%. In the Gingival index it was found that 45% of the patients presented mild gingivitis, 15% moderate gingivitis 13% and 21% severe gingivitis.

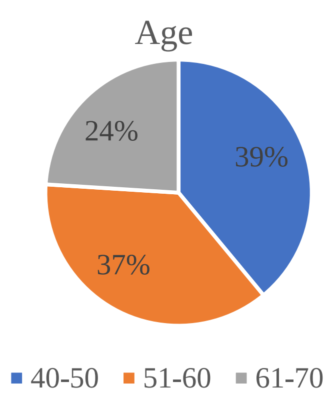
The Periodontal Disease Index showed that 20% had severe periodontitis and 11% had mild periodontitis, and 54% did not present the disease. It was observed that 39% of the patients had some fixed prosthesis, and 16% had a removable prosthesis. The statistical analysis regarding gender analysis did not show any statistically significant relationship. It was also found that there is a highly significant relationship between gingivitis, periodontitis and tooth decay. Therefore, the greater the presence of gingivitis, the greater the prevalence of periodontitis and dental caries.

Discussion

DM is a systemic disease that involves a diverse clinic and presents various manifestations in the oral cavity. World literature reports that its highest prevalence occurs in the female gender. In the present study, the majority of patients were male (51%) with an average age of 40-70 years. Possibly this is due to the fact that type 2 DM is diagnosed in adulthood in most cases. In accordance with this investigation where all the patients were type 2 diabetics.

In other investigations it is expressed that gingivitis occupies the first place of the pathologies found in DM; which was evidenced in the patients of this study. In others, despite the high incidence of gingivitis, this does not become the most frequent alteration. At the same time, studies indicate that periodontitis is a frequently reported oral disease in diabetic patients; as found in this investigation. In this regard, it has been shown that there is a bidirectional relationship between DM and the

Age



Graph 1

Periodontitis Chronic infection with large negative bacteria of the dentobacterial plaque leads, in diabetic patients, to the increase in insulin resistance of the tissues and to the increase in hyperglycemia. This can result in the accumulation of irreversibly altered proteins, which bind to receptors in macrophages and induce the excessive release of pro-inflammatory cytosines, leading to a more catabolic situation. Chronic periodontitis associated with the presence of local irritants constantly stimulates the defense of periodontal tissues.

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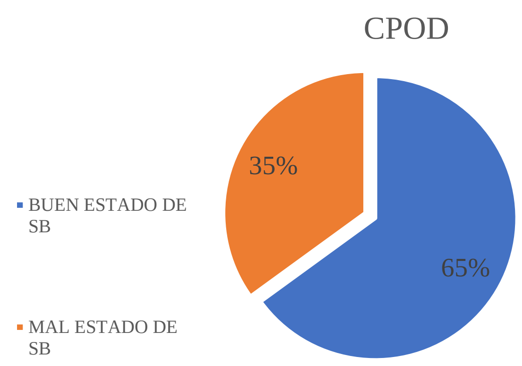
So it is believed that the possible relationship between periodontitis and certain systemic conditions such as DM, may be given in the immune response. Most research on this relationship has focused on how this disease can affect periodontal conditions.

The inverse relationship is also studied today; that is, how periodontal diseases affect the metabolic situation. In this sense, it has been determined that periodontal treatment contributes to a positive control of blood glucose levels, which leads to a decrease in the complications of DM. Thus, the well-controlled diabetic patient has a tissue response and a normal immune defense against infections. Therefore, the best method we have is the prevention of periodontal conditions in the diabetic, in order to achieve better care of the oral cavity of these patients.

Dental caries is another oral clinical manifestation that, for some authors It has a high incidence in diabetic patients, which is consistent with our results. Unlike a report made in 2003, which reports this pathology in a smaller percentage. In addition, it is indicated that diabetic patients have a high prevalence of cervical caries. In our case, only a low occurrence of cervical caries was detected, within the total number of caries detected. The majority of oral lesions in diabetic patients are located in soft tissues. Among the frequent clinical findings in the diabetic patients studied are: the saburral tongue and the fissured tongue. Research shows that there is a variability in the prevalence of these two clinical manifestations. Some studies report a low prevalence, unlike the high percentage found in this study.

It is likely that the saburral language is not a characteristic alteration of DM, since it can be associated with multiple general and local factors and occurs both in systemically compromised and healthy people. Similarly, it is presumed that our findings in relation to the fissured tongue are due to the average age of the patients studied (54.89 ± 10.85 years), since the appearance of lingual fissures increases with age.

CPOD



Graph 2

Xerostomia is one of the oral manifestations most commonly referred to by diabetic patients. According to some reports, it is described to a lesser extent; contrary to the high percentage that our results reveal. It is likely that this difference is due to the fact that in our study group the majority of patients were poly medicated it was common to observe that a patient had more than one disease, which in some cases can produce xerostomia as a side effect, as well as in the case of the use of antihypertensives. This entity is considered to trigger many alterations in the oral cavity; as well as the difficulty for chewing, tasting and swallowing food.

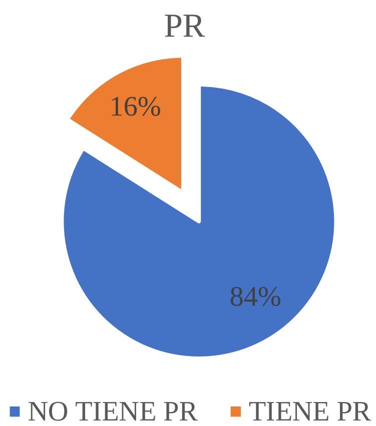
The high prevalence of xerostomia, saburral tongue and candidiasis could be a warning signal to make an early diagnosis of diabetic patients by the Dentist. This alteration was found significantly in the diabetic patients of our study, compared to other reports. Also, some studies indicate a low frequency of halitosis; while others have a high presence of this alteration, similar to that obtained in this study. It is likely that this high percentage of halitosis in patients may be due to the high frequency of periodontal disease and xerostomia.

The results of our study confirm that there is a highly significant relationship between periodontitis and age groups, the group being 41 to 60 years who presented the highest rate of periodontitis in accordance with another report. This indicates that, at a higher age of the patient with DM there is a greater predisposition to suffer from periodontal disease. For many years, experts raised the possibility that there were specific diseases of the diabetic that affected the mouth. Today we know that there are only differences in frequency of occurrence but there are no oral lesions exclusive to DM.

Conclusion

In this study conducted in patients with type 2 diabetes mellitus who attended the clinics of the Faculty of Dentistry of San Francisco de Campeche 2014, We can conclude that of the total of 100 patients included in the analysis The most representative age group was 40 to 50 years with (39%) and according to the gingival index we found a prevalence of 21% severity of the disease in patients contrasting with 45% of patients who still have a mild level of the disease. Likewise, the periodontal disease index showed that 20% of patients have a severe level of oral disease, in addition to 39% of patients having fixed prostheses that in many cases are in poor condition or poorly adapted and only 16% use removable prostheses. It was also found that there is a highly significant relationship between gingivitis, periodontitis and CPOD index.

Removable protesis

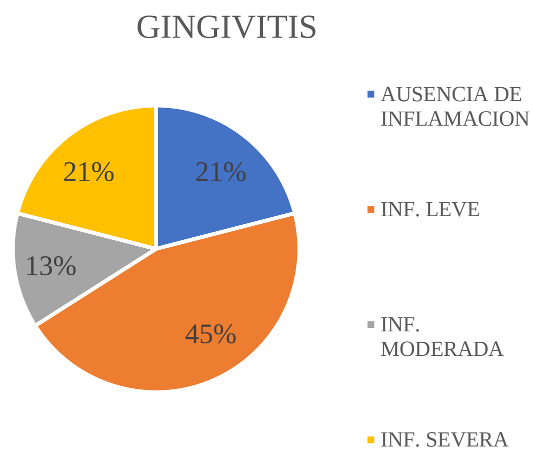


Graph 3

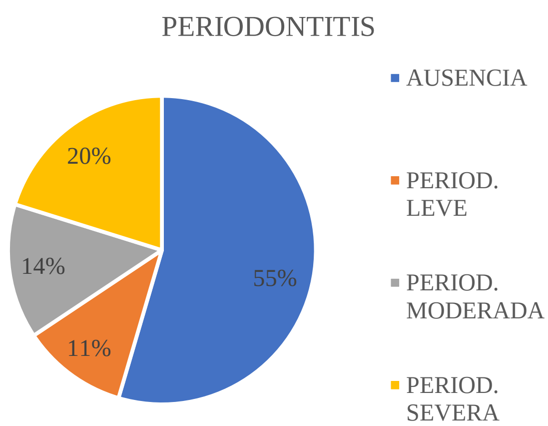
Therefore, the greater the presence of gingivitis, the greater prevalence of periodontitis, tooth decay and dental loss. No significant difference in gender was found. It is worth mentioning that the majority of the total patients mention that they do not have enough knowledge or information about the extreme care they should have when having DM in their body as an example the care of not having any infectious focus on the oral cavity.

Which predisposes to have high blood glucose levels and not being able to control them for no apparent reason even while carrying out a medical check-up does not give it enough importance when trying to preserve your dental organs until the moment of being able to swallow your food correctly or comfortably. As a personal recommendation.

I would like that, according to the results obtained in this investigation, greater emphasis was given to prevention talks in the faculty, especially to patients with diabetes mellitus on oral care since the moment they were diagnosed disease to patients; starting with a simple semiannual prophylaxis and constant checkups so that they can lead a good quality of life and have adequate glucose control.



Graph 4



Graph 5

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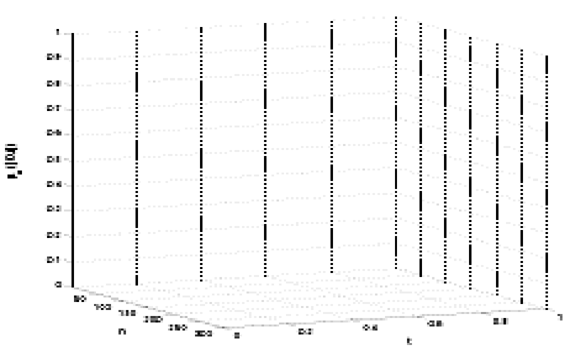

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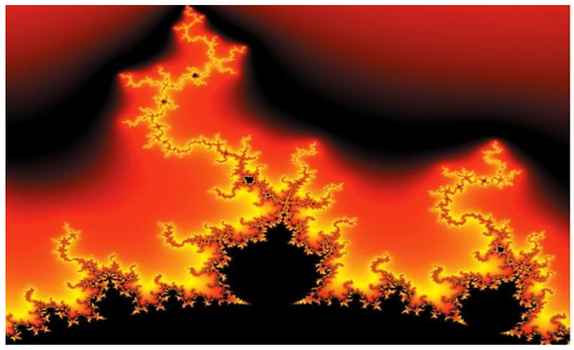

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1Editorial Policy and Management

38 Matacerquillas, CP-28411. Moralzarzal –Madrid-España. Phones: +52 1 55 6159 2296, +52 1 55 1260 0355, +52 1 55 6034 9181; Email: contact@ecorfan.org www.ecorfan.org

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