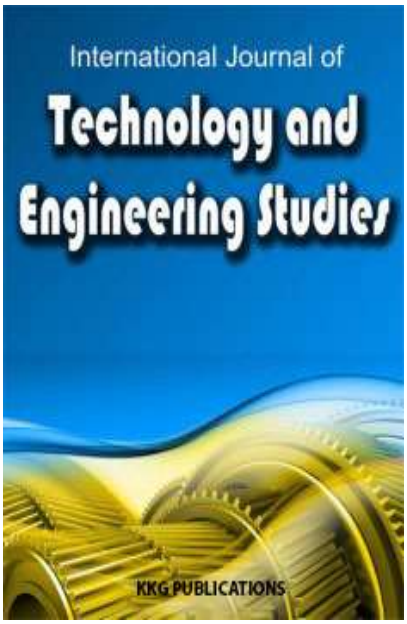

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ELECTRIC BIKE BASED ON HYDROGEN FUEL CELL SYSTEM [SPFC- 400 W]

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Index Terms
Design
Construction
Fuel Cell
E-Bike

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Abstract. This paper presents a study on the design, construction, and performance test of an electric-assist bicycle powered by a solid polymer fuel cell system. The implementation uses ready-made fuel cell components assembled on an ordinary pedaled bicycle to upgrade the bike into an electric vehicle. An empirical method is used to determine the tracking power, which is obtained at 400 W. Mechanical construction consists of the determination of equipment lay-out and packaging and electronics and control system, taking into account safety and hazard factors. This configuration results in the electric bike running at a maximum speed of 20 km/hr, with acceleration within 15 seconds. The control system can maintain speed at an ascending slope of about 25 degrees. For hydrogen supply, a metal hydride cylinder is used. Metal hydride storage is very efficient, showing by a cylinder with dimensions 3.2 inches in diameter and 8.8 inches long had 370-liter hydrogen capacity. Such an amount can supply fuel to the fuel cell for two (2) hours at maximum load. The electric-assist bicycle is also equipped with a 12 Amp-24 Volt battery for backup, mounted at the middle part of the bike. The fuel cell components are arranged at the rear of the bike.

INTRODUCTION

The central issue in the development of fuel cell technology or fuel cells relate to the issue of development of clean energy technologies that are based on the development of research materials to produce systems energy generation with zero emissions (zero emission). Intrinsically, the development of fuel cell technology is development of materials technology for energy conversion systems used in unconventional technologies fuel cell. In the system, the fuel cell is a device that involves the design of energy technology energy generation systems, instrumentation and control systems, packaging, prototyping and mechanical. The electrical energy generated by the fuel cell convert fuels such as hydrogen and oxygen through an electrochemical reaction that appears as the characteristic and oxygen.

In contrast to the conventional energy conversion systems that using a combustion reaction [11], the conversion system with the electrochemical reaction does not produce pollutants such as smoke, dust and toxic particles. The discharge is pure water that can be thrown away or used again to produce hydrogen gas through electrolysis (the system hybrid solar cell and fuel cell) [1], [2], [3], [4]. In addition to a vehicle, fuel cells can be used to drive biplane, controls long distance, satellite, and others [5], [6]. Research Centre for Physics – Indonesian Institute of Sciences developed of fuel cell technology that is done in two ways, namely approach fuel cell development through the development of materials and systems approach. Specifically in this paper, approach discussed is the approach of the system by means of reverse engineering and multi/inter-disciplinary. Space scope of the discussion is the design and construction of hydrogen-fuel electric vehicles. Construction vehicles hydrogen fuel power starts from the small-scale fuel cell or e-bike with a power of hydro-cycle 400 W.

TECHNICAL BACKGROUND

The design of the e-bike uses fuel cell is more emphasis on the computation power requirements and positioning fuel cell, hydrogen cylinders, motors and control equipment. Besides the issue of the need for traction power e-bike, also pay attention to the design and layout problems of control systems for fuel supply. Concept designing an e-bike uses fuel cell described in this chart Figure 2. Fuel cells also e-bike was developed by the Manhattan Aprilia and Palcan Fuel Cell Canada [7].

Elements of a motor vehicle propulsion system are using a fuel cell, that is [8]:

- Alternative fuel cell design
- ➔ Heat exchange ratios, different shape for the reformer, steam generator and a fuel cell stack
- Engineering rules (standards)
- Occupant packages (standard)

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• The function of the mechanical design of the fuel cell components
• Fuel cell design parameters
➔ Fuel reformer and burner, steam reformers and generators, saturator cell system, condenser water.
➔ Fuel cell coolant loop heat exchangers, air conditioner, turbo compressors, batteries, traction motors / drives
• Alternative packaging
➔ Front, rear etc.

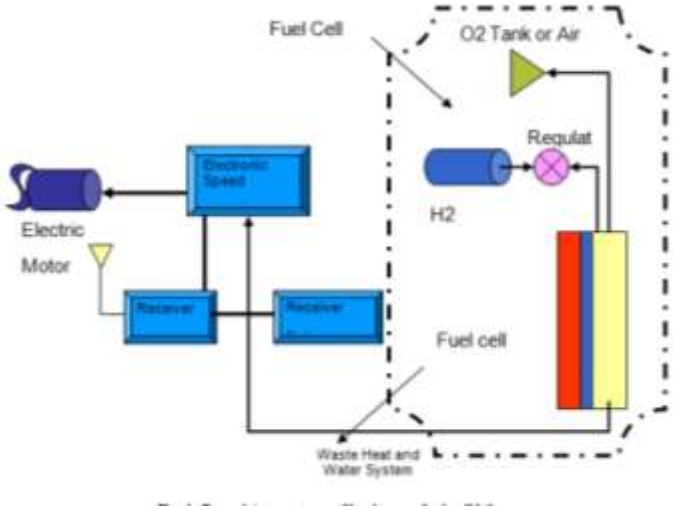

Fig. 1. Propulsion system of hydrogen fuel cell bike.

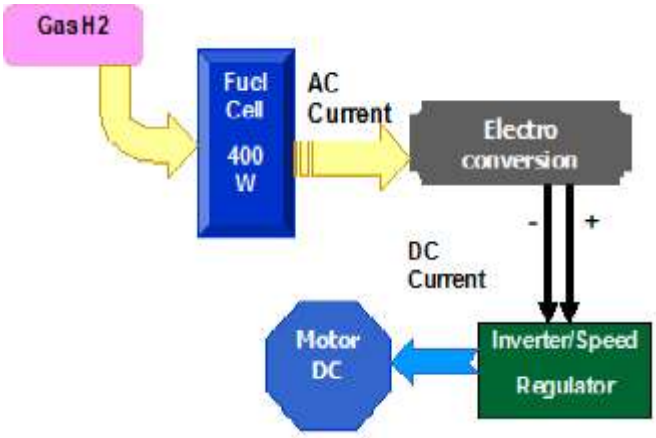

Fig. 2. Block diagram of hydrocycle design.

METHOD AND MATERIALS

The methodology used in the design of an e-bike is an empirical method of study of other parties previously to determine the necessary power, and a reverse engineering based design of Manhattan-Aprilia to determine the components of the electric bike. Arrangement of components on the bike is designed mechanically superposition and support that is needed and can be determined. The performance of an e-bike fuel cell is determined by looking at hydrogen consumption, power output and power. The maximum that can be obtained from the system designed [9,10] pedal power required by a bicycle is determined by the torque produced by the human foot, construction crack and pedal arm, wheel size, gear ratio, as well as the weight of the rider. Basically the torque generated almost equal to the torque produced by the steam engine as illustrated in the following diagram. Until one the price of a certain rpm (100 rpm) torque generated constant, and the corresponding increase in rpm will decrease, because the power foot pedal to start moving out.

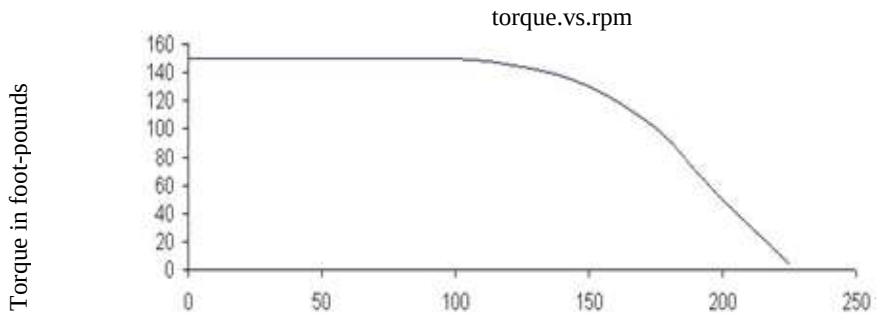

Fig. 3. Torqueat crank FC bike [rpm].

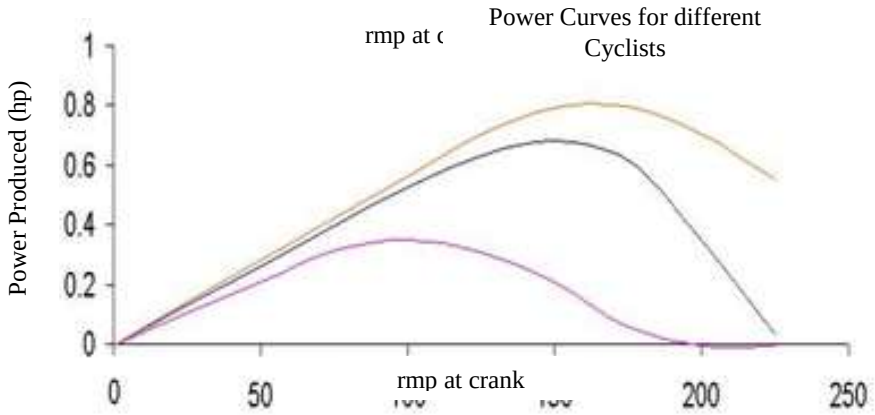

Fig. 4. Power of human drive at convensional bicycle.

The curve above is the power or pedal force generated by some cyclists. Power required by most cyclists would be loss to overcome friction (± 15%) and air resistance (0.2 - 1.3 HP) depending on the speed. To overcome the frictions and obstacles is necessary several levels of gear that serves to control the balance of the vehicle. Power required, different teeth for different levels of installation as shown in the curve below, which graphs left is to low gear and high gear for the right hand.

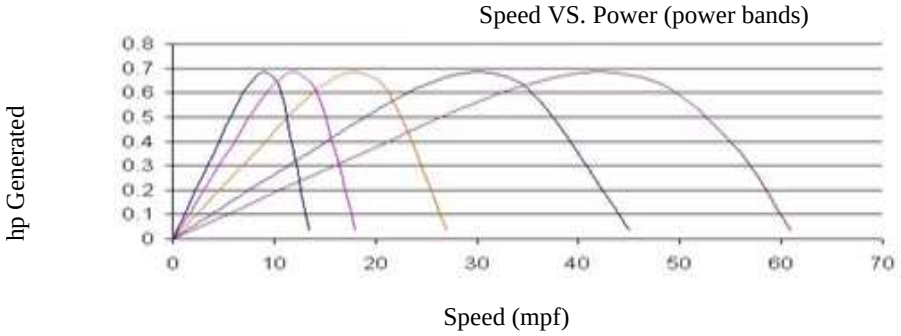

Fig. 5. Power for different speed gear.

From these curves it can be concluded that the power required by an electric bike depending on the load and motor size. For high loads required electric bike between 600 to 800 W or about 0.7 HP. For low load, the power required is quite 200 W (0.3 HP). Generally the electric bike required motor power of 100 W, of the type brushless i.e. a combination of AC and DC (Hall Effect) which has been adapted for the use of electric bicycles.

In this study determined the fuel cell power of 400 W.

The parameter study that to be observed are:

- ➔ Speed Bike
- ➔ Hose hydrogen gas
- ➔ Hose wastewater
- ➔ Aluminum Casing and fiber
- ➔ Acceleration
- ➔ Efficiency (W / h and mileage or mileage)
- ➔ Analysis of construction and quality control systems for safety and hazard
- ➔ Analysis of components of the fuel cell system suitable for motor.

For the construction of e-bike components and equipment required are:

- ➔ Fuel cell 400 W
- ➔ Conversion kit (motor and accessories)
- ➔ Tube hydrogen and regulators
- ➔ Valves and bolts
- ➔ Bicycle pedal

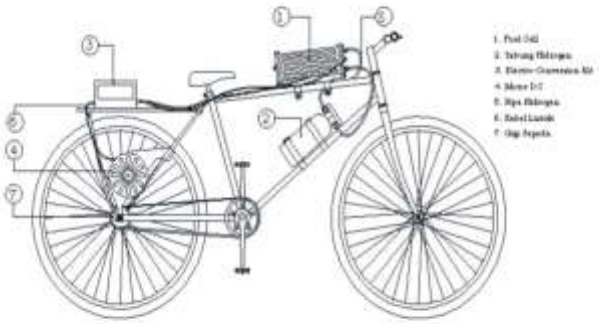

Fig. 6. Conceptual design of FC bike.

RESULTS AND DISCUSSION

Schematically e-bike is designed as shown in the mechanical drawings below. At the end of construction, motor components, fuel cell and battery mounted on the rear of the bike. The total weight of the additional component of approximately 35 kg, causing point gets weight of the bike falling behind.

Thus, with the configuration of fuel cell electric bike can be driven at a maximum speed of 20 km/h with acceleration of 15 seconds. The control system developed specifically to be able to keep pace on the bike a 25-degree slope. Supply of hydrogen stored in metal hydride tubes with a capacity of 370 litre and dimensions 3.2 inches in diameter and 8.8 inches long. The maximum capacity of hydrogen in the tube can be used for load maximum of 2 hours. Electric bikes are also equipped with a battery 24 Volt 12 Amp-to back up and start up.

Fig. 7. FC bike with capacity 400 W.

Fig. 8. FC bike at METRO TV

CONCLUSION AND RECOMMENDATIONS

Electric vehicles use a fuel cell can be developed for wider usability because it is technical easily constructed and applied. However, the current high price of components has not been possible in economically mass produced. Likewise, the lay-out and mechanical systems need to be improved in order bikes can be more stable and lighter. Regulation of the use of e-bike on the highway may need to be considered and implemented because it comes with a high-speed vehicle that requires its own rules in its implementation. Currently in the U.S. e-bike maximum speed is 20 mph.

Declaration of Conflicting Interests

This study has no conflicts of interest.

Acknowledgement

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