Renewable Energy Source: 'Solar Energy Conversion and Storage in Electrical Energy'

'Mahesh Chandra'

'Department of Chemistry,Deshbandhu College,University of Delhi'

Abstract
In the solar cells, solar energy is transformed via the "photo galvanic effect" using photo sensitizers and then stored in the batteries. In a system comprising a reducing agent and a photo sensitizer, the "photo galvanic effect" was also explored. It is determined that the "photo potential" generated in a cell is 1800.0 mV and the "photocurrent" generated in a cell is 480 A when measured in light and without light under forward and reverse bases. The cell's "highest power" was 120.20 W, while its "experimental conversion efficiency" was 0.1829 percent. When measured in the dark, the cell's storage capacity was 104.0 minutes. In "photo galvanic cell," there has been a suggestion for converting solar energy, and the impact of various restrictions on the “electrical output” of solar cells has been seen.

Keywords: *photo potential, photocurrent, fill factors, conversion efficiency, power point, storage capacity.*

Introduction

As a result of the increasing usage of fossil fuels, energy resources are depleting and the planet is warming. As a result, renewable energy sources, such as solar energy, are gaining popularity as a potential source of electricity. The light sensitizer "Ponceau-S" and the reductant "KI" are employed in this work to generate "electrical energy" in the "photo galvanic cell." The first person to document photochemical reactions was Becquerel [1, 2]. "Alonso et al. discovered the usage of a CdSeO-5 TeO-5 electrode (electrically deposited) for the conversion of solar energy." [3]. "Jana and Bhowmik showed that the combination of dyes improves the power output in a solar cell" [4]. This novel "coumarin dye" has the "thiopene" components, which Hara et al. are investigating for a highly effective natural dye-sensitized solar cell. "[5]. In the "Azur A-KI [7] Bromophenol- EDTA [8]" and "Fluoroscein-EDTA [9]" systems, "toluidine blue nitroloacetic acid (TB-NTA)"[6] has been reported to be used. These "photo galvanic cells" [10].

I. Experimental Methods

Double distilled water is used to prepare the solutions and in order to protect from the light they are stored in the containers that are of amber colour. A cell which is made up of glass and is H shaped is filled with the solution made up by mixing the dye, potassium iodide (KI), NaOH and H_2O. In one partition of the cell, an electrode made up of platinum is sited and in the other section of “the cell SCE” is placed. The “platinum electrode” was placed in a tungsten lamp with 200 watt and at the same time saturated calomel electrode is kept where there is no light and the temperature is optimized to 303 K (±0.1). In order to stop the infra- red radiations water filter is utilized. The “potential” is measured with the help of an electronic pH meter and the “current” is measured by a small ammeter. An extra load is applied by the pot made up of “carbon” (log 500 K) and ‘connected’ within “circuit” so as to determine the features of the current and the voltage. This variable resistor which is pot made up of carbon pot helps in plotting the curve between the current and the voltage.

II.Results and Discussion

1.Impact of pH:

The "photo potential" & "photocurrent" grow with pH up to pH 13 are presented in Fig.1, and as pH increases further, the "electrically" produced by the "cell" starts to decrease in quantity. Results from an investigation into how "photo potential" and "photocurrent" are affected by dye concentration are presented in Fig. 2. After reaching a concentration of $4.8x10^{-6}$ M, both of these parameters begin to decrease. When the concentration of "Ponceau-S" is increased, "photo potential" increases along with it, as does "photocurrent." When the Ponceau-S concentration is low, the output is minimal when the concentration of dye molecules is high, most of the light along the path is absorbed by dye molecules, which reduces the light intensity that reaches dye molecules near the electrodes and hence decreases the "photo potential".

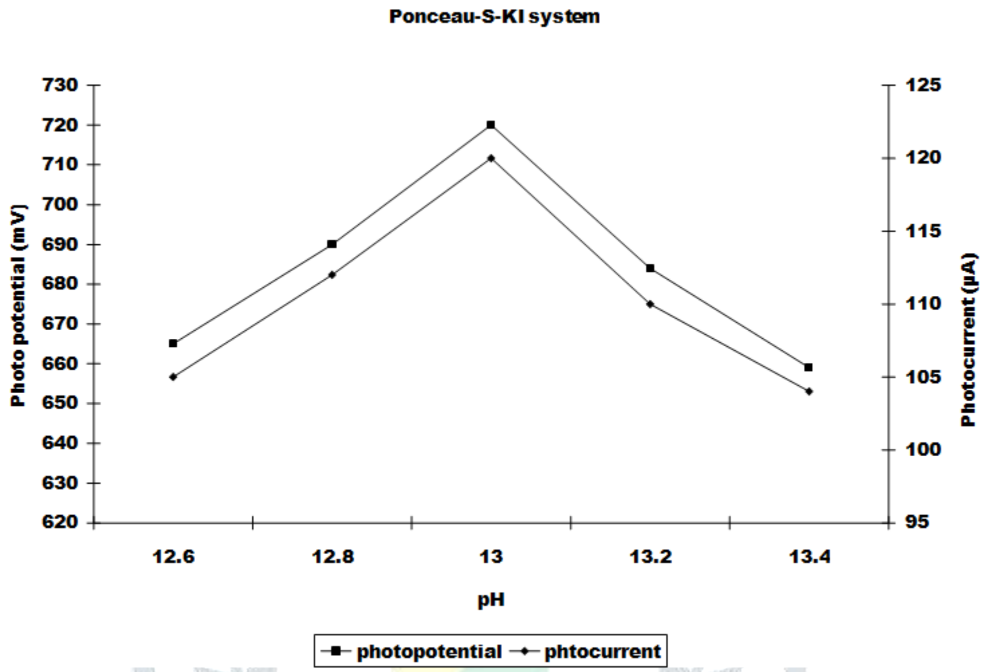

Figure-1. pH-dependent changes in photopotential and photocurrent.

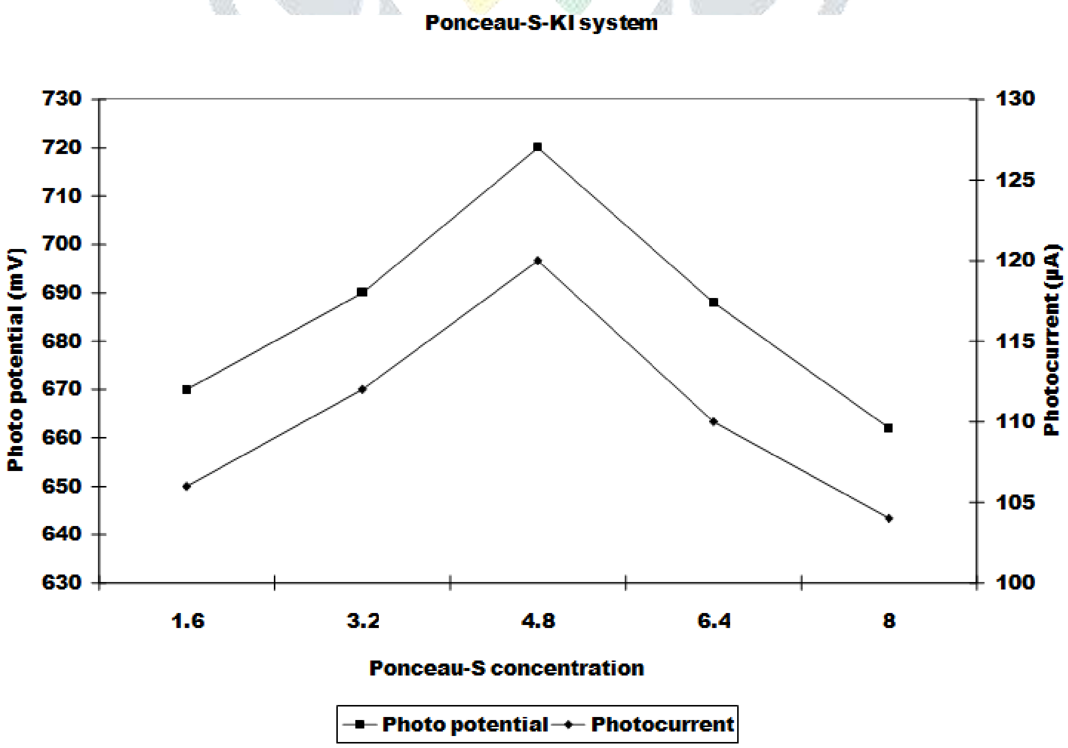

Figure- 2 Impact of Ponceau-S Concentration on Photopotential and Photocurrent Variation

2. Impact of KI Concentration

An experiment was conducted to see how the concentration of the reductant potassium iodide affected "photo potential" & "photocurrent." Photo potential and photocurrent are at their highest when potassium iodide (KI) is present in a concentration of 2×10^{-3} M. Only a few reductant molecules are available when the concentration of potassium iodide (reductant) is low, making it difficult to donate electrons to dye molecules. When potassium iodide (reductant) concentrations are high, dye molecules become immobile and cannot reach their destination (electrode) in the required time period.

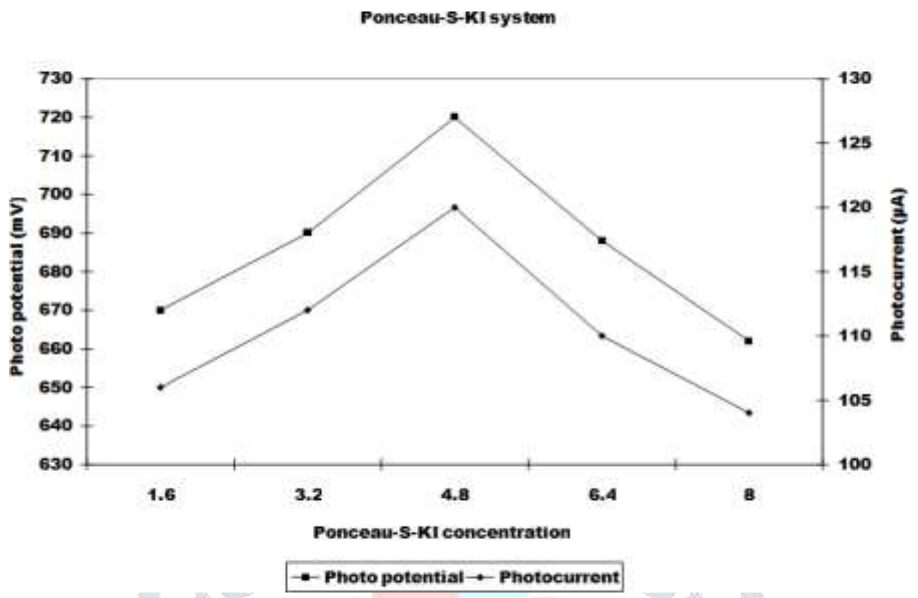

Figure-3. Impact on variation of Photo Potential and Photocurrent of KI Concentration.

.

3. Impact of Light Intensity

Figure 4 depicts the changes in two electrical parameters. With an increase in "light intensity," "photocurrent" increases linearly. Photon counts, which are an incident power at every unit area and which strike dye molecules near platinum electrodes, rise in response to rising light intensity. Because of this, "photocurrent" and "photo potential" in a "photo galvanic cell" will grow under ideal circumstances.

4. Effect of Diffusion Length

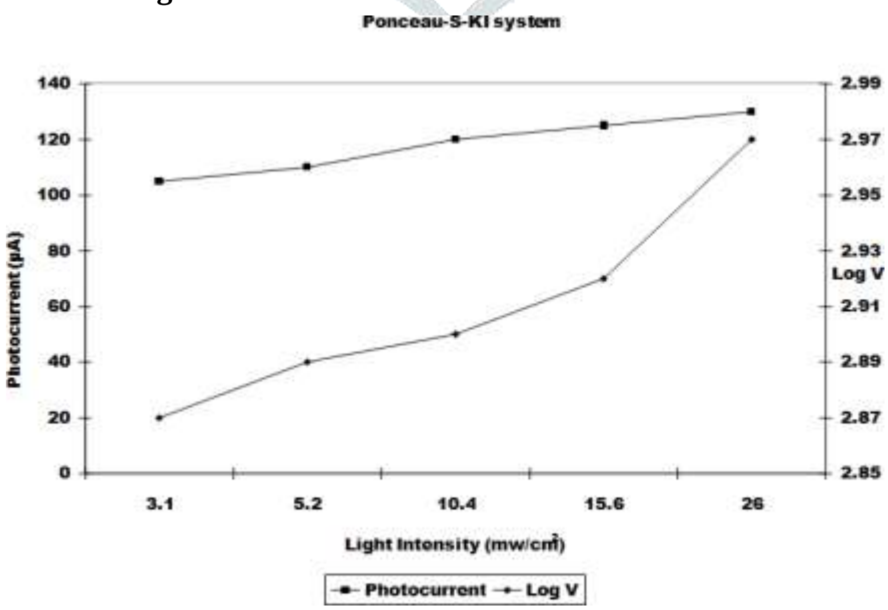

Figure- 4. Light Intensity Impact on photo potential & Photocurrent.

The parameters of current of the cell are "i_{max},i_{eq}" and "initial rate" of "current generation". The impact of difference of the "diffusion length" based on these factors is studied by using various sizes of the H cells. Fig. 5 is showing the outcome of the study where it is "observed" that at beginning "photo current" (i_{max}) is "sharply" rise which shows an "initial rapid reaction" and later on it is seen that there is a slow rate determining step.

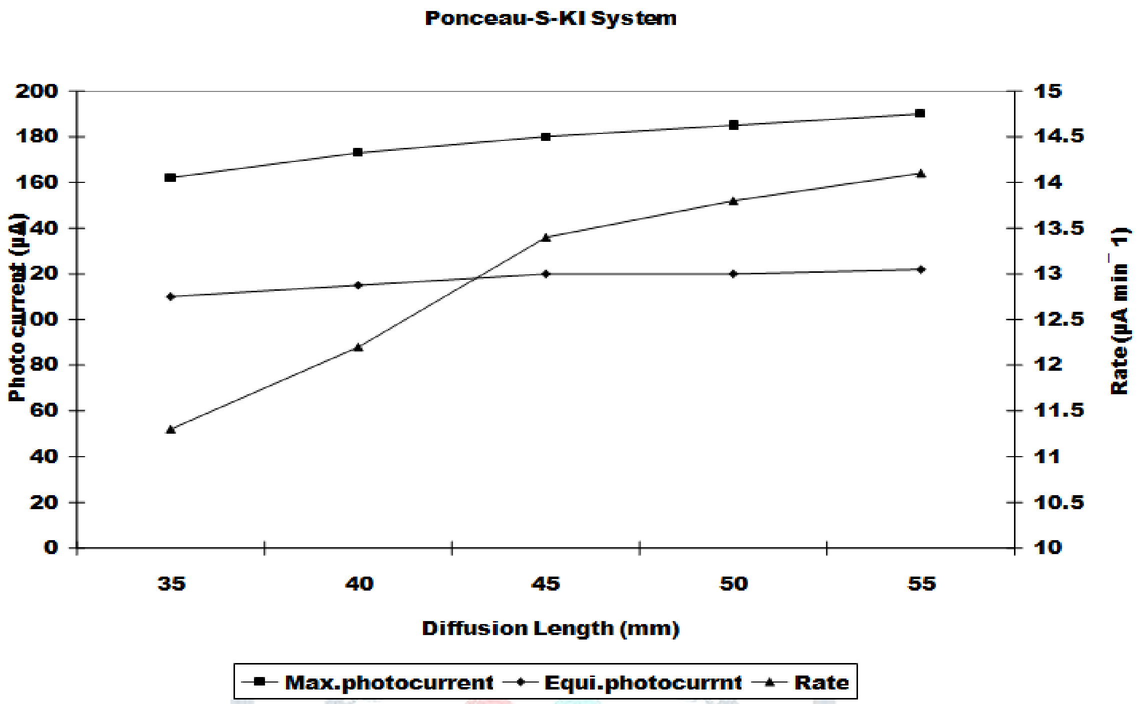

Figure-5. Diffusion Length Effect on Current Variation

5. Current Voltage (I–V) Characteristics, Conversion Efficiency and Performance of theCell:

It is possible to measure V_{oc} (open circuit voltage) with a "digital meter" and i_{sc} (short circuit current) by using a micro ammeter in "photo galvanic cells. "A pot made of carbon (linear 470 K) is used to record the "current" and "potential" between 2 highest values when the pot helps in applying the load externally. In this process the carbon pot is connected in the multi meter circuit.Fig. 6 are showing the cell's i-V feature that contains a "Ponceau-S KI" cell. The following formula use curves to help them work out (i-V) are used to find the cell's "fill factor" & "conversion efficiency." "Fill factor" is 0.55% & "conversion efficiency" is 0.0829%.

$$\text{Fill Factor} = \frac{V_{pp} \text{ X } i_{pp}}{V_{oc} \text{ X } i_{sc}}$$

$$\text{Conversion Efficiency} = \frac{V_{pp} \text{ X } i_{pp}}{10.4 mWcm^{-2}} \text{ X } 100\%$$

At the power point, V_{pp} represents the "potential" & i_{pp} represents ' current' & pp represents 'Power point'

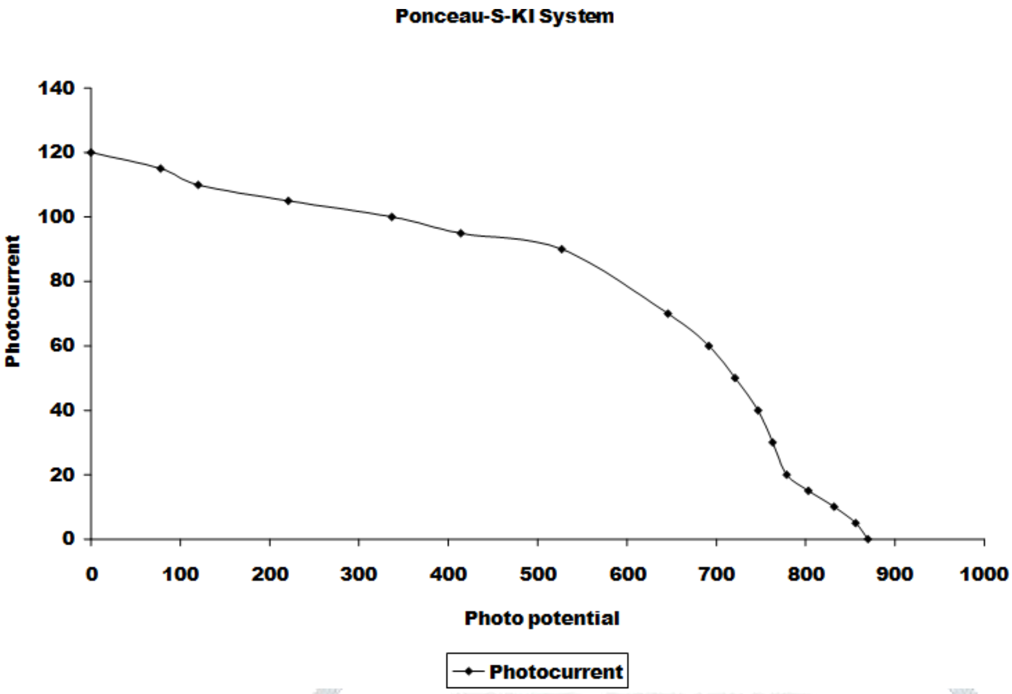

Fig-6. "Current-Potential" "I-V Curve" of "Ponceau-S-KI" System

"A" point in "i– V curve" and at this point "product" of "photocurrent" & "photopotential" is "maximum". By applying the load externally the cell's performance can be calculated and this load is essential to get "current"&"potential" at pp "power point" when "light source" is removed. The "cell" at its pp (power point) is able to provide light in the dark for about 104 minutes but the "photo voltaic cell" is not has this capacity and at the same time the "photo galvanic cell" can be used in the light with it slow efficiency of conversion.

6. Mechanism

It is found that in the dark since there is no reaction between "Ponceau-S"& "KI", the conclusion can be made that "redox potential" of " potassium iodide" is much high as compared to "Ponceau-S". When the illumination is done in "platinum" electrode and it gets its stable value when is exposed to some period of time. Even though when the light source is removed the change inpotential up turns its direction and it sdoesn't comes back to "primary value'. This shows that "main reversible photochemical reaction" goes along with "side irreversible reactions."Therefore, in"photogalvanic system" the electro-active specie is not like the "thionine– iron (II) system" that is thoroughly studied by the scientists and the researchers. In thisexperiment, in the chamber which is illuminated the electrode active specie is "leuco- or semireduced dye" and in the chamber which is dark the dye itself is the electrode active specie. According to prior research, the photo galvanic cell's process for generating "photo current" is as follows:

<u>"Illuminated chamber"</u>

$$\text{Dye} \xrightarrow{h\nu} \text{Dye*}$$

$$\text{'Dye*' +' R'} \longrightarrow \text{"Dye}^{-}\text{"+ 'R}^{+}\text{'}$$

At "platinum electrode":

$$\text{"Dye}^{-}\text{"} \longrightarrow \text{"Dye" + 'e}^{-}\text{'}$$

"Dark chamber"

At "calomel electrode":

.

$$\text{“Dye”} + e^- \longrightarrow \text{“Dye}^{-}\text{“}$$

To get back to the original dye and "reductant" molecule, you must combine the leuco/semi form of dye with the oxidised form of the "reductant." This mechanism's cycle is continually repeated, resulting in continuous current production.

$$\text{“Dye}^{-}\text{“} + \text{“R}^{+}\text{”} \longrightarrow \text{“Dye”} + \text{“R”}$$

Here 'Dye', 'Dye*', 'Dye', 'R-'&'R+' are the "excited form of dye," "semi or leuco dye," 'reductant' and "oxidized form of the reductant," respectively.

III Conclusion

The study concludes after analyzing the results that in the "photo galvanic cell," "Ponceau-S" works well as a photo sensitizer because of its chemical makeup. Cell "conversion efficiency" is "discovered" to be 0.1829 percent in dark it can be used with its pp (power point) for good 104 minutes. There is a good advantage of "photo galvanic cell" as it has an in built capacity to store. Therefore, the there is a good possibility for the photo galvanic cell to become feasibility for the commercial uses.

Acknowledgements

This study would not have been possible without the laboratory facilities provided by for which the writers are grateful: the Principal of Deshbandhu College at Kalkaji, New Delhi.

Reference

[1]. Becquerel E, Studies of the effect of actinic radiation of sunlight by means of electrical currents. *C.R. Acad.Sci.Paris.*, 9,145–159**(1839a)**

[2]. Becquerel E,On electric effects under the influence of solar radiation. *C. R. Acad. Sci. Paris*. , 9,561 **(1839b)**

[3]. Alanso V N, Belay M, Chartier P, Ern V, *Rev. Phys. Appl.*,16, 5 **(1981)**

[4]. Jan a A K, Bhowmik B B, Enhancement in power output of solar cells consisting of mixed dyes. *J. Photochem.Photobiol*, 122A, 53 **(1999)**

[5]. Hara K, Kurashige M, Dan-oh Y, Kasada C, Shinpo A, Suga S, Sayama K, Arakawa H, Design of new coumarin dyes having thiophene moieties for highly efficient organic dye- sensitized solar cells. *New J. Chem.*, 27,783–785 **(2003)**

[6]. Ameta S C, Ameta R, Seth S, Dubey T D,Studies in the use of toluidine bluenitrilotriacetic acid (TB-NTA) system in photogalvanic cell for solar energy conversion. *Afinidad*. XLV, 264–266 **(1998)**

[7]. Ameta S C, Khamesare S, Ameta R,Bala M, Use of micelles in photogalvanic cell for solar energy conversion and storage: AzurA- KI system. *Int.J. Energy Res*, 14,163– 167 **(1990)**

[8]. Ameta S C, Punjabi P B, Vardia J, Madhwani S, Chaudhary S, Use of Bromophenol Red–EDTA system for generation of electricity in a photogalvanic cell. *J. Power Sources*. 159,747–751 **(2006)**

[9]. Madhwani S, Ameta R, Vardia J, Punjabi P B, Sharma V K, Use of Fluoroscein- EDTA System in Photogalvanic Cell for Solar Energy Conversion. *Energy sources*,29,721-729 **(2007)**

[10]. Bohrmann-Linde C, Tausch M W, Photogalvanic cells for classroom investigations- A contribution for the ongoing curriculum modernization. *J. Chem. Educ.*, 80, 1471-1473**(2003)**