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Photochemical Study of Surfactant in Solar Cell for Solar Energy Conversion and Storage in Electrical Energy

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Abstract
In this,we discuss on four systems namely Rh B – EDTA - Tween80, MB – EDTA -NaLS, Rh 6G – EDTA - CTAB &Safranine - EDTA - ALS. The "Photo voltage"and"photocurrent" in "photo galvanic cell" contains different dyes and reducing agentshave been determined. The photo output with reducing agent ismore than photo sensitizer and surfactant. Photo sensitizer and the various types of surfactant are very useful to raise the "conversion" and "storage capacity" due to formation of micelles in the reacting mixture.The efficiencies of the Rh B-EDTA-Tween80, MB-EDTA-NaLS, Rh 6G-EDTA-CTAB &Safranine-EDTA-ALS are 1.2653%, 1.087%, 1.7663% & 1.286% respectively. The "photo potential" and "photo current" is generated, "conversion efficiency," "cell power" and "cell performance" of the "photo galvanic cell" was determined and the effect of different parameters on "electrical output" of the cell was observed.

Introduction
The scientists of all over the world are working to find out renewable source of energy apart from the renewable energy resources like geothermal, biomass, wind, tidal, hydro energy etc. The solar energy has required characteristics for present day suitable energy source. Solar energy is not only non-polluting, in exhausting and harmless but clean, low cost and hazardless having no disposal problem.
In the present study it is proposed to investigate the "conversion" and "storage capacity" of "solar energy" taking different types of surfactant with the photo sensitizer in the presence of suitable reductant. In context to "viability" and "applicability" the researches are still in their initial stages and there is the need to explore more so as to increase the "conversion efficiency" and "storage capacity" by opting suitable "redox couple."

Objectives
- To increase the "conversion efficiency" and "storage capacity" by selecting the suitable "redox couple."
- The source of energy is non-conventional and cost of solar energy conversion is negligible through photo galvanic cell.
- To investigate the suitable composition for the better "conversion" and "storage capacity" of "solar energy" of "photo galvanic cells."

Methodology
A solution of photo sensitizer, NaOH (sodium hydroxide), surfactant, and reductant" whose amount is unknown was filled in an H shaped tube and the total volume of the mixture is

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fixed with the help of dilled water. A "Pt-electrode (1.0cm X 1.0cm)" is immersed in one side of the H shaped tube and "Standard Calomel Electrode (SCE)" is dipped in another side of the H shaped tube. The whole setup is kept in dark and the electrode terminal was connected with the digital pH meter and when the cell reaches to its suitable potential it is measured in mV. The platinum electrode was then exposed to a tungsten lamp with 200W and the intensity of the light can be changed by using the lamp with different voltage. To cut off the IR radiations a water filter is used which is kept in between the "illumination chamber" and the "light source."

Result and Discussion

I. Rh B-EDTA-Tween 80

At different pH values the measurement of photo potential of Rh B-EDTA-Tween 80 system is observed and it is seen that it reaches to its maximum value at pH 12.2. This value is taken as standard and all the other subsequent measurement is taken at this pH only. In about 140 minute of illumination, the value of photo potential increases up to 1162.0 mV and do not increases on further illumination and after switching off the light, the system do not regains its original potential value. Therefore, it is confirmed that the system is not perfectly "reversible".

II. MB-EDTA-NaLS

At different pH values the measurement of "photo potential" of Methylene Blue – EDTA – NaLS system is observed and it is seen that it reaches to its maximum value at pH 10.3. This value is taken as standard and all the other subsequent measurement is taken at this pH only. In about 130 minute of illumination, the value of photo potential increases up to 1082.0 mV and do not increases on further illumination and after switching off the light, the system do not regains its original potential value. Therefore, it is confirmed that the system is not "reversible".

III. Rh 6G-EDTA-CTAB

At different pH values the measurement of photo potential of Rh 6G – EDTA - CTAB system is observed and it is seen that it reaches to its maximum value at pH 12.8. This value is taken as standard and all the other subsequent measurement is taken at this pH only. In about 140 minute of illumination, the value of photo potential increases up to 1380.0 mV and do not increases on further illumination and after switching off the light, the system do not regains its original potential value. Therefore, it is confirmed that the system is not "reversible".

IV. Safranine-EDTA-ALS

At different pH values the measurement of photo potential of Safranine – EDTA – ALS system is observed and it is seen that it reaches to its maximum value at pH 11.9. This value is taken as standard and all the other subsequent measurement is taken at this pH only. In about 130 minute of illumination, the value of photo potential increases up to 1205.0 mV and do not increases on further illumination and after switching off the light, the system do not regains its original potential value. Therefore, it is confirmed that the system is not "reversible".

In the presence of EDTA, the photo current of Rhodamine B is examined and it is found that the "photo potential" and "current" is less when to compare to Rhodamine B-EDTA-Tween 80 system.

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The photo induced short circuit current of Rh B-EDTA-Tween 80, MB-EDTA-NaLS, Rh 6G-EDTA-CTAB &Safranine-EDTA-ALS was measured. When exposed to light, maximum photocurrent 510 µA is obtained in 260 minutes in "Rh B-EDTA-Tween 80 system," 490 µA is obtained in 200 minutes in MB-EDTA-NaLS, and 780 µA is obtained in 360 minutes in "Rh 6G-EDTA-CTAB"& 622 µA is obtained in 300 minutes in Safranine-EDTA-ALS. The MB-EDTA-NaLS system takes much less time than other three systems. The trend of short-circuit photocurrent of "Rh 6G-EDTA-CTAB" is much better than other three systems.

Table-1

S.No.	**Electrical parameter**	**Observed value of systems**			
		Rh B-EDTA-Tween80	MB-EDTA-NaLS	Rh 6G-EDTA-CTAB	Safranine-EDTA-ALS
1.	Photo potential	1162	1082	1380	1205
2.	Maximum photocurrent	510	490	780	622
3.	Short circuit current	450	420	720	554
4.	Equilibrium photocurrent	450	420	720	554
5.	Current at power point	200	220	440	311
6.	Potential at power point	658	514	680	602
7.	Power at power point	131.6	113.8	298.6	224.8
8.	Rate of generation of current	14.17	13.61	78.17	42.66
9.	Charging time	140	130	140	130
10.	Fill factor	0.2516	0.2488	1.026	0.9896
11.	Conversion efficiency	1.2653	1.087	1.7663	1.286
12.	$T_{1/2}$	170	160	340	280
13.	Open circuit voltage	1162	1082	1380	1205
14.	Storage capacity	1.2142	1.2307	1.5412	1.1206

V. "Power conversion efficiency" of "photo galvanic cell"

The "power conversion efficiency" of an "electro chemical cell" is considered to be one of its most important characteristic features and in order to get the "power conversion efficiency" of the cell in all the 4 systems, their i-v characteristic is been investigated. The rectangular of maximum area is been used to get the highest possible "power output" from the cell and this can be drawn under "i-v characteristic curve."

The "power point in i-v curve"was determined and there "fill factor" were calculated. The efficiencies of all four systems of photo galvanic cell have been calculated.

Table-2

System	V_{OC}(mV)	I_{SC}(µA)	V_{pp}(mV)	I_{pp}(µA)	Fill Factor
Rh B-EDTA-Tween	1162	450	658	200	0.2516

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80					
MB-EDTA-NaLS	1082	420	514	220	0.2488
Rh 6G-EDTA-CTAB	1380	720	680	440	1.026
Safranine-EDTA-ALS	1205	554	602	311	0.9896

VI. "Conversion efficiency" and "sunlight" conversion data of the cell

Table-3

System	Fill Factor	Conversion efficiency (%)
Rh B-EDTA-Tween 80	0.2516	1.2653
MB-EDTA-NaLS	0.2488	1.087
Rh 6G-EDTA-CTAB	1.026	1.7663
Safranine-EDTA-ALS	0.9896	1.286

VII. Performance of the Cell

The required load is applied externally in order to study the performance of all the 4 systems and get the "potential" and the "current" that matches to "power point." The time was determined after the light it is removed and this is the time which is taken to reach half the value of "cell power".

Table-4

System	Power(μW)	$T_{1/2}$(minutes)
Rh B-EDTA-Tween 80	131.6	170
MB-EDTA-NaLS	113.8	160
Rh 6G-EDTA-CTAB	298.6	340
Safranine-EDTA-ALS	224.8	280

4. Conclusion & Future Direction

The aim of the study is to convert "solar energy" to "electrical energy" in the photo galvanic with the help of redox reactions due to the reason that at present the absolute cost of the "solar energy" is very high in comparison to any other source of energy like non renewable source. Photo galvanic cell is used as converter device which converters "solar energy" in to "electrical energy" which is the only "solar energy" conversion device that has the storage capacity as well.Our study reveals that photo galvanic cell gives high"electrical output"that has better "storage capacity" and that also gives special attention to reduce the cell cost so that it can give commercial feasibility. Since the dye is been used in the "photo galvanic"cells, its cost is less because the dyes are cheap and in very less quantity reductant such as "EDTA" whose cost is also very less. Therefore, the scope of development is more while working with the "photo galvanic cells." Based on the observations, the study concludes that the "photo galvanic cells" are better option to convert and store the "solar

energy," also it is observed in the study that the "photo galvanic effect" on all the four systems, Rh 6G-EDTA-CTAB system was efficient in all the ways.

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References

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, AmetaR,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)**
11. Monat J E,McCusker J K, Femtosecond excited-state dynamics of an Iron (II) polypyridyl solar cell sensitizer model. *J. Amer. Chem. Soc.*, 122, 4092–4097 **(2000)**
12. Schwarzburg K, Willig F, Origin of Photovoltage and Photocurrent in the Nanoporous Dye-Sensitized Electrochemical Solar Cell. *J. Phys. Chem.*, 103B, 5743 **(1999)**
13. Tennakone K, Kumara GR R A, Dye-sensitized photoelectrochemical and solid-state solar cells: Charge separation, transport and recombination mechanisms. *J. Photochem.Photobiol*, 117A, 137 **(1998)**
14. YadavSushil, Yadav R D, Singh Gautam, Use of Dyes in Photogalvanic cell for solar energy conversion and storage: Bismarck Brown and Ascorbic Acid System. *Int. J. Chem. Sci.*, 6 (4), 1960-1966 **(2008)**

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Received 20 January 2021; Accepted 08 February 2021.

15. Meena R C, Gautam Singh, Gangotri K M, Role of reductants and photosensitizer in Solar Energy Conversion and Storage: Photogalvanic cells a newer approach. *Afinidad*, 59 (501), 253-256 **(2003)**
16. Meena R C, Sindal R S, Use of surfactants in photogalvanic cell for Solar Energy Conversion and Storage: Tween-80-Oxalic Acid – Totudine blue system. *Int. J. Chem. Sci.,* 2 (3), 321-330 **(2004)**
17. Ameta Suresh C, SadhanaKhamesra, Chittoro Anil K, Gangotri K M, Use of sodium lauryl sulphate in a photogalvanic cell for solar Energy Conversion and Storage: - Methylene blue – EDTA System. *Int. J. Energy Res.,* 13,643-647 **(1989)**
18. Gongotri K M, MeenaRC,MeenaRajni, Use of micelles in photogalvanic cells for solar energy conversion and storage : Cetyetrimethyl ammonium bromide – KI – toluidine blue system. *J. Photochem and photobiol. A:Chem.*123, 93-97 **(1999)**
19. Meena R C,Studies of solar effect of Safranine, Methylene blue and Azur-B with reductants and their photo galvanic effect. *J.Indian Chem. Soc.*, 85, 280-285 **(2008)**