Fabrication Hydrogen Generation System from Application Backup Power of PEMFC Stacks

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Abstract. This research fabrication hydrogen generator and effects of hydrogen gas from Al powder. The hydrogen production reaction between activated CNTs/Al and water has been investigated. The effect of different parameters such as water, Al ratio, CNTs/Al and pressure ratio. Reactor hydrogen generation consists of NaOH tank, filter cylinder and gas replace the water tank. The resulting rate and yield of hydrogen production from the reaction between activated Al/CNTs and water have been investigated. The effects of different parameters such as water, pressure ratio, and CNTs/Al ratio, in-house developed Al activation method involves 0-5 vol. %CNTs of the NaOH solution activator which is diffused into the Al powder, the highest hydrogen production rates in the range of 0.5 -0.7 l/second/g Al and hydrogen yield about 90.01%, depending on operating parameters, were demonstrated. Hydrogen gas generated from the hydrolysis of the CNTs/Al composite has high purity without any production of undesirable CO. PEMFC produced electricity with hydrogen generated from the hydrolysis of pressure 6 N/m² at 5 vol. % of CNTs/Al composites. The CNTs/Al composite was effectively used as a hydrogen source for PEMFC.

1. Introduction

In recent years much effort has been made in order to reduce the world dependence on fossil fuels and to meet the increasing energy needs using alternative sources of energy. The main disadvantages associated with the use of hydrogen are difficulty of storage and transportation due to its very low density, and safety problem because of its very high reactivity. The method involves a small fraction of NaOH-based activator (typically 20 wt%) which diffuses into the Al particles and modifies the hydroxide/oxide protective film on their surface, allowing a spontaneous and sustained chemical reaction between Al and water which produces hydrogen [1]. The stoichiometry of a reaction (Equation (1-3)) yields theoretically 11% hydrogen mass compared to the Al mass (equivalent to over 1.2 liters of hydrogen per gram of Al), making the concept very efficient for hydrogen storage.

$$2Al(s) + 6H_2O(l) \rightarrow 2Al(OH)_3(s) + 3H_2(g)$$ (1)
$$2Al(s) + 2NaOH(s) + 6H_2O(l) \rightarrow 2NaAl(OH)_4(aq) + 3H_2(g)$$ (2)
$$NaAl(OH)_4(aq) \rightarrow NaOH(s) + Al(OH)_3(s)$$ (3)

Al powder displays the dexterity for high reaction, so it is not suitable for actual use due to explosiveness when exposed to humidity or heat slightly. You should also securely store the powder more sophisticated
equipment required Al an attempt to use the material of hydrogen in Al security development in building hydrogen quickly, so it's a challenge. Al matrix composites with high porosity can solve this problem by using a carbon (CNTs) increases the tendency for the Al matrix composite for strength particularly dedicated to fill Al matrix of CNTs composite have become quite interesting because the structure has been used in many industries, such as automobiles, aircraft, and aircraft [2]. It has been reported that there are noble phases that occur in Al matrix accelerating rate of hydrolysis reactions result in corrosion [3]. In the present work, to yield the best possible hydrogen generation rate, the effects of CNT content and porous structure on the hydrogen generation rate were examined to optimize the CNTs/Al composite synthesized by a hot compress. The surface area was controlled by changing the applied stress during the hot compress process. Further, the feasibility of using hydrogen generated from the hydrolysis of CNTs/Al composite to operate a PEMFC was examined using a PEMFC.

2. Materials and Methods

Design system hydrogen generation with program SketchUp Pro as shown in Figure 1. CNTs/Al mixtures containing various amounts of CNTs (0-5vol. %) were prepared by the hot compress method using Al powder (purity: 99.9%, particle size: 3 mm) and a CNT mixture. The applied uniaxial stress was changed from 20 to 40, and then to 60 MPa. The Al and CNTs/Al composites have a disk shape with a diameter of 13 mm and a thickness of 1 mm. The effect of the surface area of Al on the hydrogen generation rate. The hydrogen generation rate was measured in 75 ml of 10 wt.% NaOH solution at room temperature using a mass flow meter (MFM). The feasibility of using the hydrogen gas generated from the hydrolysis of CNTs/Al composite potential in a PEMFC was investigated via a PEMFC test.

![Figure 1. Schematic diagram of process hydrogen generation a) program SketchUp Pro and b) Experimental](image-url)
3. Result and Discussion

3.1 Effect of the pressure Al power mixed CNTs as Hydrogen rate and Hydrogen yield

From Figure 2.a) compares the relationship between hydrogen rate and time preparation with sodium hydroxide (NaOH) 10 wt% found that the volume of hydrogen gas obtained from the reaction of Al powder and CNTs of concentration 5 percent by volume, the pressure in mixed grain 6 N/m$^2$ volume of hydrogen production rate 0.753 l/second/g Al that Al powder mixed CNTs pressure 2 and 4 N/m$^2$ at the same concentration as the volume of hydrogen rate 0.353 and 0.36 l/second/g Al, respectively. Notice the volume of hydrogen by reaction with Al powder mixed CNTs that 5 percent concentration at pressure 6 N/m$^2$ will gradually increase until the end (stop reaction) at the time 350 seconds the volume of hydrogen production and pressure 2 and 4 N/m$^2$ for the at time 270 and 330 seconds, respectively. Figure 2.b) a comparison of results percent hydrogen yield, mixed Al powder and CNTs that 5 percent concentration by volume, in comparison with the pellets with various pressure as follows: 2, 4, and 6 N/m$^2$, respectively. Found percentage of hydrogen yield and Al increasingly the CNTs mix at 5 percent concentration by volume at a pressure of 2, 4 and 6 N/m$^2$, the percent of hydrogen yield is 51.51, 68.31 and 90.01% respectively.

![Graphs and Figures](image-url)
3.2 Effect of the concentration CNTs mixed Al power as Hydrogen rate and Hydrogen yield

From Figure 3.a) compares the relationship between hydrogen rate and times, preparation with sodium hydroxide (NaOH) 10 wt% CNTs using Al powder with CNTs concentrations 0%, 1, 2, 3, 4 and 5 by volume at a pressure in 6 N/m² mixed pellets react respectively. It found that the volume of hydrogen rate will increase rapidly at first, then gradually more and more and the end is reduced. The volume of hydrogen gas obtained from the reaction of Al powder, with CNTs 5 percent by volume, the maximum of hydrogen rate which the very 0.753 l/second/ g Al. Figure 3.b) compares the relationship between hydrogen yield, preparation with sodium hydroxide (NaOH) 10 wt% carbon nanotube using Al powder with CNTs concentrations 0%, 1, 2, 3, 4 and 5 by volume at a pressure in 6 N/m² mixed pellets react the hydrogen yield there is 36.66, 38.41, 39.28, 48.68 and 90.01% respectively. The CNTs 5 percent by volume is the result of hydrogen yield than other of concentrations CNT.

4. Conclusions
The pressure and concentration increase the hydrogen production rate and percent yield of hydrogen production increase. The appropriate conditions for this research are Al alloy, carbon nanotube that is the size of the pressure at 6 MPa at a concentration of CNTs at 5 percent by volume. Found that the incidence of more hydrogen gas. The time, in reaction to the pressure and concentration hydrogen rate maximum 0.753 l/min/g Al and the percent yield maximum 90.01, to produce hydrogen gas system from mixed materials, Al with carbon nanotube catalyst in fuel cells can produce voltages at 6.1 V after that will surely bring electrical charging battery size 3.7 V, then is taken into a place where the pressure is 12 V and the lamp LED connected 12 V makes the bright lights.

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