Indicating Device for Measuring Blood Alcohol

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Abstract— *This article presents a practical application of an alcohol meter. The alcohol meter created, named Indicating Device for Measuring Blood Alcohol can be easily used by anyone. The main objectives of this study were the reductions of costs and dimensions of the device, as well as designing a casing structure for it. The final purpose for this device is to implement it in the auto industry. It can be used to establish levels of safety and to prevent car drivers to drink alcohol and drive. Before the driver starts the engine of the car, he/she will be tested with the Indicating Device for Measuring Blood Alcohol. If the response is positive (red LED), the car engine will not start, therefore avoiding road incidents or accidents. If the response is negative (green LED) or in the range of tolerance (yellow LED) the car will start normally.*

Key words— *blood alcohol, alcohol test, alcohol meter*

1. INTRODUCTION

An Alcohol Test represents a chemical or electronic device which helps to determine the quantity of alcohol from expired air. Due to the fact that there is a direct link between the expired air alcohol quantity and the blood alcohol quantity, it is possible to determine the alcohol quantity from the blood through non invasive methods.

Police use Alcohol Tests all over the world, as a method to detect and to punish persons who drive under the influence of alcohol. Lately, Alcohol Tests are also being used in the auto industry as a new safety method. Alcohol Tests detect alcohol and stop the car from functioning when alcohol is detected in the expired air of the driver.

After being consumed, most alcohol is absorbed in the blood system. 80% is absorbed in the small intestine and the rest of 20% is absorbed at the stomach level. The speed at which alcohol enters into the blood depends on the way it is consumed (drank fast or slow), on the health state of the stomach and on the type of the alcoholic drink. The fastest absorption occurs in drinks with a maximum of 6% alcohol consumed on empty stomach. It is considered that after 60 to 90 minutes the alcohol is entirely absorbed [1][2][3].

The alcohol concentration in blood is calculated in "promil" (‰). A blood alcohol concentration of 1‰ means that the person has one milliliter of pure alcohol in one liter of blood [1][2][4][6].

For determining this blood alcohol concentration the next formula is used:

$$C = \frac{A}{G} * r \quad (1)$$

where: C- represents blood alcohol;
A- is the alcohol quantity expressed in grams;
G- is for the body weight;
r- represents the diffusion factor (it has a value of 0.7 for men and 0.6 for women). [1][3]

The body weight of the person represents an important factor in establishing the blood alcohol quantity. The calculus is more complex; and factors such as sex and alcohol tolerance are taken into consideration for determining the blood alcohol [1][3][8].

In a natural way, the human body eliminates around 0,15‰ alcohol per hour. An amount between 5% and 10% of pure alcohol exits the body without alteration. This quantity exits the body mostly through the expired air, but also through perspiration and urine. 90% to 95% of alcohol absorbed by the body is processed by the liver. The decomposing of the alcohol in the human body is made through an oxidation process. In just an hour, an amount of 10g of alcohol can be eliminated. This fact reflects in a drop of blood alcohol of 0,15‰ [1][2][3].

In order to determine the blood alcohol concentration, police and forensics uses more methods which can serve as trial evidences. These methods describe the insulation of alcohols and glycols, their identification and their determination from the air [1][2][6][7].

The volatile alcohols and glycols are insulated from the air by retaining them on appropriate solutions and from biological products and other products (according to their physical properties) by distillation or by entrainment of hot air or micro diffusion in Conway or Mezincescu cells [2][3][5][8].

2. IMPLEMENTING THE PRACTICAL APPLICATION

This paper describes the practical implementation of an alcohol test device which is used to determine the quantity of alcohol vapors in the expired air.

The alcohol vapors are captured with an ethyl alcohol sensor named SENS HS-130A.

The sensor detects ethyl alcohol. It is made of a ceramic tube with a very thin layer of tin dioxide on its surface, a measuring element and a heating element. The analyzed air enters the sensor through a very thin metallic grid made of stainless steel [4].

The sensitive element of the sensor has a powerful dependence on humidity and on temperature [4]. This type of sensor has been chosen due to its qualities referring to this project. The characteristics that made it reliable for the practical application are:

-fast response;
-high sensitivity;
-long predicted lifetime;
-low cost.

The voltage used for this sensor is 5V regardless the alternative or direct current. The heating voltage is 5V (I=AC/DC), the load resistor is 100 kΩ, the heat resistor is 33 Ω, the consumed power is less than 800 mW, the operating temperature is -20 ~ +50°C and the maximum humidity accepted in bigger than 95%.

This type of sensor can be used in many applications, but it excels in detecting alcohol.

Due to its reduced dimensions, the sensor can be placed in various circuits [4].

The alcohol sensor used (figure 1) has both the heating resistor and the sensitive element powered at 5V DC. Both voltage supplies are made with a 9V battery tied to two 5V voltage stabilizers. A 100kΩ potentiometer is placed in series with the sensitive element. This helps to make voltage corrections. The sensitive elements SE1 and SE2 pins are linked to the analog inputs of the PIC microcontroller used. The voltage drop on the variable resistor is 4.4-4.9V. The moment in which clean air (alcohol free) is blown into the sensitive device, the voltage drops because the sensitive element is cooled. The moment in which the sensitive element senses the alcohol vapors, a chemical reaction takes place which results in a voltage increment of up to 5V (depending on the amount of alcohol). In this way the microcontroller detects the change in the voltage and gives a signal to three diagnostic LEDs [9]:

-green LED: 4~4.59V (0~0.39mg/l);
-yellow LED: 4.6~4.79V (0.4~0.79mg/l);
-red LED: 4.80~5V (>0.8mg/l).

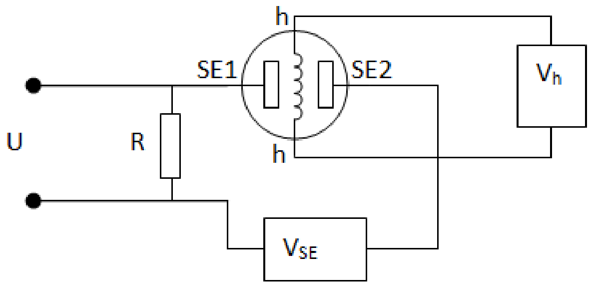

Fig. 1 The alcohol sensor

where: U-power voltage;
V_h- heating circuit voltage;
V_{SE}- sensitive element voltage;
R- variable resistor 100kΩ;
h, h- heating circuit terminals;
SE1, SE2- sensitive element terminals.

In the process of making this alcohol meter application the following constraints were made in order to make it reliable and low cost:

-reduction of the circuit/cables;
-reduction of components costs.

The PIC 16F1827 microcontroller was used due to its low acquisition cost. Even the Arduino microcontrollers are smarter, PIC was chosen due to its dimensions and cost, even if it is limited in actions.

The components for the Indicating Device for Measuring Blood Alcohol are:

-HS-130 A alcohol sensor;
-PIC 16F1827 microcontroller;
-7805CT voltage regulator;
-9V battery;
-different colors LEDs;
-resistors;
-capacitors.

Depending on the received voltage on the microcontroller analog input, it decides to light one of the three LEDs (green, yellow and red)

The Indicating Device for Measuring Blood Alcohol is powered by a 9V battery. After it passes through the voltage regulator 7805CT the circuit voltage becomes constant 5V in the whole circuit.

In order to create the wiring for the Indicating Device for Measuring Blood Alcohol the Eagle 6.2.0 programming language has been used (figure 2).

First problem that needs to be solved is the reduction of the circuit/wiring. The simplest way is to place the components on a Breadboard; this is also the fastest way to practically implement the device. Despite these facts it was chosen to make the circuit on a Circuit Board. This action reduces the size of the whole device and makes it easier to insert in the special created case.

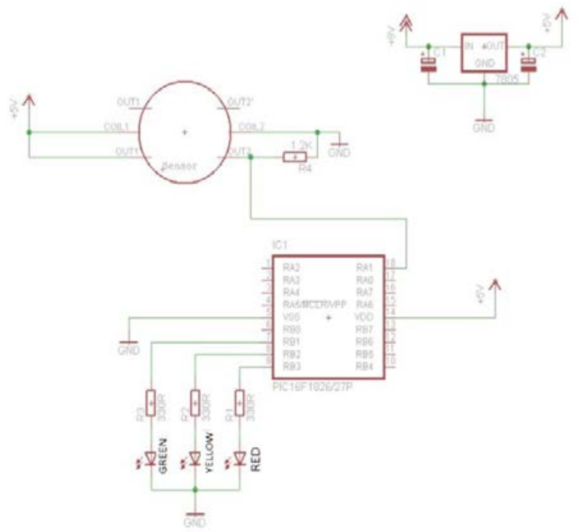

Fig. 2 The Indicating Device for Measuring Blood Alcohol wiring

Components placement has been done on a perforated plate test (figure 3). As well as in the microcontroller's case, the use of a perforated plate test lowered the cost of the project.

Fig. 3 Internal structure of the Indicating Device for Measuring Blood Alcohol

Second problem that needs to be solved is the reduction of costs. The most expensive part of the device is the brain of the device (the microcontroller). Even if an Arduino microcontroller is smarter and has a faster response, we choose a PIC microcontroller with a minimal market cost. In this way, having good results, the cost was reduced to half.

The third problem is to make a low cost casing for this device. The casing was designed for this device and it is made of plastic materials.

Next issue regards hygiene. It is not allowed for two or more persons to use the device one after the other. With the help of a 3D printer the nozzles were created (figure 4). They are easy to use and low cost.


Fig. 4 The Indicating Device for Measuring Blood Alcohol nozzles

3. RESULTS

The Indicating Device for Measuring Blood Alcohol (figure 5) can be easily used by anyone. It has an on/off switch; and after it is pushed the user has to wait for 10 seconds until the sensor is heated. To obtain a good result, the next step is for the user to blow slowly (not forced expiration) for about 3 or 4 seconds.

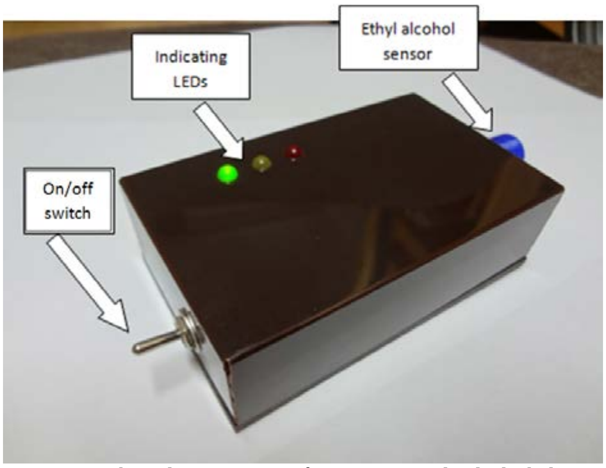

Fig. 5 The Indicating Device for Measuring Blood Alcohol

By analyzing the presence of the alcohol vapors, they can be classified in three categories:

1. The green LED is lighted – that means: the user has not consumed alcohol drinks; the voltage values on the sensor terminals are 4~4.59V that means a blood alcohol quantity of 0~0.39mg/l (figure 6).

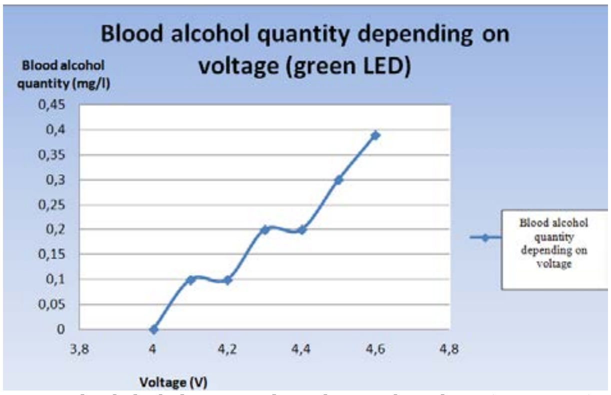

Fig. 6 Blood alcohol quantity depending on the voltage (green LED)

2. The yellow LED is lighted – that means: the user has consumed alcohol drinks in the legal limits; the voltage values on the sensor terminals are 4.6~4.79V that means a blood alcohol quantity of 0.4~0.79mg/l (figure 7).

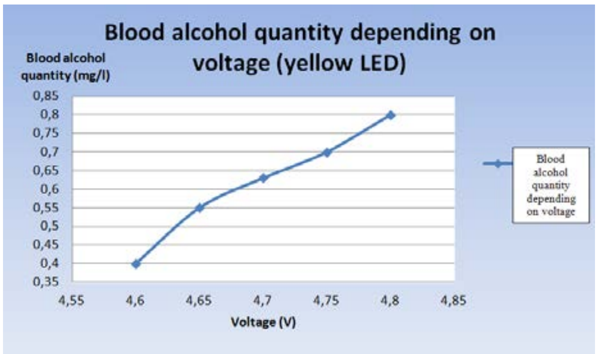

Fig. 7 Blood alcohol quantity depending on the voltage (yellow LED)

3. The yellow LED is lighted – that means: the user has consumed alcohol drinks over the legal limits; the voltage values on the sensor terminals are 4.80~5V that means a blood alcohol quantity bigger than 0.8mg/l (figure 8).

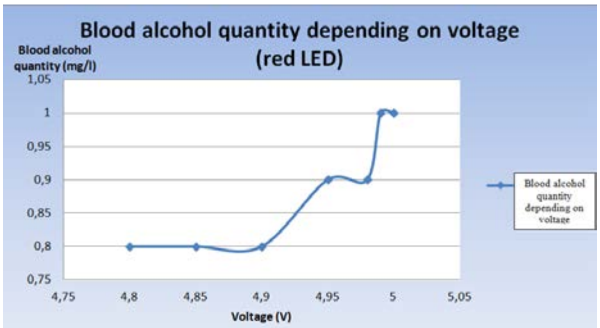

Fig. 8 Blood alcohol quantity depending on the voltage (red LED)

The sensor which determines if there are alcohol vapors records a small voltage for little amount of alcohol and a bigger voltage when the quantity of alcohol is larger.

4. CONCLUSIONS

In this paper the objective was to create a device that functions as an alcohol meter. Due to the fact that there is a direct link between the quantity of alcohol in expired air and the quantity of blood alcohol, the quantity of pure alcohol in the blood system can be determined by non invasive methods.

Reduction of costs, reduction of the dimensions of the device, as well as designing a casing structure for the Indicating Device for Measuring Blood Alcohol were the main objectives. These characteristics help the device to be implemented in many environments.

The final purpose for this device is to implement it in the auto industry. It can be used to establish levels of safety and to prevent car drivers to drink alcohol and drive. Before the driver starts the car, he/she will be tested with the Indicating Device for Measuring Blood Alcohol. If the response is positive (red LED), the car engine will not start, therefore avoiding road incidents or accidents. If the response is negative (green LED) or in the range of tolerance (yellow LED) the car will start normally.

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