VARIATION OF ELECTRICAL PARAMETERS OF PHOTOGALVANIC CELL WITH SAFRANINE SYSTEM (SAFRANINE-EDTA AND SAFRANINE-NTA) AS A PHOTOSENSITIZER IN SOLAR CELLS

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1.**Abstract:** Among solar energy's most attractive charms are its conceptual simplicity, benign nature, diversity and the intuitively captivating promise of a lessened dependence on the power utilities. In conjunction with the inevitable rise in conventional energy prices, these are the attributes that will swing public sentiment towards active acceptance of solar energy, once cost-effectiveness is established. In the present work, safranine has heen used as a photosensitizer in solar cells with three different systems like safranine-EDTA and safranine-NTA systems. The effects of variation of the different parameters on electrical parameters of photogalvanic cell were studied in detail. To decide satisfactorily the photogeneration of current as well as the role of safranine dye as photosensitizer for electrical output, in photogalvanic cells, it is worthwhile to analyse and discuss the findings.

2.**Key Words**: Solar energy, Safranine, Photosensitizer,.,EDT., NTA, and Solar cells

3.**Introduction:** For many years, people have sought to overcome the energy problems by using solar radiation to produce electricity. If that could be easily and achieved at low cost , then the electricity would become the prime source of power for motor vehicles, trains, heating, lighting and industry, and fuels could be reserved for the more important aspects of conversion to necessary chemical and industrial materials.

We must immediately start to use our collective intellect and technology where withal as the tools with which to graduate to a new stage of human development a stage in which renewable (therefore limitless) resources are used to support further elevations in the worldwide standard of living and other realization of our potential. If we are wise enough to take this essential step, solar energy will definitely play a major role. Although the photogalvanic effect was first of all reported by Rideal and Williams[1] but the iron-thironine system was systematically investigated by Rabinowitch[2-3]. Later on, it was investigated by many workers time to time[4-14]Many workers have used different photosensitizers in different photogalvanic systems and observed a reasonably electrical output compared to iron-thionine system. Some of the photosensitizers used

in solar cells are proflavine, tolusafranine[15-16], methylene blue[17], niboflavin, flavin mononucleotide, Poly (N-acylamidomethylthionine), toluidine blue, brilliant cresyl blue[18- 26]etc.

4.**Material and Method:** The redox potential of all the three reductants is much higher than the dye used in the present work and hence these do not react in dark. On illumination the platinum electrodes, there was a rapid fall in potential and after some time, a constant value was obtained. On removing the source of light, the change in potential was reversed but it never reaches the initial value. It suggests that main reversible photochemical reaction is also accompanied by some irreversible side reactions.In an effort aimed at bringing down the comparative cost of solar cells with easily available, stable, low cost and indigenous material used and, hence, safranine dye has been selected for the present investigations.

The important observations of different systems are given in Table- 1 and 2 which are reflecting the overall outcome of the present studies, and justify the significance of these cells from the solar energy conversion and storage point of view.

TABLE – 1

SAFRANINE -EDTA SYSTEM

[Saf.] = 4.00 x 10^{-6} M [EDTA] = 3.24 x 10^{-3}M

pH = 12.8 ,Light intensity=10.4mWcm $^{-2}$ Temp = 303 K

S. No.	Observations	Values
(I)	Open Circuit Voltage (V_{oc})	1055mV
(II)	Photopotential (ΔV)	760.0mV
(III)	Potential at power point (Vpp)	882.0mV
(IV)	Equilibrium Photocurrent (i_{eq})	50.0 µA
(V)	Maximum Photocurrent (i_{max})	85.0µA
(VI)	Current at power point (i_{pp})	30.87 µ
(VII)	Short circuit current (i_{sc})	50.0 µA
(VIII)	Rate of generation	10.6 µA min^{-1}
(IX)	Power at power point	27.22 µW
(X)	Fill factor (n)	0.588
(XI)	$t_{1/2}$	19 minutes
(XII)	Change time	225.0 minute
(XIII)	Conversion efficiency	0.2618 %

TABLE –2

SAFRANINE- NTA SYSTEM

[Saf.] = 4.0 X 10^{-6} M [NTA] = 2.00 X 10^{-2} M

pH = 12.6 , Light intensity = 10.4 mw cm^{-2} Temp = 303 K

S.NO	Observations	VALUES
i	Open circuit voltage (V_{OC})	655 mV
ii	Photopotential (V)	415.0 mV
iii	Potential at power point (V_{PP})	350.0 mV
iv	Equilibrium Photocurrent (i_{eq})	35.0 µA
v	Maximum Photocurrent (i_{max})	40.0 µA
vii	Short Circuit Current (i_{sc})	35.0 µA
viii	Rate of generation	6.0 µA min^{-1}
ix	Power at Power point	8.75 µW
x	Fill factor (n)	0.3759
xi	$t_{1/2}$	8 minutes
xii	Charging time	120.0 minutes
xiii	Conversion efficiency	0.0841 %

5.VARIATION OF POTENTIAL WITH TIME

It was observed that potential decreases on illumination and direction of change in potential was found to reverse on removing the source of light . It was observed that different time periods was there to obtain the stable dark potential as well as to attain a stable potential after illumination in all the three systems with this photosensitizer .

The value of open circuit voltage was found to be highest in safranine -EDTA system and the lowest in safranine – NTA system. The value of voltage at power point was highest in safranine–EDTA system. The rate of fall in potential on illumination was observed 3.46, 3.37 and 1.96 mV min^{-1} in safranine–NTA and safranine–EDTA systems respectively.

The rate of change In potential after removing the source of illumination was 1.57, 0.44 and 0.36 mV min^{-1} in safranine–EDTA and safranine–NTA systems respectively. On the basis of observed results , the most

efficient photogalvanic cell is the cell with safranine as a photosensitizer and EDTA as a reductant followed by cell containing NTA and glucose as reductants .

6.VARIATION OF CURRENT WITH TIME

It was observed that within few minutes of illumination, the current of all the systems increases rapidly to reach a maximum value (i_{max}) at 85.0, 61.0 and 48. 0 µA in safranine–EDTA and safranine–NTA system respectively and rates of initial generation of current are also in same order having the same values 10.6, 6.1 and 6.0 µA min^{-1} respectively .

The short circuit current (i_{sc}) (i_{eq}) was also observed and the values are 50.0 µA in safranine–EDTA system and 35.0 µA in safranine–NTA system. On the basis of these observations , the most efficient system is that , which involves safranine as a photosensitizer and EDTA as a reductant followed by NTA as reductants from photogeneration of current point of view .

7.EFFECT VARIATION OF pH

It was observed that all the three systems with safranine as photosensitizer work effectively in strong alkaline range. The working range for the present work was pH=12.6 to 12.8. The photopotential of the system was found to increase as the ph was increased reaching a maximum value for a particular ph and then decreases on further increase in ph values .It is observed that the desire pH should be higher than their pk_a values of reductant in every ease of reductant used in their present work .

8.EFFECT OF VARIATION OF [REDUCTANT] CONCENTRATION

The effect of variation of concentration of reductant EDTA and NTA with safranine as photosensitizer have been already done. On increasing the concentration of all the three reductants in different systems , the output of these cells was found to increase , which reaches a maximum value and then there was a decrease in output of the cell on further increasing the concentration of the reductants in all the cases .In these systems ,the ratio of dye and reductant was kept $1:10^5$-10^1 . The fall in electrical output for lower concentration of reductant is due to lesser number of molecules available for electron donation and higher concentration may hinder the movement of dye molecule towards electrode in desired time limit.

9.EFFECT OF VARIATION OF [SAFRANINE] CONCENTRATION

It was observed that there was an increase in the photo potential and photocurrent on increasing the concentration of safranine. It was felt necessary to keep the concentration of safranine – 10^{-6}- 10^{-5} M for effective results in electrical output .On the lower side of concentration range of dye , there will be limited number of dye molecule to absorb major light in path and , therefor, there is low electrical output whereas higher concentrations of dye will not permit the desired light intensity to reach the dye molecules near the electrode , and hence , there will be a corresponding fall in the power of cell .

10. CONCLUSION

At present, we are very much in the research stage of the problem and having a great deal of fun in unraveling the details of the reactions as well as in trying to find other ways to store sunlight in the form of high-grade chemical energy which can be converted efficiently into water. Much of our present material

prosperity depends on an abundant supply of coal, gas and oil, which provide energy to operate our machines. These fossil fuels are limited in quantity and are essentially irreplaceable. Although the world will not suffer a shortage of fuel in this generation, we can not blithely assume that our descendants can continue indefinitely to have all the fuel that they desire.

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