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Utilization of Renewable Energy Technology in Performing some Agricultural Operations

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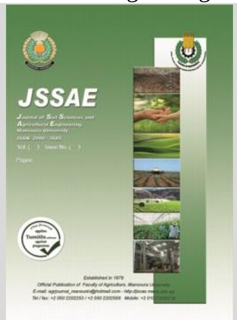

ABSTRACT

Designing a photovoltaic system that aims to pumping air in fish tanks by air pump in order to meet the fish needs of the vital oxygen. The system consists of two circuits, load circuit and control circuit. 1. Circuit load: solar panel, Battery, charge controller and Inverter. 2. Circuit control: relay 12 V, pic microcontroller 16f877A, Transistor BC547, Diode 1N4148, Crystal 4MHZ and Capacitor 22 Pf. The analysis shows the configuration of photovoltaic 400W, 1battery of 200 Ah, inverter 1 kW and 4 charge controller 10 A. This is the most economically feasible and average cost of energy (ACOE) is about 2.6 EG₱/kWh. . "Dissolved oxygen" or DO, and is measured in parts per million or ppm in fish tank rise above 3 (stressed level).

Keywords: photovoltaic; blower; fish tank; dissolved oxygen

INTRODUCTION

Energy is considered a prime agent in the generation of wealth and significant factor in economic development. Renewable energy technologies produce marketable energy by converting natural phenomena into useful forms of energy.

(Perz, 2015) Aeration blowers and water pumping are the main energy consuming equipment in aquaculture at the farm level and electricity accounts for 29% of tilapia production cost. Aerators mechanically or electrically. Driven increase dissolved oxygen in water, aeration is the process of bringing water and air into close contact.

(Gary, 1996) In complex organisms such as fish, both a specialized anatomical structure for gas exchange, and a transport system (blood and circulation) are required to supply sufficient amounts of oxygen (O_2) to the tissues (while).

(Maycok, 1997) There is a growing need for energy in the world and since the traditional energy sources based on the fossil fuels are limited and will be exhausted in future, PV solar energy is considered a promising energy source candidate. Large-scale application of PV solar energy will also contribute to the diversification of energy sources resulting in more equal distribution of energy sources in the world.

The aim of these study utilization of renewable energy technology contributes to solving the problem of energy shortage and as a suitable alternative to conventional energy.

2. Analysis.

The area size will be used for tilapia is 300 m^2. The area divided into 2 parts; 1 part for fish tanks, 1part for control room area of the solar power generation. The location of fish tank is far from power lines, so that the solar power generation system that is used is off-grid system. All of the loads will be supplied by the solar power generation. This area will be divided into 10 fish tank; the tank size is (6mx3mx1m) and this tank area also will be used for tilapia seeds.

Oxygen gas in liquid is described as "dissolved oxygen" or DO, and is measured in parts per million or ppm.

Oxygen is added to your water when the surface is broken and an exchange of atmospheric oxygen with the water takes place, you can create bubbles within the fish tank by using an aeration device. These send air through narrow tube connected to a valve on the aerator at on end, at depth 20 cm, at middle fish tank.

In general, you ought to attempt to keep your oxygen degree in your fish tank above 6 ppm. Most fish will come to be confused at a DO of 3 ppm, and many will die at 2 ppm or below (Sylvia, 2001).

The blower that can be draining the air with 50 m^3/h. The volume flow will be distributed to 1fish tank. The blower with flow rate 50 m^3/ h needs 320 watt

From Experiment data:

1. Identifying how sunny it is in your location

The solar powered is located in Mansoura city .Solar radiation data measurement in agriculture research station. solar radiation = 1.807.68 kwh/m2/day.

Table 1. calculation of blower running.

Duty cycle	Time working	Discharge at depth 0.2 m	Volume of air
$T_{Total}=T_{on}+T_{off}$ 15 = 2+ 13 min	3.2 h /day	45 m^3/h	144 m^3 /day

Time total (T_{Total}) = time running (Ton) + stopping time (Toff)

2. Load energy usage

The load determined by the energy usage. Table 2 shows the energy usage of fish tank in Mansoura city.

Table 2. calculation of fish tank load

No	Utilization	Power	value	Working time	Energy usage
1	blower	320 w	1unit	3.2 hours	1.02 kwh/day

Calculating the overall system losses, assumed that the inverter efficiency (η_{inv}) at 80 %, the total load calculated to be 1.27 kwh based from equation below $Total\ load = \frac{\sum E_{usage}}{\eta_{inv}}$ (pearsall, 2017).

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3 Power calculation

Power from photovoltaic cells using the relation:

Maximum power= maximum current x maximum voltage.

$$P_{max} = I_{max} V_{max} \quad \text{(Soteris, 2014)}$$

For one solar panel produces 250 watt a full sunlight, thus inverter Efficiency=80% and output power from inverter=320 watt, hence Input power in inverter = 320 / 80%=400 watt, and need to output power from photovoltaic cells = 400 watt.

Table 3. Power calculation

NO	Power	Value	Unite
1	from photovoltaic cells	400	watt
2	motor	320	watt
3	required for the pump	20	watt

Power required for the pump using the relation:

$$\boldsymbol{power\ pump = wQV_{w1}v_1} \quad \text{(R, 2000)}$$

V_{w1} = **Velocity of whirl at outlet**

v_1 = **Tangential velocity of impeller at outlet**

V_f = **Velocity of flow at inlet,**

V_{f1} = **Velocity of flow at outlet**

w = Air density

3. System components

There are two circuits load circuit and control circuit.

1. **Circuit load:** solar panel, Battery, charge controller and Inverter.
2. **Circuit control:** relay 12 V, pic microcontroller 16f877A, Transistor BC547, Diode 1N4148, Crystal 4MHZ and Capacitor 22 Pf shown in fig1.

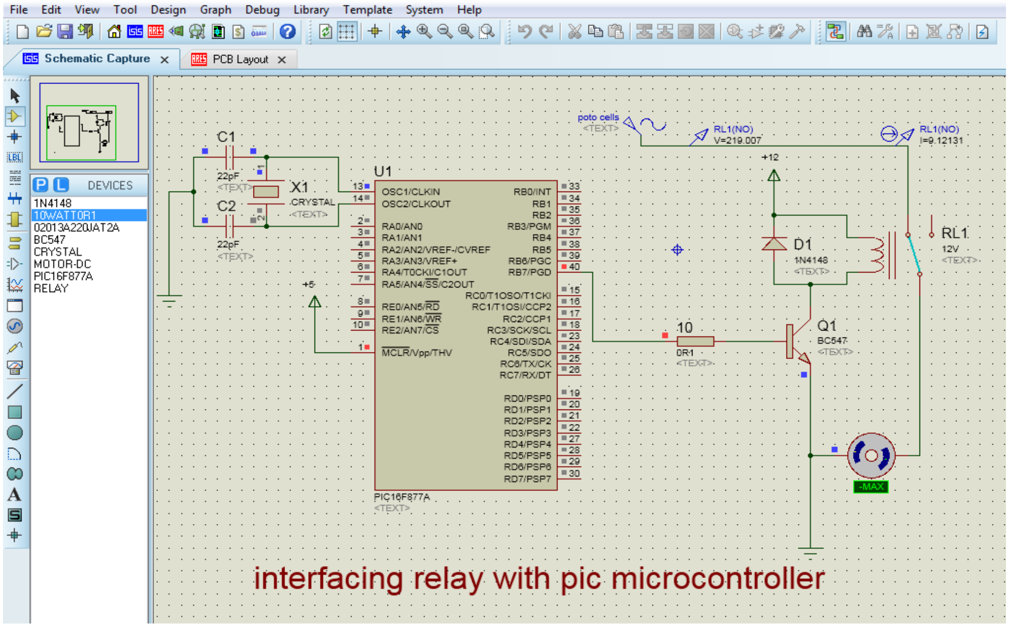

Fig .1. Schematic diagram in Proteus

1. Load circuit

Solar panels.

Where Eusage is the total load of the system 1.27 kwh/day and DE receives (Esun) 1.807.68 kWh /m²/day (hours /day). It calculates the monthly and yearly potential electricity generation in kWh of a photovoltaic system with defined modules tilt and orientation.

$$\textbf{Array size (kW)} = \frac{\boldsymbol{Total\ kWh\ used\ by\ appliances\ /day}}{\left(Solar\frac{hours}{day}\right)*(Efficiency\ factor\ 0.72)} \quad \text{(Qazii, 2017)}$$

The size of PV 400 watt. Initial cost PV system 6000 EG₱ and average cost /watt 15 EG₱ for 5 years. According to the availability of the component in the local market. We assume lifetime corresponding to 25 years for solar panel.

Battery

The function of battery is an electric storage container. The battery consists of reversible electrochemical cell and has a high efficiency. The accumulator battery capacity is more than 50%. The system carried out for 2 days of autonomy. The accumulator should be adjusted with the power needed.

Battery capacity (Ah) =

$$\frac{(Total\ watts\ in\ hours\ per\ day\ used\ by\ appliances)*(Days\ of\ autonomy)}{(depth\ at\ Discharge)*(Teemp.\&\ dischaege\ rate\ derating\ factor)*(nominal\ battery\ volage)}$$

(Qazii, 2017).

Charging time can be calculated by the following equation:

Time taken to charge battery

$$= \frac{Capacity\ of battery\ in\ mA\ or\ A\ too\ be\ charged}{Output\ of\ solar\ panel\ in\ mA\ or\ A} \quad \text{(Qazii, 2017).}$$

The state of charge (SOC) is the ratio between the present capacity of the battery (q) and the nominal capacity (q_{max}); that is,

$$SOC = \frac{q}{q\ max} \quad \text{(Soteris, 2014).}$$

This battery specification is the most appropriate specification of the system demand. Assumed that the battery cost is 4000 EG₱ for 1 piece of battery 200 Ah, lifetime for 5years. The battery storage will need to replace along the system lifetime.

Inverter

Inverter is an electricity tools used for convert the direct electrical current (DC) to alternating electrical current (AC). The inverter convert the DC current from the battery. As electrical devices, there are lacks efficiency because of electrical losses. The typical inverter efficiency is 80%. Inverter efficiency: the ratio of the input power (P_{ac}) reduced by the inverter losses (P_{losses}) and the DC input (P_{dc}) is called the conversion efficiency (η_{Conv}).

$$\eta_{Conv} = \frac{P_{ac}}{P_{dc}} = \frac{P_{dc} - P_{losses}}{P_{dc}} \quad \text{(pearsall, 2017).}$$

Assumed that the inverter cost is 300 EG₱ /1 kW, lifetime for 5 years.

Charge controller

A solar charge controller is used to keep the battery from overcharging by regulating the voltage and current coming from the solar panel to the battery. Need to 4 charge controller 10 A. Assumed that the charge controller cost is 300 EG₱, lifetime for 5 years.

4. Controller Design

A control system cosmists of a number of components together to perform a desired function. The aim of the control system is to maintain the “dissolved oxygen” or DO in the tank at the above 3 ppm. The controller block diagrams show a microcontroller 16f877A, an aeration device as shown in fig 2, and fig 3.

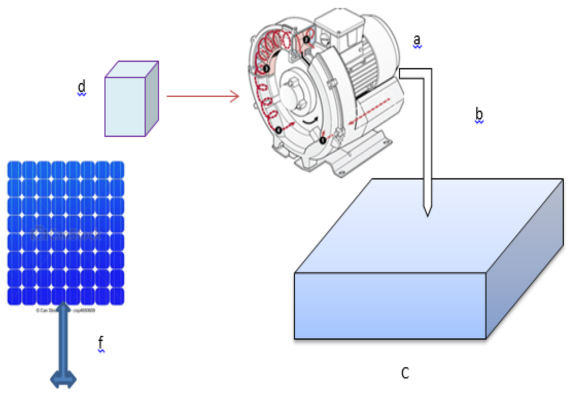

Fig. 2. View of a pumping air system showing (a) AC motor + Air pump, (b) tube, (c) fish tank , (d) motor controller, (f) photovoltaic system.

Transistor is wired as a switch which carries the current required for operation of the relay. When the pin RB7 of the pic microcontroller goes high, the transistor BC547 turns on and current flows through the relay. The diode D1 is used to protect transistor and the microcontroller from Back generated in the relay coil. Normally 1N4148 is preferred as it is a fast switching diode having a peak forward current of 450mA. This diode is also known as freewheeling diode. A relay can be easily interfaced with microcontroller using transistor as shown in fig 4.

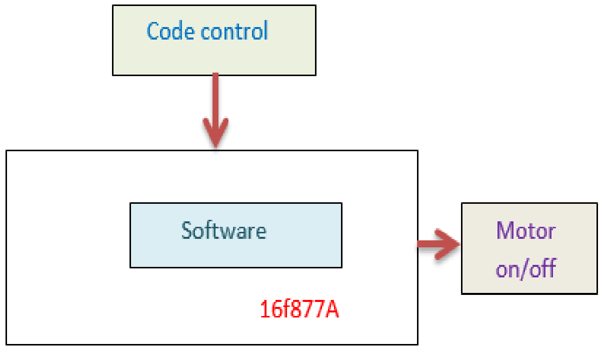

Fig. 3. Block diagram of the controller

5. Measurements of dissolved oxygen inside the tank and conclusion the most preferably duty cycle.

Do three duties cycle A, B, and C runs and takes measurements.

The time of running is the time of the addition of oxygen, bringing the dissolved oxygen from 2ppm (die point) to the top of 3 ppm (stressed).

The stopping period is when the dissolved oxygen decreases from greater than 3 ppm to 3 ppm (parts per million).

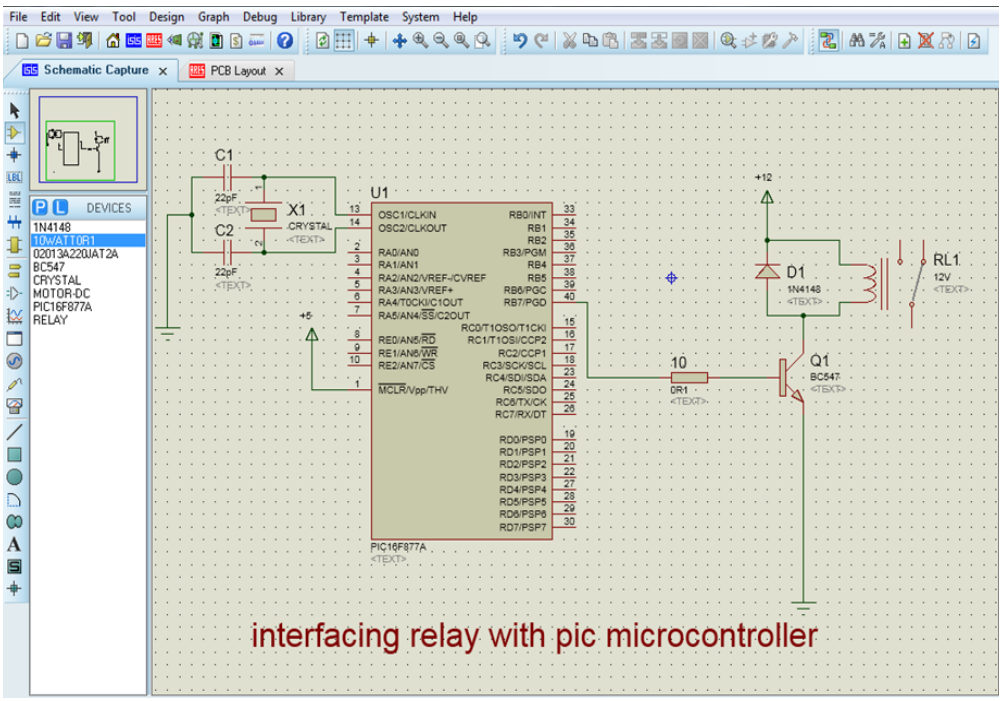

Fig. 4. interfacing relaywith pic microcontroller

A. The first cycle begins when the oxygen addition is at the lowest level 2 p.p.m (die point) and three readings are taken at each time running before the start of operation, at the end of the time running (T_{on}) and at the end of the stopping time (T_{off}).

B. The second cycle. The readings of the end of the stopping time in the first cycle are readings before the start of the second cycle.

Table 4. Measurements of dissolved oxygen at cycle (A).

Duty cycle A Measurement DO p.p.m	Before running	End of T_{on} =2 min	% increase	End of T_{off}=13 min	% decrease
1	2	3.7	85	3.1	16.2
2	2	3.5	75	3	14.2
3	2	3.5	75	2.9	14.7
mean	2	3.56	78.3	3	15

Table 5. Measurements of dissolved oxygen at cycle (B).

Duty cycle B Measurement DO p.p.m	Before running	End of T_{on} =2 min	% increase	End of T_{off}=13 min	% decrease
1	3.1	4.1	32.2	3.3	19.5
2	3	4	33.3	3.1	22.5
3	2.9	3.9	34.4	3.1	20.5
mean	3	4	33.3	3.1	20.8

C. The third cycle. The readings of the end of the stopping time in the second cycle are readings before running in the third cycle.

Table 6. Measurements of dissolved oxygen at cycle (C).

Duty cycle C Measurement DO p.p.m	Before running	End of T_{on} =2 min	% increase	End of T_{off}=13 min	% decrease
1	3.3	4.5		3.3	
2	3.1	4.3		3.2	
3	3.1	4.3		3.2	
mean	3.1	4.3		3.23	

After knowing the measurements during time periods, the duty cycle can be deduced.

We choose the second table b. from the average values of dissolved oxygen and the total cycle time, we draw a curve representing the duty cycle.

Table 7. Mean measurements of dissolved oxygen at cycle

Duty cycle		T_{on}	T_{on}+T_{off}
Time per min	0	2	15
Dissolved oxygen ppm	3	4	3.1

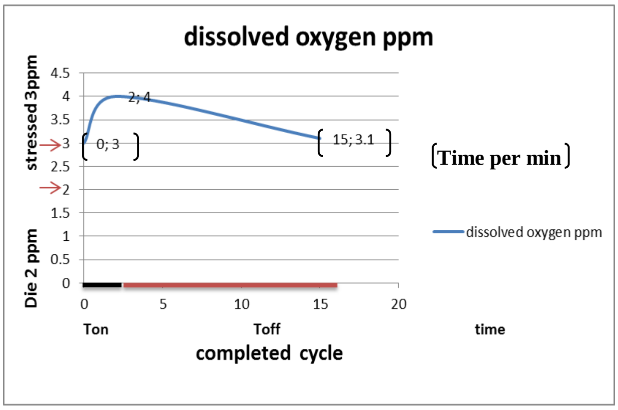

Fig. 5. chart time running and dissolved oxygen ppm

Thus 13.33 % duty cycle is preferably.

Running motor time = 13.33 % x 24 hr. = 3.2 hr. /day.

RESULTS AND DISCUSSION

Designing a photovoltaic system begins by obtaining horizontal radiation data from agriculture research station in the proposed location. The component configuration of power generation system consist of photovoltaic (PV), battery, inverter, charge controller and the primary load. The analysis shows the configuration of photovoltaic 400W, 1battery of 200 Ah, inverter 1 kW and 4 charge controller 10 A. This is the most economically feasible and average cost of energy (ACOE) is about 2.6 EG₱/kWh. "Dissolved oxygen" or DO, and is measured in parts per million or ppm in fish tank rise above 3 (stressed level) shown in fig 5.

CONCLUSION

In this paper, utilization of renewable energy technology in performing some agriculture operations is presented. The size is (6mx3mx1m) of fish tank with of renewable energy technology meets the feasibility demand of 1.7 kwh/day usage load by photovoltaic 4oo watt, 1 battery of 200 Ah,Inverter 1kw and 4 charge controller 10 A when average cost of energy is about 2.6 EG₱ / kwh.

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إستخدام تكنولوجيا الطاقة المتجددة فى إدارة بعض الأعمال الزراعية

عماد الدين أمين عبد الله[1]، عيد عبدة الباقى احمد جودة[2] و محمد سليمان إبراهيم أبو سمرة[1]

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تهتم الدولة بالأستزراع السمكى لسد الفجوة الغذائية وكأحد الركائز الأساسية فى تحقيق الأمن الغذائى, وللمساهمة بشكل فعال فى التنمية المستدامة للثروة السمكية يجب العمل على تطوير الأستزراع وهذا يتأتى بأستخدام تقنيات العصر لخفض التكلفة وخاصاً تكلفة الطاقة ..ولعل أهم ما يواجهة الأنسان من تحديات هى مشكلة الطاقة. الهدف من الدراسة: استخدام الطاقة المتجددة (الطاقة الشمسية) فى بعض العمليات الزراعية للمساهمة فى حل مشكلة نقص الطاقة وكبديل مناسب للطاقة التقلدية . وقد تمت الدراسة والتجربة العملية فى معمل الطاقة الشمسية بكلية الهندسة جامعة المنصورة وتم بناء نموذج محاكاة الكترونى باستخدام برنامج البروتس والميكروسي والتجربة الثانية فى مزرعة الكلية وأخذ قياسات الأكسجين المذاب فى معمل كلية طب بيطرى جامعة المنصورة. الخلاصة : تصميم منظومة فولتية الهدف منها ضخ الهواء فى الأحواض السمكية لتوفير الأكسجين للازم للأسماك , وتتكون من دائراتين دائرة للحمل ودائرة للتحكم 1- دائرة الحمل وتتكون من الخلايا الشمسية والبطاريات ومضخة الهواء ومتحكم للشحن وانفرتر و(موتور تيار متردد + مضخة هواء) . 2 – دائرة التحكم وتتكون من رلية 12 فولت وميكروكونترولر 16f877A و ترانزستور BC547 و دايود 1N4148 ومقاومة 10 أوم وكرستالة 4MHZ ومكثف 22 Pf . إستخدام تكنولوجيا الطاقة المتجددة فى إدارة بعض الأعمال الزراعية أظهرت . إمداد حوض سمكى(بلطي) بحجم (6m x 3m x 1m) بالأكسجين المناسب (فوق 3جزء فى المليون) بإستخدام نظام طاقة شمسى وحددت االدراسة الطاقة اليومية 1.7 كيلووات ساعة فى اليوم وحمل الفولتية 400 وات وبطارية 200 أمبير ساعة وأنفرتر 1000 وات و4 متحكم شحن ومتوسط تكلفة الطاقة حوالي 2.6 جنية لكل كبلووات ساعة .