DESIGN AND EVALUATION OF A PORTABLE METER OIL POLLUTION PROTOTYPE WASTEWATER WITH TEMPERATURE CONTROL USING ARDUINO TECHNOLOGY

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ABSTRACT

In search of an efficient and quick way to determine the amount in ppm hydrocarbons in wastewater sample, design and evaluation of prototype portable meter oil pollution in wastewater temperature control is performed Using arduino technology, depositing the sample of water in a flask, is carried to the base of the device where the heating plate is located; the flask is plugged with plug support containing the temperature sensor and gas sensor. Depending on the concentration of hydrocarbon in water and using the increase in temperature causes the oil to evaporate, causing increased conductivity in the sensor as it is composed of metal oxide, which is a better conductor in the presence of hydrocarbons. Operation of the device is designed with the LabVIEW program, which allows obtaining the data generated by the sensors by means of an algorithm in language G, wherein the temperature sensor is required and the temperature of this is shown marked plus a graph of voltage vs. time obtained using the gas sensor. Both graphs generated data that is exported as a table and then perform the analysis of the results obtained from the sample. To determine the concentration of parts per million (mg / l) of hydrocarbons in the water is required experimentally obtained table, which entered with the aid of voltage and determine the concentration of hydrocarbon. After several tests and compared to the analysis performed by a laboratory certified to perform Aqualim total hydrocarbon tests, resulting in an error between the device and the laboratory is 3.27%. Being a very low percentage, compared to the elements used.

Keywords: prototype, arduino, simulator, water, temperature, hydrocarbons.

1. INTRODUCTION

Speaking of oil is important to know as it appears in our environment, knowing how it is form from underground billions of years, accumulated in formations where they you as Ferrer says [1] "a series of organic compounds consisting exclusively of carbon (C) and hydrogen (H), called hydrocarbons "(p.1), varied structure and different molecular weights, has given rise to a number of derivatives we use daily," oil is currently the main source of energy, and the most important commodity traded between countries" [2]; made great improvements in our development, progress towards industrialized find comfort and well-being processes, but it is undeniable that poor waste disposal operations acquisition and processing of hydrocarbons causes pollution, and usually one of resources more dependent "water".

In the early days of the oil industry water proved to be an undesirable product in the fields, leaving his treatment and monitoring to focus on the acquisition, production and processing of crude oil. In a producing well fluid reaches the surface is not composed solely of raw, this fluid is associated both gas and water, studies have shown that "water production appears relatively early, mainly in nearby wells to water contact -palm" [2], the latter being the one that occupies the largest volume of production, and as production is declining water vole is increased, increasing the importance of knowing the characteristics of residual water from fields production. These characteristics lead to the need to know the presence of oil in the water to be discharged into the environment, and establish whether it meets current standards.

Different methodologies have been developed to study oil pollution in drinking water, in which two analytical methods are used: the determination of hydrocarbons by ultraviolet spectrophotometry and the number of incipient odor (NOI), [3] these methods obey laboratory tests and methods that can determine more quickly the oil content are sought.

In Colombia and the world has increased the stringency of environmental policy states that "States must ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or areas beyond national jurisdiction" [4], in the Colombian constitution have resolutions that apply to specific discharges to surface waters and public sewage systems in the country, by most important management that he takes to the water reaches the surface in the company of oil and other pollutants, good management for waste water from a well leaving on acceptable terms for dumping or use within the same field being indispensable.

2. METHODOLOGY

2.1 Hydrocarbons effects on the environment

Oil pollution occurs by accidental or deliberate release into the environment, causing adverse effects on man or the environment, directly or indirectly [5].

Hydrocarbons interfere with the exchange of gases between air and water. This eliminates the supply of oxygen to the animal obstructs gills and in many cases, the possibility of pulmonary respiration of other aquatic animals.

It is known that some hydrocarbons tend to accumulate in organisms through the food chain with increased risk of cancer and mutagenesis. These pollutants include benzene, phenols, and polycyclic hydrocarbons and are very dangerous for their carcinogenic effect.

The hydrocarbons stick to sediments, there are deposits, which are released into the environment slowly for a long time and act as sources of contamination for a long period.

2.2 Samples

Prior to the determination of hydrocarbons in water must be carried out sample preparation, which normally will include a step of extraction, purification and concentration in order to obtain a reliable sample with known hydrocarbon content. Table-2 shows the data obtained from water samples relate.

2.3 Labview

R. Trejo is said as "Labview programming language is a high level of graphic type, and focused on the use instrumentation [6], this means that programs are not written, they are drawn, facilitating their understanding. Having already pre-designed a lot of blocks, supports the user creating the project, which instead of being a lot of time to program a device / block is allowed to invest much less time and devote a little more in the user interface and interaction with the end user. Each virtual instrument consists of two parts:

- **Front panel:** The Front Panel is the user interface is used to interact with the user when the program is running. Users can see data updated in real time program. Controls on this interface are defined (used as inputs, can be buttons, markers, etc.) and indicators (used as outputs, may be lights, graphics, etc).

- **Block diagram:** the program itself, where its functionality is defined here icons that perform a particular function are placed and interconnected (the code that controls the program).

On the front panel, find all types of controls or indicators, where each of these elements is assigned to the block diagram terminal, i.e. the user can design a project on the front panel controls and indicators, where these elements are input and output terminal interacting with virtual instrument. We can see in the block diagram, all values of controls and indicators, as they flow between them when running a virtual instrument program.

Figure-1 shows a block diagram of a program in which a random array of 100 elements is generated, then this makes the FFT array and shown in a graph:
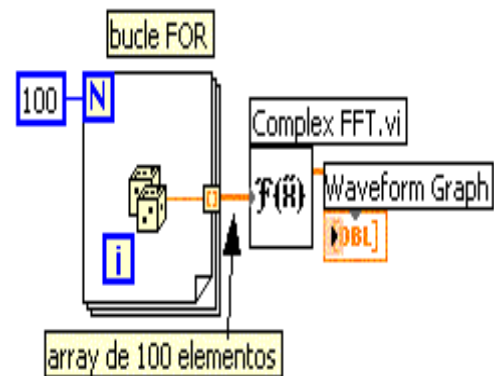

Figure-1. FFT of random array of 100 elements.

2.4 Stages of processing

The designed system consists of stages and incorporating software and hardware integrated for manufacturing of a portable prototype of meter oil pollution in waste water with temperature control.

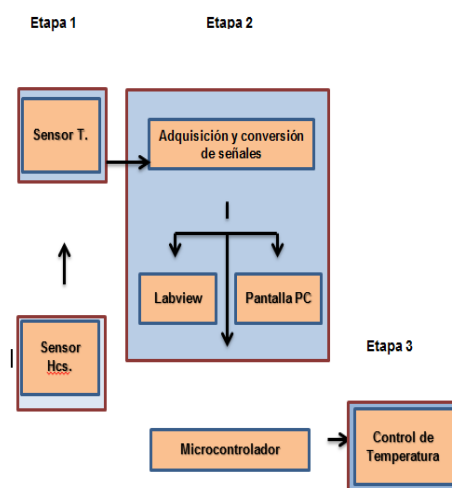The general outline of the project is presented in the following Figure-2.

Figure-2. General scheme of the project.

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2.5 Hardware Processing

Arduino is a prototype platform open source. It consists of a plate which is based on a microcontroller, and a development environment for writing the software for this plate [7].

To develop the prototype the Arduino UNO R3 card is used because it is a plate with a microcontroller. The ATmega328 sufficient capacity to perform the processes necessary for the completion of the processing system and control of various devices coupled by its large capacity digital inputs and outputs, also for being an open-hardware can be used to develop any type of project without acquiring a license. Figure-3 shows the algorithm.
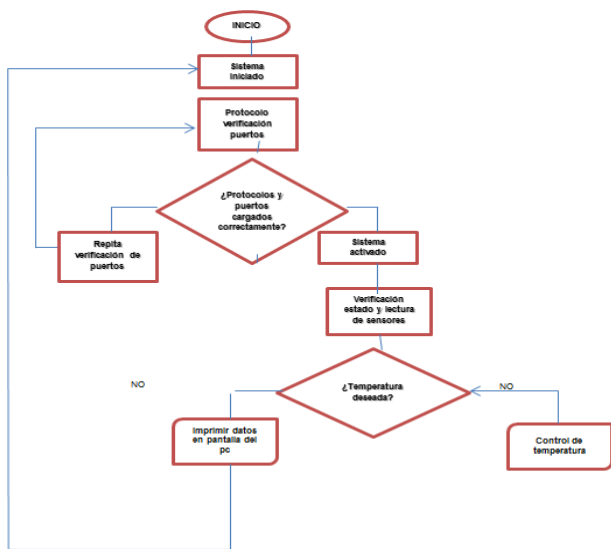

Figure-3. Algoritmo general del sistema.

The portable system measuring device having the form of obtaining and processing the results, Figure-4:
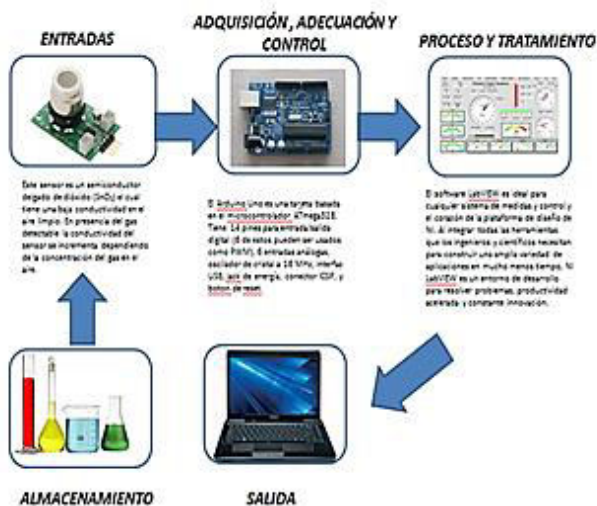

Figure-4. System overview.

2.6 Control system

2.6.1 Driver

The control system of temperature shown in Figure-5, is performed in real time using the current temperature directly from the sensor that is located in the container, and obtain the temperature at which are subject our water samples, this temperature we can program directly from the interface, there will have an indicator that will show the time, including date and exact time at which measurements are made, to set the desired temperature, our arduino board will send a signal on or off via the pin 13, this, added to a cluster, which will initially be zero, will allow us to be consistently adding the respective results for graphing.
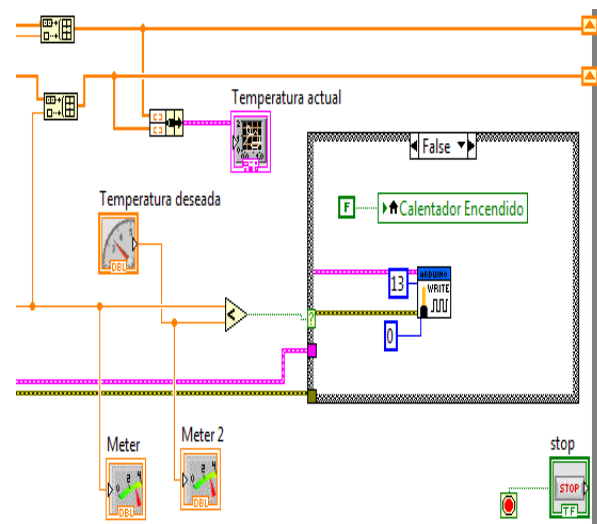

Figure-5. Temperature control.

2.6.2 Arduino

Arduino can take information from the environment through their input pins of a range of sensors and can affect what surrounds controlling lights, motors, and other actuators. The Arduino microcontroller is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing).

The projects made with Arduino can run without connecting to a computer, while having the ability to do and communicate with different types of software.

2.6.3 Programming

Programming is done using the Labview software.

Made with arduino programs are divided into three main parts: structure, values (variables and constants), and functions. The programming language based on C / C ++ code and is easily implemented in any

application due to its large library of examples and applications developed found on the web.

Because they must perform a conversion of programming languages as the language G Labview handles, a supplement is used.

This supplement does is convert the arduino language C / C ++ and makes it understandable language for Labview.

2.7 Detection of the presence of hydrocarbons

For detection of the hydrocarbons contained in the water samples, the use of GTS 813 Figaro sensor which detects hydrocarbons in general is needed.

It is important to clarify that the sensor is connected to a simple electric circuit and Table-1 presents certain electrical characteristics, which then goes to the arduino, to process the data.

The sensitivity of the Figaro sensor Figure-6, and its variation with temperature and humidity Figure-7, is defined by the relationship between changes in gas concentration and variations in the sensor resistance, which is achieved by the application of films SnO2 and SnO2 thin [8] [9]. Each type of sensor has its own characteristic sensitivity, which allows it to be used for different purposes.
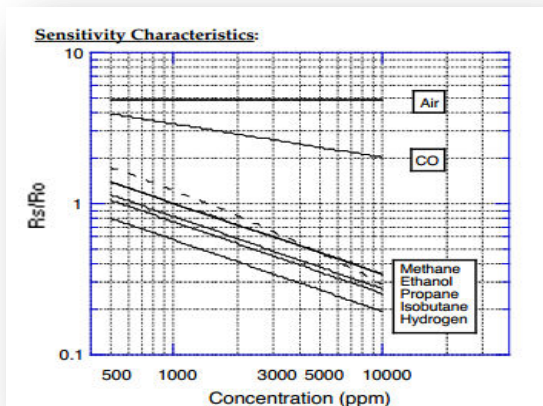

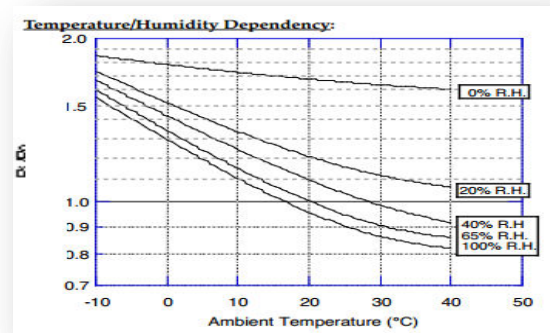**Figure-6.** Characteristics of sensor sensitivity Figaro TG813.

Figure-7. Characteristics of temperature sensor Figaro TG813.

Table-1. Characteristics of sensitivity of the sensor Figaro TG813.

Electrical Characteristics:

Item	Symbol	Condition	Specification
Sensor Resistance	Rs	Methane at 1000ppm/air	5kΩ ~ 15kΩ
Change Ratio of Sensor Resistance	Rs/Ro	$\frac{Rs \ (Methane \ at \ 3000ppm/air)}{Rs \ (Methane \ at \ 1000ppm/air)}$	0.60 ± 0.05
Heater Resistance	RH	Room temperature	30.0 ± 3.0Ω
Heater Power Consumption	PH	VH=5.0V	835mW (typical)

Figure-8 shows the LabVIEW interface and programming forming the portable measuring device are observed.
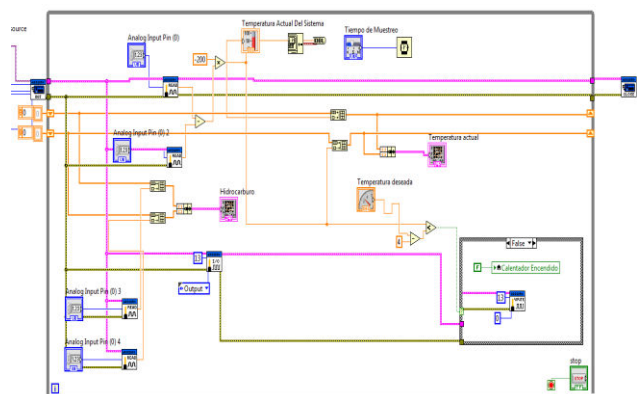

Figure-8. Labview interface and device programming.

2.8 Conditioning of signals from the temperature sensor and gas

Wheatstone bridge Figure-9 is used to measure unknown resistances by balancing arm of the bridge. These are constituted by four resistors forming a closed loop, one being the low resistance measurement.
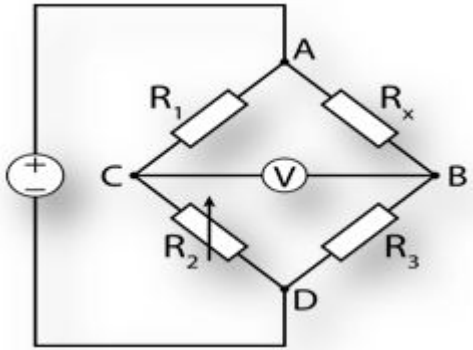
Figure-9. Wheatstone bridge.

Taking into account the principle of Wheatstone bridge, and because of our temperature sensor, we can say that the value of resistors used in our bridge are 100 Ohm, that this calibration at 0 ° c, to obtain a differential potential between the corners C and B, this spread is read by our arduino card, which internally is responsible for converting the differential when multiplied by a constant, since our RTD is linear, we have no problem to convert our signal.

The TGS 8 Series has a standard basic measuring circuit Figure-10, given by the manufacturer, and then you can see the corresponding circuit.
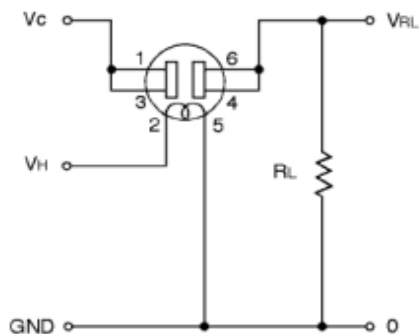
Figure-10. Electric gas sensor circuit.

According to the data gives us the manufacturer, we know if our sensors are working properly under these conditions.

Using these data, the ranges must meet our output signals when measuring clean air are calculated, so we can know if the sensors are under proper conditions of temperature and relative humidity.

TGS 813 to obtain the following data:

$$\frac{Rs(aire)}{Rs(1000\ ppm_{metano})} \cong 5$$

We know that:

$$Rs(1000ppm\_metano) \rightarrow 5K\Omega : 15K\Omega$$

Then:

$$Rs(aire) \cong 5xRs(1000ppm_{metano})$$

$$Rs(aire) \rightarrow 25K\Omega : 75k\Omega$$

Rs in fresh air at 20° ± 2 °C and relative humidity of 65 ± 5%.

Now calculating the VRL:

$$V_{RL-}max = \frac{10}{\left(\frac{25}{4}\right)+1} = 1,38V$$

$$V_{RL-}min = \frac{10}{\left(\frac{25}{4}\right)+1} = 0,51V$$

$$V_{RL}(aire) \rightarrow 1.38v : 0.51v$$

In fresh air at 20 °± 2 °C and relative humidity of 65 ± 5%.

After performing the software to run the portable meter device in wastewater hydrocarbons, it becomes necessary to make the device.

Initial design plans is initiated, the selection of materials for the construction of the housing and the sensor assembly in the cork which is introduced to the flask in which the sample is deposited, Figure-11.

Figure-11. Device portable meter.

3. RESULTS

Considering the experiments performed with different concentrations of hydrocarbons in the samples,

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and samples of pure water, the following table is performed, which is identified as from a voltage greater than 0.39 V hydrocarbons are present in samples.

After making the standardisation Table-3, the evaluation of the device was, by reference to a sample of water which is an analysis of total hydrocarbons in the laboratory Aqualim located in the city of Yopal resulting 27.1 mg / L, using gravimetric analysis method.

Comparing with the results obtained by the device was 26.25 mg / L, since the device scored an average voltage of 0.8V.

When calculating the percentage d device error was encountered:

$$\%error = \frac{27,1 - 26,25}{27,1} * 100 = 3,20\%$$

Table-2. Water samples.

	Oil gr	Water volume Lt	ppm	Voltage (V)
Sample 1	0.04	1	40	1.22
Sample # 2	0.14	1	140	4.27
Sample # 3	0.15	1	150	4.575
Sample # 4	0.07	1	70	2.135

Tabla-3. Standardisation device.

ppm (mg / L)	Voltage (V)
15	0,4575
20	0,61
40	1,22
50	1,525
60	1,83
70	2,135
80	2,44
90	2,745
100	3,05
110	3,355
120	3,66
130	3,965
140	4,27
150	4,575

4. RECOMMENDATIONS FOR USE

- The sample of water used should be free of solids, to guarantee greater efficiency of the device.

- If water is taken from a tributary, must be heated to a temperature of 50 ° C to ensure full recognition of the sample.

- Clean equipment.

- Do not wet the warming plate

- Operate the device 110V

- Do not use more test 200ml

- Check the software a test run.

5. CONCLUSIONS

- The development and operation of control systems obtained respond as stated from the outset, thus fulfilling the defined objectives.

- It was possible to develop a portable system capable of determining the presence of hydrocarbons, with a recognition rate of 96.791% and a very good assertiveness.

- The design of this device proved capable of detecting hydrocarbons in the range of sensor and also managed to do a good range of temperature stability for each sample.

- It is possible to adapt existing systems to the needs that must be met, such as the present work.

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