

Automated Prototype of a Distiller Fractioned Ethanol from Corn using the Platform Arduino

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Abstract

This study has the general objective to make a comparison between a model of an automated prototype of a distiller fractioned ethanol from corn using the arduino platform with a template without automation. It was demonstrated that the distiller fractioned in the search results had a gain higher than the method without automation. The methods applied to research was the use of empirical research, which were demostrados in search results. The sample information in a comparative study, the number of experiments which have been tested on a alcoolimetro. The results of the research has demonstrated that there is a great advantage in reducing the time of ethanol production in relation to the method without the use of arduino platform.

Keywords: Prototype, distiller, ethanol, corn and arduino.

I. INTRODUCTION

The ethanol in Brazil is one of the most marketed products on the world market and in Brazil, due to its importance and participation in all economic scenarios [1]. However, the ethanol is one of the most important alcohol that is obtained by chemical and physical processes of fermentation, distillation and condensation of amylose substances or sweetened, such as sucrose in maize, and also through synthetic processes. It is a liquid colorless, volatile, flammable, soluble in water, with characteristic smell and flavor [2].

One of the main uses of ethanol, in its most common term "alcohol" is used as a fuel has its consumption coupled to the gasoline, associated to the parameters of caloric "power" and "price", i.e., as the calorific power of alcohol is lower than that of petrol, it will be more consumed per kilometer rotated [3].

Several researches have stated that the alcohol, within the current guidelines for sustainability, it is advantageous both for renewable resource, as pollute less than fossil fuels [4].

Thus, the production of ethanol from corn is practically an alternative way to produce alcohol with less environmental impact, the use of arduino is a

technological resource used in order to reduce losses in production and, consequently, improve the production of ethanol is processed through the fractional distillation of corn. Although the fractional distillation of ethanol from maize in Brazil is much smaller than that of the sugar cane the quality of ethanol is similar to both processes [5].

By the way, the benefits of using automated prototype of a distiller fractioned ethanol from corn using the platform arduino is unquestionable in relation to other alternative methods. Such are the reduction of costs, increase of profit, improvement of production in addition to be highly accurate.

With the aim of maintaining direct contact with what has already been written on the subject of research and allow the construction of the theoretical framework to support the analysis of the research line in the study. Were researched in collections of books, survey of scientific articles, journals, magazines, among others.

II. LITERATURE REVIEW

As regards the impacts of ethanol production in Brazil, it is observed that the adoption of the production of ethanol from corn has been one of the best alternatives, of which the United States is world champion, which its production has increased in the last decade [6].

The ethanol and the development of technologies involving maize and the sale of alcohol-powered cars with dual fuel engines (Flex) identifies the great importance that has the ethanol plants, for economies around the world and Brazil. It has been observed that the production of ethanol from maize is being well accepted in Brazil [7].

Thus the annual growth of corn production occurred since 2004 which was of 3% to 4% per year [8]. The production of maize in Brazil contributes in 2017 with approximately 80% of grain production in Brazil. Brazil is practically the third world producer of corn. China is the second ranking with a production of 215 million, which were the data from the 2017/2018 harvest and must approach this next season of 2018/2019 in the mark of 225 million, according to data from the USDA. And to sign the United States lead the ranking as the largest producer of maize in the world with 370 million tonnes in the 2017/2018 season. Their expectations for the season

of 2018/2019 is approaching the 361.4 million tonnes [9].

So the ethanol from corn has been an alternative in relation to ethanol produced from sugar cane due to the cost of production of ethanol from maize to be cheapest.

According to [10] for both models the most common use of production of ethanol from corn or sugar cane using the distiller fractionated ethanol from corn using the platform arduino can present different characteristics according to the need and operating conditions.

According as the portal New Sugarcane Brazil has 411 sugar mills and ethanol and more than 172 microns distilleries recorded. Currently, there are many micro distilleries that are not recorded, in the manufacture of homemade Sugarcane liquor [11].

The micro distilleries in Brazil in relation to large power plants are on a small scale, due to its economic viability and factors are more payable before the standardization and Brazilian legislation about the production of ethanol.

According to [12] the production of Brazil is on a smaller scale than the United States and other countries producing ethanol, which demonstrated that the economic viability of ethanol production in micro distilleries are mostly administered by cooperative system operation or by associations of producers.

As [13], the micro distilleries are structured on the model of industrial plants with a production capacity of 200L to 2 billion liters of ethanol per day, and the mini-distilleries with daily capacity of 20 thousand L/day to 60 thousand liters/day.

According to [14] also define micro distilleries as units with production capacity of up to 5 thousand liters per day of ethanol. In its turn [15] thus consider the plants between 100 L/day and 1 thousand liters/day. Federal and state laws have adopted the tracks of up to 5 thousand or 10 thousand L/day as limits of Microproduction [16].

On the other hand, ethanol that is obtained from maize has become a good deal for Brazil. Many researchers have stated that the conditions are favorable due the excess of production by evaluating the conditions for export and domestic consumption. Thus, the state of Mato Grosso is what produces ethanol from corn with a production of 15.4 million tons of maize, and the estimates has pointed to a production of 34.9 million tons in less than 10 years [16].

However, if compared to the production of ethanol from sugarcane, maize has demonstrated its potential. With a large-scale production, the corn is with a great price to produce ethanol. Then costs for production of ethanol from corn in relation to the sugar cane are more advantageous.

According to [14] The cost on average to produce one liter of ethanol from sugar cane on average is by R\$1.15 and R\$0.97 to produce one liter of ethanol from corn. Then, to produce ethanol from maize

leaves cheapest and generate greater profitability. However, one of the biggest problems in relation to the maize is the difficulty of selling.

The percentage of ethanol that can be purchased per ton is 70% of maize starch that produces 370 to 400 liters of hydrous ethanol. Depending on the yield and quality of corn, you can reach the 410 L of EH/ton of maize [14].

According to [17] the production of ethanol from corn for use as fuel for transport is recognized as a mature technology used since mid 1900.

Finally, the forms of production of ethanol is most commonly used are primarily distinguished in synthetic tracks, track fermentative [18] and track distillatory [19]. Synthetic tracks the production of ethanol is through indirect hydration reaction of ethylene and direct hydration of ethene. In the via fermentation is a fermentation from raw materials, and ligninocellulosic saccharines amylaceous substances [20]. And the track distillatory is the production of ethanol from wine, and which is used to control the marketing of vine wine [19].

III. METHODOLOGY

The present study refers to a research with qualitative approach, applied nature, exploratory goal, based on data collection procedures through bibliographic research and empirical, aiming to develop a prototype automated a distiller of ethanol from maize, whose objective is to make a comparison of the functioning of the prototype working with and without the automation of arduino, showing the gains with energy savings of automated model.

However, the choice of a qualitative approach was based on the design of [21] by the need to bring to the discussion a more comprehensive universe of meanings of processes and phenomena which cannot be reduced to simple operationalization of variables. It is a survey of nature applied, as defined by [22], because it involves the technical knowledge for the practical application, designed to solve specific problems. Because the method, in its more general sense, is the order that must impose on different processes needed to achieve a certain order or a desired outcome. For these authors, the sciences, it is understood by the method set of processes employed in research and demonstration of the truth.

The aim of the research is exploratory, as defined by [23], it aims to provide greater familiarity with the problem, with a view to make it more explicit or construct hypotheses. Among them, the study was applied in three stages, being them: the process of alcoholic fermentation of corn, construction of the distiller and automation via arduino.

This study was carried out empirically, through the construction of a prototype automated a distiller fractionated ethanol from corn using the platform arduino.

Finally, we compared a model without automation with an automated model (with the use of arduino).

A. The Fermentation Process of Corn

According to [19], for the production of ethanol from corn, you must perform the preparation of the wort (sugar mixture intended to fermentation), saccharification and fermentation and distillation.

For the preparation of the wort of corn, it is necessary to saccharify the starch polysaccharides (milled grains), because the agents of alcoholic fermentation do not have amylolytic enzymes. The process of SACCHARIFICATION is where occurs the conversion of starch into fermentable sugars. You can perform this step through chemical, biological or enzymatic action [19].

Saccharification is the process that the maize starch passes through the cooking process, where the water is heated to a temperature of 55 to 65, in a proportion of 1 kg of maize starch for every 2 to 3 liters of water. After this process, the mixture will absorb from 40 to 50% of the water, this process typically takes between 13 to 15 hours [19].

According to [24] fermentation is the step that are added yeasts in wine, the production time of fermentation can vary according to the characteristics of the raw material (soil, fertilizing, humidity, temperature, among other factors), this variation can be two to five days. The proceeds from this step is called "fermented" or "wine". Several physical factors, chemical and microbiological contaminants can affect the yield of fermentation, i.e. the conversion of sugars into ethanol. According to best practices, it is advantageous to distil the "wine" as fast as possible, because if the fermentation is completed and the wine is distilled, the reaction will transform all material on vinegar [24].

B. Fractional Distillation Process

The research has demonstrated through the fractional distillation process in accordance with automated prototype for the arduino that fermented submitted between 7 and 10% of ethanol, in addition to other components of nature liquid and solid. Among the liquid is water in a proportion of 89% to 93%, glycerin, homologous higher alcohols, furfural, acetic aldehyde, succinic and acetic acids, among others in quantity is too less. Composing the solids are identified yeast, non-fermifiaable sugars, minerals, raw albuminoids and others. [24].

Finally, for the distillation of fermented was filtered, thus separating the liquid portion of solids. The solid material will be dried in the sun and subsequently may be used in the production of feed, manure for plants or as an input of worm farm. The remaining liquid is heated to the point that ethanol will evaporate inside the distiller, where waste

water will be filtered and obtain the alcohol content of 96% ethanol.

According to [10], the distiller may present different characteristics according to the need and operating conditions. He still defines flows of the different processes of distillation, the arduino model used in this work follows the following methodology as shown in Figure 1:

- Operating System - Batch
- Contact Device - Filing
- Heating System - Electric

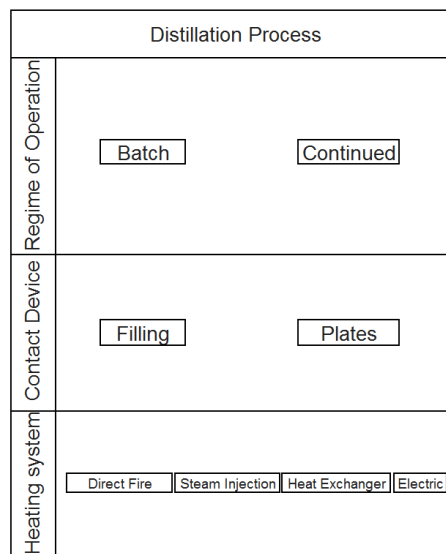


Fig. 1: Fractionated distillation process used in the Arduino platform.

In the construction of this model, we adopted the distillation column built by Mayer [25], the fractional distillation through the platform of arduino which is powered by the electric iron.

The Arduino development platform is a platform of physical computing, in which digital systems connected to the sensors and actuators are capable of measuring variables in the physical environment, perform numerical calculations, and make logical decisions on computational environment generating new variables in the physical environment [26].

The process of fractional distillation by the Arduino platform is considered to be automated. Automation is a system that is connected to a certain software based on monitoring data and technological control.

IV. RESULTS AND DISCUSSION OF RESEARCH

The process of fractional distillation with the use of the Arduino platform however has presented up to 10% gains of ethanol, the samples were tested in a hydrometer of ethanol in relation to other methods without the Arduino.

The construction of the distiller fractioned was made of artisan way. Its structure is directly linked by

the condenser, structured with a 3,2m copper tube in the form of spirals, it was placed a PVC pipe of 78mm diameter of 1.3 length, being sealed with two caps of 78mm in diameter, the caps with two holes to allow 11cm of copper pipe stayed out of PVC on both sides. Thus has two holes that were also made in PVC pipe in its length of sides. There are two holes that were connected to the Arduino device near the tap spout sealed with silicone adhesive, where will the entry of water to cool the alcohol in the form of gas condensing it.

The second step in the process of fractional distillation with application of the Arduino platform was the insertion of a boiler in the structure of the distiller craft and automated to seal the boiler was applied a plastic mass to prevent leaks. Robberies were inserted in the center of the cap on the end of the vacuum where it was connected to Arduino systematization, where close to pass the gauze. The Distiller to be fed, was also done a 33mm hole in the upper part of the side of the boiler, which has an opening closed metal threaded that prevents leaking gas by feed-forward input.

The last step of the structure of the prototype is the tower of distillation, made 8 metal shares of thick plate reaching 110 cm in height. Then, the passage of gas through these compartments occurs because of the many holes in the bottom of the same, and on top a record that is turned on and connected to the structure of the Arduino platform that controls the temperature of the process distillatory fraction of ethanol. In its various connections and compartments has clamps that are attached to the condenser.

The heat source is variable between 79° and 81°, because it is proven that that having it turns "ping", but it is also controlled by the Arduino platform. The heat source chosen here was the use of electrical boiler of 1000W of power so that the final product is a highly fuel ethanol.

The whole process of construction and application of the prototype of the platform of fractional distillation with the use of the Arduino is commonly more effectively than other conventional methods, and for demonstration of the connections of the sensor and actuator connected to the Arduino board, we used the Fritzing software to perform modeling, as shown in figure 2.

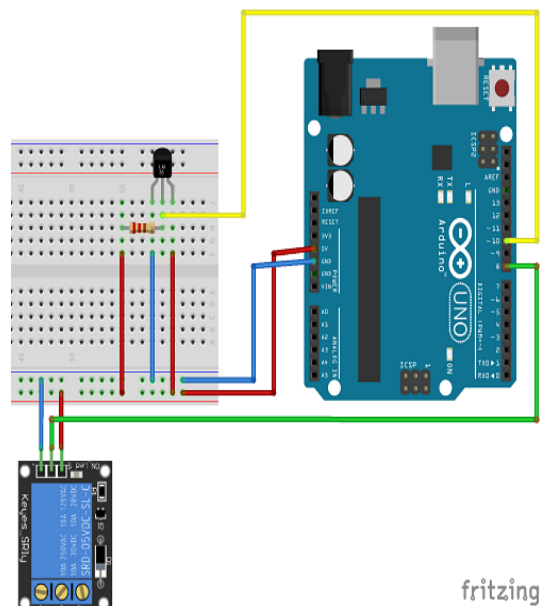


Fig. 2: Image of the Arduino generated by software Fritzing

The program was done with the aid of the Arduino program, its language is C++. The program was done by the author himself and communication with the Arduino was performed with the USB cable, where the Arduino receives the codes of the program through the Fritzing software that performs its functions as the conditions imposed in programming as code entered below.

```
#include <OneWire.h>
#include<DallasTemperatura.h>
Float SensorPin = 10;
PinMode(8,OUTPUT);
OneWire device(SensorPin);
Void setup(void) {
Serial.begin(9600);
}
Void loop(void) {
Float temp = obterTemp();
Serial.println(temp);
Delay(100);
}
ObterTemp float(){
Byte data[12];
Byte addr[8];
If ( device.search(addr) {
Search_Device.reset();
Return -1000;
}
If ( OneWire::CRC8( addr, 7) != addr[7]) {
Serial.println("CRC is invalid!");
Return -1000;
}
If ( addr[0] != 0x10 && addr[0] != 0x28) {
Serial.print("Device Not Recognized");
Return -1000;
}
}
```



```

Device.reset();
Device.select(addr);
Device.write(0x44,1);
Byte present = device.reset();
Device.select(addr);
Device.write(0xBE);
For (int i = 0; i < 9; i++) {
Date[i] = device.Read();
}
Search_Device.reset();
Byte MSB = date[1];
LSB byte = date[0];
Float LeituraTemp = ((MSB 8) | LSB);
Float Temperature = LeituraTemp / 16;
Int connected =0
If((temperature<81)&&(connected ==0)
{
DigitalWrite(8,HIGH);
Connected =1;
Delay(1000);
}
Else if (Temperature>=91)
{
DigitalWrite(8,LOW);
Delay(1000);
}
If((temperature<79)&&(connected ==1)
{
DigitalWrite(8,HIGH);
Connected =1;
Delay(1000);
}
Return temperature;
}

```

However, programs for the Arduino are known as *sketches* (draft or sketch) [27].

The Arduino UNO that appears in Figure 1 was used for controlling the whole process. This device is useful due to its low cost and the ability to be programed in an environment of free platform itself, thus enabling the control of the process through circuits, actuators if sensors.

A. The Prototype Applications

The prototype was mounted on a *Protoboard* for 400 points, which favored the connections between the microcontroller, temperature sensor and relay. Food was used a 5v source, responsible for keeping the prototype working. The electrical boiler will be connected to the 92V relay that will be fed the energy of residence through an outlet, in addition to being connected to the card arduino and protobord.

This is responsible for raising the temperature of the monster of maize which is contained inside the pressure cooker. The temperature sensor has been adapted to the pressure cooker, doing so reading in real time of the temperature inside the container, the internal temperature of the silencer must be between 79° and 81°.

It was connected to the pressure cooker, a half-inch hose, who will be responsible for transporting gases coming from evaporation of the show. These gases are transported to the PVC pipe that will be full of glass beads. For achievement of the seal of the tube, it uses two tampons caps in two extremities, being sealed by a layer of plastic mass.

With the heating of the monster inside the pressure cooker temperature of 80°, the ethanol present in the mixture will evaporate and scroll through the hose in gas form until the container where are the glass beads. The glass beads will serve to capture any particle of unwanted water gas, leaving only the ethanol in the liquid state. This in turn will be transported by a coil made of hose through within the condenser to be cooled and condensed milk.

The final product of this condensation is the ethanol in composition of approximately 90°. The remaining waste of production may be used as fertilizer or for feeding cattle, pigs and poultry.

Lastly, to enable the research was also used in the process of fractional distillation without the use of the Arduino, which resulted in an extra time of use of electrical boiler for 12 minutes, compared with the tests performed with the aid of the Arduino, since that time for ethanol production with the use of the Arduino, used the boiler for 39 minutes, and without the use of the Arduino 51 minutes. You can observe that the main advantage of the use of the Arduino platform is the saving of 23.5% of the time spent with energy as a result of another conventional method, in this case, an economy of 200W.

V. CONCLUSION

During the application of the prototype ethanol obtained in only a distillation is genuinely flammable, with potential for use in the production of automobile and other inputs, such as cosmetics, solvents etc.

This product obtained through the process of fractional distillation by the Arduino platform had gained in savings of up to 23.5% in the consumption of electrical energy, i.e., 200W in relation to the test performed without the use of the Arduino controller, just warming the liquid without any control.

Finally, the process of fractional distillation with the use of the Arduino platform is clearly one of the best methods, because it provides greater accuracy and control of time in the general process of ethanol distillation favoring a quality to the market, and also result in savings of electrical energy.

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