Solar Bubbling system report

Objective:

To design the solar powered Bubbling system for grey water treatment/ aquaponics system.

Problem Identification:

To maintain the oxygen level in hydroponics, aquaponics and grey water recycling system, aeration is required in water. So as to maintain the oxygen level, air pumps are used for aeration (bubbling). It requires about 5 to 12 hours of bubbling in water according to our application to maintain the oxygen level up to 2-5 PPM in water. [1]

In rural areas, load shedding is the factor due to which farmers are unable to aerate water for 12 hours in a day, so to maintain this Solar DC bubbling system is the best solution for it.

If availability of electricity is not a barrier then cost required for bubbling in day is very large. If we take 2000 liters of aquaponics, we need to spend 430 rupees for 43 KW electricity in 30 days. This cost of bubbling is very much higher and not economical. If the same system operates on DC air pumps in the solar system then the cost of electricity will also be saved.

Background:

Aeration brings water and air in close contact in order to remove dissolved gases (such as carbon dioxide) and oxidizes dissolved metals such as iron, hydrogen sulfide, and volatile organic chemicals (VOCs). Aeration is often the first major process at the treatment plant. During aeration, constituents are removed or modified before they can interfere with the treatment processes. Aeration brings water and air in close contact by exposing drops or thin sheets of water to the air or by introducing small bubbles of air (the smaller the bubble, the better) and letting them rise through the water. The

bubbling process caused by the turbulence of aeration physically removes dissolved gases from solution and allows them to escape into the surrounding air. [2]

For Aquaponics:

In day time, algae present in the ponds produces oxygen in water, but it's very low as compared to normal water as it is non-moving water. So to maintain the oxygen level up to 5ppm we need bubbling the water. In day time it not required on continue as algae already producing some oxygen, but in night time algae takes oxygen from water and release carbon dioxide in water so in absence of sunlight pond water requires continuous bubbling to maintain the oxygen level in water. [3]

The time between 2:00 am to 9:00 am pond water requires continuous bubbling as oxygen level is very low in this period of time.

Due to deficiency of oxygen in water, fishes present in the water dies. If we use the solar system then the effect on fish farming will not occur.

For grey Water treatment:

Any wastewater produced by domestic usage is known as greywater. Our daily life involves water usage in various causes like bathing, cleaning and washing. These already used waters are called greywater. However, sewage water cannot be considered as grey water as it contains larger organic components. This greywater can be preserved and used for multiple purposes that doesn't involve drinking.

The content of biological oxygen demand (BOD) and chemical oxygen demand (COD) indicates the risk of oxygen depletion due to the degradation of organic matter during transport and storing and the risk of sulphide production, causing bad smell.

The parameters need to be maintained are BOD (Biological oxygen demand), COD (Chemical oxygen demand), DO (Dissolved oxygen), Turbidity, Oder, etc.

Type of users

1. Farmers which are doing Aquaponics, hydroponics.
2. Grey water treatment & black water treatment.
3. Aquarium users

Financial Model

Cost of existing bubbling system	Cost of Solar bubbling system
For 120 Watts AC Air pump [4]	For 120Watts DC Air pump [5]
Low initial cost of installation : 4500/-	High Initial Cost of installation : 30000/-*
Cost of electricity : 10 rupees/ Unit	Cost of electricity: Free
Amount of Units consumed in one year: 526 KW	Amount of units consumed in one year: 526KW
Total cost in one year: 5260/-	Total cost in one year: No extra cost
Total cost in two years: 10520/-	Total cost in two years: No extra cost
Total cost in three years :15780 /-	Total cost in three years : No extra cost
Total cost in four years:21040/-	Total cost in four years: No extra cost
Total cost in five years:26300 /-	Total cost in five years: No extra cost
Total cost in ten years: 52600/-	Total cost in ten years: No extra cost
Cost of maintenance in 10 years: 10000/-	Cost of maintenance in 10 years: 15000/-
Total cost in 10 years :62600/-	Total cost in 10 years:45000 /-
Net loss in 10 years : 17600/-	Net saving in 10 years: 17600/-

- The maintenance cost mentioned above for the solar system is the cost of replacement of batteries and its maintenance, distilled water costs and labor charges.
- The maintenance cost for AC air pumps is changing of AC air pumps 2 times in 10 years or maybe more as the warranty is 2 years only.

Required motor: DC air pump/ Bubbler

Required specifications: Voltage: 12/24V

Frequency: 50Hz

Power: 35 Watts to 60 Watts

Pressure: 0.024 MPa to 0.03 Mpa

Output : 65 L/min to 100 L/min

Dia of mouth : 8mm to 10mm

The quotation received for DC air pump has specifications as follows:

Technical Specifications:

Voltage: 12VDC

Power :120 Watt

Pressure: 0.1 MPa

Discharge: 125 LPM

DC air pump

The above air pump has 125 LPM discharge

Solar System Design Calculations for DC air Pump :

Sl. No.	Products	Capacity	Qty
1	Solar Module (36 Cells)	150 Wp, 12 V	4
2	Solar Battery	200 Ah, 12 V	2
3	MMS	150 Wp, 1M	4
4	Solar Charge Controller - Phocos CNXup40	40 A, 12 V	1
5	AJB with SPD & MCB	4 IN, 1 OUT	1
6	Cables red+black (M-M)	4 sq mm	8 m x 2
7	Cables red+black (M-B) (B-B)	16 sq mm	7 m x 2
8	Cables red+black (B-L)	10 sq mm	5 m x 2
9	Earthing Cable	10 sq.mm.	15 m
10	Earthing Kit		2
11	Double pole MCB (Load side) with box	16 A, 12 V	1
12	Consumables		1

Solar system design received from SELCO
Calculations for 7 hours of battery backup:

Days of Autonomy	3 Days
Load efficiency	80%
Charging efficiency	90%
Dust Factor	95%
Max. Depth of discharge	80%

Panel wattage calculations

Maximum Daily load = (Total load in Wh)/(load efficiency× system voltage)

1.Maximum Daily load = (840)/(0.8×12)

= 87.5 Ah

2. Total current required=

(Max daily load)/ (eq. Sunshine hour× charging efficiency× dust factor) A

= 87.5 / (5 × 0.9× 0.95)= 20.46 Amp

3. Total panel wattage required=

= (Total current required× system voltage× (real panel voltage÷ input panel voltage)

= 20.46 × 12 × 18/12 = 368 W

Series module = (system voltage) ÷ (I/P panel voltage)= 12÷12 = 1

Parallel module:

= 368/(1/200)

= 1.84

Which tends to 2 panels of 200 W

Battery Capacity:

Battery capacity required=

(Days of autonomy × max daily load) ÷ DOD. ×discharing efficiency)

= (2 × 87.5)÷(0.4 ×1) = 218 Ah

Charge controller

Current rating of CR should be above the maximum current from PV array and maximum load current that the CR should

handle.

Here in this case 20.46 is maximum current rating in system so we have to choose 25 A CR.

- Estimate cost for 7 hours backup system

Particulars	Quantity	Price
Solar Modules (150Wp)	2	7000
Solar Battery (200AH, 12V)	2	15000
Solar Charge controller	1	2500
AJB Box	1	3000
Cables	-	2500
Earthing kit	2	2000
MCB double pole	1	800
Total		30800/-

- Estimate cost for 12 hours backup system

Particulars	Quantity	Price
Solar Modules (150Wp)	2	7000
Solar Battery (200AH, 12V)	1	34000
Solar Charge controller	1	2500
AJB Box	1	3000
Cables	-	2500
Earthing kit	2	2000
MCB double pole	1	800
Total		57600/-

- Estimate without battery backup

Particulars	Quantity	Price
Solar Modules (150Wp)	2	7000
Solar Battery (200AH, 12V)	2	1500/-

Solar Charge controller	1	2500
AJB Box	1	3000
Cables	-	2500
Earthing kit	2	2000
MCB double pole	1	800
Total		16400/-

Estimate cost for without battery backup system

Design of solar system

best-solution-for-grey-waterDownload

The comparison study of solar system design is mentioned in the document below:

https://docs.google.com/presentation/d/1YYe–0GTydGmHomByMFoPuyj1DJursnCjq8Ye35ns20/edit

Final Bill of material:

Item Name	Description	Quantity	Unit Cost	Total
DC Air Pump	120 W, 125 L/min	1	5200/-	5200/-
Solar Panels	165 W, 12V	2	4290/-	8580/-
Solar Charge Controller	12 V, 20A PWM type	1	900/-	900/-
DC MCB	2P-20A	1	883/-	883/-
DC cable	4 Sq. mm (Black & Red)	8 meter	33.50/-	268/-

DC cable	6 Sq. mm (Black & Red)	8 meter	46.20/-	369/-
Battery	12 V, 26 Ah	1	2300/-	2300/-
Flexible pipe	To cover the wires from open atmosphere	20 foot	3/-	60/-
C clamps	Used to clamp the flexible pipe on wall	10	5/-	50/-
MCB holder box	Used to mount MCB	1	20/-	20/-
Hose pipe	10 mm ID	50 foot	4.5/-	225/-
Drip T	16 mm dia	7	5/-	35/-
Hose clamps	½ inch	6	10/-	60/-
Insulation Tape	Black	1	10/-	10/-
Total				18960 /-

This solar system design given by the SELCO team was costing about 54000/- rupees. Our system gives 9* hours of continuous bubbling operation. It cost around 18960/- rupees. Our system design is 35% less costly than SELCO design.

Installation of system:

: 


Solar Panels

Payback period and Return on investment:

Payback period:

$$PP = \frac{\text{Costs of Project / Investment}}{\text{Annual Cash Inflows}}$$

Payback period = 18960/ 5260 = 3.6 years

Return on investment:

$$\text{ROI (\%)} = \frac{\text{Net Profit}}{\text{Total Investment}} \times 100$$

ROI = (5260/18960) * 100 = 27.74%

Bubbler:

This Porous tube has an infinite small opening on its periphery so its blows air in water with high pressure.

Pressure loss due to length of hose pipe:

dp= (7.57×q^1.85×L×10^4)/d^5× p

dp = pressure drop (kg/cm2)

q= Air volume flow at atmospheric conditions (m3/min)

L= Length of pipe (m)

d= inside diameter of pipe

P= Initial pressure (kg/cm2)

q= 0.125 m3/min

P= 1.0197 kg/ cm2

L= 12 m

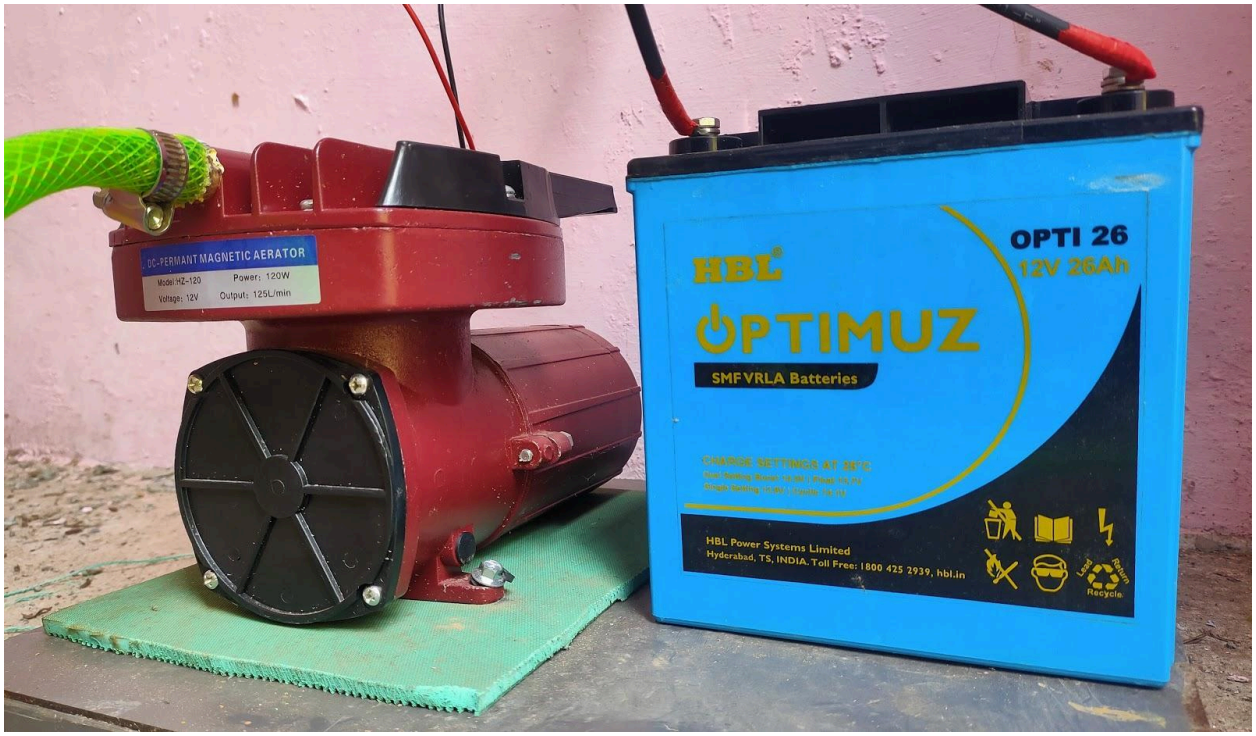
d= 10mm

dp = (7.75× 0.125^1.85 × 12× 10^4)/ 10^5×1.0197

dp = 0.19 kg/cm2

Therefore 0.018MPa pressure will be dropped.

The pressure drop is around 10% which is negligible as per our application.



Solar water bubbler

Solar charge controller