Volume 8, No. 1, May 2024, pages 01 - 11

JEE

Jurnal Edukasi Elektro

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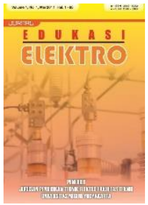

Design of Thermoelectric-Based Salinity and Temperature Control for Nomei Fish

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Abstract— Nomei fish (Harpodon nehereus) are creatures commonly found under layers of mud or fine sand along the coast. They cannot survive in waters with extreme salinity and temperature. When daylight comes and the air temperature rises, the temperature inside the fishpond also tends to rise, while when night falls, the water in the pond becomes colder. Extreme temperature changes, both high and low, can make these fish susceptible to disease and impact their ability to feed and immune system. This research is developmental research as the objective is to test the control of salinity and temperature in Nomei fishponds. To achieve this goal, a system has been developed. The system uses two sensors, namely a conductivity sensor that serves to measure the level of water salinity and sends data to the Arduino device to set the pump based on an average of about 17 ppm. In addition, there is also a temperature sensor that measures the water temperature in the pool and sends data to the Arduino device to adjust the heater and thermoelectric based on the average temperature between 28.5°C and 31.5°C, to maintain stable water quality. The results of this study show that the developed system successfully maintains and controls the salinity and temperature in the Nomei fishpond in accordance with the predetermined set points.

Keywords: nomei fish, temperature, salinity, system control, microcontroller

Article submitted 2023-10-05. Resubmitted 2023-11-06. Final acceptance 2023-12-19. Final version published as submitted by the authors.

1 Introduction

Tarakan is an island located in the North Kalimantan region has abundant sources of marine products in the fisheries sector, one of the fishery products on the island of Tarakan is Nomei fish [1]. Nomei fish which has a Latin name, namely (Harpodon nehereus) is a special fish and is a characteristic of the city of Tarakan, because this fish is included in one of the endemic fish that is only found in the coastal waters of Tarakan City, precisely in the sea Friday area. Nomei fish is included in the demersal fish that commonly live in the coastal areas of Tarakan City and is originally located in muddy areas, estuaries, coastal areas, and this fish has a body length of around 40 cm, and generally between 20 – 25 cm. Food from Nomei fish in the form of basic animals and small fish so that this fish is classified into the group of wild fish [2].

One of the characteristics of Tarakan City is the Nomei fish which can only be found in the waters of Tarakan City and its surroundings. Predators, such as albino dolphins that inhabit the sea near the waters of Juata Tarakan City, like to eat Nomei fish. Given the importance of the potential of Nomei fish, studies on Nomei fish are needed to ensure their existence can continue sustainably [3].

Nomei fish is one type of fish with high economic value with a selling price of around IDR. 600,000 per 25kg (basketball). The people of Sea Juata call Nomei fish as mushy fish or dried fish [4].

Temperature is like a big problem for creatures living in the ocean. It affects how they live and make babies. That's why some animals are only found in certain parts of the world where the water is warm enough for them, such as coral animals in the tropics and subtropics [5],[6].

Salinity is how salty water is. This is measured by how much salt is in each liter of water [7],[8]. It is usually measured using special units. Oceans contain salt, and some sea creatures can handle different amounts of salt better than others. Some fish can swim in salty and less salty water, in contrast others need a fixed amount of salt to survive. Some creatures like crayfish cannot handle large changes in the amount of salt in the water [9],[10].

To prevent the decline in population levels of Nomei fish, it is necessary to do a way to overcome the problem, namely by sustainable cultivation appropriately and synergistically. Nomei fish or by other names pepija fish has a poor survival rate or cannot stand, this is evidenced from the results of catching by fishermen using nets, therefore Nomei fish need to be cultivated by domestication. Domestication is the process of adaptation or transfer of fish from their natural habitat into a controllable pond. Domestication is carried out with human intervention through stages that are carried out systematically, so that domestication here can also be interpreted as a series of adaptation activities or adjustment of fish to a new place of residence [11],[12]. This study aims to develop pond water temperature control technology as part of the Nomei fish domestication system. The control of pond water temperature aims to maintain a stable temperature in the pond, so that the Nomei fish in it can survive well.

2 Method

In this study, the authors used the development research method, given that the main objective is to test the control of salinity and temperature in pond water. Based on the description in the introduction, the author will carry out an implementation related to controlling the temperature and salinity of Nomei fishpond water to match its natural habitat conditions. In the context of this research, control becomes a crucial aspect in achieving predetermined levels of salinity and water temperature. In accordance with the title of the research, namely " Design of thermoelectric-based salinity and temperature control for nomei fish" which involves the use of microcontrollers as a means of controlling the water quality of fishponds, this research can be summarized as research that focuses on two main parameters, namely salinity and temperature in Nomei fishpond water.

This research involves the implementation of a microcontroller to control the water temperature in the Nomei fishpond. This research will be carried out with systematic steps and in accordance with the research objectives. The stages that will be carried out in this research are as follows.

2.1 Literature study

Literature study is reviewing references that meet literature studies is reviewing references that meet the theoretical basis related to student research and is a stage for students to conduct guidance during research related to problems that are difficult to solve.

2.2 Design

At this stage, designing control of pond water quality by making flow charts to be proposed and block diagrams for the control system and preparing tools and materials in the design process. The design of the tool will focus on the design of tools for control or control of pool water quality with salinity and water temperature parameters.

2.3 Testing

At this stage, testing the temperature control of the pool water, whether the temperature of the pool water is in accordance with the data displayed. If the expected goal has not been achieved from the test, further studies will be carried out on ideas or solutions that can solve the problem so that the goal can be achieved. At this stage, testing the temperature control of the pool water, whether the temperature of the pool water is in accordance with the data displayed. If the expected goal has not been achieved from the test, further studies will be carried out on ideas or solutions that can solve the problem so that the goal can be achieved.

2.4 Report writing

In the report, the author explains what has been done during the stages of research, so that the author can explain what the problems are faced when conducting research.

One of the relevant studies is conducted by [13] entitled "Application of the Internet of Things System in Water Quality Monitoring". In this study, the researchers designed and built a telemetry system with the aim of monitoring the acidity (pH) and conductivity of water. They used various equipment, including a pH sensor, conductivity sensor, RTC (Real Time Clock), data logger, and XBee PRO which serves as a wireless communication medium. The test results revealed that under Line-of-Sight (LOS) conditions, the XBee PRO device is capable of transmitting data up to 500 meters. The acidity (pH) sensor can measure the pH range between 1 to 14 with 100% accuracy when compared with litmus paper as a comparison. Meanwhile, the conductivity sensor, which uses a two-pole electrode, showed an accuracy rate of 94.483%. However, this research has limitations that need to be considered, namely the use of only one node in the system. This results in limitations in the use of this system when applied to monitor more than one sample simultaneously. In future research, the development of the system considering a wider range of monitoring needs may need to be considered.

Another related research [14] is about the automation of monitoring and regulating the acidity level and water temperature in catfish hatchery ponds. In this study, they developed automation to monitor the pH level and water temperature. They used Electrode Eutech Instrument pH Meter Kit as the pH sensor, LM35 as the temperature sensor, and HCSR-04 ultrasound sensor to control the water level in the pond. The results of the pH and water temperature measurements are displayed directly on the LCD screen and in graphical form on the monitor screen, making it easier for catfish hatcheries to monitor the condition of the pond water more effectively. Figure 1 is a flowchart of the stages that will be carried out in writing the report so that it is achieved in this study.

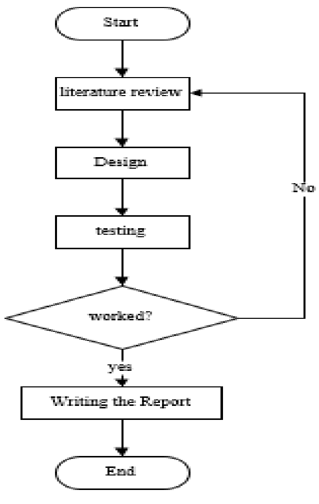

Fig. 1. Flowchart

The design of the tool will be divided into three, namely electric design, mechanical design, and overall design of the system to be followed in the Figure 2.

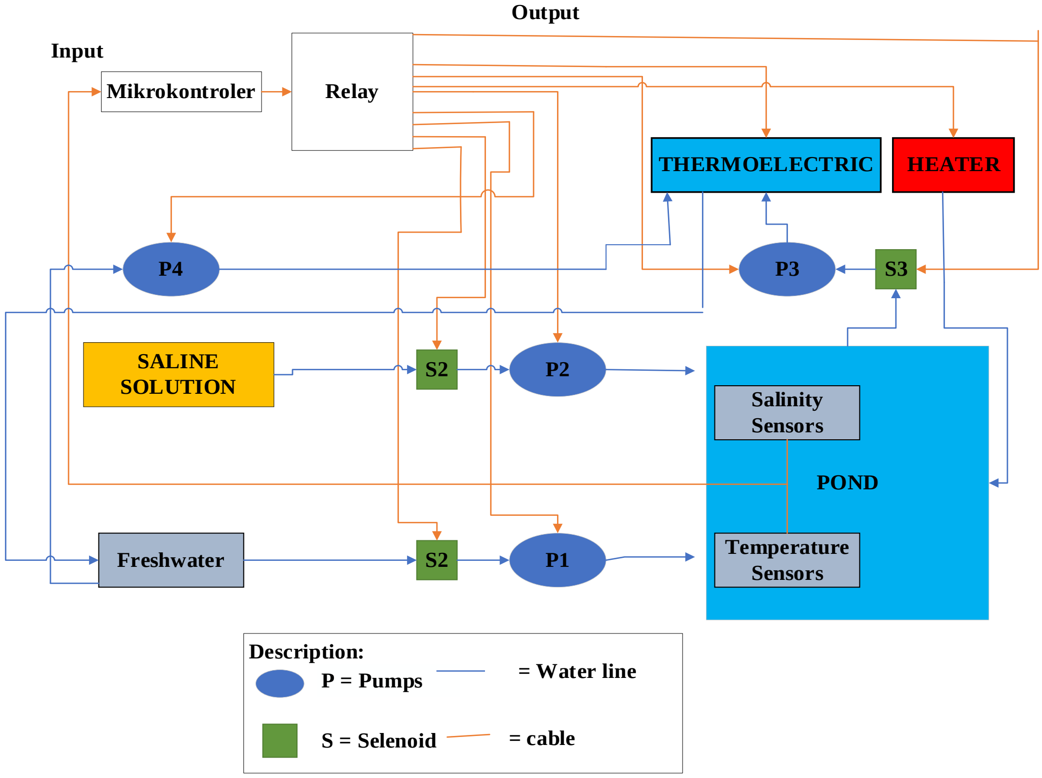

Fig. 2. Design overall block

In the block diagram of Figure 2 the S (solenoid valve) here functions to open and close the flow of water. P (pump) here serves as a tool to drain water into the pool. Which is where P1 (water pump with AC source) and P2 (water pump with DC source). When the pool water is in normal condition, there is no pump or solenoid that will work or turn on [15].

3 Result and Discussion

3.1 Design and assembly of salinity and temperature control of pool water

The design and assembly of salinity and temperature control of pool water is built consisting of power supplies, microcontrollers, salinity sensors, temperature sensors, relays, and LCD. In the assembly of this tool there is a circuit that is in the control box is on the inside of the control panel box as the controller of this entire system.

Fig. 3. Design an overall control device

Explanation for Figure 3:
a. temperature sensor,
b. salinity sensor,
c. box panel,
d. water pump,
e. reservoir.

Figure 3 is a view of the overall system of the tool. (a) a temperature sensor where the pool sensor placement is placed vertically. (b) The salinity sensor is placed side by side with the temperature sensor with the continuity of both sensors equal. (c) a panel box which contains the control circuit of the entire system of the device. (d) pumps and (e) reservoirs here function as freshwater reservoirs.

3.2 Sensor Testing Salinity

Sensor testing is carried out to determine whether the salinity sensor readings are in accordance with what is desired, which is to be able to read the dissolved salt content in the pool water to match the ultimate goal of the study. Before using a salinity sensor, it is necessary to calibrate it first as described in the previous chapter.

For calibration, a simple linear regression method is carried out in a container containing 250 ml salt solution water inserted 1 spoon of salt to see the response of readings from sensors and measuring instruments in several experimental samples, where the values of the regression coefficients and variables are used as equations to find the salinity value of the sensor readings [16]. The test is carried out by taking a sample from the container and placed on the refractometer lens to see the salinity value readings and for the salinity sensor it is done by inserting an electrode rod from the sensor into a container containing salt solution to see the readings on the serial monitor.

Table 1. Calibration data of salinity sensor and refractometer measuring instrument

No	Gauge Value	Sensor readings
	Salinity (Ppm)	**ADC (Bit)**
1	10	679.1
2	20	694.5
3	28	703.3
4	38	710.3
5	52	720
6	66	725.3
7	75	728.8
8	87	733.7

From Table 1, salinity sensor calibration data and refractometer measuring instruments can be made a graph by entering the data into Microsoft Excel which will then display the graphic form of the scatter data diagram. The appearance of the equation y, R squared, and black straight lines as signs of linear data.

Table 2. Testing Sensor Salinity

Sample	Lots of Salt (spoon)	Instrument reading	Sensor reading	*Error* (%)	Accuracy (%)
1	1	10	-2.7	127	-27
2	2	20	20.65	3.25	96.75
3	3	28	33.99	21.39	78.61
4	4	38	44.61	17.39	82.61
5	5	52	59.32	14.07	85.93
6	6	66	67.35	2.04	97.96
7	7	75	72.66	3.34	96.66
8	8	87	80.09	7.94	92.06
Average				24.55	75.44

To find error values from Table 2. can be done as follows: [17]

$$Error\ (\%) = \frac{Measuring\ Instrument\ Value - Sensor\ Reading\ Value}{Measuring\ Tool\ Value} \times 100 \quad (1)$$

$$Error \quad = \frac{20-20.65}{20} = -3.25\%$$

$$absolut = 3.25\%$$

To find the sensor accuracy value from Table 2. can be done as follows:

$$Accuracy = 100\ \% - Error\ (\%) \quad (2)$$

$$Accuracy = 100\% - 3.25\% = 96.25\%$$

Testing the salinity sensor after calibration can be seen that the average sensor error is 24.55% and accuracy is 75.44%.

3.3 Sensor Testing Temperature

In this sensor test carried out at 08.00-22.00 WITA, in this sensor test we can see variable temperature changes depending on the heater and cooler turned on by a control box system. The purpose of testing this temperature sensor is to find out the level of accuracy and desired criteria [18]. The following is a scatter diagram drawing of the correlation between the response variable (sensor reading) and the predictor variable (salinity value).

Table 3. Testing temperature sensor

Sample	Instrument reading	Sensor reading	*Error* (%)	Accuracy (%)
1	18.4	18.5	1.66	98.34
2	23.5	23	1.35	98.65
3	29.5	29.4	0.17	99.83
4	32	31.8	0.20	99.80
5	33.25	33.1	0.06	99.94
6	34.4	33.9	1.09	98.91
7	37.5	38	1.61	98.39
8	36.5	36.2	0.51	99.49
Average			0.83	99.1

It can be seen to find the error value can be done with equation (1) and for the sensor accuracy value can be found with equation (2). From the data above, it can be concluded that for testing temperature sensors in table 4.6. It has an average error of 0.83% and its sensor accuracy value has an average of 99.1.

3.4 Testing Salinity Up to Down

Up to down salinity testing is carried out by adding fresh water to the pond according to a predetermined sensor set point [19]. In the Table 4 can be seen the results of up to down salinity testing with an interval of 3 minutes, the salinity value of pool water will decrease gradually with an average decrease of 3.0316% and the average volume of increase in pool water of 2.15373%.

Table 4. Testing salinity up to down

No	Time (minute)	Salinity (ppm)	Preset decrease in salinity (%)	Volume (liter)	Preset decrease Volume water (%)
1	3	17	3.0303	1444.4	4.16667
2	6	16.5	3.125	1507.2	2.04082
3	9	16	0	1538.6	2

No	Time (minute)	Salinity (ppm)	Preset decrease in salinity (%)	Volume (liter)	Preset decrease Volume water (%)
4	12	16	3.2258	1570	1.96078
5	15	15.5	3.3333	1601.4	1.92308
6	18	15	3.4483	1632.8	1.88679
7	21	14.5	3.5714	1664.2	1.85185
8	24	14	3.7037	1695.6	1.81818
9	27	13.5	3.8462	1727	1.73542
10	30	13	-	1757.5	-
Average down salinity (%)				3.0316	
Average volume water (%)				2.15373	

3.5 Testing Salinity Down to Up

Up to down salinity testing is carried out by adding fresh water to the pond according to a predetermined sensor set point [19]. In the Table 5 can be seen the results of up to down salinity testing with an interval of 3 minutes, the salinity value of pool water will decrease gradually with an average decrease of 3.0316% and the average volume of increase in pool water of 2.15373%.

Table 5. Testing Salinity down to up

No	Time (minute)	Salinity (ppm)	Preset decrease in salinity (%)	Volume (liter)	Preset decrease Volume water (%)
1	3	17	3.0303	1444.4	4.16667
2	6	16.5	3.125	1507.2	2.04082
3	9	16	0	1538.6	2
4	12	16	3.2258	1570	1.96078
5	15	15.5	3.3333	1601.4	1.92308
6	18	15	3.4483	1632.8	1.88679
7	21	14.5	3.5714	1664.2	1.85185
8	24	14	3.7037	1695.6	1.81818
9	27	13.5	3.8462	1727	1.73542
10	30	13	-	1757.5	-
Average down salinity (%)				3.0316	
Average volume water (%)				2.15373	

3.6 Testing Temperature Up to Down

Up to down salinity testing is carried out by adding fresh water to the pool according to a predetermined sensor set point [19]. It can be seen the results of up to down temperature testing in Table 6. with an interval of 2 hours, the pool water temperature will decrease gradually with an average temperature decrease of 1.769% due to the active cooler system in the thermoelectric system [18].

Table 6. Testing temperature up to down

No	Time	Temperature value	Preset down temperature (%)
1	2	29,25	5,405
2	4	27,75	0,909
3	6	27,5	0,917
4	8	27,25	2,830
5	10	26,5	1,923
6	12	26	0,970
7	14	25,75	0,980
8	16	25,5	0,990
9	18	25,25	1
10	20	25	-
Average preset down temperature (%) 1,769			

3.7 Testing Temperature Down to Up

Down to up quality testing is done by adding a saltwater solution to the pool, after which the sensor will read changes in salinity values that occur in the pool over time [20]. It can be seen the results of down to up temperature testing in Table 7 with an interval of 1 hour, the pool water temperature will gradually increase by an average of 0.885% due to the active heating system into the pool.

Table 7. Testing temperature down to up

No	Time	Temperature	Preset Up temperature (%)
1	2	27	0,917
2	4	27,25	0,909
3	6	27,5	0,900
4	8	27,75	0,892
5	10	28	0,884
6	12	28,25	0,877
7	14	28,5	0,869
8	16	28,75	0,862
9	18	29	0,854
10	20	29,25	-
Average up Temperature (%) : 0,885			

3.8 Full Open Loop Testing Pool Water Temperature

Open loop is carried out for 1 × 24 hours with the condition that the volume of pool water is fixed, and the circulation pump will remain on to make circulation in the pool water with the aim that the condition of the water at the bottom and surface of the pool remains the same.

Table 8. Full open loop testing poll water temperature

No	Time	Temperature (ºC)
1	7:32 PM	33
2	8:30 PM	33
3	9:30 PM	33
4	10:30 PM	33
5	11:30 PM	33
6	12:30 AM	28
7	1:39 AM	28
8	2:30 AM	28
9	3:31 AM	27,75
10	4:30 AM	28
11	5:44 AM	27,75
12	6:31 AM	28
13	7:30 AM	27,75
14	8:30 AM	27,75
15	9:32 AM	27,5
16	10:43 AM	27,75
17	11:47 AM	27,75
18	12:30 PM	27,75
19	1:30 PM	27,5
20	2:30 PM	27,5
21	3:31 PM	27,5
22	4:32 PM	28
23	5:30 PM	28
24	6:30 PM	28
25	7:30 PM	32,75

You can see the test results of Table 8. Open loop pool water temperature with an interval of 1 hour taking pool water temperature data will decrease. At 19:30 – 00:30 the pool water temperature is still in the range of 33 ˚C and at 01:39 – 15:31 the pool water temperature decreases and is at 28 ˚

C and at 17:30 – 19:30 the pool water temperature value will decrease and has reached the range of 27.75 ˚C values.

3.9 Full Close Loop Testing Pool Water Temperature

Close loop is carried out for 1 × 24 hours with the condition that the volume of pool water remains fixed with a circulation pump and the entire system remains on such as sensors, coolers, and heaters.

Table 9. Full close loop testing poll water temperature

No	Time	Temperature	Condition
1	1:08	27	Abnormal
2	2:08	27,75	Abnormal
3	3:06	28,5	Normal
4	4:33	28	Normal
5	5:10	28,5	Normal
6	6:37	28,25	Normal
7	7:13	28,25	Normal
8	8:02	28,5	Normal
9	9:00	28,5	Normal
10	10:00	28,5	Normal
11	11:00	28,5	Normal
12	12:00	28,5	Normal
13	13:00	28,75	Normal
14	14:00	28,75	Normal
15	15:01	28,75	Normal
16	16:00	28,75	Normal
17	17:00	28,75	Normal
18	18:00	28,75	Normal
19	19:00	28,5	Normal
20	20:00	28,5	Normal
21	21:08	28,5	Normal
22	22:01	28,25	Normal
23	23:04	28,25	Normal
24	0:17	28,25	Normal
25	1:03	28	Normal

Table 9 shows the results of close loop pool water temperature data collection with an interval of 1 hour. At 01:08-02:08, the pool water temperature reads around 27°C, which indicates that the pool water temperature is below the predetermined sensor set point range. However, at 03:06-18:00, the pool water temperature reads between 28.5°C to 28.75°C, indicating that the pool water temperature is normal. At 19:00-01:03, the pool water temperature again ranged from 28.5 ° C to 28.75 ° C, indicating that the pool water temperature remained normal because it had been heated by the heater.

Based on the test results of the Nomei fishpond water temperature and salinity regulator, the salinity sensor gets an error value of 24.55% with an accuracy rate of 75.44%. The ability of the tool to reduce salt levels by 4 ppm within 24 minutes and increase salinity levels by 5 ppm at the same time shows a very good system response. The sensor can measure salt content and water temperature controlled by Arduino. On the other hand, for the temperature sensor, the error value is only about 0.83% with an accuracy rate of 99.17%. In taking data, the device can reduce the temperature within 2 hours, with an initial temperature of 29.75°C down to 25°C. Meanwhile, to increase the pool water temperature, this tool takes 30 minutes, with an initial temperature of 26.5°C rising to 29.25°C. The overall system performance test results show that the system can control the salinity and temperature of the fish pond water according to the commands from the sensor properly.

4 Conclusion

The test results of the Nomei fishpond water temperature and salt level regulator show that the salinity sensor has an error of 24.55% with an accuracy level of 75.44%. The tool can reduce salt levels by 4 ppm within 24 minutes and increase salinity levels by 5 ppm within the same time. This indicates a very good system response, with the ability of the sensor to read salt levels and water temperature controlled by Arduino. While in the temperature sensor, the error that occurs is only about 0.83%, with an accuracy rate of 99.17%. In taking data, the tool can reduce the temperature within 2 hours, from an initial temperature of 29.75°C to 25°C. Similarly, to increase the pool water temperature, it only takes 30 minutes, with an initial temperature of 26.5°C increasing to 29.25°C. Overall, the system performance test results show that the system can control the salinity and temperature of the fishpond water according to the commands given by the sensor. Although the system is effective, there are some weaknesses that need to be considered. One of them is the time required for sensor readings which is quite long. Therefore, further research can be focused on using sensors with better performance, as well as developing devices with the integration of several additional measurement parameters, such as oxygen levels, humidity, pond water level, and other relevant sensors.

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