GAS ELECTRIC VALVE DESIGN

Kartika[1], Ahmad Rezki Setiawan[2]
Prodi Teknik Elektro Fakultas Teknik, Universitas Malikussaleh, Lhokseumawe
Email: Kartika@unimal.ac.id

ABSTRACT

In this era of globalization, science and technology has developed rapidly, especially in the industrial world. As for science and technology that is beneficial to industry, namely for components of the production process, one of which is Valve control. This technology is used to modify the fluid flow or pressure rate in a process system by using power for its operation. The application of this control valve is used to control a pressure rate or quantity, such as the amount of oxygen gas content (O_2) and carbon dioxide (CO_2) in fruit and vegetable plants. In the research that has been carried out on the carbon dioxide (CO_2) process using a porous fiber membrane contactor, the gas model is absorbed in a pure state at cold room temperature. In this study, it is still an obstacle when applied in the field because there are many factors that have not been taken into account, so in an effort to control the wasted gas, an electric gas valve control system device is needed which is designed to determine the value of wasted gas. This system is designed with valve components, servo motors, solenoid valves, Arduino uno, and relays, where all these components are built and programmed with Arduino uno microcontroller. The results of the test are carried out to determine the level of accuracy of each input to the control valve and to determine the value of the gas wasted at the degree of opening of the valve. The test results on the ten forms of angular movement are when the valve works and opens at a movement angle of 0° to the movement, the valve opens at 0%. When the valve works and opens at an angle of movement of 10° to rotation, the valve opens by 11.1%, and when the valve works and opens at an angle of movement of 20° to 80° to the movement, the valve opens by 22.2% to by 88.8%, then when the valve works and opens at an angle of movement of 90° to the movement, the valve opens by 100% or fully opens. The benefits of this research in the performance process of production technology in industry are to meet consumer demand by producing safe, minimally processed, additive-free, and stable quality food.

Keywords: Control Valve, Servo Motor, Arduino Uno, Oxygen (O_2), carbon dioxide (CO_2)

1.INTRODUCTION

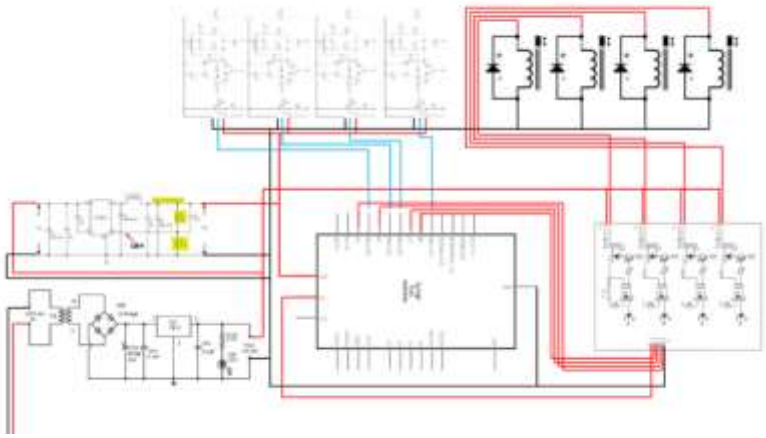
Fruits and vegetables are the most important part because they are nutritious. Fruits and vegetables contain vitamins, essential micronutrients, fiber, vegetable protein and biofunctional components, and chemical components found in fruits and vegetables: water, carbohydrates, protein, vitamins and minerals, and small amounts of lipids. In general, fruits and vegetables tend to be used as sources of vitamins and minerals. The benefits of fruits and vegetables are to prevent chronic diseases such as heart disease, cancer, diabetes and obesity, as well as eliminate micronutrient deficiencies. Naturally harvested fruits and vegetables undergo a process of aging and eventually spoil. Although isolated from the parent plant after harvest, fruits and vegetables are still actively metabolized by living tissues. One of the metabolic reactions that is closely related to the quality and shelf life of post-harvest fruits and vegetables is the respiration process. When actively breathing, fruits and vegetables utilize oxygen in the material and its environment, releasing carbon dioxide and water, and reaction products in the form of a certain amount of energy. The presence of oxygen promotes reactions related to food spoilage such as lipid oxidation, browning, and pigment oxidation. Oxygen also supports the growth of aerobic microorganisms that need oxygen to live, grow and reproduce the presence of oxygen promotes reactions related to food spoilage such as lipid oxidation, browning, and pigment oxidation. Oxygen also supports the growth of aerobic microorganisms that need oxygen to live, grow and reproduce the presence of oxygen promotes reactions related to food spoilage such as lipid oxidation, browning, and pigment oxidation. Oxygen also supports the growth of aerobic microorganisms that need oxygen to live, grow and reproduce[1][2].

Non-heat technology is a challenge that is applied as an alternative to fruit and vegetable products. The novelty and development of this heat-free technology is in line with the increasing consumer demand for safe, minimally processed, additive-free, and stable foods. The use of high-pressure carbon dioxide (HPCD) technology shows the potential to produce foods with natural properties when used alone or in combination with other processing techniques. High pressure carbon dioxide (HPCD) is a pasteurization process that affects microorganisms and enzymes, using pressures below 50 MPa and temperatures below 50 °C. This technique is very suitable for applications because CO2 is non-toxic, inexpensive, non-flammable, recyclable. leaving no residue on the product after the decompression process.[2][3].

In this era of globalization, science and technology is developing very rapidly. Industrial technology that develops from time to time. Technology is developing rapidly, and technical knowledge varies from person to person. In industry, knowledge is of little importance for anyone interested in industry in terms of materials and parts that are useful in the manufacturing process. One of the key components commonly used in industrial production is the control valve. A device used to change the fluid flow or pressure factor of a process system by using electricity to operate the process system. Control valves play an important role in industrial processes. Therefore, it is very important for businesspeople to know the benefits of control valves. This is especially important for students who are also entering the professional world.

2.RESEARCH METHOD

All control components on the gas electric valve system are arranged in a control box to make it neater and more protected. Meanwhile, the electrical valve components are arranged directly on the actuator control box according to their respective locations and functions. After the components are arranged, a circuit scheme is made for the gas electric valve control. The gas electric valve system is designed and processed by the Arduino Uno microcontroller with the Arduino IDE program. This program is carried out to control the performance of the relay in activating the solenoid valve for the fluid flow rate so that it can be adjusted. The overall circuit on the gas electric valve can be seen in Figure 1 as follows.



Picture1Electric Valve Control System Circuit

2.1. Solenoid Valve

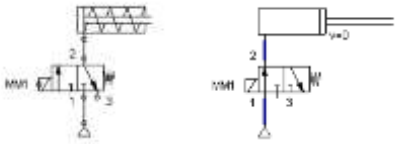
The solenoid valve is a type of coil made of a long cable that is tightly wound and it is assumed that its length is greater than its diameter as shown in Figure 1 which is the physical form of a solenoid valve.[5][6].

Picture2Solenoid Valve Physical Form

2.2. Solenoid Valve Working Principle

The principle of the solenoid valve was discovered by a French physicist named Andre Marie Ampere, in the field of engineering this term refers to a transducer device that converts energy into linear motion. The solenoid valve works electromechanically which has a coil as the driving force.

When the coil gets a voltage supply, the coil turns into a magnetic field to move the pluger (piston) inside. The actuator which has the working principle of opening and closing channels from two chambers is shown in Figure 3 (a) the initial/inactive position and Figure 3 (b) the working/active position which functions to continue and stop the fluid channel [5][6].



Picture3(a) Off Position (initial); (b) Active Position (work)

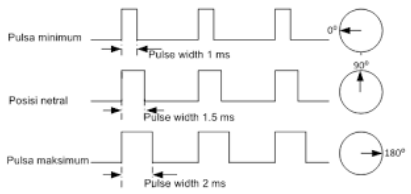
In Figure 3 (a) and (b) the inner shaft of the solenoid is a piston like cylinder made of iron or steel, the magnetic field then applies a pluger force to either attract or return it to its initial position. When the magnetic field is turned off, the pluger spring then returns to the initial/off position.

2.3. Servo Motor

Servo motor is a motor that has a closed feedback system function in which the position of the motor is sent back to the control circuit in the servo motor. Servo motor has several parts, namely motor, potentiometer, gear and control circuit. The function of the potentiometer on the servo motor is to determine the angle of the servo rotation.

2.4. Servo Motor Working Principle

The angle of rotation of the axis of the servo motor is adjusted by setting based on the width of the pulse distance sent through the signal leg through the motor cable. The relationship between the PWM pulse width and the direction of rotation of the servo motor can be seen in Figure 4 as follows.



Picture4The Relationship Between PWM Pulse Width with Rotation Direction In Servo Motors

2.5. Arduino Uno Microcontroller

Arduino UNO is a microcontroller board based on the ATmega328.

Arduino UNO has 14 digital input and output pins, 6 of which can be used as PWM outputs, namely on pins 11, 10, 9, 6, 5 and 3 with 8-bit resolution. Arduino UNO also has 6 analog input pins, namely on pins A0 - A5 with a resolution of 10 bits, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. Arduino UNO contains everything needed to support the microcontroller, it's easy to connect it to a computer with a USB cable or supply it with an AC to DC adapter or use a battery to get started.

2.6. Arduino Uno's Working Principles

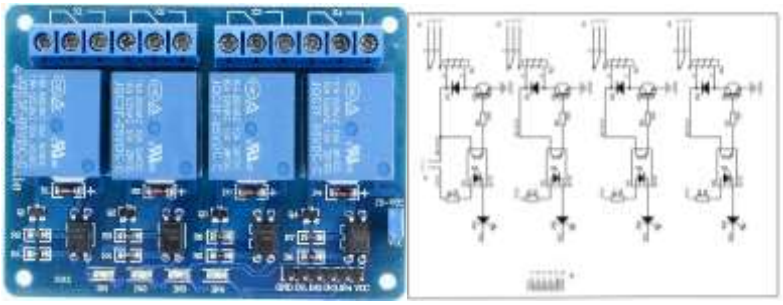
Unlike a computer system that is capable of handling various kinds of application programs (eg word processing, number processing and so on). The microcontroller can only be used for one particular application. Another difference lies in the comparison of RAM and ROM. In computer systems, the ratio of RAM and ROM is large, meaning that user programs are stored in a relatively large RAM space, while hardware interface routines are stored in a small ROM space. Whereas in the microcontroller, the large ratio of ROM and RAM means that the control program is stored in ROM which is relatively larger in size, while RAM is used as a temporary simple storage area.

2.7. Arduino Uno Pin Configuration

Arduino Uno is a board based on the microcontroller on the ATMega 328. This board has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack and a reset button. These pins contain everything needed to support the microcontroller, just connect it to a computer with a USB cable or a power source can be obtained from an AC-DC adapter or battery to use it.

2.8. Relay

Relay is a switch which is part of an electromechanical component consisting of 2 main parts, namely an electromagnet (coil) and a mechanical (contact switch) which is operated electrically. The physical form of the relay can be seen in Figure 5 (a), the relay circuit in Figure 5 (b) as follows.

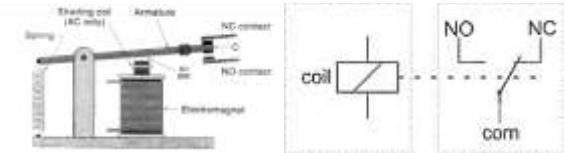


(a) (b)

Figure 5 (a) Relay Physical Form; (b) Relay Circuit

2.9. Relay Working Principle

Relays use electromagnetic principles to actuate switch contacts so that small currents (low power) can conduct higher voltages of electricity. There are 2 types of contact points, namely, Normally Close (NC) and Normally Open (NO). NC is the initial condition before activating it is always in the closed position. NO, meaning that the initial condition before being activated is always in the open position.Relays are used in electronic circuits as implementers as well as interfaces between loads and electronic control systems with different power supplies [9][10]. The simple working structure of the relay is shown in Figure 6 (a), the relay symbol is shown in Figure 6 (b) as follows.



(a) (b)

Figure 6 (a) Relay Working Structure; (b) Relay Symbol

Relay symbol In Figure 6 (b) on the left is a coil or coil and the right is a single pole double throw (SPDT) switch. If the coil is connected to the power supply, the switch that was "com" with "NC" becomes "com" with "NO". Pole is the number of contacts that the relay has, while throw is the number of conditions that the contact has [10].

The block diagram is made for the manufacture of this gas electric valve system including the manufacture of hardware and software. When the hardware and software manufacturing is ready, the monitoring system is tested to determine how well it is working.

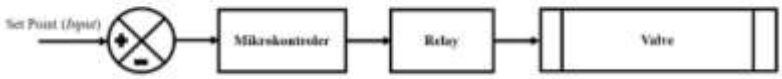


Figure 7 Block Diagram of Tool Work System

The working principle of the microcontroller is sending a control signal to activate the relay and servo motor, the relay is used to activate the solenoid valve and the solenoid valve is working, which is then responded by the servo motor, the servo motor is used to open and close the valve. The relay receives a signal from the microcontroller to adjust the degree of opening and closing of the valve. The following program flow diagram can be seen in Figure 8

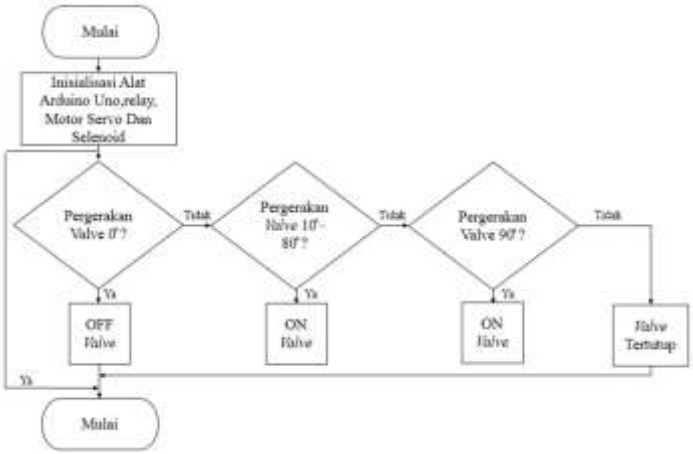


Figure 8 Program Flow Block Diagram

3.RESULTS AND DISCUSSION

3.1Result

The results of the test are carried out to determine the level of accuracy of each input to the control valve and to determine the value of the gas wasted at the degree of opening of the valve. The perspective of gas electric valve testing can be seen in Figure 12 below.

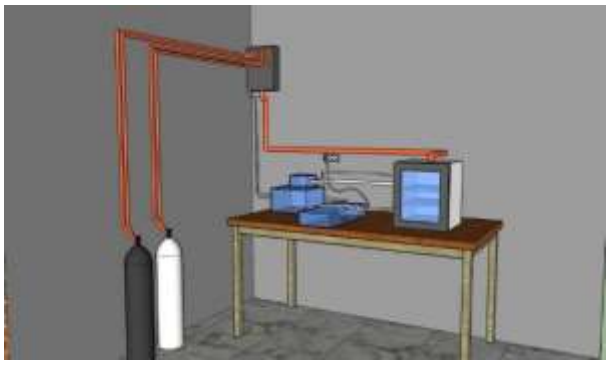


Figure 9 Perspective of Gas Electric Valve Testing

Gas electric valve testing is carried out on five triangular angles, namely 0°, 10°, 20°, 30°, 40°, 50°, 60°, 70°, 80° and 90°. The results of testing the movement of this valve can be seen in Table 1 below.

Table1Valve Movement Test Results

No	Valve Movement (°)	Valve Movement Value (%)	Information
1	0°	0%	Valve Not Open
2	10°	11.1%	Valve Open
3	20°	22.2%	Valve Open
4	30°	33.3%	Valve Open
5	40°	44.4%	Valve Open
6	50°	55.5%	Valve Open
7	60°	66.6%	Valve Open
8	70°	77.7%	Valve Open
9	80°	88.8%	Valve Open
10	90°	100%	Valve Open

In Table 1, the results of the valve movement test can be calculated. The results of manual calculations are as follows.

- When the valve works and opens at an angle of movement of 0° it can be calculated as follows.

$$\text{Movement Value (\%)} = \frac{\text{Movement Angle(°)}}{\text{Servo Rotation Precision angle (°)}} \text{x } 100\%$$

$$\text{Movement Value} = \frac{0°}{90°} \text{x } 100\%$$

$$\text{Movement Value} = 0\%$$

- When the valve works and opens at an angle of movement of 10° it can be calculated as follows.

$$\text{Movement Value(\%)} = \frac{\text{Movement Angle (°)}}{\text{Servo Rotation Precision angle (°)}} \text{x } 100\%$$

$$\text{Movement Value} = \frac{10°}{90°} \text{x } 100\%$$

$$\text{Movement Value} = 11{,}1\%$$

- When the valve works and opens at an angle of movement of 20° it can be calculated as follows.

$$\text{Movement Value (\%)} = \frac{\text{Movement Angle (°)}}{\text{Servo Rotation Precision angle (°)}} \text{x } 100\%$$

$$\text{Movement Value} = \frac{20°}{90°} \text{x } 100\%$$

$$\text{Movement Value} = 22{,}2\%$$

- When the valve works and opens at an angle of movement of 30° it can be calculated as follows.

$$\text{Movement Value (\%)} = \frac{\text{Movement Angle (°)}}{\text{Servo Rotation Precision angle (°)}} \text{x } 100\%$$

$$\text{Movement Value} = \frac{30°}{90°} \text{x } 100\%$$

$$\text{Movement Value} = 33{,}3\%$$

- When the valve works and opens at a movement angle of 40° it can be calculated as follows.

$$\text{Movement Value (\%)} = \frac{\text{Movement Angle (°)}}{\text{Servo Rotation Precision angle (°)}} \text{x } 100\%$$

$$\text{Movement Value} = \frac{40°}{90°} \text{x } 100\%$$
$$\text{Movement Value} = 44{,}4\%$$

- When the valve works and opens at an angle of movement of 50° it can be calculated as follows.

$$\text{Movement Value (\%)} = \frac{\text{Movement Angle (°)}}{\text{Servo Rotation Precision angle (°)}} \text{x } 100\%$$
$$\text{Movement Value} = \frac{50°}{90°} \text{x } 100\%$$
$$\text{Movement Value} = 55{,}5\%$$

- When the valve works and opens at an angle of movement of 60° it can be calculated as follows.

$$\text{Movement Value (\%)} = \frac{\text{Movement Angle (°)}}{\text{Servo Rotation Precision angle (°)}} \text{x } 100\%$$
$$\text{Movement Value} = \frac{60°}{90°} \text{x } 100\%$$
$$\text{Movement Value} = 66{,}6\%$$

- When the valve works and opens at an angle of movement of 70° it can be calculated as follows.

$$\text{Movement Value (\%)} = \frac{\text{Movement Angle (°)}}{\text{Servo Rotation Precision angle (°)}} \text{x } 100\%$$
$$\text{Movement Value} = \frac{70°}{90°} \text{x } 100\%$$
$$\text{Movement Value} = 77{,}7\%$$

- When the valve works and opens at an angle of movement of 80° it can be calculated as follows.

$$\text{Movement Value (\%)} = \frac{\text{Movement Angle (°)}}{\text{Servo Rotation Precision angle (°)}} \text{x } 100\%$$
$$\text{Movement Value} = \frac{80°}{90°} \text{x } 100\%$$
$$\text{Movement Value} = 88{,}8\%$$

- When the valve works and opens at an angle of movement of 90° it can be calculated as follows.

$$\text{Movement Value (\%)} = \frac{\text{Movement Angle (°)}}{\text{Servo Rotation Precision angle (°)}} \text{x } 100\%$$
$$\text{Movement Value} = \frac{90°}{90°} \text{x } 100\%$$
$$\text{Movement Value} = 100\%$$

3.2. Discussion

The test results on the ten forms of angular movement are when the valve works and opens at a movement angle of 0° to the movement, the valve opens at 0%, this calculation can be proven in the following formula. When the valve works and opens at an angle of movement of 10 ° to the rotation, the valve opens by 11.1%, when the valve works and opens at an angle of movement of 20 ° to the movement, the valve opens by 22.2%, when the valve works and opens at an angle of movement of 30° to the movement, the valve opens by 33.3%, when the valve works and opens at an angle of movement of 40° to the movement, the valve opens by 44.4%,

4.CONCLUSION

The conclusions obtained from testing the control valve are.

1. From these tests the control valve works manually in accordance with the research carried out, namely the electric gas valve testing is carried out on five triangular angles, namely 0°, 10°, 20°, 30°, 40°, 50°, 60°, 70°, 80 ° and 90°.
2. When the valve works and opens at an angle of movement of 0° to the movement, the valve opens at 0%. When the valve works and opens at an angle of movement of 10° to rotation, the valve opens by 11.1%.
3. When the valve works and opens at an angle of movement of 20° to 80° to the movement, the valve opens by 22.2% to 88.8%.
4. When the valve works and opens at an angle of movement of 90° to the movement, the valve opens 100% or fully opens.

REFERENCES

Kartika. (2022). “Temperature And Humidity Optimization to Add Save Life Strawberry (Fragaria chiloensis, L.)”. International Journal of Science and Environment (IJSE), 2(1), 1–13.

Sk, R., Nazaruddin, N., & others. (nd). (2017). Effect of Biogas Volume of Rice Waste Anaerobic Reactor on Light Intensity of Petromak Lamp. Influence Of Biogas Volume Of Anaerobic Reactor Of Rice Straw Waste To Light Intensity Petromak Lamp. Engineering Poly, 1–11.

AA Prihanto, (2017). Physicochemical Reaction of Traditional Fishery Products. Universitas Brawijaya Press.

N. Fonna, (2019). Development of the Industrial Revolution 4.0 in Various Fields. Guepedia.

AB Pulungan, AM Putra, H. Hamdani, and H. Hastuti,(2020) “Turbidity and pH Control System for Tilapia Cultivation Pond Water,” ELKHA J. Tek. Electro, vol. 12, no. 2, pp. 99–104.

Taghizadeh, M., Ghaffari, A., & Najafi, F. (2009). Modeling and identification of a solenoid valve for PWM control applications. Comptes Rendus - Mecanique, 337(3), 131–140. https://doi.org/10.1016/j.crme.2009.03.009

Syafaah, L., Suhardi, D., & Pakaya, I. (2016). Optimal Proportional-Integral (PI) Control in DC Servo Motor Using Particle Swarm Optimization (PSO) Algorithm. 613–618.

A. Amarudin, DA Saputra, and R. Rubiyah, (2020). "Design of Fish Feeding Equipment Using a Microcontroller," J. Ilm. Mhs. Full Dan List., vol. 1, no. 1, pp. 7–13.

Hasibuan, A., Kartika, Qodri, A., & Isa, M. (2021). Temperature Monitoring System using Arduino Uno and Smartphone Application. Bulletin of Computer Science and Electrical Engineering, 2(2), 46–55. https://doi.org/10.25008/bcsee.v2i2.1139

I. Nugrahanto, (2017). "Development of a Water Level as a Transistor-Based Automatic Water Pump Controller," J. Sciences Tech., vol. 13, no. 1, pp. 59–70.