Ambient Humidity Stabilizer with Nebulizer and Dehumidifier

Abdülkadir Çakir, Mehmet Ali Binici, Mehmet Karakaya

Isparta University of Applied Sciences, Faculty of Technology,
Department of Electrical and Electronics Engineering, Isparta, Turkey

ABSTRACT

The amount of water vapor in the air is called humidity. Humidity in the air varies according to regional climatic conditions. The ideal ambient humidity for human health is between 30% and 50%. The aim in this study, by keeping the humidity in the air at desired values, was to create the ideal ambient humidity for the sick people where the moisture amount is important and to increase the work efficiency in the facilities such as medicine, confectionery, food and oil where the humidity level is important. Some people with respiratory disease should take their medications directly into their lungs. In this system which the nebulizer feature added, the liquid medicines called nebul for the people with respiratory diseases such as asthma and COPD, were provided to reach directly to their lungs, by evaporating with cold steam method. Through the ambient humidity stabilizer with nebulizer and dehumidifier, the humidity in the environment was decreased and at the same time the medicine called nebul was vaporized and given to the patient. In the realized system, a user interface was created and provided the user to use the Ambient Humidity Stabilizer with Nebulizer and Dehumidifier Device in the desired mode with buttons in created interface.

KEYWORDS: piezoelectric crystal, dehumidifier, ultrasonic steam, nebulizer

1. INTRODUCTION

In recent years, using medicine by inhalation has increased gradually in the treatment of lung diseases, due to the lack of its systemic side effect as well as the local and rapid effect (Erdinç, 2002). Furthermore, some medicines that can be absorbed from the respiratory system and used in the treatment of other systems are also used in this way. In the future, the using of inhalation way will be increased gradually in the medical world (Mirici & Akgün, 2000).

In order to maintain human health, some environmental factors need to be provided. For this, the environmental factor determining the thermal balance of human body should be determined and provided from outside. Air temperature, air humidity and air circulation are constituents of environmental factors.

In this study, differently from the nebulizer devices used in the market, the ambient humidity which the device existed is controlled constantly. When the desired humidity value entered into the system is lower than the humidity value of the environment where the device is located, the dehumidifier unit added to the system is activated automatically and keep working until humidity of the environment reaches the desired humidity level. And, if the desired humidity value entered into the system is higher than the humidity value of the environment where the device is located, the nebulizer unit is activated automatically and works until the humidity reaches the desired humidity value.

In this study, a nabulizer working with the technique of obtaining cold vapour through ultrasonic sound which can be used in medical field has been realized and also in order to increase the efficiency in production, a humidifying and dehumidifying device has been realized balancing the humidity of the environment.

2. RELATED WORKS

The definition of nebulizer was made and it was stated that it provides the liquid medicines to be vaporized with sound waves (ultrasonic nebulize) or compressed air (compressor nebulizer) and so can be inhaled (MEB, 2013). The equipment and parameters required for the production of ultrasonic nebulizer were stated. Additionally, the using areas and the purposes of the nebulizer device were described.

Öngel and Mergen (2009) described the amount of humidity and oxygen required in the air for sustaining human life, by supporting their study with scientific sources. In this study performed, it was stated that humans can live in environments with humidity at a rate of 30% - 80% for 20oC and the respiratory problems may occur at lower relative humidity levels.

Hess, Fisher, Williams, Pooler, and Kacmarek (1996) described the using purposes of the nebulizer device.

Çok (2002) operated the ultrasonic nebulizers on the principle that high frequency (1-2 MHz) sound waves

generated by the vibration of a piezoelectric crystal reach the therapeutic solution in a small container and separate this liquid into small particles. Also described the advantages and disadvantages of ultrasonic nebulizers.

Saran (2015) and Uçgun (2008) determined the optimum levels of the necessary parameters by explaining the working logic of ultrasonic nebulizers. Thus, they described the data which is necessary for an ideal nebulizer.

Güler and Burunkaya (2002) used ultrasonic crystal for oscillations in all conditions in this study. Water particles are produced by ultrasonic vibration. This process was realized with an ultrasonic crystal vibrating at 1.73 MHz in a quantity of sterilized water in a small water tank. This way, the water particles in the range of 0.5-6 mm, average 3 mm were produced.

Şimşek (2015) and, Hacı and Kahraman (2016) studied the basic structure and working principle of Peltier substance. They determined the necessary parameters to use Peltier substance more efficiently and applied it in this study. Thus, they provided the thermoelectric module works as a heat pump.

3. AMBIENT HUMIDITY STABILIZER WITH NEBULIZER AND DEHUMIDIFIER
The block diagram of the Ambient Humidity Stabilizer with Nebulizer and Dehumidifier is as shown in Figure 1.
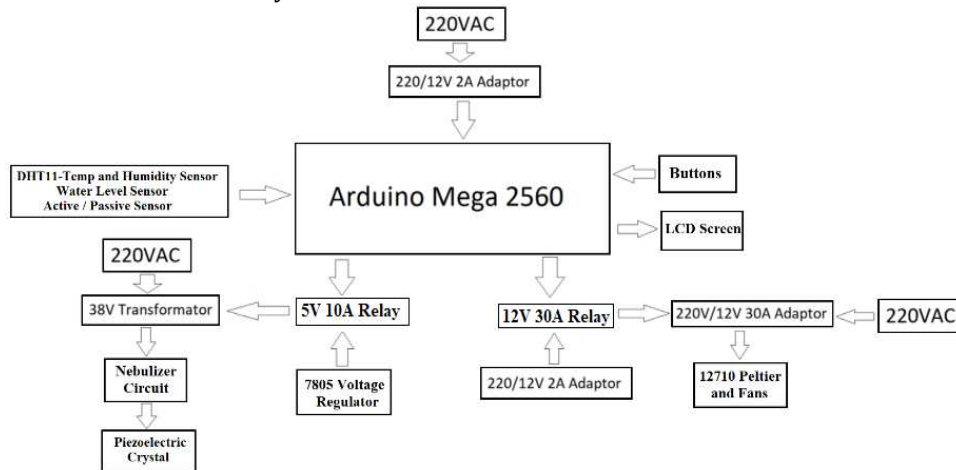

Figure1. The block diagram of the Ambient Humidity Stabilizer with Nebulizer and Dehumidifier

3.1. Power Unit
The power unit of Ambient Humidity Stabilizer with Nebulizer and Dehumidifier consists of 38V 700mA Transformer, 12V 2A Adapter and 12V 30A Adapter. These output units are energized, with the closure of the switch connected to 220 VAC input. When the base of transistor Q1 is logic 1 from the digital pin of the Arduino Mega 2560 in Figure 2, the other coil end of Relay 1 is triggered because it communicated with GND. This way, the nebulizer gets activated.
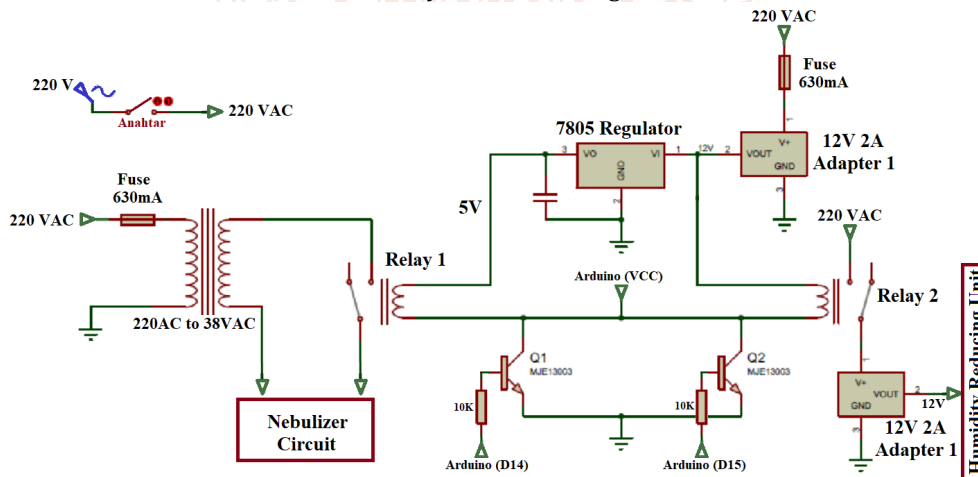

Figure2. Power Unit

3.2. DHT11 Temperature and Humidity Sensor, Water Level Sensor and Active/Passive Sensor Control Unit
The DHT11 temperature and humidity sensor, water level sensor and Active/Passive sensor are supplied from the 5V pin of the Arduino Mega 2560.

Analog data from the Water Level Sensor was measured with the analog pin of the Arduino Mega 2560, and the liquid level in the reservoir was calculated. If the piezoelectric crystal is triggered while the Ambient Humidity Stabilizer with Nebulizer and Dehumidifier is operating, when the liquid level falls below a certain value, the warning "Please add water in the reservoir" is displayed on LCD screen.

The ambient temperature and humidity are continuously measured the by DHTT11 temperature and humidity sensor, and the humidity and temperature of the environment are displayed on LCD. If the Ambient Humidity Stabilizer with Nebulizer and

Dehumidifier is working in the "Ambient Humidity Mode", the system compares the data read from the sensor with the ambient humidity desired by the user, and automatically operate the nebulizer or dehumidifier.

The active/passive sensor has 2 pins. When the jak of the breathing tube and mask is plugged into the jak input, thsese pins get short-circuited, and it is perceived that the breathing tube is plugged.

The connection diagram and circuit of the Water Level Sensor, DHT11 temperature and humidity sensor and Active/Passive sensor are as shown in Figure 3.
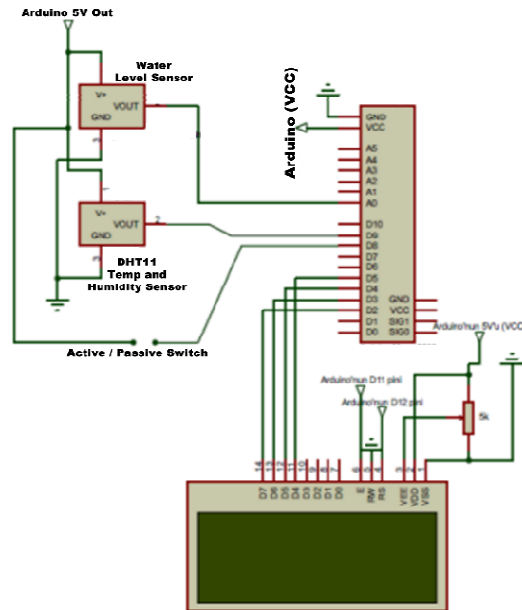

Figure 3. Arduino Mega 2560, sensors and LCD display

3.3. Operating Modes
Ambient Humidity Stabilizer with Nebulizer and Dehumidifier is operated in 2 different operating modes. When one of these modes is selected with the buttons, the selected mode gets activated by triggering the related relay when the necessary conditions are met.

3.3.1. Medication mode
If there is liquid in the water tank of the system realized, and if the breating tube and mask are perceived by the Active/Passive sensor, the Piezoelectric crystal is triggered by sine wave between 15-28V at 1.7MHz frequency and vaporizes the liquid medicine with sound waves.

If the breating tube and mask is removed while the "medication mode" is working, the nebulizer stops working and this situation is displayed to the user on LCD screen, or if the water tank runs out of liquid, the nebulizer stops and warn the user on LCD screen.

3.3.2. Ambient humidity Mode
Ambient Humidity Mode operates in 2 different ways. The first one of them is the evaporation of the water by piezoelectric crystal by operating the nebulizer circuit, in order to reach the selected humidity level from LCD screen. During this operation mode, there should be water in water tank, the breating tube and mask should not be plugged.

When the relay 1 in Figure 2 is triggered, the 38V AC voltage feeds the nebulizer, via bridge diodes and enables the piezoelectric crystal to operate. The piezoelectric crystal must be triggered by a sinusoidal signal between 15-38V at a frequency of 1.7MHz, to evaporate water with sound waves. The rectifying and filter circuit which converts the 38V AC voltage which is feeding source of triggering circuit of piezoelectric crystal, to DC voltage, is as shown in Figure 4.
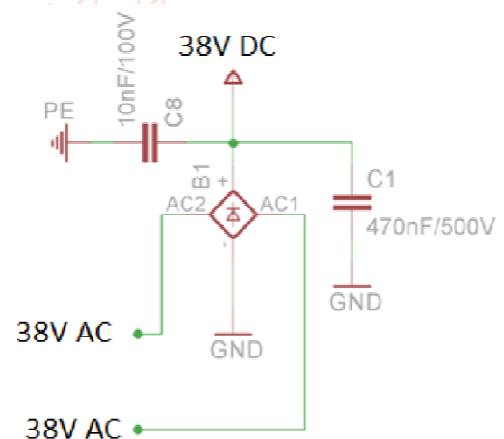

Figure 4. The rectifying and filter circuit

The nebulizer circuit created in the system realized is as shown in Figure5.
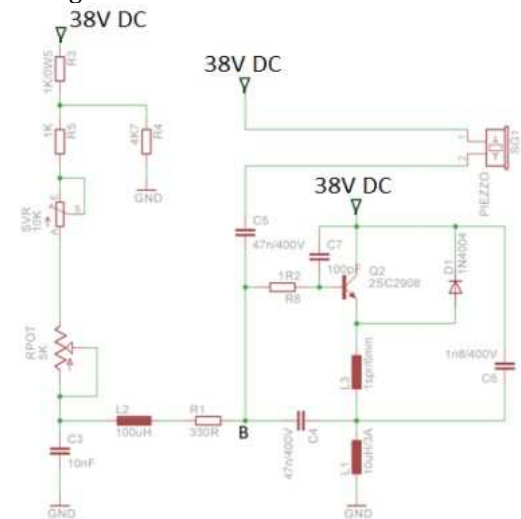

Figure 5. The nebulizer circuit

The second operating way of Ambient Humidity Mode, reduces the amount of humidity in the environment by operating the dehumidifier unit, to reach the desired humidity level selected on the LCD screen. In other words, the water particles in the air are filtered and filtered air is given back to the environment.

12710 Peltier is an electronic material that operates with 12V 10A, and when one side of it overheats, other side of it overcools. Since this happens so quickly, the water particles on cooling side get frozen suddenly. In Ambient Humidity Stabilizer with Nebulizer and Dehumidifier, it is preferred to condense and filter the water particles in the environment with the cooling side of peltier, therefore an aluminum cooler in an ideal size was cut, the freezing of the water particles in cooling side was prevented and this way the water particles were accumulated in time. The water particles in the air were condensed, via a fan spraying the air received inside, over the cooling side of peltiers. Thus, the ambient humidity was reduced, by producing water from the air. The operating principle of the dehumidifier unit designed with Peltier, is as Figure 6.
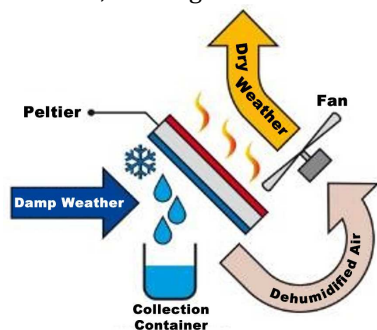

Figure 6. The Diagram of operating principle of dehumidifier with peltier.

4. CONCLUSIONS

The control of realized system was provided with 3 buttons. Arduino Mega 2560 was controlled with three buttons and the shifts were realized on the menu screen. By displaying the menu screen on LCD screen, the user was enabled to access the system modes easily. With the help of the rain sensor connected to the pin of Arduino Mega 2560, the liquid level in the reservoir was kept under control and the idle operation of the piezoelectric crystal was prevented. Additionally, the humidifying and dehumidifying units of the device were enabled to operate automatically, through the measuring the ambient humidity continuously with DHT11 temperature and humidity sensor.

The final version of the Ambient Humidity Stabilizer with Nebulizer and Dehumidifier is as shown in Figure 7.

Figure 7. The Ambient Humidity Stabilizer with Nebulizer and Dehumidifier

This device realized, can be used in health sector as well as in the facilities which the level of humidity is important such as pharmaceuticals, confectionery, food and oil, in order to increase the efficiency. Furthermore, it is thought that the studies carried out with this system will contribute to the literature.

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