Electrical Output of A Photogalvanic Cell Utilised To Perform Solar Power Conversion And Storage By With A Lauryl Glucoside, Triazine And D-Fructose System

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Abstract

Objective: The current work focuses on the role of surfactant in photogalvanic cells and how photons from sunshine can be exploited as a driving factor for energy conversion and storage.

Methods: An H-shaped pg unit was created to investigate electrical output in solar changes. Dye, reductant, surfactant, NaOH, double distilled water (DDW), multi-meter, calomel electrode, 250 k roistered, saturated calomel electrode, platinum electrode, carbon pot, resistance key, digital pH meter, microammeter, and 200 W tungsten bulb were used in the suggested electrical circuit. The proposed solar cell's reaction mechanism for generating photocurrent and photocurrent has been thoroughly investigated. For the sunlight-powered transition system, PG Cells were investigated.

Findings: Photocurrent, photo potential, efficiency of conversion, fill factor, and cell performance were all examined in PG cells. The values mentioned above are as follows: 388.0 A, 1141.0 mV, 0.7995%, 0.5389, and 129.0 minutes were measured. The cell's electrical output has also been seen for tetrazine, D-Fructose, and lauryl glucoside systems. Potential at power point, open circuit potential, power point of cell (pp), and current at short circuit were also investigated. The values obtained are as follows: 1133 mV, 1523 mV, 435.321, and 544A are the values.

Novelty: There seems to have a lot of study done on photogalvanics, but no one has concentrated on green dye-based work for a more sustainable future. As a result, an actual research work plan for comprehensive investigation in the field of photogalvanic devices for solar energy transformation was developed. The photo galvanic is an expanding area of research, and the manuscript contains significant electrical output, conversion efficiency, and storage capacity of developed photogalvanic cells, with particular focus on to better performance ($t_{1/2}$) and decreasing the expense of the photogalvanic cell to enhance business viability.

Keywords: Renewable energy, Photocurrent, Photo potential, Fill factor, Conversion Efficiency.

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Introduction

The use of fossil fuels such as wood, coal, kerosene, and so on is rapidly approaching exhaustion. Non-renewable energy sources have their own set of constraints, including damaging procedures and pollutants. The scientific community is driven to seek out renewable sources of energy that are both non-polluting and commercially viable in order to feed the entire world. As a result, sunshine is the best alternative for meeting energy demand. It was essential and planned to conduct experimental work under solar conditions. For the best results, detailed literature studies on various photogalvanic cells were used in solar transformation. With solar power and improved storage capacity, solar energy is already becoming cost competitive. The day when renewable energy competes with coal-based power is not far away. However, in order to expedite climate action, the world will need to dramatically reduce its usage of coal and oil over the next few decades. Currently, two fossil fuels – coal and oil – meet more than half of global energy demand.

Thermal power, the majority of which is coal-based, accounts for a significant share of global electricity generation. Energy is a significant role for humanity in modern society and is increasingly desired as a riding environment for industrial development and agricultural activities. Although both pv and photo galvanic devices are utilised for solar power conversion and storage, photovoltaic cells have the lowest storage capacity while photo galvanic devices have the greatest storage capacity, which is why the current research effort has been undertaken.

First and foremost, the effect of light on the ferrous iodine iodide equilibrium was investigated in (1925) [1]. In the photochemical characteristics of the thionine-iron system [2], the photo galvanic effect I (1940) was examined. The photo galvanic cell [3] demonstrated the efficacy of the iron thionine system (1959). Thin layer iron-thionine photo galvanics (1978) was discovered in electrodic processes at the anode [4] with respect to complete illumination. The use of a thionine ethylene diamine tetra acetate (EDTA) system in a photogalvanic cell (1989) for solar energy conversion and storage was observed [5]. Micelles (1999) were explored in photogalvanic cells for solar energy conversion and storage: cetyl trimethyl ammonium bromide-glucose-toluidine blue system [6]. The micellar impact experiments on photogalvanics: sunlight conversion and storage-EDTA-Safranine O-TWEEN-80 System [7] were brought up. A study [8] compared the performance of photogalvanic cells with different photosensitizers for solar energy conversion and storage: D-Xylose-NaLS system. There are currently reports on mixed surfactant (2013) systems with photogalvanic devices for solar energy conversion and storage: D- xylose methylene blue systems [9-11]. A study of surfactant in photogalvanic cell (2017) for solar energy conversion and storage was described [12]. Better research was conducted in 2018 on the photogalvanic effect in photogalvanic cells comprising a single agent as DSS, Tetrazine as a photosensitizer, and EDTA as a reductant for solar energy conversion as well as storage [13].

Sudan-I dye as well as Fructose chemicals-based photogalvanic devices (2021) are currently being studied for electrochemical solar energy conversion as well as storage at low and artificial sun intensity [14]. For improved outcomes, a thorough literature review of several photogalvanic units was conducted [15-17]. A different group of researchers (2021) discovered that a formic acid reductant-sodium lauryl sulphate surfactant increased the photogalvanic action of an Indigo Carmine dye sensitizer for simultaneous solar energy conversion and storage [18]. For improved cell performance, modified and simplified (2022) photogalvanic cells: solar energy harvesting applying bromo cresol green dye with varied electrodes and cell dimensions was further investigated [19]. In these pg cells, many photosensitisers, surfactants as well with reductants have been used, but the combined effect of lauryl glucoside, Tatrazine photosensitizer, and D-fructose system has not been examined. It is hoped that such a technology will result in a pg cell with improved electrical output and performance. Furthermore, this method will pay special attention to improved performance ($t_{1/2}$) and lowers the overall price of the photogalvanic system for commercial viability.

2. Methodology

2.1 Material required:

Tatrazine dye, D-fructose reductant Lauryl glucoside surfactant, NaOH(1N), Double distilled water (DDW), Multi-meter, Calomel the electrode, roistered 250 k glass tube, carbon pot, Resistance key, Saturated calomel the electrodes, Platinum electrode A digital pH metre, a microammeter, and a 200 W tungsten bulb are included.

2.2 Experiment method:

The current PG Cell research investigation is being conducted using a manufactured H-shaped glass tube. The total volume of the experimental set, comprising solution dye, surfactant used, and reductants, was 25 ml. Calomel electrode, 250 k roistered, H shaped glassware tube, A saturated calomel electrode platinum electrode carbon container, (resistance) key, digital pH metre and microammeter, and 200 W tungsten bulb were used to complete the electrical circuit. IR light was passed via a water filter during the studies. One leg of an H-shaped glass tube was attached to a calomel electrode, while the other was connected to a platinum foil electrode. A pH metre was used to modify and test the pH of the solution. The approach for the fabrication of an H-Type cell is shown in figure 1.

3. Result and Discussion

3.1 Effect of variation of lauryl glucoside concentration on the PG-CELL:

During the sun experiment stage, electric output increased with increasing lauryl glucoside concentration and reached an optimum position (at PH 12.09) before decreasing with increasing lauryl glucoside concentration. Less capacity to solubilize molecules for electron transfer process in hydrophilic hydrophobic contact at lower concentration range of lauryl glucoside concentration. In contrast, at higher concentrations of lauryl glucoside, there are more surfactant molecules available for electron transfer in hydrophilic hydrophobic interactions, which may limit electron transmission. There are considerable effects on electrical output for the photogalvanic system at moderate levels of lauryl glucoside concentration. This is because surfactant can aid in the separation of photoproducts via the micelle interface's hydrophilic-hydrophobic interaction.

Tables 1, 2, 3, 4, and 5 illustrate the observed results.

3.2 Effect of variation of tatrazine (dye) concentration on the system:

During the experiment stage, solar electric production grew with increasing tatrazine concentration and reached an optimum position, then decreased with increasing tatrazine concentration. At lower concentrations of dye, the low quantity of dye limits the absorption of the light source, resulting in a poor electrical output. In contrast, at higher dye concentrations, there are so many molecules that the intended light source does not reach the molecule near the electrode. There are optimum molecules existing at intermediate dye ranges such that the optimum light source does reach the molecule near the electrode and maximum photo potential, maximum photocurrent, and maximum power were obtained. Tables 1, 2, 3, 4, and 5 illustrate the observed results.

3.3 Effect of variation of D-fructose (reductant) concentration on the system:

Following the testing stage, sun electric output grew with rising D-fructose concentration and reached an optimum position, then decreased with increasing tatrazine concentration. A reduced number of reductant molecules are available for electron donation to dye to create the cationic form at lower concentrations of Reductant. At a higher level of Reductant, a greater number of reducing agent molecules are accessible for electron donation to dye to produce the cationic form that inhibits the methylene blue. There are optimum numbers of reductant molecules present at intermediate Reductant amounts, forming a desirable condition for semi or leuco form of dye molecules to get the findings. Tables 1, 2, 3, 4, and 5 illustrate the observed results.

3.4 Current–voltage (i-V) characteristics of the photogalvanic cell:

The fill ratio of a PG-cell was computed using a specific formula (figure 2).

$$\text{Fill factor}(\eta) = \frac{V_{pp} \times i_{pp}}{V_{oc} \times i_{sc}} \quad \text{… Eq. (1)}$$

Where:

v_{pp} = Potential at power point=1133 mV

i_{pp} = Current at power point=388 µA

V_{oc} = Potential at open circuit =1523 mV

i_{sc} = Current at short circuit=544µA

(η) = Value of fill factor= 0.5389

pp = The power point of cell (pp) = 435.321

3.5 Cell performance and conversion efficiency:

By using, following formula fill factor of PG-cell was calculated (figure 3)

$$\text{Conversion efficiency} = \frac{V_{pp} \times i_{pp}}{A\ 10.4 mWcm^{-2}} \times 100\% \quad \text{… Eq (2)}$$

Where:

$V_{pp,}$ = Photopotential at power point,

i_{pp} =Photocurrent at power point,

A = Electrode area for pg cell.

3.6 Comparison with past studies:

It was also discovered that the photogalvanic cell with the current method had a conversion efficiency of 0.7995% and a storage capacity of 129.0 minutes. These values are relatively higher in comparison to previously reported cells containing a single surfactant as DSS, Tatrazine as a photosensitizer, and EDTA as a reductant for solar energy conversion and storage (0.6163% and 100.0 minutes), Mixed Surfactant (NaLS+CTAB), Methylene blue as a Photosensitizer, and Xylose as Reductant (0.4326% and 90.0 minutes), Mixed Surfactant (NaLS+Tween Methylene blue as a Photosensitizer and Xylose as Reductant (0.5313% and 100.0 minutes),Gangotri and Mohan Lal (2013), Lal Mohan and Gangotri KM (2012), and Gangotri and Gangotri (2010). As a result, the photogalvanic cell with the tatrazine lauryl glucoside D-fructose system outperforms conventional cells and SK Yadav explained the Photogalvanic Effect of Dye as a Photosensitizer for Solar power Conversion and Storage. By selecting appropriate chemicals, efforts can be made to improve conversion efficiency and storage capacity while also lowering the cost of the photogalvanic cell.

4. Conclusion

4.1 Work originality: Based on the data, we inferred that a single surfactant influenced photogalvanic cells more than mixed surfactants. The single surfactant has not only improved conversion efficiency but also photogalvanic cell storage capacity, and extensive efforts are still underway to improve electrical output as well as storage capacity of photogalvanic cells while lowering their cost to achieve commercial viability. In the PG system, the conversion efficiency, $t_{1/2}$, and fill factor are 0.7995%, 129.0 minutes, and 0.5389, respectively.

4.2 Current study limitations and future study scope: With

solar electricity and increased storage capacity, solar energy is already becoming cost competitive. Renewable energy will eventually compete with coal-fired power. Thermal power, the majority of which is coal-based, accounts for a significant share of global electricity generation. However, in order to expedite climate action, the world will need to dramatically reduce its usage of coal and oil over the next few decades. Currently, two fossil fuels – coal and oil – meet more than half of global energy demand.

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Figure 1: Experimental set up of photogalvanic cell

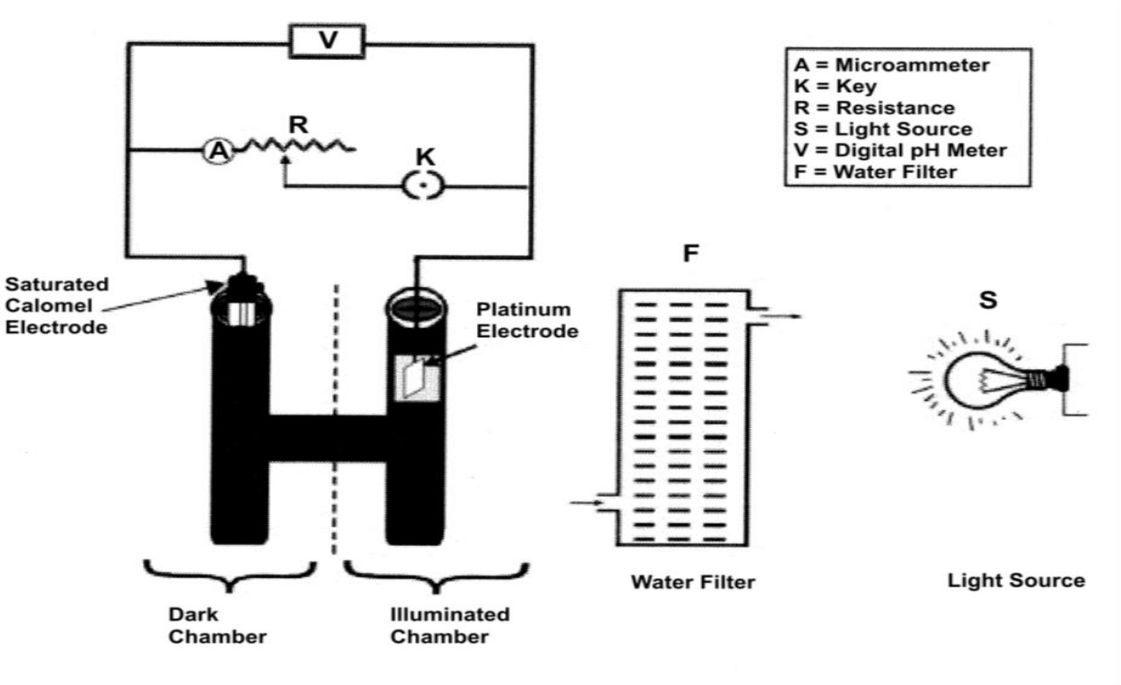

Table 1: Showing effects of variation of tatrazine concentration on electrical output of photogalvanic cell

Concentration of dye taken for experiment: Tatrazine X 10^{-5} M)	Observed results: Photopotential (mV)	Observed results: Photocurrent (µA)
1.10	837	377
1.50	883	407
1.70	935	442
1.90	888	410
2.10	833	380

Table 2: Showing effects of variation of fructose concentration on electrical output of photogalvanic cell

(D-fructose×10-^{3})	Photopotential (mV)	Photocurrent (µA)
2.16	816	381
2.20	886	410
2.24	934	439
2.28	889	406
2.32	819	379

Table 3: Showing effects of variation of lauryl glycoside concentration on electrical output of photogalvanic cell

(Lauryl glucoside x 10^{-3})	Photopotential (mV)	Photopotential (mV)
1.70	817	382
1.84	882	413
1.98	935	440
1.72	873	410
1.70	821	379

Table 4: Showing electrical output of photogalvanic cell:

Time (Min.)	Power (μW)
35.0	137.76
40.0	133.11
45.0	129.33
50.0	124.47
55.0	119.98

Table 5: Comparison of present study with past studies

S.No.	parameters	Tatrazine, D-fructose, Lauryl glucoside	NaLS, Tween-80, Methylene blue, Xylose	NaLS, CTAB, Methylene blue, Xylose	DSS, Tatrazine EDTA
		Present Study	Past studies		
1	Conversion efficiency	0.7995%	0.5313%	0.4326%	0.6163%
2	Storage capacity	129.0 minutes	100.0 minutes	90.0 minutes	100.0 minutes
3	Fill factor	0.5389	0.3024	0.2770	0.2800
4	Photopotential	1133.0 mV	645.0 mV	655.0 mV	493.0 mV
5	Photocurrent	388.0 μA	210.0 μA	190.0 μA	130.0 μA