Fabrication of magnetic water system for drip irrigation by using solar energy

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Abstract: In present investigation solar power-driven irrigation system for magnetic water was established experimentally via the improvement of greater efficiency, economic solar Photovoltaic (PV) cell panels. This system reduced the using the oil fuel for power-driven irrigation systems and reduction in greenhouse gasses. The work was established in outdoor for 7 days and seven different water volume flow rates namely 0.5, 0.75, 1, 1.25, 1.5, 1.75, 2 Litter per minute (L/min). experiment tests on a half hourly foundation, from 8:00am to 16:00pm, with gage pressure, water flow rate, moisture, solar intensity, temperature, current, voltage measurements throughout each experiment. The results shown that directly influence of solar intensity on energy construction, also it is shown inversely proportional relationship between water flow rate and salinity of water. This system can pump and desalinate water from sewage or groundwater into the ground.

Key words: Solar, Photovoltaic, water-irrigation.

1. Introduction
The PV irrigation arrangements system which used PV panels for producing electricity via solar energy that employed in combination with an electric motor for driving water pump. Also the system supplementary improved when using of electricity storage batteries and including a water storage tank. AC powered pumps and AC motor used in the system with an inverter for converting DC power via the solar cell panel to AC for systems. The reducing cost of PV cell panel equipment, relaxed integration of obtainable system, decrease of Lithium Ion batteries charge and quick installation in current periods is important factors Saeed et al [1].

Many connection PV cell panels were the greatest efficient form that of additional renewable energy systems [2, 3]. Cadmium telluride prison cell are a superior selection with component efficiency of 19.1%, via smallest amount gas emissions of greenhouse and fastest remuneration gas emissions times [2, 4]. The cost of PV systems is improved for lifetime as comparing with diesel fuel [3–5]. The initial speculation cost of PV cell panels is higher than that of Diesel and other systems of renewable energy like wind and solar thermal [3]. However, a system of PV may have a payback time of underneath 6 years which is matchless by other kinds of irrigation explanations for remote rural zones [4]. Pervious study [6] constructed a solar system for irrigating of one hectare of land via power which is less than
1kW instead of 5 kW. The pump positive displacement is exposed to be useful for greater heads while the diaphragm pump better using for lower heads both provided that efficiencies of 70% [4,7–9]. The researchers employed the solar energy for the process of water pumping round the world for overpowering the shortage of energy [10–13]. Several investigations also employed the solar water pumping for various portions of the world then establish it as suitable used for agriculture, national use, water deliveries to villages and beef watering [14–17]. It found that water pumping for sustainable via means of photovoltaic solar energy especially in respect for water consumption control and its supreme efficiency, controlled irrigation maybe employed [18] and establish greatest efficient techniques [19-20].

Talib et al. [21] produced design of two systems for tracking angles and fixed angle solar cell panel to increase the performance of solar energy during sunny and cloudy days by employing reader of AT 89552 MC dependent upon the light falls on LDR. The results are shown that the tracking angle solar panel is more efficient than the fixed one during sunny and cloudy days in morning and afternoon. Salinity [22] indicated the measurement of salts dissolved in water. The minerals of salt stick to the surfaces of pipes, which restricts water flow in pipes. To measure the salinity of water, concentration of salts in water can be indicated by using equation of mass salt over the volume of water. The effect of salt content on corrosion rate of steel pipe in turbulent flowing solutions is investigated by Hasan [23]. The investigation indicated the effect of salt content on the corrosion rate of carbon steel pipe in water under thermal turbulent flow conditions. The working principle of experiment is that the NaCl solution in container will be heated by heater and thermometer will be used to measure the temperature of NaCl solution. The results of latter study shown that less salt content causes low corrosion rate in pipes. However, it shown that high salt content leads to increase in corrosion rate. This is due to increase in electrical conductivity of water. Microfiltration is used for filtering oily wastewater. If the sizes of the oil droplets are micrometre-sized this process could improve the solution flow rate in pipe system. The effect of cross-flow velocity, oil concentration and salinity on the critical flux of an oil-in-water emulsion in microfiltration was investigated by Tanudjaja et al. [24]. The results shown that when salt concentration of oil-water mixture is increased, the critical flux of mixture is decreased. This is because of density increase. The effect of water salinity on flow pattern and pressure drop in oil–water flow is studied by Mukhaimer et al. [25]. The investigation included the effect of water salinity on flow pattern and pressure drop in oil–water flow experimentally in 2.25-cm diameter horizontal pipe. The used oil has 781 kg/m3 density and 1.85cP viscosity at 25 °C. The water density was changed by dissolving food salt in the water tank [25].

The object of this study is using the solar energy for powered irrigation system and produced magnetic water in Iraqi weather conditions.

2. Methodology
The experimental examinations accompanied at Al-Mussaib Technical College at Al-Mussaib city in Iraq, positioned at 32°5’ North latitude and 44°3’ East longitude, this location taking as position for explanation in measuring of intensity of the solar at title angle of 42.5° (Latitude plus 10° in winter ) and weather conditions. Measured intensity of solar radiation (I) with half hourly time, water volume flow rate, ambient temperature (Ta), water pump pressure at inlet (Pi) and the water pump pressure at outlet (Po), Magnetic overflow intensity, and Salinity of water. These parameters are inconstant with time and it gotten every 30 minutes from the recorder measured values. The proposed solar combined with magnetic water system as shown in Figure 1 for various pressures, flow rates, the voltage for evaluating the solar irrigation system and the planned procedure included study of system parts and its operation. Photovoltaic Solar cell Panel system employed to occur the irrigation tests is solar power-driven via means of a photovoltaic cell panels, with power of 1000 W. The drawing of complete system is illustrated in Figure 2 in which the power connecting to the battery for storing energy.

The water pump which maintains constant voltage and current with a peak flow rate of 5.6 L/min, maximum pressure 14 bar. To measure the solar radiation, a Kipp and Zonen class one Pyranometer
model CMP22 was employed. The voltage, current, and solar intensity of the systems was measured every 30 min during all the tests, the hourly energy generated (Watts hour) can be calculated as:

\[
\text{Energy (W/h) = Voltage \times Current \times Time}
\]  

(1)

Experiments tests were occurred from 8:00 am to 16:00 pm. seven different water volume flow rates were employed through the system for experimental range, namely 0.5, 0.75, 1, 1.25, 1.5, 1.75, 2 Liter per minute (L/min).

3. Calculation of solar radiation
The calculation of the total solar radiation on exposed surfaces is involved the determination for the beam, reflected, and diffuse solar radiation, which are computed depending on the solar time and position. Solar intensity values A, the atmospheric extinction coefficient B, and sky diffuse factor C were determined for any day of the month [22] as following:

**Figure 1.** Solar magnetic water system.

**Figure 2.** Sketch of solar magnetic water system.
A = 1158 [1 + 0.066 cos (360 ND/370)] (2)
B = 0.175 [1 - 0.2 cos (0.93 ND) - 0.0045 [1 - cos (1.86 ND)] (3)
C = 0.0956 [1 - 0.42 cos (360 ND/370)] - 0.0075 [1 - cos (1.95 ND)] (4)

Where ND is day number in the year. The declination angle δ and sun altitude angle α are given by as [23]:

\[ \delta = 23.45 \left( \frac{360(ND - 60)}{370} \right) \] (5)
\[ \sin \alpha = \cos \phi \cos \delta \cos \omega + \sin \delta \sin \phi \] (6)

Where: \( \phi \) is the latitude angle which equals 32.5° for Al-Mussaib city and \( \omega \) is the hour angle [23]:

\[ \omega = 15(\text{AST} - 12) \] (7)

Where AST is the apparent solar time and can be calculated as following:

\[ \text{AST} = \text{LCT} - \frac{(\text{STM} - \text{LONG})}{15} \] (8)

Where LCT is the local time in hours, STM is the standard meridian of local time zone which equals 45°E for Iraq, LONG is the longitude of the location concerned and equals 44.3°E for Al-Mussaib city. EQT is the equation of time given by Lamm [24] as:

\[ \text{EQT} = \sum_{k=0}^{5} \left( A_k \cos \left( \frac{2\pi k N_n}{365.25} \right) + B_k \sin \left( \frac{2\pi k N_n}{365.25} \right) \right) \] (9)

Where \( N_n \) is the number of day in a 4-year cycle and \( A_k, B_k \) are constant. Duffie and Beckman [25] introduced a general definition of incident angle for any surface orientation as:

\[ \cos \theta = \sin \delta \sin \phi \cos \beta - \sin \delta \cos \phi \sin \beta \cos \gamma + \cos \delta \cos \phi \cos \beta \cos \omega + \cos \delta \sin \phi \sin \beta \cos \gamma \cos \omega + \cos \delta \sin \phi \sin \beta \sin \gamma \sin \omega \] (10)

Where \( \gamma \) is the surface azimuth angle which values 0° for south facing, west is positive and east is negative (-180° ≤ \( \gamma \) ≤ 180°). For a collector due south \( \gamma = 0^\circ \) and the incident angle calculation reduced to:

\[ \cos \theta = \cos (\phi - \beta) \cos \delta \cos \omega + \sin (\phi - \beta) \sin \delta \] (11)

The direct normal irradiance is calculated as [23]:

\[ I_{DN} = A \exp \left( \frac{-P_L}{P_0} \frac{B}{\sin \alpha} \right) \] (12)

Where \( \frac{-P_L}{P_0} \) is the pressure at the altitude concerned relative to standard atmospheric pressure at sea level and is given as [23]:
Where $H_{alt}$ is the altitude in meters above the sea level. The beam irradiance can be computed as:

$$\frac{-P_L}{P_0} = \exp(0.0001148 \, H_{alt})$$

\[(13)\]

\[I_d = I_{DN} \, C \left( \frac{1 + \cos\beta}{2} \right)\]

\[I_r = \rho_g \left( C + \sin\alpha \right) \left( \frac{1 + \cos\beta}{2} \right)\]

\[(14)\]

\[(15)\]

Where $\rho_g$ is the ground reflectivity, which equals (0.2) for ordinary ground or vegetation, (0.8) for snow cover, and (0.15) for gravel surface [25]. For the present work the value was taken at (0.2). The total incident radiation on a surface is then:

$$I = I_b + I_d + I_r$$

\[(16)\]

Solar PV cell collector is calculated as:

$$\eta = \frac{P}{I Ac}$$

\[(17)\]

Where $P$ is power output, $I$ is solar intensity flux, $Ac$ is the collector area.

4. Results

The data collected for using single Solar powered irrigation technologies for magnetic water from January to February 2019, including clear, partly cloudy for different water volume flow rates namely 0.5, 0.75, 1, 1.25, 1.5, 1.75, 2 Liter per minute (L/min). Figures 3, 4 and 5 show the intensity of solar radiation, ambient temperature, and wind speed for nominated clear days. The comparison between the measuring intensity of solar radiation and theoretical incident solar radiation is shown in Figure 6.

![Figure 3. Incident radiation with time](image-url)
Figure 4. Ambient temperature with time

Figure 5. Wind speed with time

Figure 6. Comparison of measuring and theoretical Incident radiation with time
The experiment consists in taking two different waters which included the normal water and after treatment water samples shown in Table 1. It can be shown that an improving for all parameters characteristics of water after magnetic treatment.

| Parameter       | Normal water | Treatment water |
|-----------------|--------------|-----------------|
| PH              | 8.5          | 7.2             |
| Sodium (mg/L)   | 198.4        | 27              |
| Magnesium (mg/L)| 42.3         | 9               |
| Calcium (mg/L)  | 58           | 13.6            |
| Potassium (mg/L)| 4.6          | 3.1             |
| Chloride (mg/L) | 348.5        | 15.2            |
| Sulphate (mg/L) | 97.4         | 42.3            |
| Bicarbonate (mg/L)| 168.2      | 105.7           |
| Nitrate (mg/L)  | 2.4          | 0.2             |

Figure 7 illustrates the influence of solar intensity on energy construction and system efficiency, it can show that the increasing of solar intensity lead to improve the energy construction and system efficiency due to energy gain via solar system. Figure 8 shows the relation between flow rate and salinity of water. The experiment measuring data produced inversely proportional relationship between flow rate and salinity of water. If the water had small amount of salt, maximum value of the flow rate will reach for the reason that no restraint with flow rate of water in a tube while increasing quantity of salt lead to growth the salinity of the water and flow rate. Figure 8 indicates the relation of current and voltage production of the solar system along one day of experimental tests.

**Figure 7.** Influence of solar intensity on energy construction

**Figure 8.** Current-Voltage curves
Figure 9 shows the relation between intensity Overflow Magnetic and salinity. The experiment measuring data produced direct proportional relation between intensity Overflow Magnetic and salinity. The results showed that increasing the intensity of the magnetic flux leads to an increase in the possibility of separating the bonds in the sodium chloride compound and obtaining local water without salts. Figure 10 shows the relation between flow rate and salinity of water. The experiment measuring data produced inversely proportional relationship between flow rate and salinity of water. If the water had small amount of salt, maximum value of the flow rate will reach for the reason that no restraint with flow rate of water in a tube while increasing quantity of salt lead to growth the salinity of the water and flow rate.

5. Conclusion
This study included investigation of solar powered irrigation technologies for magnetic water experimentally; the effect of solar energy on the power storage and salinity on the flow rate of water was indicated. Also the effect of intensity Overflow Magnetic on the salinity was presented. The consequences display inversely proportional relationship between salinity and the flow rate of water and direct proportional relation between intensity Overflow Magnetic and salinity.
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