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# DEVELOPMENT OF REAL-TIME WATER QUALITY MONITORING SYSTEM OF TILAPIA FISH FARMING

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**Abstract**

Aquaculture plays a very important role in the Malaysian economy. The demand for fish has increased worldwide as populations have grown, incomes have increased, and the nutritional benefits of fish have become better known. Tilapia is an important farmed freshwater fish in Malaysia. With increasing consumer's acceptance and demand for tilapia fillets, the tilapia farming industry has been steadily expanding in the last few years, with 85 countries producing 1.526 million metric tons in 2003. However, the current method of raising Tilapia in the Malaysia is through fishponds exposed to the weather. Methods for measuring pH, temperature, and ammonia are limited to manually using a chemical test kit. The current application system depends on manually regulating the water quality, so the fish are at risk of harmful situations resulting from unsafe levels of temperature, pH, or ammonia. Thus, this problem can be solved by creating a system that automatically measures and regulates the pH, temperature, and ammonia while computing their factor, to allow the user to measure the behaviour of the parameters at given time, process, send the data to a MATLAB database, and use the data to automatically take corrective action against harmful levels of pH, temperature, ammonia and while notifying the user through Blynk application.

## 1.0 INTRODUCTION

The current system relies on manually regulating the water quality, so the fish are at risk of harmful situations resulting from unsafe levels of temperature, pH, dissolved oxygen, or ammonia. This major issue can affect the water quality as well as the health level of fish, one of parameters that must be maintained is ammonia levels. Ammonia levels which are left high will be harmful to the health of fish when the fish unable to extract energy from feed efficientlyso that it can cause death.

Manual system in fish farming is a little bit intense since the farmer is needed to monitor all the parameters regularly by presenting themselves at the ponds. They need to check and monitor the pH levels, ammonia, and temperature repetitively to obtain the feedback, but it may cause redundant result. Alternatively, controlling all the parameters using automatic system can be beneficial. It can improve aquatic product quality by controlling and monitoring the parameters to maintain the water quality to ensure fish healthiness so that can minimize fish death besides competition.

## 2.0 EXPERIMENTAL Project

### Overview

This project or thesis provide a potential to allow the student to demonstrate a diffusion of skills, as well as capability to set up a research, conduct the study needed, manage their time and resources. In this project, monitoring the waterquality of the Tilapia fish is crucial to maintain thefish healthiness by controlling the parameters which are pH between 6 to 8, ammonia between 0 than 80 ppm, and temperature between 20◦c to35◦c. When pH levels go away (up or down), animals can be depressed, and the hatching and survival rates can be decreased. The higher the mortality rates the higher outside of the optimal pH range. In addition to biological implications, extreme pH levels typically increase the solubility of elements and compounds, make toxic chemicals more "mobile" and increase the risk of water life absorption. Besides, oxygen for all types of life is a critical ingredient. In order to provide for aerobic life forms, natural stream purification processes need sufficient amounts of oxygen. As the water dissolves less than 2.55 ppm with oxygen, water life is pressured. The lower the amount, the more stressful the fish are. Oxygen levels below than 2.55 ppm can causelarge fish to die for a couple of hours. Moreover, for several days, Tilapia fish will produce waste. This waste is called ammonia. This ammonia is toxic for fish they are allowed to accumulate in fish production systems. When ammonia builds upto toxic levels, fish cannot extract energy from feed efficiently. If the concentration of ammonia gets high enough, the fish can lead to coma and die.

## 3.0 Operating System Overview

1. Temperature Flowchart

Figure 3.2 above shows the process of flowchartfor controlling and monitoring the temperature value. Firstly, the system will be in the normal mode. When the water reaches below 20◦c, the heater will on until the temperature reach more than 25◦c. After the temperature reach more than 25◦c, heater will off and then solenoid valve (SV1) for 30 seconds to flow the water inside the fish tank. The solenoid valve (SV1) will off after 30

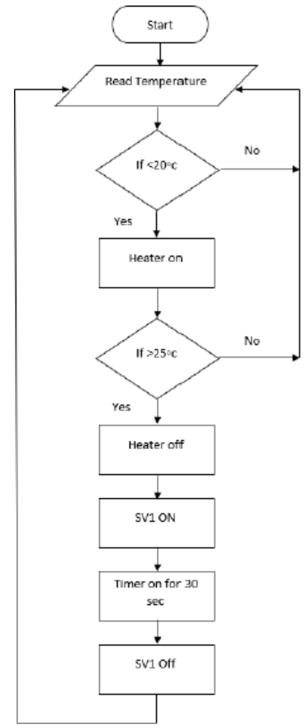
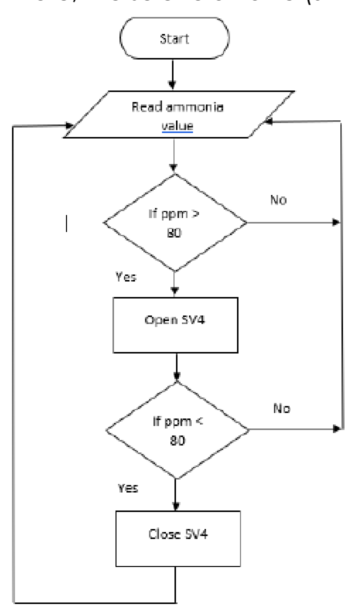



Figure 1: Flowchart

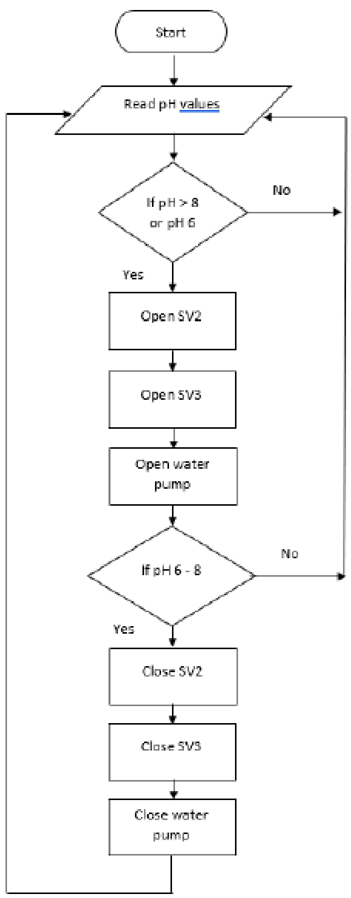
2. Ammonia Flowchart

Figure 3.4 shows flowchart for ammonia detection and controlling in fish tank. When ammonia sensor detects high concentration of ammonia value of the water above 100ppm, the solenoid valve (SV4) will open to drain out the wastewater for one minute. After one minute, the solenoid valve (SV4) will close.



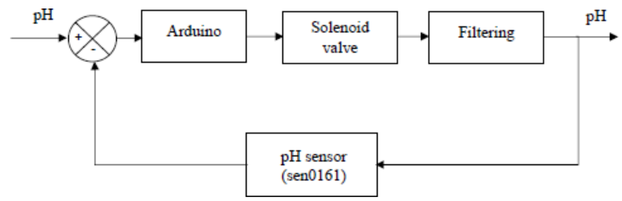
### 3. Ph Flowchart

Figure 3.3 above shows a flowchart for controlling and monitoring the pH value for water in fish tank. Firstly, the pH sensor will detect the pH value inside the water regularly. When the pH value of the water rises to 8, solenoid valve 3 (SV3), solenoid valve 2 (SV2) and water pump will open to drain out the wastewater for 1 minute into filter tank and notify the user through blynk application. After 1 minute, the pH value will drop since the water decreases. So, the solenoid valve (SV3), solenoid valve 2 (SV2) and water pump will close. This valve is connected to water tank to supply new water to replace the drain water. The pH value will be reached at set point between 5-8.



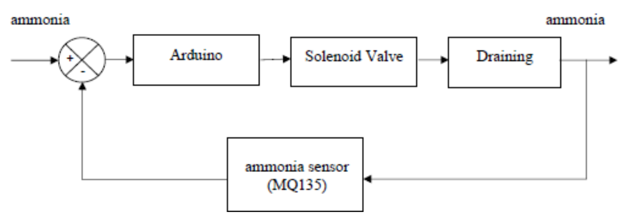

## 4.0 Block Diagram

### 4.1 Ph



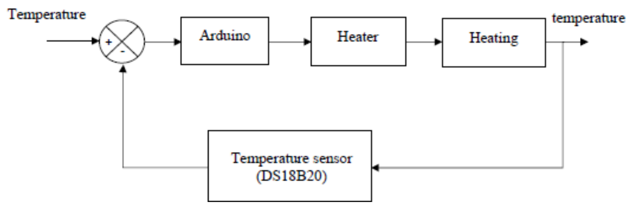

This pH sensor would monitor the actual pH value of the water between 5 - 8 and compare it with the input reference. The error signal is amplified by the controller, and the controller output makes the necessary correction to the solenoid valve to reduce any error. For example, if the pH value is more than 8, solenoid valve will open to drain out approximately 50% of water and pump the water inside the filter tank.

### 4.2 Ammonia




Close-loop control always implies the use of feedback control action in order to reduce anyerrors within the system, and its feedback which distinguishes the main differences between an open-loop and a closed-loop system. Theammonia sensor will monitor the ammonia value of the water. The tolerance of ammonia for the Tilapia fish is lower than 80 ppm. The sensor will detect the behaviors of the ammonia with comparing them with input reference. If the ammonia value increased more than 80 ppm (error signal) which amplified by the controller, the controller output makes the necessary correction to the solenoid valve to reduce any error by draining process.

### 4.3 Temperature

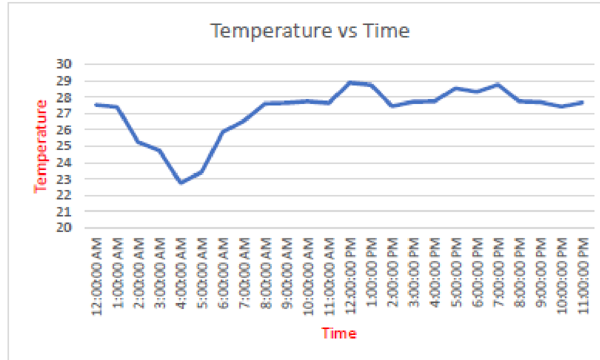



The preferred temperature range for optimum tilapia growth is 20◦c to 35◦c. Growth reducessignificantly at temperature below 20◦c and death will occur below 10◦c. The temperature of the fish tank may be affected by the surrounding temperature or the water source used. So, the temperature behaviour is needed to monitor from time to time by temperature sensor. When the input reference is difference from the set point, the controller output will make an adjustment according to the set point to eliminate the error.

## 5.0 Result & Discussion

### 5.1 Relationship between time and temperature of fish tank

| Time | Temperature(°C) |
|---|---|
| 12:00:00 AM | 27.54 |
| 1:00:00 AM | 27.41 |
| 2:00:00 AM | 25.60 |
| 3:00:00 AM | 24.75 |
| 4:00:00 AM | 22.75 |
| 5:00:00 AM | 23.93 |
| 6:00:00 AM | 25.87 |
| 7:00:00 AM | 26.56 |
| 8:00:00 AM | 27.62 |
| 9:00:00 AM | 27.66 |
| 10:00:00 AM | 27.75 |
| 11:00:00 AM | 27.64 |
| 12:00:00 PM | 28.89 |
| 1:00:00 PM | 28.76 |
| 2:00:00 PM | 27.46 |
| 3:00:00 PM | 27.73 |
| 4:00:00 PM | 27.75 |
| 5:00:00 PM | 28.55 |
| 6:00:00 PM | 28.35 |
| 7:00:00 PM | 28.77 |
| 8:00:00 PM | 27.75 |
| 9:00:00 PM | 27.71 |
| 10:00:00 PM | 27.43 |
| 11:00:00 PM | 27.68 |




From the collected data, the graph is generated to observe the trend of the data. From the graph shown in Figure 27, it can conclude that the temperature is affected by a time in one day. The lowest peak of the temperature occurs between 4.00 am and 5.00 am which is 24.75°c and 24.43°c. During this time, the temperature is drop due to cold weather caused by morning dew. The highest temperature observed is at 12.00 pm and 8.00 pm which is 28.89 and 27.62. During this state, the temperature starting to rise slowly from 8.00 pm till 12.00 pm due to sun rises. When the temperature in the fish tank drop below the setpoint, heater inside the main tank will turn on and heat up the water until 30°c, Then, solenoid valve 1 (SV1) will open to flow the water from the main tank inside the fish tank. The temperature then will achieve above setpoints and SV1 will close. Figure 28 below shows that the graph behavior in the Blynk application. The blue line represents the temperature parameters.


Figure 28: Changes in the temperature value (blue line)

**5.2** Relationship between day and ammonia of fish tank

| Days | Ammonia | Days | Ammonia |
|---|---|---|---|
| 1 | 4 | 16 | 25 |
| 2 | 5 | 17 | 28 |
| 3 | 5 | 18 | 32 |
| 4 | 7 | 19 | 37 |
| 5 | 6 | 20 | 46 |
| 6 | 7 | 21 | 55 |
| 7 | 10 | 22 | 56 |
| 8 | 13 | 23 | 65 |
| 9 | 12 | 24 | 65 |
| 10 | 13 | 25 | 75 |
| 11 | 13 | 26 | 85 |
| 12 | 13 | 27 | 54 |
| 13 | 20 | 28 | 55 |
| 14 | 24 | 29 | 49 |
| 15 | 23 | 30 | 40 |

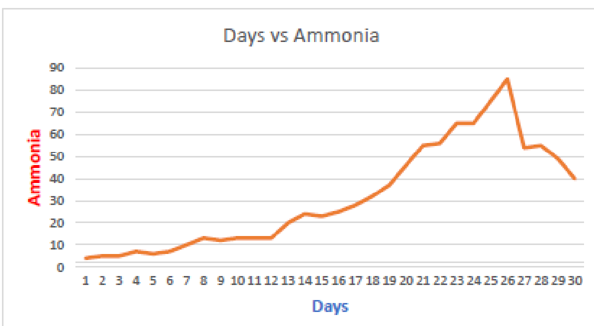



Figure 29: Ammonia different within days

From the graph collected above, it can observe that the ammonia increases within days until 26 days. The ammonia produced by fish excretion is one of the main causes the increasing of ammonia contents inside the fishpond. The rate at which fish excrete ammonia is directly related to the feeding rate and the protein level in feed. After 26 days, the ammonia level inside the fish tank drops tremendously due to draining a lot of ammonia water by solenoid valve 4 (SV4). This ammonia content is very dangerous to the fish health which it could damages the brain and organs of the fish, until they eventually die. So, this factor is crucial to maintain the growth of Tilapia fish as well as controlling their diet. Figure 30 shows the data collection through Blynk application. The graph with green line is refer to ammonia parameters.

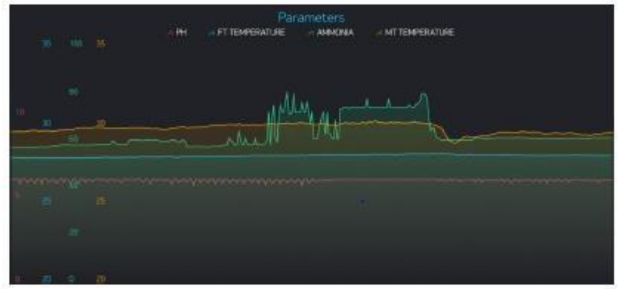



Figure 30: Data for ammonia

**5.3** Relationship between pH and ammonia of fish tank

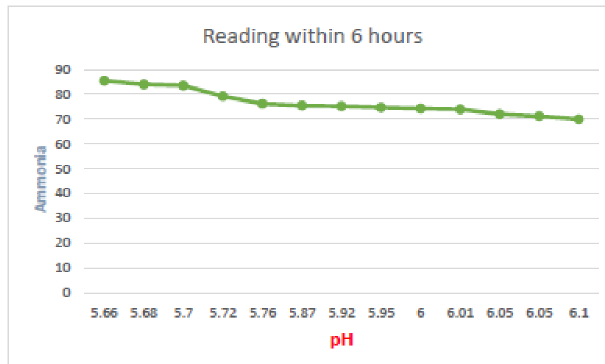



Figure 31: Relationship between pH and ammonia

From the graph above, it can conclude that the higher the ammonia level in the fish tank, the lower the concentration of pH value. Ammoniahas a basic pH, the processes that create it in fish tank produce enough hydrogen ions to overcome this and lower the ph. Since ammonia is a weak base between ph 11 to 13, the hydrogen ions have a stronger effect on ph, so this process ultimately lowers the ph.

5.3 Relationship between between days and ph value

| Days | pH | Days | pH |
|---|---|---|---|
| 1 | 6.57 | 16 | 6.32 |
| 2 | 6.51 | 17 | 6.39 |
| 3 | 6.54 | 18 | 6.30 |
| 4 | 6.54 | 19 | 6.27 |
| 5 | 6.58 | 20 | 6.29 |
| 6 | 6.54 | 21 | 6.25 |
| 7 | 6.52 | 22 | 6.31 |
| 8 | 6.42 | 23 | 6.15 |
| 9 | 6.48 | 24 | 5.85 |
| 10 | 6.47 | 25 | 5.74 |
| 11 | 6.42 | 26 | 5.66 |
| 12 | 6.49 | 27 | 5.92 |
| 13 | 6.58 | 28 | 6.24 |
| 14 | 6.24 | 29 | 6.35 |
| 15 | 6.53 | 30 | 6.41 |

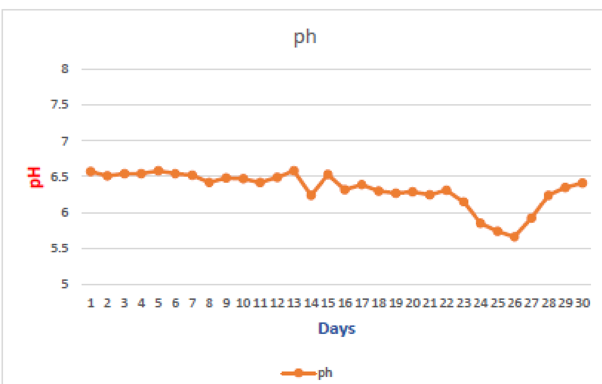


Figure 32: Relationship between pH and days

From the graph collected above, we can observe that the graph is in consistent state in the first weeks followed by second weeks. In the thirdweeks, the pH value is slightly drop between days13 to days 17 and continue to drop until days 26. The decreasing of pH in the fish tank is due tosome reasons. The first one is the present of carbon dioxide in the water. The second one is thehigh-level content of ammonia inside the water. When the pH below than 6, solenoid valve 3 andwater pump will turn on to flow out the water inside the filter tank and solenoid valve 2 will turnon.

## 6.0 Conclusion

The sensors included have been adjusted prior to being utilized in this venture. Every one of them have been tried and portrayed, considering the information sowed on the GUI of the Blynk application by getting to the specific token received from google email. The hub red dashboard for the GUI show has been set up and effectively showed the information from the cloud worker. The sensors need to was with refined water to forestall cross-sulllied as it is submerged in the different states of water particularly as fas as pH other than to guarantee a more extended life expectancy of the sensor. The test that has been created delivered precise ongoing information of the tried water condition dependent on the estimation of the sensors coordinated into the framework.

## 7.0 Recommendations

For future studies in this area of research it is recommended that the sensors, the biological factor, and the database be improved. In the area of sensors and measurement, it is highly recommended to obtain sensors that are more durable and do not require frequent calibration because this usually disrupts the system's data gathering. Also, it isrecommended to find a more consistent and moreeffective way to electronically measure ammonia as the sensor delicate and required maintenance which is needed to pre-heat the sensor more than 24 hour to increase the sensitivity. As far as natural factors, thetank of the fish ought to be improved to viablyeliminate waste and food build up from the lower part of the tank. Likewise, as opposed to restrictingthe framework to a tank setting, the frameworkcould be applied and acclimated to lake settingssince lakes are the most well-known approach tobring Tilapia up in Malaysia. It is prescribed toimprove the nature of the food and have longerdeveloping periods for better outcomes.

**8.0 Acknowledgement**

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