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Making a prototype of the Fuel Pump Test Bench with a method of measuring fuel pressure, current, and temperature of a microcontroller-based fuel pump

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ABSTRACT

The object of this research is a vehicle with a fuel injection system that uses *a fuel pump* to produce pressurized fuel. *The fuel pump* has decreased performance for some time of use. Reduced performance is characterized by abnormal engine power. But these symptoms can also be caused by other factors, such as disturbances in the ignition system, fuel system, or air intake system. A comprehensive examination of related systems is carried out to obtain the actual causative factors by the workshop. F the causative actor in the fuel system is the *fuel pump*, then the action taken by the workshop is a replacement. Fuel pump replacement is carried out in two-wheeled vehicles after *the fuel pump* cannot operate. While four-wheeled vehicles, *fuel pump* replacement is recommended every 80,000 km. From the average data of Astra workshops, the number of cars that replace *fuel pumps* is 3 to 4 units within one month. Based on the procedure for checking the condition of the Astra vehicle fuel pump, which only measures fuel pressure and the resistance value of the *fuel pump* coil. The standard fuel pressure value is 2.94 bar, and the fuel pump coil resistance value is 0.8 ohms. The measurement of the two parameters does not represent the actual condition of the fuel pump, whether the *fuel pump* can still be used or must be replaced. According to Denton in a book entitled *Automobile Electrical and Electronic System Fourth Edition* (2012) that the proper *fuel pump* testing method must be with manufacturing standards, namely a flow discharge of 120 liters per hour with pressure conditions of 3 bar, source voltage of 12 volts, coil resistance of 0.8 ohms and maximum current to the coil of 10.5 amperes. To determine whether *the fuel pump* can still be used or must be replaced, it is necessary to make a *test bench* to measure fuel pressure, current, and temperature. This tool is made based on microcontrollers for all measurable parameters to be displayed in the conclusion. This fuel *pump test bench* can be used to determine the condition and predict the age of the *fuel pump*.

INTRODUCTION

The development of motor vehicle technology is required to be more environmentally friendly with the application of electronic systems, one of which is the electronic fuel injection vehicle fuel system. The advantage of vehicles with this system is that they are efficient in fuel use because fuel and air are controlled using an electronic system that produces a mixture of fuel. The atmosphere is reasonably accurate (Bakeri & Syarief, 2012).

The working principle of the injection system. is a carburetor development that feeds or enters a mixture of fuel and air into the combustion chamber. If the vehicle that uses a carburetor does not require pressurized fuel, unlike the injection system, this system requires pressurized fuel; then a fuel pump is installed in the fuel tank. There are two components that play a role in the process of entering power into the combustion chamber, namely the fuel pump and the injector. (Kortam, Tolba, & Hassen, 2018) The fuel pumped from the tank must have a stable pressure of 3 bar. To get that pressure, the gas pump installed a fuel regulator or fuel pressure regulator (Bandak et al., 1999).

The fuel pump generally uses a DC motor with permanent magnets with a working voltage of 12 Volt DC, a motor resistance value of 0.8 Ohms, and a maximum allowable current of 10.5 Amperes. (Denton, 2013) This fuel pump is submerged in the fuel tank. The pressure regulator is installed in one fuel pump unit, including the fuel filter. The check valve function on the fuel pump functions to avoid the return of fuel back to the fuel tank (Nugraha &; Sriyanto, 2007). In actual conditions, fuel pump replacement is done by replacing one unit and cannot be repaired like another fuel pump.

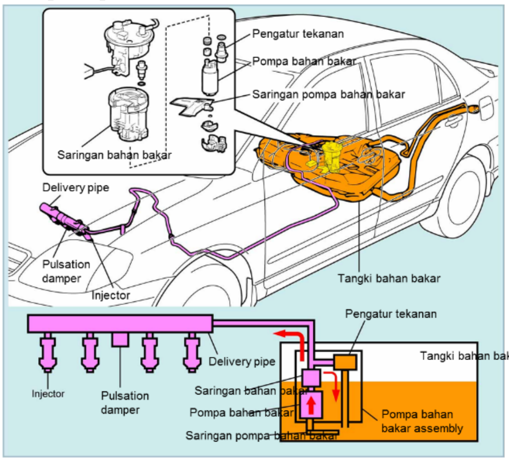

Figure 1. Fuel injection system

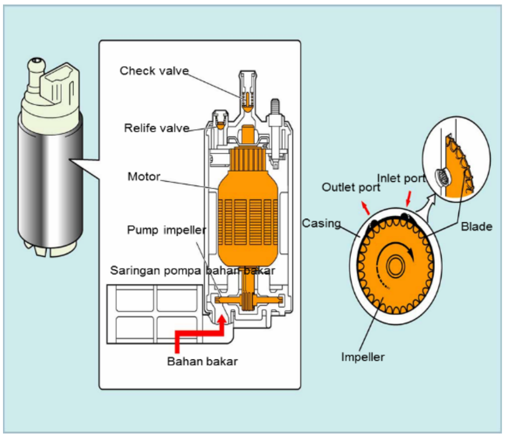

Figure 2. Fuel pump construction

The fuel pump maintenance or inspection process is carried out based on the instructions in the repair manual of each vehicle brand. Usually, the inspection is carried out by measuring the fuel pressure leading to the injector with a standard of at least 2.7 bar and a maximum of 3.5 bar. (Setyadi &; Setyawan, 2017) In this condition, it is difficult to predict whether the fuel pump performance condition is still suitable for use because there is no particular test on the work of the fuel pump seen electrically. This research needs to be done to obtain information on whether the fuel pump is still suitable for use by looking at the current, pressure, and temperature parameters of the fuel pump (Setiawan, 2021).

METHOD

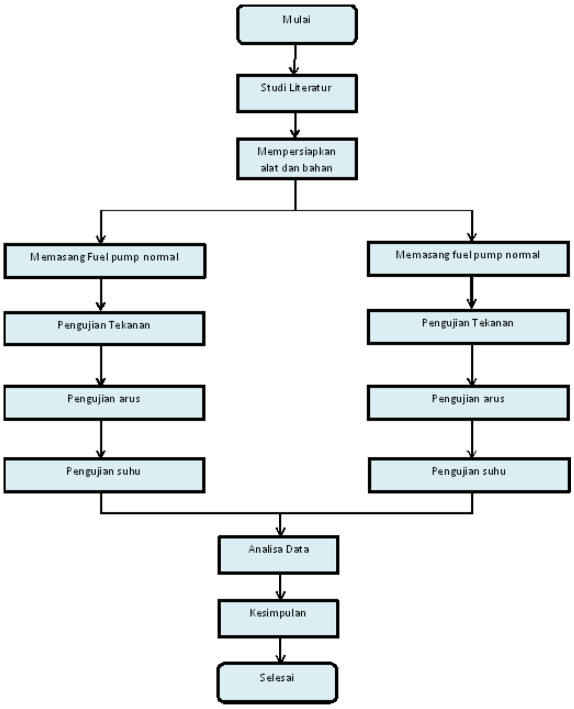

Figure 3. Research flow chart

This research is developing a fuel pump inspection method based on manual repair by producing tool products to detect fuel pump performance (Sanusi, Ululi, & Arafat, 2019). The design of this fuel pump test bench product uses an Arduino Uno microcontroller. The sensor used to measure pressure is an Arduino pressure transducer with a working voltage specification of 5VDC and a maximum pressure of 1.2 Mpa (Edwards &; Otterson, 2014). This sensor determines the force the fuel pump produces with a pressure range value of 2.7 bar to 3.5 bar (Nasrullah &; Saputra, 2019).

The current sensor is ACS712ELC-20A, with a maximum current of 20 Amperes. This sensor determines the current flowing in the fuel pump with a current range value of 2.5 Amperes to 9 Amperes. At the same time, the temperature sensor that will be used to measure the temperature of the fuel pump is DS18b20 Waterproof. This sensor measures the fuel pump's temperature while running (Denton, 2013).

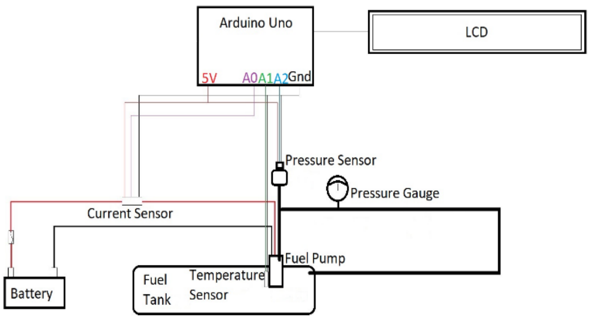

Figure 4. Diagram of fuel pump test bench

In testing, the tool uses three types of fuel pump conditions, the first of which will be tested to obtain data on the fuel pump's current, pressure, and temperature. The second fuel pump with weak conditions will be tested to get data on the state of the fuel pump that produces low pressure, low current, and low temperature (Suárez-Warden &; Mendívil, 2015). The third fuel pump is a fuel pump that has low pressure, rising current, and increasing fuel pump temperature.

RESULTS AND DISCUSSION

From the results of the fuel pump test bench using several types of fuel pump conditions, data on the current, pressure, and temperature of the fuel pump vary (Sumardiyanto &; Susilowati, 2018). The first condition is to use a standard or new fuel pump.

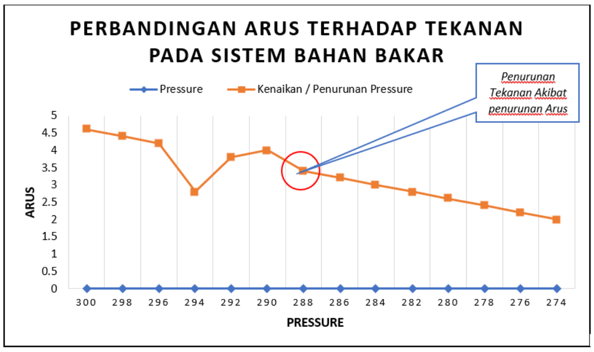

Figure 4. Normal fuel pump graph

Figure 4 is the result of testing normal fuel pump conditions and can be used on vehicles; the graph shows that the change in current to pressure is still within the allowable range in cars, which is at least 270 to 300 kph (Irawan, Winoko, Puspitasari, &; Dwiyono, 2021), the current shown in the graph has obtained a value of 2.5 to 4.5 Amperes and is still by the standard. In this condition, the fuel pump temperature is standard with a value of 32°C; the second condition is to simulate the fuel pump in the state of a worn carbon brush, and the fuel pump is jammed.

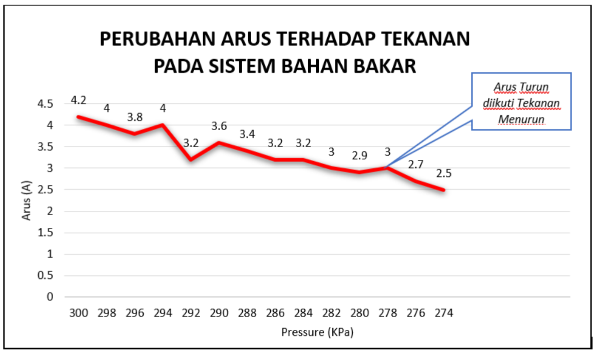

Figure 5. Fuel Pump Carbon Brush Wear Chart

Gambar 5 menunjukkan hasil pengujian dengan mensimulasikan kondisi fuel pump yang carbon brushnya aus, dari data di dapat nilai tekanan dan arus terlihat penurunan nilai arus diikuti dengan turunnya nilai tekanan fuel pump. Ini menunjukkan bahwa fuel pump sudah harus diganti atau dapat di prediksi fuel pump sudah dalam kondisi lemah (Nasrullah & Pambudi, 2020).

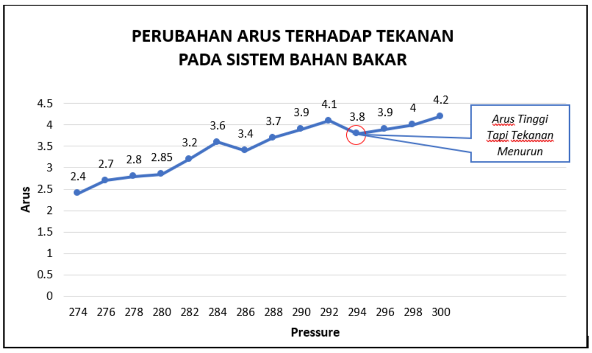

Figure 6. Fuel pump graphic on damaged bushings or clogged ducts

Figure 6 is the test result by simulating the condition of the fuel pump or related to the fuel pump until the injector has a problem; from this data, it is obtained that the current value rises, followed by an increase in the fuel pump temperature but the pressure generated by the fuel pump decreases. Automatically this condition is not allowed or interpreted as a stuck fuel pump (Aryadi, 2020).

CONCLUSION

Making a fuel pump test bench consists of the working concept of a fuel pump, then implemented into the design of the system and parameters measured to determine the deviation value of current, pressure, and temperature of the fuel pump. The performance of the fuel pump test bench produces the value of the three parameters that indicate the condition of the fuel pump is suitable and not suitable for use and can be used to predict the age of the fuel pump.

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