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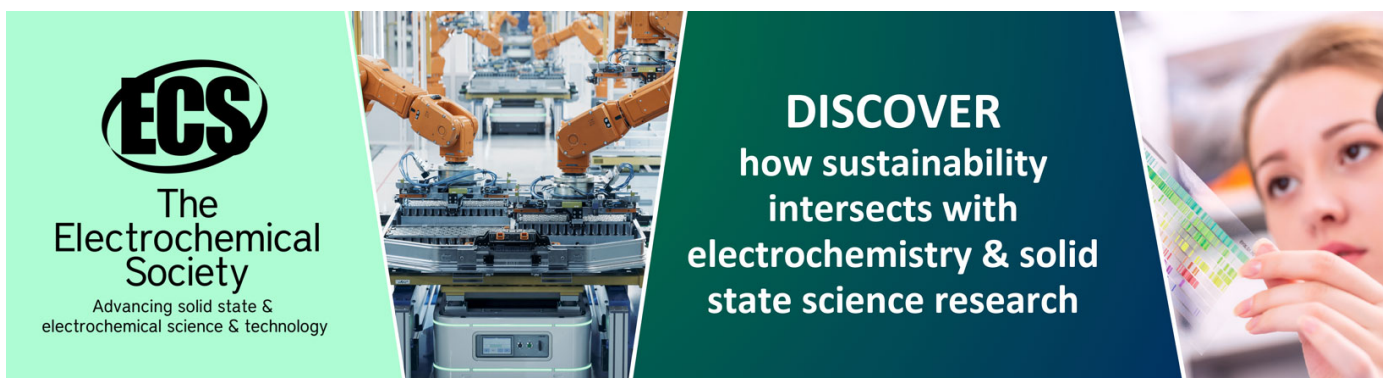
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Water pump control system in hydroponic plants using the ebb and flow method

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Abstract. Along with the restrictions during the covid-19 pandemic, many new farmers are growing vegetables for their own needs or for sale and there are also many new farmers who are planting ornamental flowers which are currently booming, these new farmers are mothers or people who have free time at home. In growing vegetables using the hydroponic method, it does not require a large area of land and yields faster harvests by paying attention to the accuracy in providing nutrients, the intensity of light and temperature around the plant and the flow of water that is maintained to circulate oxygen and nutrients to the plant roots. In previous research, Hydroponic Plants powered by Solar Panels have been designed and tested but in the middle of the night the motor stops flowing water to the plants due to insufficient battery voltage, so it is necessary to find a solution so that the existing equipment can be optimized again, so this research aims to get a solution so that the existing system can be optimized by using the control system carried out by Arduino so that the pump can continue to flow water (oxygen and nutrients) for 24 hours continuously.

1. Introduction

At this time, hydroponics became a way to grow plants that are on the rise because to grow plants no longer needed extensive soil and land. We can plant anywhere with planting media using water so that we can hone creativity in processing and creating new media for planting. Planting using hydroponic means, the harvest will be faster. However, it should be considered some other aspects, namely, accuracy in the provision of nutrients, the intensity of light and also the temperature around the growing plant. Generally, beginners pay less attention to nutrient water that is really right and can be absorbed perfectly. Plants by hydroponic means require nutrients obtained only through nutrient water only.

There are 2 (two) ways to grow hydroponics, namely using NFT (Nutrient Film Technique) and using WICK. Using the NFT method is the most popular way used by many people in applying it. While using the WICK method is no less famous in the first way, this method is preferred because of its easy manufacture and materials that are easy to obtain and cheap / using used goods. Growing plants using NFT means requires a water pump so that nutrients flowing with water can be streamed to the roots of the plant.

While plants using the WICK method do not require a water pump. Planting using NFT is the most popular way, and the nutrient supply lies in water so it takes water rotation / water flow so that the nutrients and oxygen needed by the roots can be supplied. Imagine if we forget to turn on the pump or there is a rotating blackout / PLN electrical disturbance, then plants that need nutrients and oxygen will song and die or not develop, then a solution is needed so that lovers of hydroponic plants that use NFT methods remain creative without having concerns about the above problems. To design solar panels that



are efficient in the use of batteries and the size of solar panels, a control system is needed so that the energy consumption in water pumps is not large at night.

In this study, the author will provide a solution that is the Water Pump Control System in Solar Home System Hydroponic Plants Using Arduino. It is hoped that this research can contribute and benefit especially for lovers of hydroponic plants. Based on the description above, the problem of a small battery that cannot turn on the pumping water until the morning or sunrise the next day becomes able to drain water containing nutrients and oxygen to the roots of the plant without adding batteries or batteries but with other solutions.

2. Literature Review

Hydroponics is a term used to grow crops without using soil as a growing medium. Plants can be planted in pots or other containers using water and or other porous materials, such as gravel, precarious shards, sand, shards of threshold stones, and so on as a planting medium. Hydroponic planting can develop quickly because it has advantages. The main advantage is the success of the plant to grow and produce more guaranteed.

Other advantages are more practical care, the use of fertilizers is more efficient, plants can grow rapidly and not dirty, production is more continuous, and some types of plants can be cultivated outside the season (Lingga, 2005).



Figure 1. Hydroponic Plants

2.1. Electric Motor as Water Pump

An electric motor is an electromagnetic device that converts electrical energy into mechanical energy. This mechanical energy is used to rotate or pump water on hydroponic plants. Electric motors are used also in the home (mixers, electric drills, fans or fans) and in industry.

The working principle of an electric motor is essentially the same for all types of motors in general :

- a. The electric current in the magnetic field will give a force if the wire carrying the current is bent into a loop, then both sides of the loop, i.e. at the right angle of the magnetic field, will get the force in the opposite direction.
- b. The force pair generates rotary power/torque to rotate the coil.
- c. The motors have several loops on their dynamos to provide more uniform rotational power and their magnetic fields are generated by electromagnetic arrays called field coils.

In understanding a motor, it is important to understand what is meant by the load of an electric motor. Load refers to the output of rotary power / torque in accordance with the required speed. Expenses can generally be categorized into three groups (BEE India, 2004) :

- a. Constant torque load is a load where the demand for energy output varies with its operating speed, but the torque does not vary. Examples of loads with constant torque are conveyors, rotary kilns, and constant displacement pumps.
- b. A load with variable torque is a load with torque that varies with operating speed. Examples of loads with variable torque are centrifugal and fan pumps (torque varies as quadrat speed).
- c. A load with constant energy is a load with a changing torque demand and is inversely proportional to speed. An example for a load with constant power is machine tools.

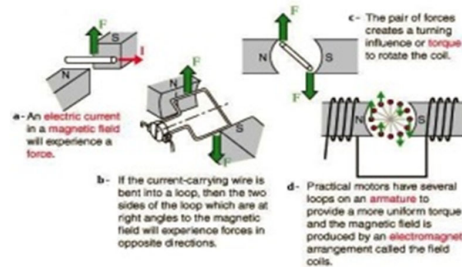


Figure 2. Working principles of electric motors

2.2. Solar Panels

Electricity can be generated using a variety of methods. The photovoltaic effect (wikipedia.org) is the most popular method used to generate electricity. The photovoltaic effect is the phenomenon of converting solar energy into an electric current. Scientists developed solar panels based on the principle of converting light energy into electrical energy through the law of conservation of energy. We need to know, that the notion of solar panels is a device consisting of solar cells that can be used to convert light into electricity.

These solar cells need to be protected from moisture and damage that could occur. This is done so as not to significantly damage the efficiency of solar panels and so as not to decrease their life. Usually, these solar panels have a lifespan of about 20 years. Usually, in that time period the use of solar panels will not experience a significant decrease in efficiency. Today, despite the advancement of advanced technology, most commercial solar panels are only capable of achieving an efficiency of about 15%. Commercial solar panels are very rare that can exceed 20% efficiency.

Do we need to use solar panels? Why? The answer is very simple. Solar panels do not emit harmful greenhouse gas emissions as in the burning of fossil fuels. So, the use of solar panels does not contribute to the effects of climate change. By using solar panels, we can get clean energy from the most abundant energy source on planet Earth, namely the sun. So, why are there still so few people who use solar energy as a source of electricity through these solar panels? Because there are still many people who do not know the advantages and disadvantages of solar panels.



Figure 3. Solar Panels

Advantages of Solar Panels : 1. Solar panels are environmentally friendly because they do not emit harmful greenhouse gas emissions, such as carbon dioxide. Solar panels also do not contribute to climate change. 2. Solar panels utilize solar energy, and the sun is the most abundant energy source on planet Earth. 3. Solar panels are easy to install and also have very low maintenance costs. 4. Many countries in the world offer favorable incentives for homeowners who use solar panels. 5. Solar panels do not lose much efficiency in their life which reaches about 20 years. 6. Because of the long pie period, which reaches 25-30 years. So, solar panels guarantee their users to save energy costs.

Disadvantages of Solar Panels : 1. Currently, solar panels are still relatively expensive. Although solar panels have decreased in price, the price of solar panels still tends to be expensive. 2. Solar panels still need to significantly improve efficiency. The average solar panel currently achieves an efficiency of less than 20%. This is one of the reasons many people do not choose solar panels. 3. Solar panels are made of some materials that are not environmentally friendly. For example, it is made of silicone. 4. If not careful, recycling solar panels can cause environmental damage, because the content of solar panels such as silicon, selenium, and others, of which they are all greenhouse gases, can be found in solar panels. This is dangerous because it can be a source of pollution during the recycling process.

3. Result and Discussion

3.1. Hydroponic design with solar panels

Some trials have been conducted before, namely solar panel hydroponic plant systems without batteries, from the results of experiments obtained the result that dc motors as water pumps can only supply water and nutrients when the solar panel receives enough light from the sun so that when it will be dark and dark, nutrients and water do not flow to hydroponic plants.

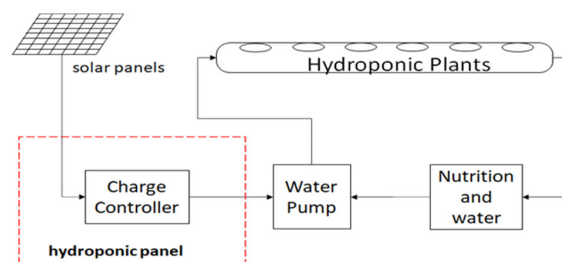


Figure 4. Solar Panel Hydroponic Plant System Without Batteries

Furthermore, a trial of the solar panel system using the battery as a solution to the above problems with the purpose of the battery is used to store electrical energy when the solar panel gets enough light from the sun, but the problem is that it takes a large enough battery to be able to turn on the water pump until morning or sunrise again.

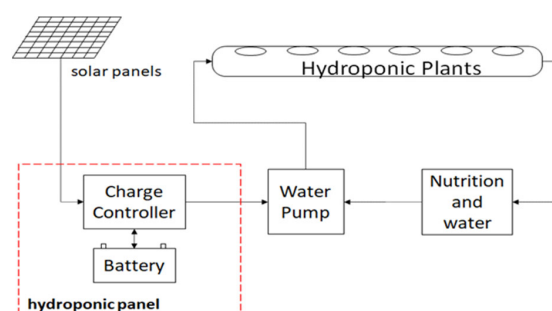


Figure 5. Solar Panel Hydroponic Plant Systems Using Batteries

While the technical specifications of the dipping water pump used are Material: Plastic, Dimension: Approx. 6.5(D) x 8(H) cm, Inlet/Outlet: 1/2" male head, Voltage: 12V DC/24V DC, Maximum Rated Current: 1000MA, Power: 22W, Max Flow Rate: 800 L/H, Max Water Head: 5m and Max circulating water temperature: 100°C



Figure 6. Hydroponic Plant Water Pump

Based on the technical specifications above, information is obtained that the power of the dipping water pump is 22 W which means, if the pump is turned on from 18:00 (afternoon / sunset) to 07:00 (sunrise again) then it takes a total power of 13 hours x 22 Watts = 286 Watts. While the battery used is a dry battery with a capacity of 7.2 A (dry battery, commonly used in UPS) so the battery power capability is $7.2 \text{ A} \times 12 \text{ V} = 86.4 \text{ Watts}$.

To be able to produce 286 watts, it takes more than 3 batteries or 4 batteries so that the procurement of batteries becomes large, so the idea arises how 1 battery can turn on or supply water and nutrients continuously until the morning before sunrise again. The selection of time intervals is adjusted to the battery owned against the load or power needs on the water pump where the power requirement to turn on when sunlight is less or less is not divided by the ability on battery power stored as the internal Val of time to be used so that the total load power / total battery power = $286 / 86.4 = 3.31$ or rounded to 4.

3.2. Improvements made to hydroponics with solar panels

Here are some common hydroponic methods, and the need for circulation pumps :

- a. Axis Method (Wick System). No circulation pump is required. With this method, the axis serves to absorb nutrient fluids from the reservoir. The roots of the plant will come into contact with the axis, so it can always absorb nutrients.
- b. Deep Flow Technique (DFT) method. A circulation pump takes 12-16 hours. This is because when the pump dies, there are still hydroponic nutrients left around the roots of the plant.
- c. Tidal Method (Ebb and Flow). A circulation pump takes 24 hours, but not continuously. Circulation pumps with this hydroponic technique usually turn on and off at certain intervals (for example, 5 minutes on, 5 minutes off)
- d. Thin Film Method (NFT, Nutrient Film Technique). The circulation pump takes 24 hours. If the pump dies for a long time, then there are no hydroponic nutrients left in the roots of the plant.

In this study, the authors used the ebb and flow method in which the water pump is simulated to drain water and nutrients for a full 24 hours but not continuously, where the pump is on and off using a specific time interval. Based on the calculations above, it takes intervals of 1 : 3 where life is 5 minutes and turned off 15 minutes so that the total power is obtained by: 5 minutes x 3 = 15 minutes (lifetime) and 15 minutes x 3 = 35 minutes (dead time). So that the lifetime of 15 minutes x 13 is 3.2 hours of life for 13 hours from 18:00 to 07:00 am, meaning the power needed is 3.2 hours x 22 watts = 70.4 watts which means 70.4 watts < 86.4 watts (existing batteries can turn on the water pump for 13 hours with a time interval of 1:3 on and off).

To control the time of life and death according to the above design of 1:3 where life lives 5 minutes and dies 15 minutes, then a system of control or control is needed. In this study, the authors used Arduino as a control system to set the water pumps on and off according to predefined time intervals. The script or command can be stated as follows:

```
int pump = 1;
void setup() {
  use pin 1 as output to the water pump relay
```



```

pinMode (pump, OUTPUT);
}
void loop() {
  living arrangements for 5 minutes or 300secs
  digitalWrite (pump, HIGH);
  delay(300);
  living arrangements for 5 minutes or 300secs
  digitalWrite (pump, LOW);
  delay(900);
}

```

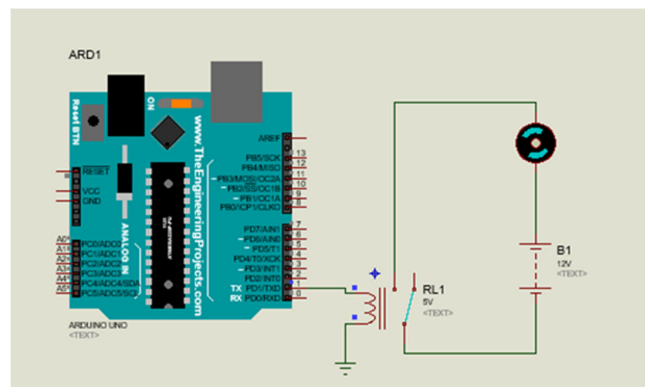


Figure 7. Simulation of tidal methods

After the simulation was done, then the author made a prototype with the following design:

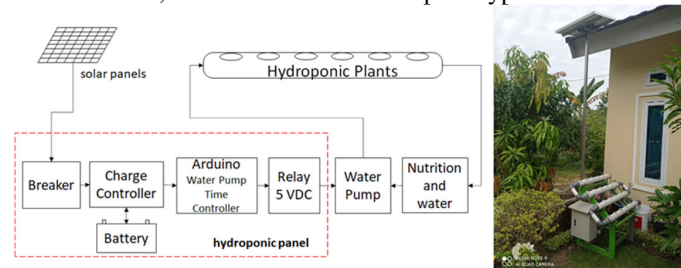


Figure 8. Solar Panel Hydroponic Plant System with Time Control/tidal method

Comparison of water pump conditions on solar panel hydroponic plants using a 7.2 Ampere battery between not using the tidal method and using the tidal method as follows:

Table 1. comparison does not use tidal methods and uses tidal methods

No	Time	Water Pump Status	
		Not using the tidal method	using the tidal method
1	18:00	Working	Working
2	19:00	Working	Working
3	20:00	Working	Working
4	21:00	Working	Working
5	22:00	Working	Working
6	23:00	Working	Working
7	00:00	Not Working	Working
8	01:00	Not Working	Working
9	02:00	Not Working	Working
10	03:00	Not Working	Working

11	04:00	Not Working	Working
12	05:00	Not Working	Working
13	06:00	Not Working	Working
13	07:00	Working	Working

From the results of the comparison can be seen that the tidal method can work at night until the morning while not using the tidal method water pump does not work after consuming battery energy for 5 to 6 hours.

4. Conclusion

Based on the results of experiments conducted, the tidal method can turn on the water pump in hydroponic plants longer because the tidal method does not turn on the water pump continuously but is regulated the time of life and death so that when it dies, electrical energy is not consumed by the water pump but consumed when the water pump is working only. Tidal methods are suitable for being used in hydroponic plants that use solar panels as an energy source to turn on water pumps that serve as an introduction to nutrients and oxygen to plant roots.

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