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Fabrication of hexagonal photoreactor indoor lights

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Fabrication of hexagonal photoreactor indoor lights

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Abstract. Photoreactors are systems that convert light into an energy source. This research aims to design and build a visible light hexagonal photoreactor to generate electrical energy. The method used is geometry design and photoreactor prototype making. The tested photoreactors were tested using the integrated android F1-S (Appertude 2.0 Camera) light detector, and the resulting voltage and current measurements. The ability of hexagonal Photoreactor to convert visible light into electrical energy reaches a maximum condition of 16,728 mWatt in a light flux of 4573 lx. The light panel is characterized by FTIR, at 769.40 cm-1 wavelength, transmittance is only 23.39%, while at 921.34 cm-1, transmittance remains only 3.24%. In visible light, nearly 100% of the light can be passed on. Photoreactor hexagonal light space produces electrical energy reaches 0.0763835616 Watt/m^2.

1. Introduction

Photoreactor is a set of energy generating systems of light that are converted through a catalyst process[1,2]. In indoor light, the photoreactor is developed with an active nano-catalyst material at wavelengths between 400-600 nm. This effort can be done by modifying the material, such as copper into its oxide[3,4]. Another way is to dopan metal catalyst that reduces the band gap, so that the material works on visible light [5,6].

Photocatalyst applications not only on light conversion, on waste handling have been widely applied, especially in waste degradation [7,8]. Basically, the catalyst can be used to eliminate the presence of waste through transformation methods [7,8], for water splitting [9] and material modification ie PCC [10]. In contrast to heavy metal waste such as Pb, Cd and Cr, more effectively eliminated by adsorption method [11,12]. Some eliminant processes of this metal contaminant have also been carried out, such as the use of soil and organic extracts of unused parts, such as jengkol skin and other biomass.

In recent research, the application of catalysts to generate energy from visible light becomes interesting [13-16]. Researchers have made every effort to get photoreactors capable of converting room light into electrical energy such as design to materials, designing light-exposed panels, and assembling photoreactors in plenary [17]. In this research, the researcher wants to study the integrated design system in a hexagonal shaped frame, so that the light panel converter panel can be in one hexagonal place.

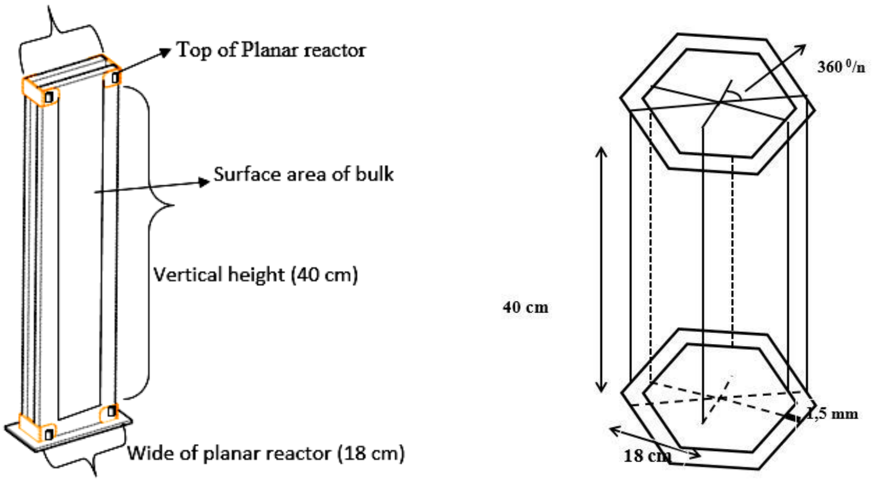
2. Experimental Section

2.1. Tools and Materials

Equipment used Sensor Light Detector with Camera Appertude (Brand Oppo), Volmeter/Ampere Meter Digital (Brand Heles), LED LV-45W 110-230 V, 50-60 Hz D17 410 mA /60 Lm/w (Hannoch), FTIR (PerkinElmer FTIR Spectrometer Frontier). The materials used are Na_2SO_4 (Merck), Aquadest, Copper Plate thickness 0.25mm, Alumunium Plate thickness 0.4mm, Glass with thickness 5 mm, Zinc Plate and Iron Frame 0.5cm diameter, and Silicon Glue.

2.2. Design of Photoreactor Hexagonal

The Photoreactor design is based on the size of the prepared electrode, which is 36.5 cm x 5 cm. The design is divided into a separate part of the wall, with the size of the container 8 cm x 40 cm as shown in Figure 1. The thickness of the panel is 15 mm with the contents of the panel 0.5 cm x 7 cm x 40 cm. The panel is assembled as shown in Figure 1.



(a) (b)

Figure 1. Planar Planet Sketch (a) and Hexagonal Photoreactor Scheme (b)

2.3. Assembling of hexagonal Photoreactor

The reactor base framework is a circle with a diameter of 36 cm, and 6 reactor sides have a side length of 18 cm. This is because on one side there are two photovoltaic panels. Thus there will be 12 photovoltaic panels to be arranged on a hexagonal prepared. After assembling the skeleton with desoldering, the hexagonal Photoreactor is paired as in figure 2.

(a) (b) (c)

Figure 2. The photoreactor hexagonal framework (a) the source of the fluorescent lamp (b) and the photoreactor with the panel attached (c).

2.4. Photovoltaic Panel Setup

The panel is prepared with a copper oxide catalyst plate having a thickness of 0.25 mm as shown in Fig. 3. This preparation is carried out by thermal oxidation method at 400°C for 1 hour of combustion. Anode side used Alumunium plate with thickness of 0.40 mm, and copper oxide plate (Cu_2O) acts as cathode, while the source of electron comes from 0.5 M Na_2SO_4 solution in Gel form.

(a) (b) (c) (d)

Figure 3. Front side reactor panel (a; b) side view (c) and copper oxide/Aluminum electrode (d)

2.5. Preparation of Photovoltaic Panel

Bulk is the contents of a reactor made from Sodium Sulfate salt (Na_2SO_4) with a concentration of 0.5 M. This salt solution is formed into gel by using agar powder produced by PT. Agar Swallow. This flour is made from seaweed Gracilaria SP. The bulk making process is carried out by heating and stirring until it boils and then the solution is poured into the planar reactor and at the same time the $CuO\text{-}Cu_2O/Al$ electrode plate is placed in a symmetrical position in the planar reactor housing. After the cooling is complete, the bulk will harden and the panel has been transformed into a photovoltaic panel that can generate electrical current.

3. Results and Discussion

The built hexagonal photonactor can produce a maximum voltage of 10.20 V using a series system on 12 hexagonal Photoreactor panels. The maximum current generated by series in 12 bulk units is 1.64 Ampere and maximum voltage of 10.20 mVolt, at an average flux of 4,573. On the inside there is a small gap with a distance of 3 mm to the outer and inner sides. The electrolyte will be inserted into the gap called the bulk or reactor. On one side of the Hexagonal there are two one-sided or two-sided bulk as shown in Figure 4. Since the hexagonal has 6 sides it requires 12 bulk units.

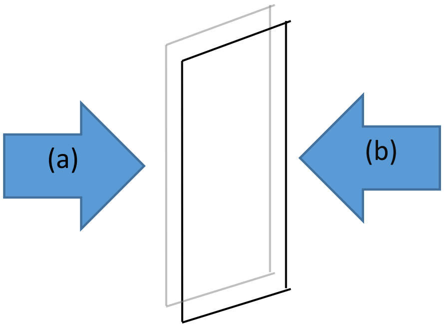


Figure 4. One bulk side by side (a) photons coming from a solar light coming into the room and (b) photons derived from the illumination of the LED light

Photons derived from room light only activate wall a is caused on the inside (b) is the Aluminum plate. In part a, photons will cause the activation of electrons in the valence band to experience

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excitation to the conduction band. In part a, a thin plate of CuO/Cu_2O will be used as an electron generator when exposed to photons from room light, so that the electrons in the valence band jump into the conduction band. The next process, in a closed circuit, the electrons in the conduction band will flow through the system in the hexagonal photoreactor. The conduction band's electron flow is what causes the photoreactor to have the ability to generate electrical energy.

The hexagonal photonactor constructed using 6 main wall blocks used as the side side of the Photoreactor. In principle, each side is a planar wall which is a unit of the planar reactor. In the manufacture of planar reactors, the effective surface area that activates the semiconductor is the surface of the CuO/Cu_2O plate, with a width of 5 cm and a height of 36.5 cm. Meanwhile, the bulk area that interacts directly with photons is 7 cm wide and 40 cm high. Based on this, one planar unit has an effective area of 0.01825 m^2, and a bulk interaction area of 0.0280 m^2.

Photoreactor hexagonal which has 6 sides has an effective surface area of 0.219 m2, ie 12 times 0.01825 m2. While the area of light room interaction in the hexagonal photoreactor bulk is 0.336 m2, ie 12 times 0.0280 m2. This broad calculation corresponds to the equation put forward by Bold. The equation is A6 = $\frac{1}{2}$ x r2 x sin $\frac{360^\circ}{6}$ (Bold, B, 1969 : 61-62). The surface area is the total total surface of an object, which is calculated by summing the entire surface of the object.

Photoreactors are made to have a photoreactor finger with the calculation of cosine rules as follows:

$$\text{Hexagonal radius of diameter} = \sqrt{\frac{2s^2}{1-\cos 60^\circ}} \quad (1)$$

$$\text{(The cosine rule) } s^2 = r^2 + r^2 - 2r^2\cos\frac{360^\circ}{n} \quad d = \sqrt{\frac{2(18\text{ cm})^2}{0.5}} \quad (2)$$

$$r = \sqrt{\frac{s^2}{2(1-\cos 60^\circ)}} \quad d = \sqrt{\frac{648\text{ cm}^2}{0.5}} \quad (3)$$

Based on this calculation, the photoreactor finger is obtained 18 cm. This calculation is used to produce maximum photoreactor capability in converting light space. The material used as a panel wall is glass with the ability to forward the light of space close to 100%. The characterization of the glass material using FTIR as shown in Figure 5, where the glass material used (PT Asahimas production), has a 100% near tramsmitan capability in room light. At wavelength 769.40 cm^{-1}, transmittance is only 23.29%, while at 921.34 cm^{-1} wavelength, transmitters are only 3.24% left. In this state, almost all light that interacts with the glass will be absorbed. Based on the FTIR characterization, the Photoreactor works well by using glass as a planar reactor panel.

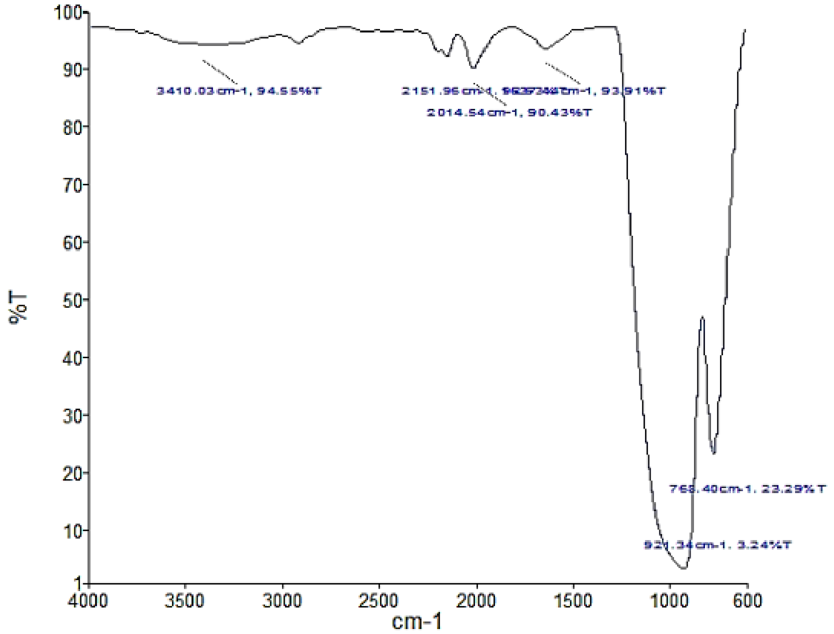

Figure 5. Result of characterization of glass material using FTIR

The ability of hexagonal photoreactors to produce maximum power is 0.0763835616 Watt/m^2. This energy is generated from 12 planar reactor units in a closed system in series, with a photon source at room light, at an average intensity of 4573 flux.

Photoreactors are made to have a surface area of electrons for photon reactions of 2160 cm^2, by calculation = (s – 8) (t – 4) n. The value of n is the number of the photoreactor side, and s is the width of the sides. Whereas, the surface area for the electrolyte reaction is = (s – 4) 40 n, so that the total reaches 3360 cm^2. The surface area of the reactor is = $\frac{1}{2}$ x r2 x sin $\frac{360^\circ}{n}$, and obtained for 35,073 cm^2. The hexagonal area (Hexagon) is = $\frac{n}{2}$ x r2 x sin $\frac{360^\circ}{n}$, ie 841.752 cm^2. The reactor volume is a hexagonal x height, ie $\frac{ns^2}{4}$ x $\frac{\sin\frac{360^\circ}{n}}{1-\cos\frac{360^\circ}{n}}$ x t, then obtained value 33670.08 cm^3.

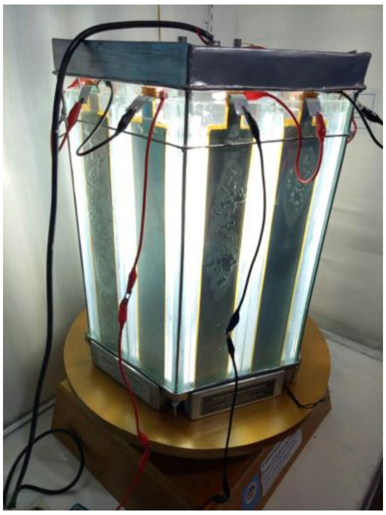

Figure 6. Hexagonal photocractors made with glass materials and copper oxide electrodes and gel electrolyte systems made from Na_2SO_4 salt solution.

4. Conclusion
Photoreactor Hexagonal made room light produces a maximum current of 1.64 mA and a maximum voltage of 10.24 V. Conversion energy production capability by utilizing light space reaches 0.0763835616 Watt/m^2. This capability can still be improved by improving the design and construction systems and materials used.

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