Chemistry -An-Eco-Friendly- Technology for "Solar Energy Conversion and Storage in Electrical Energy"

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Abstract- Today we are very much concerned about the energy security just like the oil security in India. While the increasing demand of hydrocarbons and dependence on oil is important, the security of energy in India should be consider in the respect of primary supply of energy, whether its commercial or non-commercial. It must not be restricted only to the availability of only hydrocarbons. Our electricity demand per year is increasing by 5.4 billion KW. Out of the total demand of energy, around one fourth consists of biomass, animal waste and fuel wood. There are number of renewable things have now become commercially feasible. It is observed that renewables could play a big role in rural development in terms of electrification if we equip and make use of these technologies and opportunities properly. The demand for technological needs promotes the whole range of renewable form of energy as solar hydro, solar photovoltaic, bio-energy etc. One of the most essential issues is conservation of energy. A number of moves has been taken for hundreds of years in regard of this, especially in the case of oil but the best thing could not be achieved till now. Therefore, to solve our energy conservation and global changes issues, new technology and energy efficient are so crucial. Photo galvanic effect has observed in a particular system which contain a dye Victoria Blue act as photosensitizer and a reducing agent Ascorbic acid. In light and dark under reverse and forward biases, the current voltage relationship has been observed of the cell. There are several parameters were studied which acts on electrical outcome of the cell and for production of photocurrent, a procedure has also been put forward.

Key Words : Photo potential, Photocurrent, Fill Factor, Energy security and environmental sustainability.

I. INTRODUCTION

Energy is essential for the development of nation. The degree of industrial development as well as the prosperity of every nation is known that is directly related to the per capita energy consumption of nation. In few decades the search for renewable source of energy has to protect health and environment. Though, the people of some countries are affluent than others. This disparity was much less in primitive times.

One of natural source of energy is sun, which provides the solar energy, which can directly convert into the electrical energy. High-energy consumption has traditionally been associated with high quality of life, which is often associated with development of nation.

Energy is consumed for the variety of requirement of life and has become a prosperous life such as energy is required for every step of life and field of life, without energy the life is not prosperous. For the development of nation and life the modern techniques (technology) of energy generation are also required.

So now we classified the different solar cells in which solar energy converted to electrical energy are following –

(1) Photo electrochemical cells.
(2) Photo biological cells.
(3) Photo semiconductor cells.
(4) Photo catalytic cells.
(5) Production of hydrogen cells.
(6) Fuel cell.
(7) Photo galvanic cells

Photo galvanic Cell:

Photo galvanic cell is a device in which when the photons strike the molecules of photosensitize, its excited and excited molecule of photosensitize is known as energy rich species. These energy rich species release energy electrochemically when return to ground state. This phenomenon is known as photo galvanic effect.

In photo galvanic cells excitation of molecular by photon to produce high-energy products, it produces energy. Their reaction is reversible, endergonic reaction, which pushed uphill with light. The conversion efficiency of photovoltaic

cells has high and frequently need to be charged. These are expensive and used in space exploration programmed only.

The current flow in between the two asymmetrical irradiated metal electrodes was firstly noticed in 1839 by Bequerrel [1-2]. Clark and Eckert [3] reported the photo galvanic effect]. Some important photo galvanic systems have accounted by Rohatgi Mukherjee et al [4-8]. The detected conversion efficiency are low, somehow because of less consistency of dyes and return displacement of electron but the theoretical value of conversion efficiency is about 20%.

An elaborated literature survey [9-26] discloses that many reductants and photosensitizers have applied in the cells (photo galvanic) but there is no concentration given to Victoria blue, a dye which was used as photosensitizer with a reductant, name Ascorbic acid in a “photo galvanic cells” for conservation and ‘storage of solar energy’. Thus, this present work was taken up.

II. EXPERIMENTAL

In the present work, sodium hydroxide (s.d.fine), Ascorbic acid (LOBA) and Victoria blue(LOBA) were used. The solutions associated in this experiment are made in water which is doubly distilled. To protect these solutions from sunlight they were kept in the dark coloured containers. In H-type glass tube, a combination of solution of dye Victoria blue, Sodium hydroxide and Ascorbic acid were taken. One of the front lines of the H-tube was submerged by an element (Platinum) , "saturated Calomel electrode" was mounted in another front lane of the H-tube. Till the time a measurable potential was observed, the complete system was placed in dark first, after that the forelimb having SCE was placed in dark. There was a Tungsten lamp of 200W under which the platinum electrode was revealed.

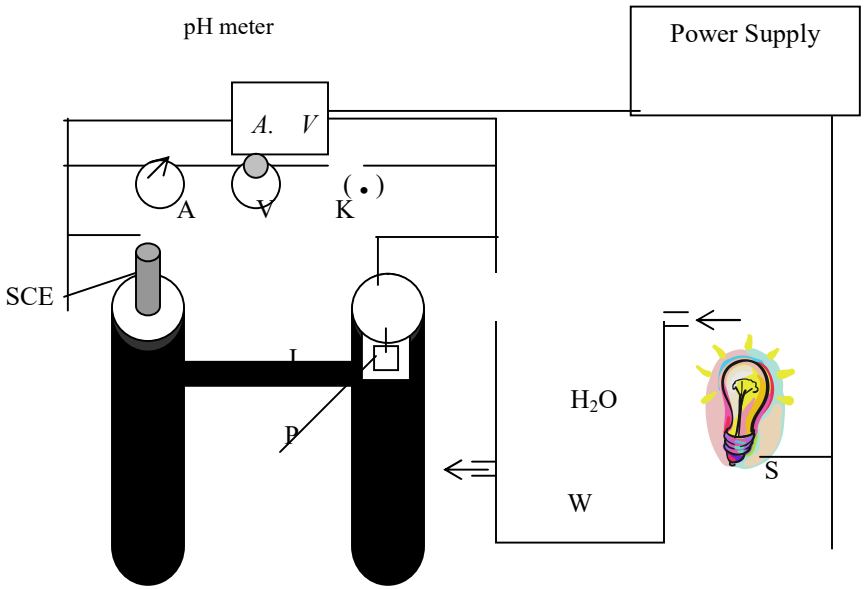

Fig. 1: Circuit diagram of commonly used photo galvanic cell.

V= pH Meter
A=Microammeter
L=load (carbon pot)
K=Key
SCE= Standard calomel electrode
J=Junction tube
P=Platinum electrode
W=Water filter
S=Source of light

A water filter acted as Infra-red radiations protector. The analysis was done by the potentiometry method, how the Victoria blue photo bleaching was chemically done. The current and potential produced by this system measured by a microammeter(OSAW, India) and digital pH meter(Agronic model 511)

III. RESULT AND DISCUSSION

1. Result of Variation pH: Changes in pH are the major factor on which electrical production of the cell depends. From the table-1, it can easily notice that when pH value increases, there will be an electric production also. A maximum value was observed at pH 13.7. If the pH still increases, the value of photocurrent and photo potential will tend to be lesser and lesser. So, there is certain sensitivity is observed in case of photo galvanic cells having a system of Victoria blue acting as photosensitizer and Ascorbic acid be a reductant.

Table-1 Result of variation of pH

	pH				
	13.0	13.4	13.7	13.8	14.0
Photopotential (mV)	866	882	895	870	845
Photocurrent (μ A)	134	147	160	142	128
Power (μW)	90	93	95	91	82

It was noticed in this system that the pH in suitable state linked by pKa (AA) and the required pH is greater than pKa value of it. Because in its anionic form, there is a presence of AA and this AA is a superior donor form.

2. Consequences variation in the concentration of ascorbic acid

The mutation of the concentration of reducing agent is another factor on which electric production or output of a cell depends. Table 2 indicates the obtained results.

Table-2. Consequences variation in the concentration of ascorbic acid

	4.6	4.8	5.2	5.0	5.4
Photopotential (mV)	737	810	895	828	747
Photocurrent (μ A)	107	130	160	134	111
Power (μW)	85	94	95	93	86

There will be decrease in electrical production or output when the reducing agent concentration get lowered, the reason being the lesser molecules of reducing agent were there for convey the electrons to the molecules of Victoria blue.

There will be decrease in electrical production or output, when the reducing agent concentration get higher, the reason being the molecules of dye which are chasing the electrode in required duration limit got disturbed by the greater number of molecules of reducing agent.

3.Consequences variation in the concentration of Victoria Blue.

Reliability of "Photo potential" and Photocurrent on Victoria Blue concentration was thoroughly studied and the output is summed up in Table 3.

Table-3 Consequences variation in the concentration of Victoria Blue

	3.2	4.8	6.4	8.0	9.6
Photopotential (mV)	865	880	895	877	762
Photocurrent (μ A)	125	143	160	140	120
Power (μW)	83	94	95	94	82

There is decrease in photocurrent and photo potential when concentration of dyes is less, the reason being the dye molecules which are excited and electron donating are less. There will be falling in electrical production if the concentration of dyes is high because there will be the inhibition of the larger part of light by dyes molecules which are there in its way, as a result the light intensity which is to be reached to the dye molecules close to the electrode got decreased.

4. Result of Diffusion Length

Study has been done about the consequence of changes in distance between the two electrodes. This illustrates the recent trends with cell diffusion on the cellular variables by taking all possible dimension H-cells. Table 4 indicates the obtained results..

Table.4 Result of Diffusion length

Diffusion length D_L (mm)	Maximum photocurrent i_{max} (μ A)	Equilibrium photocurrent i_{eq} (μ A)	Rate of initial generation of current (μ A min^{-1})
35	190	140	18.2
40	198	150	19.2
45	204	160	20.4
50	208	160	21.3
55	213	164	22.2

In just first few minutes of illumination an abrupt increase was noticed in photocurrent and after that a progressive fall reaching to a steady reading of photocurrent. At some stage,this photocurrent has reached to equilibrium and denoted by ieq. The whole reaction is a fast reaction initially but with a course of time it is a slow rate determining step. In this study, Kaneko and Yamada studied the effect of degree of diffusion duration on current parameters of half reduced type of dyes. and the dyes themselves are the very important electroactive element in the dark and irradiated electrodes also.

Although, the oxidised products of reducing agents and reducing agent itself work like the electron carrying species in cell which is diffusing through the way.

5. i-V charateristics of Cell

It was noticed that there was a deviation of the graph of cell from its exact rectangular shape which can be seen in figure 2.

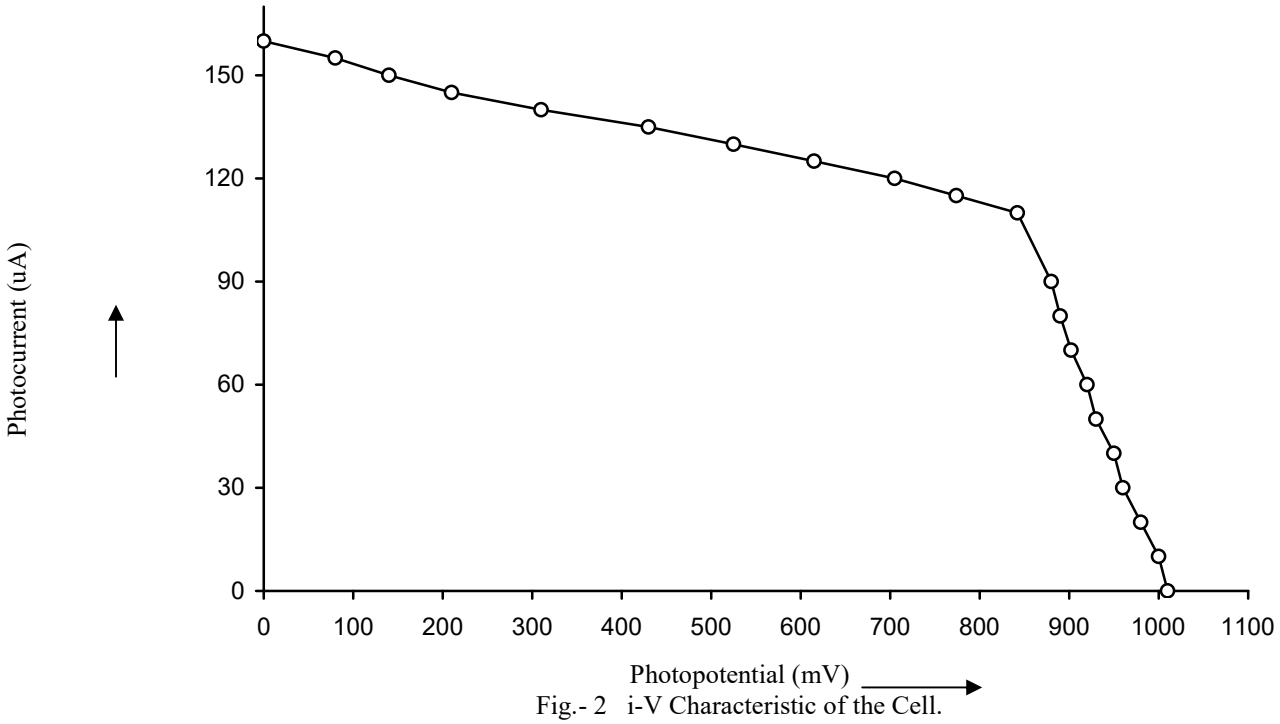

Fig.- 2 i-V Characteristic of the Cell.

A point called power point in the above curve where the value of product of current and potential was at its peak i.e. maximum value. This curve tells the values of conversion frequency and fill factor of the cell [28] were calculated as 0.9254% and 0.59 respectively, using the relation:

$$\text{Fill-factor} = \frac{V_{pp} \times i_{pp}}{V_{oc} \times i_{sc}} \quad (1)$$

$$\text{Conversion efficiency} = \frac{V_{pp} \times i_{pp}}{10.4(mW/cm^{-2})} \times 100\% \quad (2)$$

Where, Vpp = Power point potential

ipp = Power point current

Voc = open circuit voltage

isc = short circuit current

At normal conditions the whole set up was revealed to sunlight.

IV. ELECTROACTIVE SPECIES

Number of possible processes can be making suitable for the production of photocurrent in photo galvanic cells. To study about electro active species more, the values of consequence of diffusion length on variation of current were used. In table 5, the suitable additions in photo galvanic cell for these species are specified:

Table-5: Electro active Species

Illuminated chamber	Dark chamber
VB	Oxidized form of reductant (R^+)
Leuco - VB^-	Oxidized form of reductant (R^+)
Leuco - VB^-	VB

The oxidized form of Ascorbic acid i.e. reductant is generated in the irradiated chamber only and if it is assumed like electro active species in section which is dark. And then the resulting electron has to diffuse from the irradiated portion of the sample to the darkened portion for absorption of the electron.. So, maximum photocurrent and frequency of rise in photocurrent must fall with a rise in diffusion length, but experimentally it was not that so. It was also noticed to not to be dependent with respect to variation in diffusion length. Thus it can be sum up that important electro active elements are the leuco or semi- VB and the dyes VB in irradiated section and dark section. Since the reductant and its oxidized species only act in the manner of electron bearers.

V. MECHANISM

Thus the process for the development of photocurrent photo galvanic cells can be described as follows from the above studies::
lluminated Chamber

Bulk Solution

$$VB \xrightarrow{h\upsilon} VB^* \quad (1)$$

$$VB^* + R \longrightarrow VB^- + R^+ \quad (2)$$

At Electrode

$$VB^- \longrightarrow VB + e^- \quad (3)$$

Dark Chamber

AT ELECTRODE

$$VB + e^- \longrightarrow VB^- \quad (4)$$

Bulk Solution

$$VB^- + R^+ \longrightarrow VB + R \quad (5)$$

Where VB, VB^-, R and R^+ are the Victoria Blue and its semi leuco or leuco forms, reductant and its oxidized form, accordingly.

VI. CELL PERFORMANCE

The performance of this cell was investigated by supplying an outsourced load needed to handle the potential and current at the point of displacement of the light origin until the result was only 1/2 of power point in the dark. It was summarized that at the 64 minute power point, the cell could also run in the dark.

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