The H2O-Dry-Cell Control System for Car

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Abstract

Variation of battery voltage and resistance of H2O dry cell causing the current of H2O dry cell is not constant. This may affect the electric charger system of car. To avoid this problem, therefore, this paper proposes the control system to regulate the current of H2O dry cell and to protect the electric charger system. The current control system uses PID control to produce PWM signal for regulating the output current of buck power converter. While the protection system measures the battery voltage and temperature of dry cell if the battery voltage is lower or the temperature of H2O dry cell is higher than the set point value the control system will cut off the dry cell from the system of car. The experimental results show the efficiency of the proposed control system.

Keywords: H2O dry cell, PIC microcontroller

1. Introduction

Hydrogen is the most abundant element in the universe. With the "green-energy" craze and talk of powering our future oil-free economy on hydrogen, it has gotten much attention in the last few years. Learning about this potential fuel of the future is important and interesting. Hydrogen can be separated from the water by electrolysis reaction. Hydrogen electrolysis is a process of running an electric current through water (H2O) and separating the hydrogen and oxygen from water. Hydrogen electrolysis has met commercial resistance in the past but much of that resistance is now fading. Hydrogen electrolysis now offers much hope for making real the dream of hydrogen cars running upon the hydrogen highways of the world.

Electrolysis is not the most efficient way to obtain hydrogen, but it is one of the easiest and cheapest ways to "homebrew" hydrogen. Therefore, electrolysis hydrogen is used as fuel energy for car by using electric current from battery car [1] – [2]. This may be dangerous to the electric charger system of car if it absorbs the electric energy over than the limitation of electric charger system.

To avoid the mentioned problem, this paper designs the control system that consists of feed back control and safety system. This system is implemented by using PIC microcontroller. The experimental results show that the control system regulates the H2O dry cell current or output current, although, the resistance of H2O dry cell (water mixes salt as a good conductor) or the battery voltage is varied. While, the safety system will cut off the H2O dry cell from the electric charger system when the battery voltage is lower or the temperature of H2O dry cell is higher than the set point value.

2. Electrolysis Hydrogen Process

Figure 1 shows the electrolysis hydrogen system that consists of H2O dry cell, separator, filter and supply voltage (electric charger system) [3] - [5]. From Fig. 1, when the supply voltage supplies an electric current through the H2O dry cell resulting electrolysis reaction. This process produces gas bubble which consists of water, oxygen and hydrogen. These are separated by their weights at separator. Then, the pure oxygen (O2) and hydrogen (H2) will be cleaned by filter. These gases are used to inject into ID pipe mixing with oil as fuel energy for car.

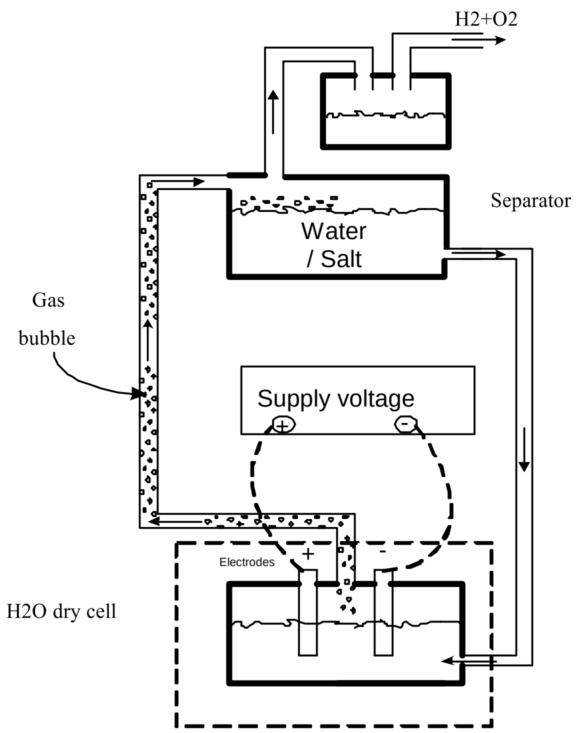

Figure 1 Block diagram of hydrogen electrolysis

The H2O dry cell can be modeled as a resistor whose resistance depends on many factors such as the distance of electrodes, electrode material, sort of electrolyte including its mixed percentage, and temperature. These factors directly affect to the output H2O dry cell current (they also affect to the quantity of gas but are not considered in this paper). In this paper, we focus the variation of H2O dry cell current causing from the battery voltage and temperature of sort of electrolyte. Other factors, we assume that they are constant. To maintain the H2O dry cell current, therefore, we design the control system for H2O dry cell which will be presented in the next topic.

3. Control system

Figure 2 shows the block diagram of the control system that consists of two microcontrollers and the power circuit. The first microcontroller uses for the control system, which consists of; 1) the key switches use for selecting two Mode operations where Mode 1 uses to select the display mode such as temperature, output current and battery voltage and Mode 2 uses to reduce or increase the parameters for safety system such as the minimum battery voltage, maximum output current and maximum temperature, 2) the PID control uses for generating pulse width modulation (PWM) signal where output current is feed back to compare with the reference current input signals producing the error signal which is computed by gain, integral, and derivative control.

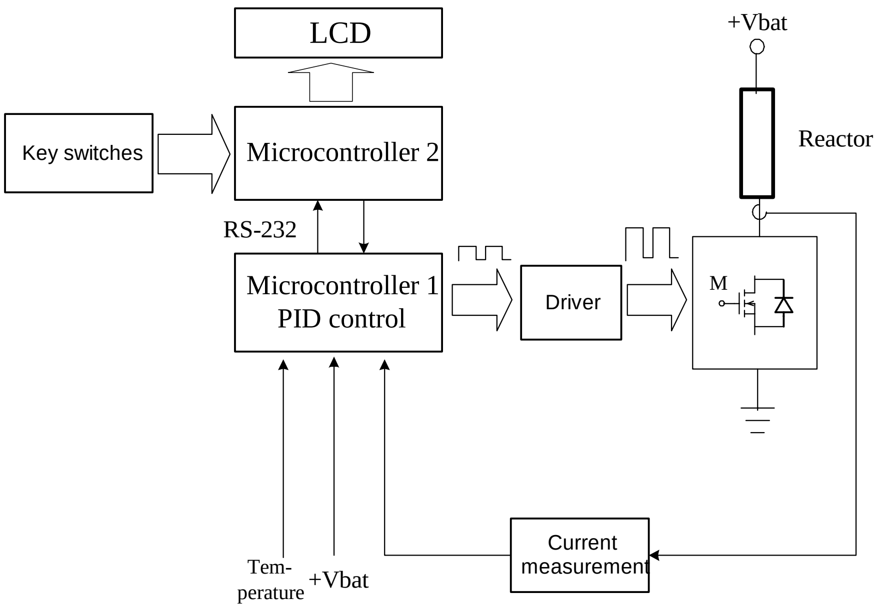

Figure 2 Block diagram of the control system

This result gives the voltage signal which determines the duty cycle of PWM signal. The PWM signal is amplified for driving the power MOS-FET as shown in Fig. 2. The second microcontroller is used for displaying the information of the control system, which communicates with the first microcontroller by RS-232 port. In the power circuit, we use the buck converter, where its average of output voltage can be found by integral the square wave pulse across the H2O dry cell. Its average is varied by the H2O dry cell resistance to maintain the constant of output current.

4. Experimental Results

Figure 3 shows the implemented circuit for H2O dry cell control system. The H2O dry cell control parameters are set as follows: the maximum output current 10 A, minimum battery voltage 10 V and maximum temperature 40 C^{o}. Because, it is difficult to find the transfer function of H2O dry cell. Therefore, the optimal PID parameters of the control system can be found using Ziegler - Nichols tuning method. This results the PID parameters for digital control: P = 96, I = 48 and D = 8 where scaling factor is 8 and switching frequency 2 kHz. The results are shown in Figures 4 - 8.

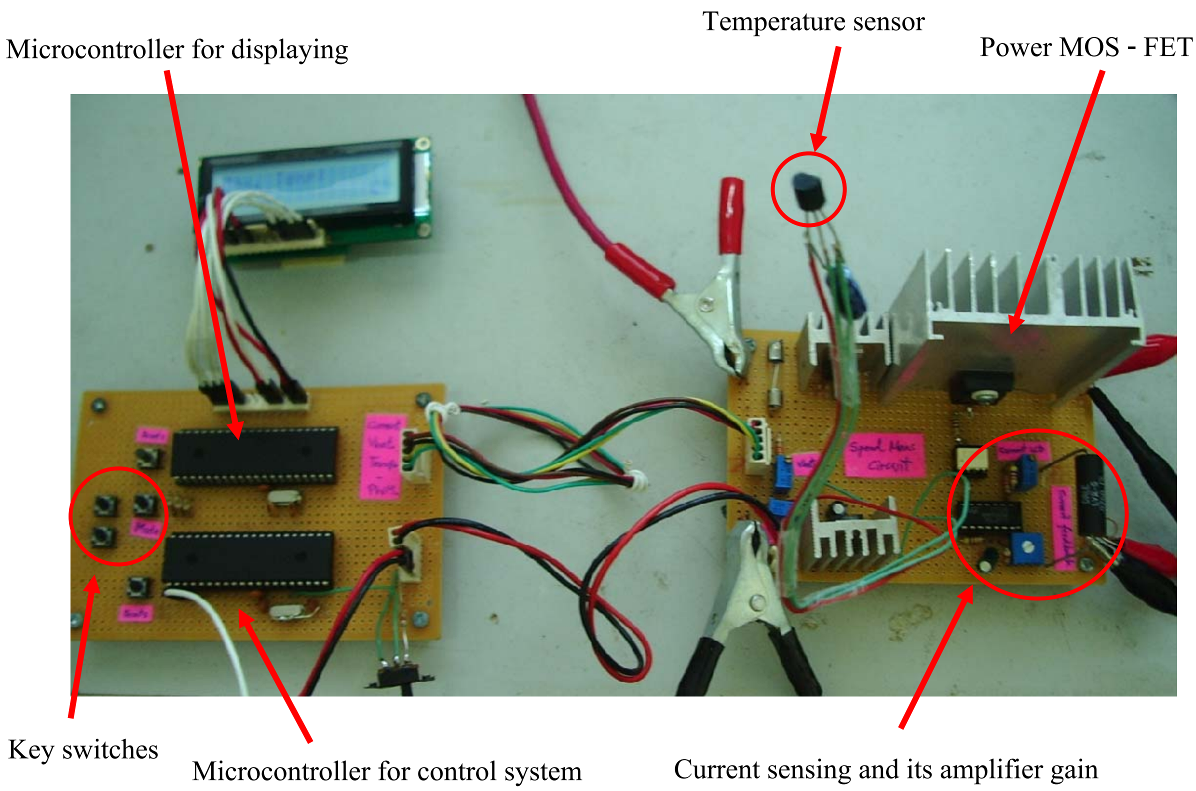

Figure 3 Implemented circuit for H2O dry cell control system.

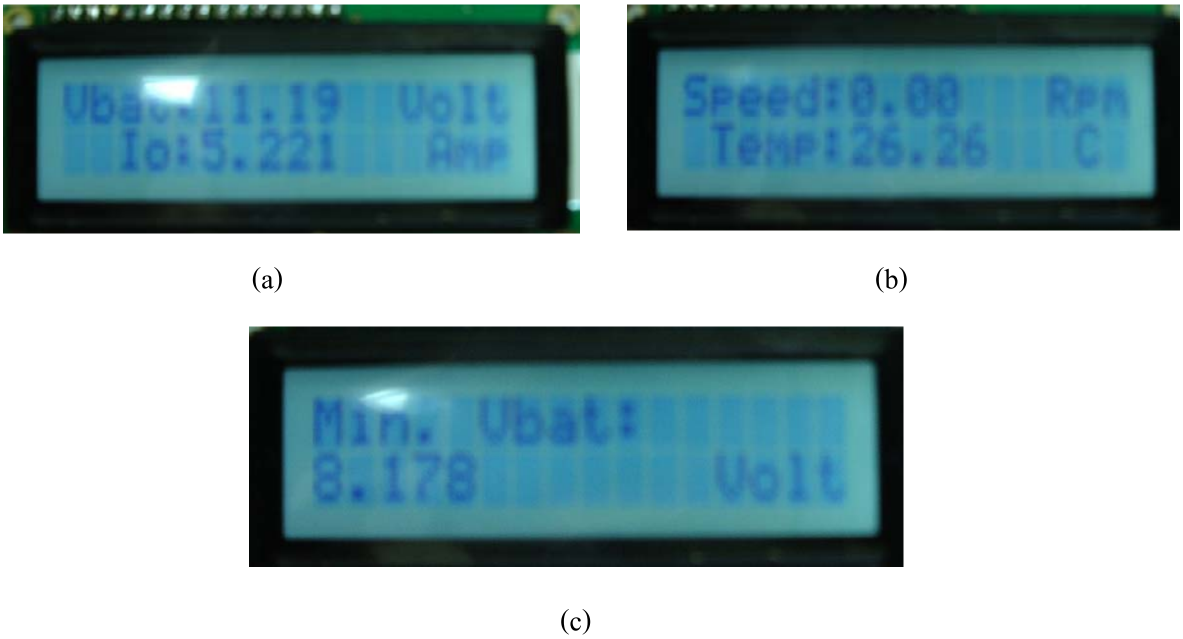

Figure 4 Displaying information of H2O dry cell control system.

Figure 4 shows the experimental results of Mode 1 for displaying the battery voltage, Vbat, output current, Io, temperature, Temp, and the example of Mode 2 for setting minimum voltage, Min. Vbat.

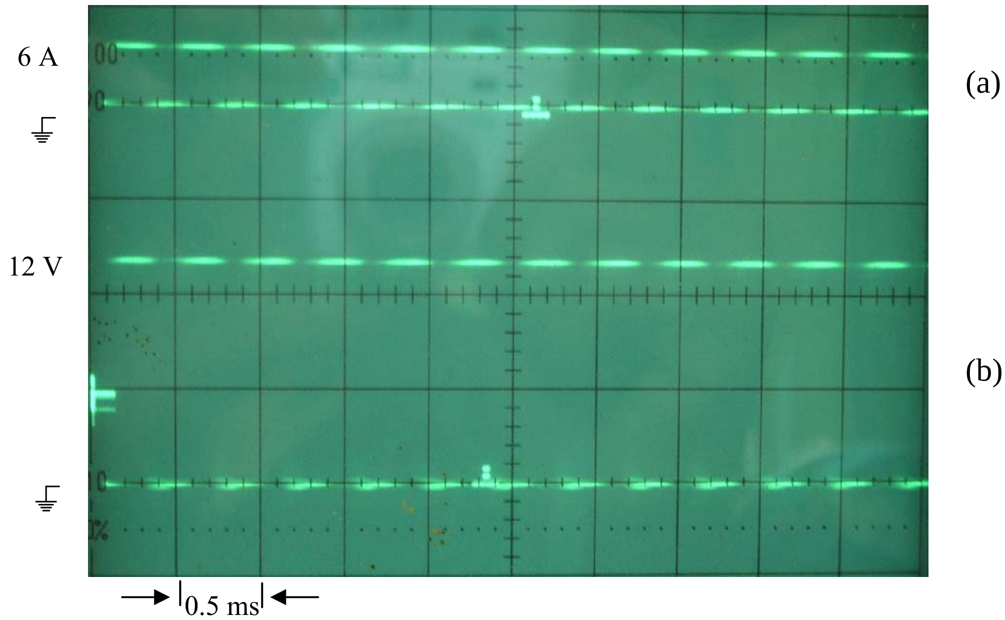

Figure 5 H2O dry cell current and voltage

Figure 5 (a) shows the output current where its sensing amplifier gain is equal to 250 mV / 1 A while Fig. 5 (b) is the result of output voltage resulting the average of output current 4.5 A. Figure 6 (a) shows the signal for controlling the step of output current. While Fig. 6 (b) shows the results of output voltage. When the H2O dry cell resistance increased from 2Ω as 3Ω the control system still maintains the average of output current at 3 A by increasing the duty cycle.

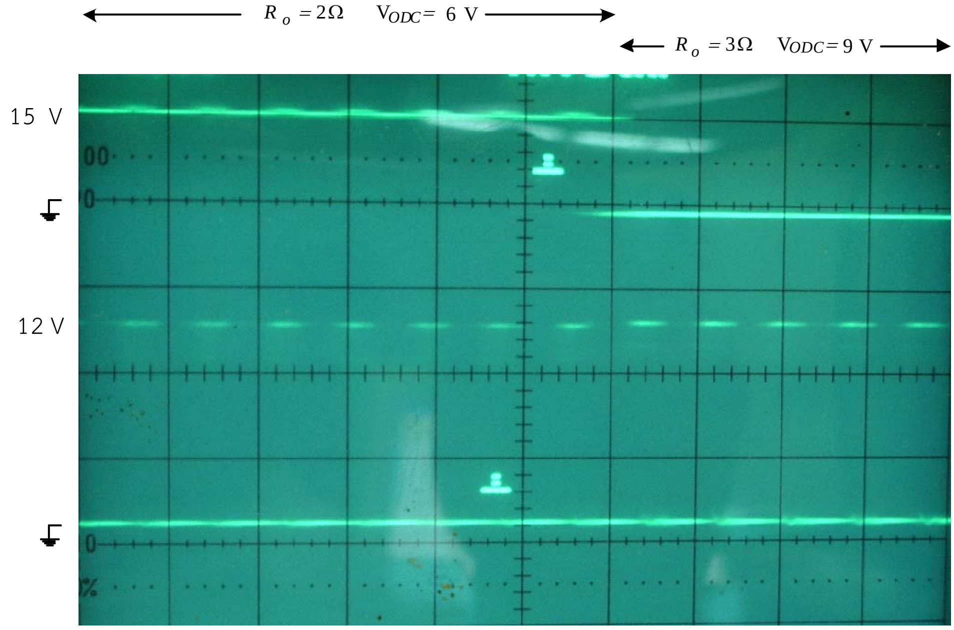

Figure 6 (a) Signal for controlling the step output current (b) Output voltage.

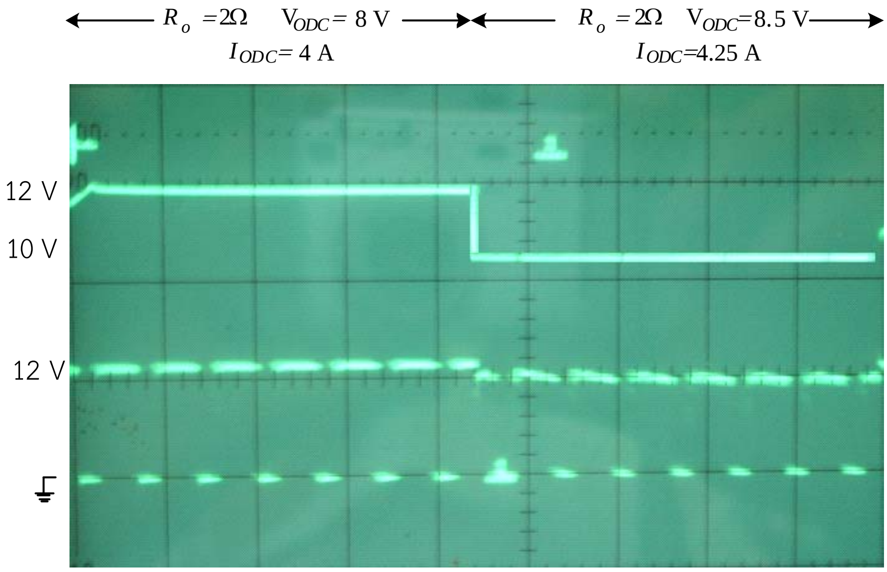

Figure 7 (a) Battery voltage and (b) Output voltage.

Figure 7 shows the experimental results in case of the step of battery voltage from 12 V to 10 V. To maintain the output current constant, the control system will increase the duty cycle as shown in Fig. 7 (b). Therefore, the average of output current is approximately constant as 4 A.

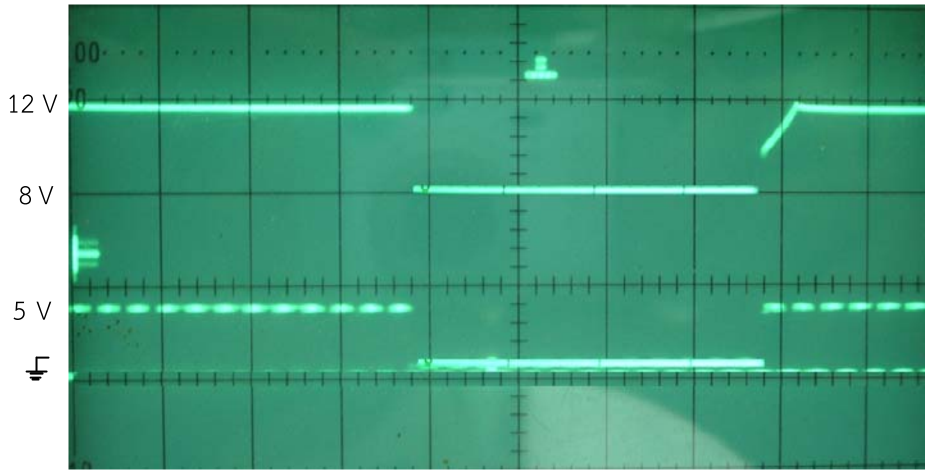

Figure 8 (a) Battery voltage and (b) PWM signal.

For the experimental results of the safety system, when the supply voltage is lower than 10 V, the control system will give the PWM signal equal to 0 V as shown in Fig. 8 (b). This resulting, the safety system will cut off the power circuit from the battery voltage.

5. Conclusion

This paper presents the control system for hydrogen electrolysis. This control system is implemented by PIC microcontroller. From the experimental results: 1) For the variation of the battery voltage and the H2O dry cell resistance, the control system can maintain the H2O dry cell current constant. 2) For the safety system, the control system can limit the maximum reactor current and cut off the power circuit from the battery voltage when the battery voltage is lower than the set point value.

ACKNOWLEGMENT

The authors would like to thank the Faculty of Engineering, Mahasarakham University, Mahasarakham, Thailand, for the financial supporting of this project under grant of modern researcher development.

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This paper was submitted on 12 September 2011 and published on 22 September 2011.