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Design and Development of Dry Cell Type HHO Gas Generator Gauge

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Abstract**—***Measuring instrument is a tool used to measure objects to determine the value of the measuring results of these objects. All gauges can be subject to varying equipment errors. In this research, a dry cell type gas generator performance measurement instrument has been made, the Arduino Mega based measuring device uses K type Thermocouple to measure gas temperature HHO, temperature around gas generator HHO, electrolyte (liquid) temperature, plate / electrode temperature at HHO gas generator type dry cell, then uses a voltage sensor to measure the voltage generated from the HHO gas generator, uses a current sensor to measure amperes, and uses a gas flowmeter sensor to measure the gas discharge generated from the HHO gas generator. In this study, data collection was performed comparing the existing measuring instruments with measuring instruments programmed accurately. The parameters to be measured are the electric voltage, electric current, temperature, and gas discharge in the dry cell type gas generator. The expected results in this study are to determine the accuracy of the sensor measuring instrument which is well programmed.*

Keywords**—** *Gas generatortype dry cell, performance, thermocouple, voltage sensor, current sensor, flowmeter gas sensor.*

I. Introduction

HHO Gas. HHO/Gas Brown is the result of water (H2O) being mixed with a catalyst and altered by a water electrolysis device, the HHO gas generator. In modern times, many tools are designed to make measuring instruments such as voltage, HHO gas temperature, electric current, and HHO gas production discharge. While calculated is the electricity consumption of HHO generators, HHO gas production rate, and HHO generator efficiency. For the measurement of the performance of HHO gas generator type dry cell for the results of data obtained is relatively difficult to design and still requires more than 1 measuring instrument for testing the performance of HHO gas generators. To overcome this, then to help a researcher so that when making measurements more efficient and running smoothly. The tools produced in this study are expected to further assist researchers in measuring HHO Gas generators.

In this study, the tool was designed with the function to know the accuracy of the performance results of the HHO gas generator and to know the results of the prototype value of the HHO gas performance sensor with conventional measuring instruments. This tool is designed to have a cooperation system like previous measuring instruments with additional functions using temperature sensors, gas flowmeter sensors, and voltage sensors (voltage and electric current).

II. Literature Review

A. *Comparison of the performance characteristics of dry cell type HHO generators with 316 stainless steel electrodes and titanium electrodes (Fig.1).* [15]

In this study it was found that HHO generators with stainless steel 316 electrodes have characteristics of electrical power consumption that tend to rise, while the consumption characteristics of HHO titanium electrode generators tend to continue to fall as the testing time increases. The highest electrical power consumption in 316 stainless steel electrode HHO generators is much higher at 431.99watt compared to titanium electrode HHO generators which only reach 5.89 watts. The 316 stainless steel electrode HHO generator produces a higher gas discharge that reaches 0.88 liters/minute than a titanium electrode HHO generator whose HHO gas discharge is zero.

B. *Use of Type K-based Thermocouples atmega16 Microcontroller To measure Low Temperature in Cryogenic Machines (Fig.2).* [1]

Research conducted by Sigit Adi Kristanto et al, in 2013 on hardware design. The digital thermometer used is a Digital Omega Data Logger Thermometer that has a resolution of 0.1 °C / 0.1 ° F and uses a thermocouple sensor type K. This Omega Data Logger Digital Thermometer has a range and accuracy of -200 ° C to 1370 ° C and -328 ° F to 2498 ° F. The calibration process is carried out by simultaneously placing the sensors of the two devices on the mechanical system made and then lowering it by being driven by a stepper motor into a thermos containing liquid nitrogen. Liquid nitrogen filled has a height of 1 cm to 2 cm from the base of the flask. The data was recorded from a height of 20 cm from the base of the thermos to both thermocouple sensors dipped and recorded changes in temperature each decreased by 0.5 cm.

C. *Design a Current Measuring Device Using Atmega328 Microcontroller-Based Current Transformer (Fig.3)*[2]

Based on this research to facilitate in the reading of AC electric current displayed in digital form or interface with LCD made a current measuring instrument. The reading system and data interface via LCD 2x16 on System, there is a current transformer as a current measuring device that will be measured then the voltage output from the secondary side is serialized with signal conditioning.

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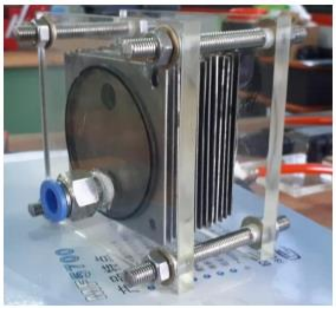

Fig. 1. GHHO [14,15,16,17]

Fig. 2. Sensor Thermocouple

This signal coding is a DC voltage that is regulated by a large voltage using a regulatory IC that is supplied with a voltage of 5VDC, after passing the signal conditioning then the voltage is inserted into the ADC (Analog Digital Converter) on the microcontroller and this microcontroller will process analog data into digital data and then displayed through a 2x16 LCD.

D. Development of Monitoring Systems on Web-Based Building Automation System (Bas) at the Faculty of Engineering Andalas University (Fig.4). [9]

It has been successfully conducted with three points that are used as objects to analyze data generated by sensors, namely lecture halls 1, 2 and 3. One lecture hall consists of three sensors, namely ACS758, DHT11 and MQ9 sensors. Arduino uno is used as a monitoring device equipped with etherent shield, which is a Network Interface Card (NIC) to be able to communicate using local networks at the Faculty of Engineering Unand. Arduino uno boards use external power connected to a 5 volt adapter. Ethernet Shield provides a library for creating realtime monitoring applications. Calibration on the program needs to be done to get the actual current value. When without load, the current sensor output of 2.5 mV/A is lowered first to 0 mV/A. The input signal from the sensor is converted to digital data by the ADC arduino resolution of 10bit which means there will be 1024 (0-1023) possible values that will appear. So to lower the current sensor output value from 2.5 to 0, the data obtained from the ADC is reduced by 513 (readable analog data) under normal conditions. This is half of 1023 (511), then the data is divided by 1023 and multiplied by 50 (5x25), this is due to the sensitivity of this current sensor of 40 mV /A.

E. Analysis of Gas-Rise Velocities From Full-Scale Kick Experiments (Fig.5). [7]

In this research that has been done gas kick experiments in oil and water-based mudslides have been studied in full-scale research wells. One of the main goals of this experiment was to study the rising speed of the gas. In gas kicks high concentrations of gas rise faster than low and moderate concentration kicks, this is observed for oil and water based mudslides. The correlation of the rising speed obtained from these experiments did not significantly depend on the fraction of gas voidness, mud density, slope, mud rheology, and surface tension. The results are very different from other previously reported correlations, and this has major implications on kick simulations.

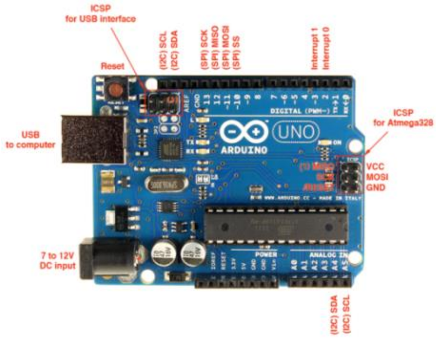

Fig. 3. Arduino Uno

Fig. 4. Sensor ACS758

F. Design Electric Voltage Measuring Instrumentation In Electrolyte Solution Using Personal Computer Based Electrode (Pc) With Arduino Uno R3 (Fig.6)[13]

This previous research aims to make an electrical voltage measuring device on a personal computer-based electrode (PC) with Arduino Uno R3 with the aim to list the electrical voltage measuring program on the electrode that has been designed, as well as to find out the response of the tool to the measurement output that is able to record measurement data in real-time. In this study used hardware (hardware), which is a series of voltage sensors consisting of two resistors with specifications of 100Ω and 10K, Arduino Uno R3, ATMega328 microcontroller, LCD and one laptop as a power supply then for software (software) used is a voltage level monitoring application. Based on the results of tests conducted, namely the measurement of electrical voltage on electrodes with samples of urea (0.001M), vinegar asa (CH3COOH) (0.1M), sodium chloride (NaCl) (0.001M), hydrogen chloride (HCl) (0.001M), microcontrollers will display measurement data on LCD screens in the form of ADC values, Volt (milli Volt), then will be connected to personal computers (PCs) with voltage monitoring level applications that have been designed to record measurement data in real-time in the form of Graphs.

Fig. 5 Flowmeter gas sensor

Fig. 6. Voltage sensor

The voltage generated from the data resulting from the measurement undergoes oxidation and reduction reactions. Tests of tools designed against standard electrical gauges conducted are an average error percentage of 0.25% with a correlation value of 0.97. The measuring limit of the tool designed in this study has a range of 0 mV –5000 mV.

G. *Computerized Measuring V-R Meter for Characterization of Ni DAQ BNC-2110 Calibrated Gas Sensor* [8]

In this study for data acquisition system testing was done by connecting the minimum system of AVR atMega16 microcontroller with the computer via USB Port. Data acquisition system tests are conducted until the minimum system atMega16 can send and receive data to the computer. The next step is the optical merging of the characterization gauge of the ammonia gas sensor. In this process, all parts in the cassing use the appropriate box. Then test the measuring instrument as a whole. The last step of the process of making this measuring instrument is to calibrate the measurement results. Calibration of measurement results is done by comparing the measurement data of the V-R meter measuring instrument with the standard NI DAQ type BNC-2110 device and the UNI-T multimeter as a reference. This calibration process aims to obtain the level of accuracy, precision and error of the V-R meter measuring instrument.

Electric Power Consumption HHO Generator Type Dry Cell Gas HHO

HHO Dry Cell Gas HHO generator electricity consumption is generated from the water electrolysis process.
It requires power or electrical energy with direct current.

$$P = V \, x \, I$$

Where:
P = power (Watt)
I = arus (A)
V = voltage (V)

HHO Gas Production Rate (ṁHHO)

HHO gas is the main result of the process of water electrolysis in HHO gas generators, to find out how well the work of the HHO generator needs to be known how much HHO gas is produced by the generator (12)

$$\dot{m} = Q \text{ x } p$$

Where:
ṁ = HHO gas production rate (kg/s)
Q= HHO gas production discharge (m3/s)
p = HHO Type Period (kg/m3)

HHO Gas Discharge Value

The value of HHO gas discharge according to Silaen and Kawano in 2014 can be calculated

$$Q = \frac{V}{t}$$

Where:
Q= HHO gas production discharge (m^3/s).
t = HHO gas production time(s).
V = measurable gas volume (m^3).

III. METHOD

A. *Software Design*

Program Arduino (Figure 7)

B. *Dry Cell Type HHO Generator Performance Data Testing and Retrieval Procedure*

In this study, the first HHO generator tested was an HHO generator with 316 stainless steel electrodes, then, followed by testing of an HHO generator with grade 1 titanium electrodes. First, it is ensured that the test tool or measuring device on the HHO generator circuit is installed correctly. Next, prepare a time gauge or stopwatch. Then, the HHO Generator is turned on by connecting the jumper cable to the cable.

```
const int gas=A0;
const int arus=A1;
const int suhu=A2;
const int tegangan=A3;
float tampung_gas,tampung_tegangan, tampung_arus, tampung_suhu;

void setup() {
  Serial.begin(9600);
  pinMode(gas,INPUT);
  pinMode(arus,INPUT);
  pinMode(suhu,INPUT);
  pinMode(tegangan,INPUT);
}

void loop() {
  tampung_gas = analogRead(gas);
  tampung_arus = analogRead(arus);
  tampung_suhu = analogRead(suhu);
  tampung_tegangan = analogRead(tegangan);
  Serial.print("gas = ");
  Serial.println(tampung_gas);
  Serial.print("arus = ");
  Serial.println(tampung_arus);
  Serial.print("suhu = ");
  Serial.println(tampung_suhu);
  Serial.print("tegangan = ");
  Serial.println(tampung_tegangan);
```

Fig. 7. Program Arduino

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It divides the electrical power of the HHO generator electrode plate and begins to measure time. Recorded electric current, electric voltage, temperature, and HHO gas discharge every 1 minute. Measurements up to ≤ temperature of 70°C ± 1°C. Record keeping is done by adjusting the data sheet table testing the performance characteristics of the dry cell type HHO generator.

C. Procedure for Applying Measuring Sensor On HHO Gas Generator(Fig 8)

First, a dry cell type HHO generator is prepared. Next, prepared test kits and measuring device sensors needed for research. Then, prepared a series of sensor measuring instruments HHO dry cell type generator and testing support components. Thermocouple sensors are installed in acrylic holes properly, then, glued firmly so that there is no leakage in the HHO generator. Slang and tank reservoirs are installed or connected to the HHO generator and ensure that the connection is not leak a geed. Prepared a mixture of electrolytes and catalysts consisting of aquades (distillation water) and KOH. The ratio of electrolytes with catalysts is 1 liter of aquades: 4 grams koh. Inserted electrolyte mixture with catalyst on the HHO generator through the tank reservoir until the electrolyte mixture with catalyst on the tank reservoir reaches the maximum limit. Prepared 12 v battery and battery charger. Then, the battery and battery charger are assembled on the HHO generator. It is ensured that the voltage sensor, amperemeter sensor, gas flowmeter sensor, and thermocouple sensor can work normally. It is ensured that the entire electrical circuit has been properly connected and the condition of the electrical components is in good condition or not damaged. The voltmeter and amperemeter gauge sensors are properly connected to the Arduino Mega. The HHO gas discharge gauge (flow meter) is connected to the HHO gas output slang and to the Arduino Mega. Then, it is confirmed that there is no gas leak in the HHO gas generator and its supporting components.

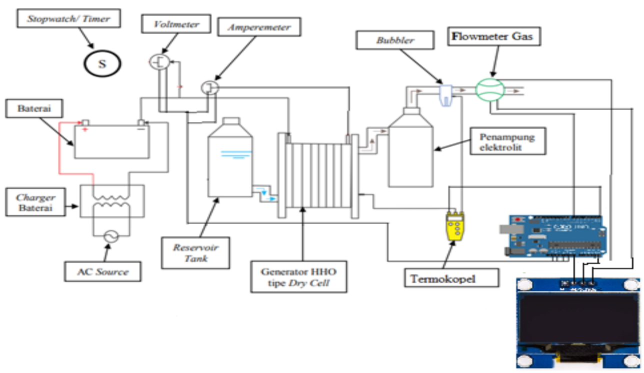

Fig. 8. Application Scheme

D. Dry Cell Type HHO Generator Test Data Calculation Procedure

For the procedure of Calculating the Power Required HHO Generator, among others, the results of the reading of voltage and electric current on the voltmeter and meter every 1 minute. Furthermore, from the voltage and electric current data every five minutes, then, can be done calculation of the power of the HHO generator needed by the generator every 1 minute. As for procedure Calculation of HHO gas production rate among others, make a note reading of gas discharge at flow meter every 1 minute and find out the mass of HHO type. Furthermore, the calculation of the rate of HHO gas production is carried out. For procedure Calculation of Efficiency of HHO Generator among others calculated and recorded the power required HHO generator to work every 1 minute. Then, it is known that the energy required to break 1 mole of bonding from a molecule in the form of gas (bond energy) and molarity per unit time. Then, the calculation of the efficiency of the HHO generator is carried out.

E. Circuit Scheme

The circuit scheme is made to make it easier to understand how the system works from the tools created can be seen in Figure 9.

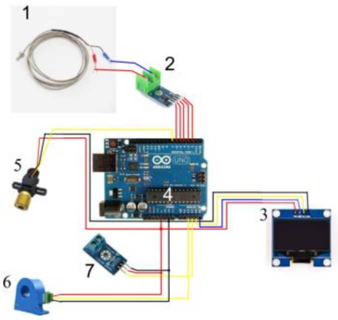

Fig. 9. Electronic Circuit Scheme

F. Flowchart

In this research the design / scheme is made to make it easier to understand how the system works from the tools made can be seen in Figure 10.

IV. Result and Discussion

A. Design Process to Build HHO Dry Cell Type Gas Generator Performance Measuring Device

In the process of making this HHO generator measuring device includes the preparation of components. Based on the identification of existing needs, several needs analysis is obtained of the tool to be made with the following specifications:

Arduino Mega microcontroller as an overall system control device.

Thermocouple MAX6675 sensor as a sensor to measure temperature.

SENSOR ACS758LCB-050Bs as sensors to measure current.

Voltage sensor as a sensor to measure voltage.

Flow sensor as a sensor to measure the speed of fuel.

Oled LED as a data display viewer.

Adapter 12V 1A as a power supply of the tool voltage.

Design a design tailored to the overall performance of the device.

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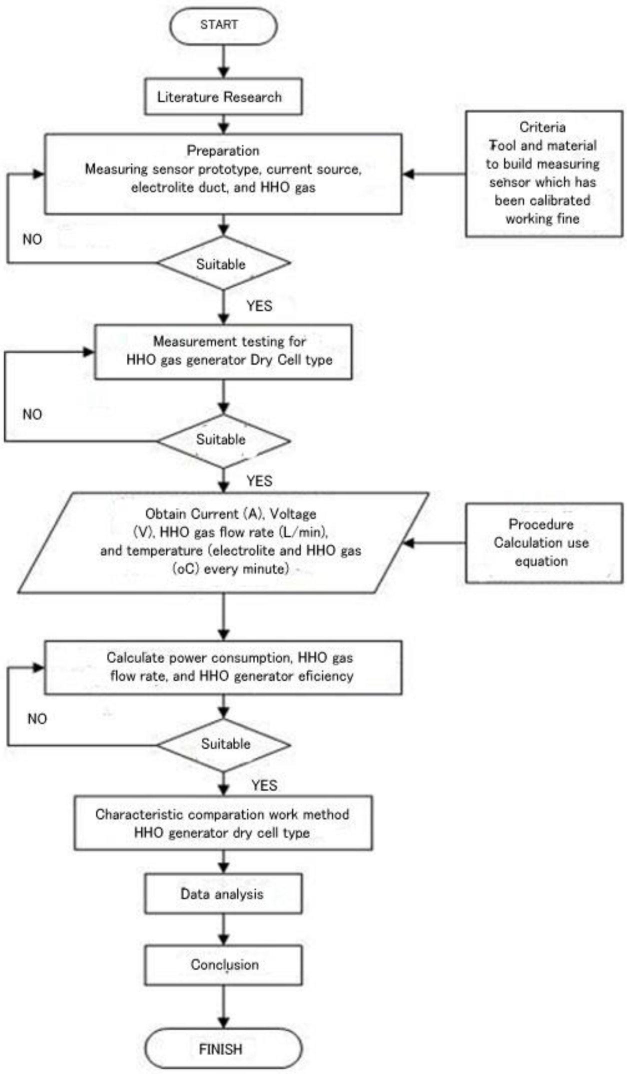

Fig. 10. Flowchart [14,15,16,17]

B. Tool Planning

1. Max6675 Thermocouple Sensor Range

The temperature sensor used in the working system of this tool uses 4 units of thermocouple sensors with IC MAX6675 which are each connected to the SPI pin on the Arduino Mega 2560 microcontroller as the main controller of the built tool.

In Figure 11 thermocouple 1 sensors are connected to digital pins 8, 9 and 10 according to the order of the MAX6675 thermocouple sensor pins on the SCK, CS, DO/SO pins. Thermocouple 2 sensors are connected to digital pins 4, 5 and 6 according to the order of the MAX6675 thermocouple sensor pins on SCK, CS, DO/SO pins. Thermocouple 3 sensors are connected to digital pins 27, 28 and 29 according to the order of the MAX6675 thermocouple sensor pins on the SCK, CS, DO/SO pins. Thermocouple 4 sensors are connected to digital pins 31, 32 and 33 according to the order of the MAX6675 thermocouple sensor pins on SCK, CS, DO/SO pins.

Each sensor works to measure temperature independently and transmit data to arduino mega microcontroller simultaneously, so that each sensor has a real-time temperature measurement.

2. ACS Current Sensor Circuit 758

In this current sensor circuit is used ACS758 type current sensor that will measure the current load used. The measurement of the current sensor is done by connecting the OUT pin sensor with the analog pin of the arduino mega microcontroller. The ACS758 current sensor is connected to 13 analog pins on the arduino mega microcontroller. The analog readings of the sensor are converted into digital data through the ADC (analog digital converter) feature on the digital pin 13 so that the measurement data can be sent towards the OLED Led supply module.

3. Voltage Sensor Circuit

The series of voltage sensors in the design of this tool uses a voltage sensor that uses the concept of voltage divider. So that the data that is read is still analog data.

This voltage sensor is directly connected to analog pin 12 which will be converted into digital data using the ADC (analog digital converter) feature so that it can be processed by microcontrollers and the data can be displayed on the file. Oled LED.

4. Flow Sensor Circuit

This series of flow sensors will measure the rate of gas passing through the sensor so that it can be known the capacity used. This sensor uses an interrupt method where the reading data will be transmitted to the arduino mega microcontroller in the form of simultaneous accumulation.

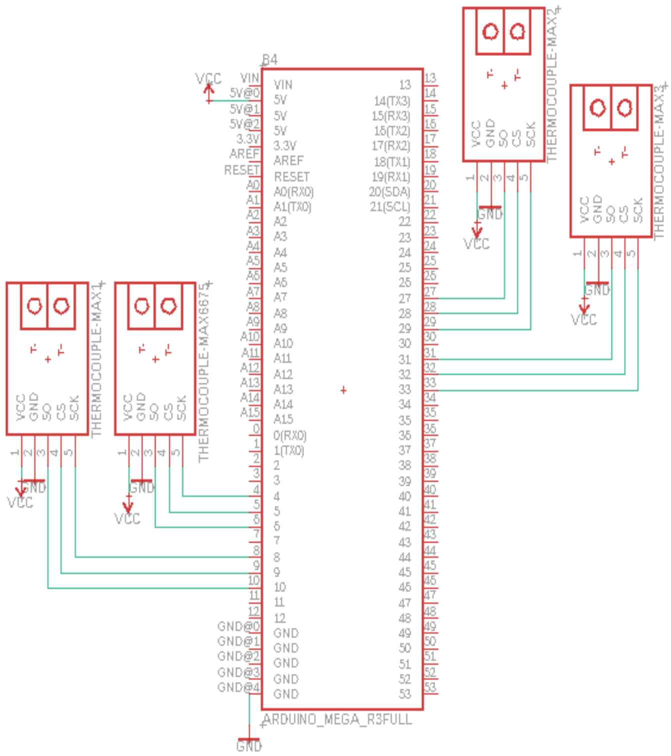

Fig. 11. Sensor Thermocouple Circuit

The flow sensor on the output part is connected to the digital pin 2 which has an interupt feature. The data is then calculated by a microcontroller and displayed on an oled led supply.

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5. Circuit Panel OLED LED

This series of Oled Led panels is a supply device that will display all sensor reading data that has been processed by the arduino mega microcontroller so that apat is monitored by the user.

The LED OLED panel uses I2C communication that will connect with pins on the arduino mega microcontroller which also features I2C namely digital pin 20 (SDA) and digital pin 21 (SCL). These two pins are connected to the I2c SDA and SCL pins on the OLED Led display panel pinout.

6. Software Creation

Creating software line program code is done using the arduino idea application version 1.8.9 with a C language base that is adjusted to support the overall performance of the tool. The first thing to do is to configure the process of uploading programs from the computer to the microcontroller according to the new flowchart after which a command is made for each sensor. Namely temperature sensors, voltage sensors, current sensors, flow sensors, then create commands that will display the data of each sensor.

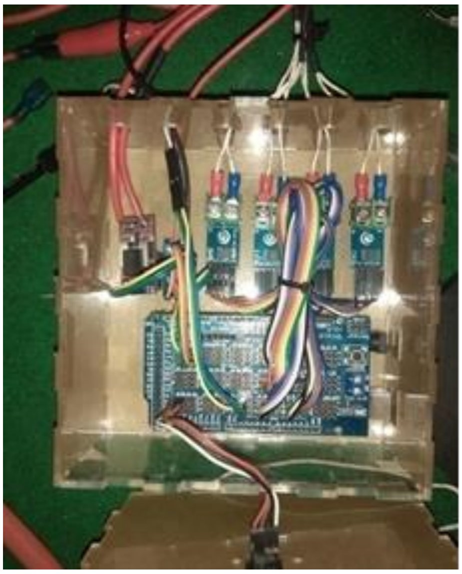

Fig. 12. HHO generator test tool

C. Dry Cell Type HHO Generator Testing Process

In the process of testing HHO generator type dry cell is divided into 2 stages, namely: preparation of HHO generator testing and testing of HHO generators. The preparation process of testing HHO generators and the process of testing HHO dry cell type generators are generally carried out according to research methodology.

1. Preparation of HHO Generator Testing Tool.

The testing tool in this study consists of a test tool and an HHO generator power supply device. The test tool that is prepared is the HHO generator performance gauge sensor that has been made. Figure 12 is an image of an HHO test tool.

Here is the description of the function of the test tool in this study:

a) Voltage Sensor
The Voltage sensor serves to measure the voltage that goes into the HHO generator.

b) Current Sensor
Acs758 type current sensor serves to measure the electric current entering the HHO generator.

c) Thermocouple Sensor + Max 6675
Thermocouple sensor type K there 4 function is to measure the temperature on the electrolyte, measure the temperature around the HHO generator, measure the temperature of the plate on the HHO generator, and measure the temperature of the gas in the HHO generator.

d) Sensor Flowmeter Gas
The gas flowmeter sensor serves to measure the flow discharge produced by the HHO generator.

e) Who
Batteries are used to supply electrical power on HHO generators. The battery has a voltage of 12V.

f) Charger Aki
Battery charger serves to charge the battery, so that the battery does not *drop.*

g) Power Supply Adapter

Fig. 13. HHO generator testing suite scheme

This power supply adapter serves to power the HHO generator measuring device sensor.

2.Tests Generator HHO Tipe Dry Cell

Before conducting testing, the arrangement of HHO generators, measuring instruments, hoses, and electrical power supply components is carried out in accordance with the test scheme plan on the research methodology. Figure 13 above is a scheme of HHO gas generator testing series of dry cell type.

Testing of this HHO generator is carried out until the electrolyte temperature reaches 70°C or until the HHO generator performs the electrolysis process for 20 minutes. Data collection on this test is carried out every one minute which includes: electric current, electric voltage, electrolyte temperature in HHO generator, electrolyte temperature in tank reservoir, temperature around HHO generator, temperature HHO generator plate and gas discharge produced by HHO generator.

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D. Test Results of Dry Cell Type HHO Generator

After testing and retrieving HHO gas generator data of dry cell type, then the HHO generator data is calculated according to the procedure in the research method. In Figure 14 is the current error electricity on the HHO generator against stainless steel 316. In this test, the electric current produced there is a comparison between the existing measuring instrument and the newly created measuring instrument sensor.

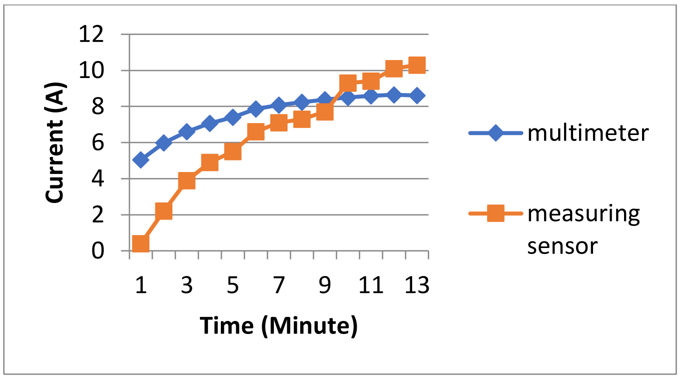

Fig. 14. Current comparison graph on HHO generator

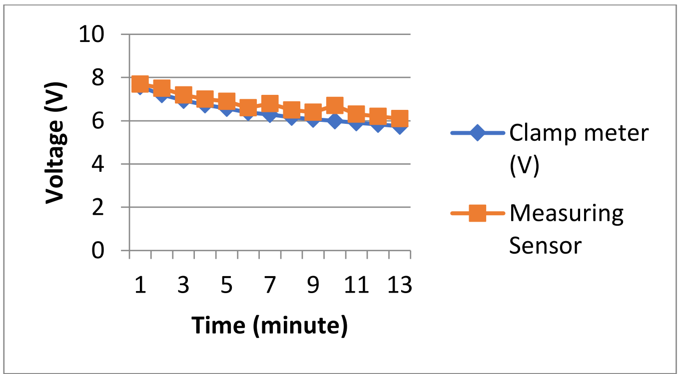

Fig. 15. Voltage comparison graph on HHO generator

The result of the measuring sensor at 2 minutes increases until the electric current at 13 minutes reaches 10.30A on the HHO generator. Next is the ratio of voltage on the HHO generator to the time (minutes) stainless steel 316.

Figure 15 is a comparison of the voltage ratio on the HHO generator to the time (minutes) of Stainless Steel 316. In this test, the electrical voltage generated there is a comparison between the existing measuring instrument and the newly created measuring device sensor. The result of the measuring sensor at 2 minutes decreased to 13 minutes, electricity reached 6.1V on the dry cell type HHO generator.

In Figure 16 is the temperature of electrolytes in reservoir tanks against the time (minutes) stainless steel 316. In this test there is a comparison of HHO gas temperature produced by HHO generator with stainless steel electrode 316 for existing measuring instruments experiencing a temperature increase and the temperature measuring sensor experiencing ups and downs, at the last minute the temperature tends to be stable at 30°C.

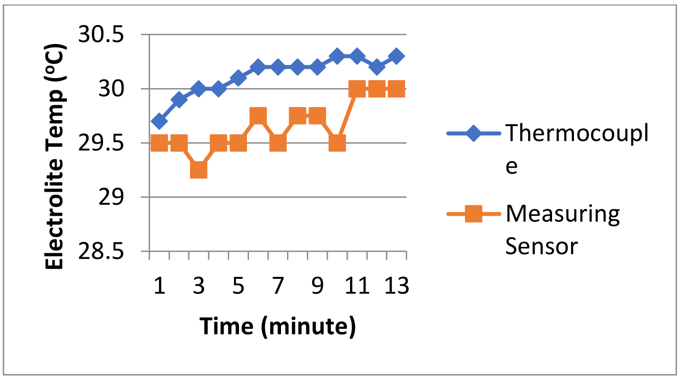

Fig. 16. Electrolyte temperature comparison graph on HHO generator

In Figure 17 is a comparison of HHO °C Gas Generator Temperature to Stainless Steel Time (Minutes) 316. In this test, the ratio of HHO gas temperature produced by HHO generator with stainless steel electrode 316 for existing thermocouples experienced up to 13 minutes reached 71°C, while the results

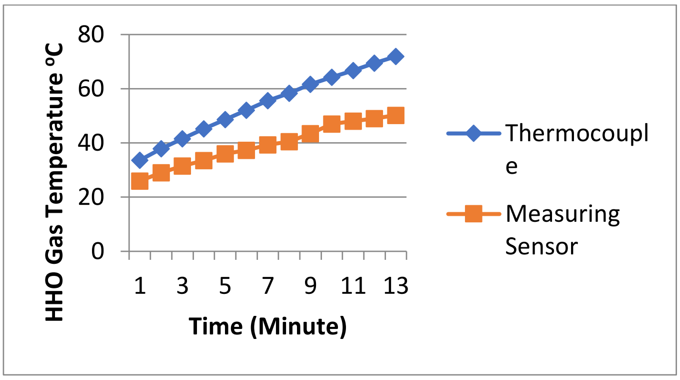

Fig. 17. HHO Stainless Steel gas temperature comparison graph 316

The measuring device sensor that is made increases up to 13 minutes, the temperature reaches 50.25°C. Then the temperature of HHO gas in the titanium electrode HHO generator is not displayed on the graph, because the HHO generator does not have HHO gas temperature. This is because HHO generators with titanium electrodes do not produce HHO gas.

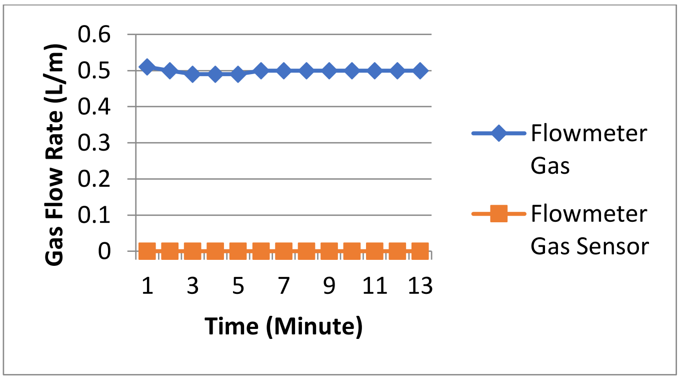

Fig. 18. Gas discharge comparison graph

In Figure 18 is a comparison of HHO Gas Discharge (L/m) to Time (minutes). In this test, the flow of gas discharge in the

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HHO generator occurs a comparison, i.e. the result of the gas flowmeter measuring device produces 0.5 l / m tends to be stable, while the gas flowmeter sensor, the gas flow is not readable, because the gas pressure is too low and the gas flowmeter sensor is of medium sensitivity level.

V. CONCLUSION

After conducting research on *dry cell* type HHO generators, the following conclusions can be obtained. The sensor performance of the measuring instrument created on the measurement generates data:

a. An electric current of 10.30 A in the 13th minute of duty cycle 40%.
b. Voltage of 6.1 V in the 13th minute duty cycle 40%.
c. Electrolyte temperature of 30oC in the 13th minute duty cycle 40%.
d. The temperature is around 41oC in the 13th minute duty cycle 40%.
f. Plate temperature of 36.75oC in the 13th minute of Duty Cycle 40%
g. HHO Gas Generator temperature of 50.25oC in the 13th minute duty cycle 40%.
h. Gas Discharge of 0 L/m in the 13th minute duty cycle 40%.

The comparison measurement of conventional measuring instruments with measuring instrument sensors results are not much different. In existing gauges the gas temperature in the 316 stainless steel HHO generator tends to rise to 70 °C within 13 minutes, while in the reading of the newly made gauge sensor the gas temperature on the 316 stainless steel HHO generator reaches 50.24 °C within 13 minutes. Comparative measurement on conventional electric current gauge on HHO stainless steel generator 316 amounted to 8.61A, while on the sensor reading of electric current measuring instrument on 316 stainless steel HHO generator of 10.30A within 13 minutes *of Duty Cycle* 40%. Comparison on conventional gauges, the voltage on HHO stainless steel generator 316 is 5.75A, while in the sensor reading the voltage gauge on HHO stainless steel generator 316 is 6.1 within 13 minutes *duty cycle* 40%. The comparison measurement on conventional gas discharge gauges on 316 stainless steel HHO generators is 0.50 L/m, while on the sensor readings the gas discharge gauge on HHO stainless steel generator 316 is 0 L/m within 13 minutes *duty cycle* 40%.

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REFERENCES

[1] A.K. Sigit, B.Indarto, "Use of Atmega16 Microcontroller-Based Type K Thermocouples To Measure Low Temperatures In Cryogenic Machines"2013. Surabaya: Institut Teknologi Sepuluh November.
[2] A. Dimas, Y. Rahajo, L. Hakim. "Designa Current Measuring Device Using Atmega32 Microcontroller-Based Current Transformer". Lampung: Universitas Lampung.
[3] Anonymous. https://www.aliexpress.com/item/32659319740.html?spm=a2g0o.detail.1000014.41.763e3852Wa3H1s&gpsid=pcDetailBottomMoreOtherSeller&scm=1007.13338.142407.0&scm_id=1007.13338.142407.0&scmurl=1007.13338.142407.0&pvid=60d97569-bce0-4e85-88c8-5b2a555dfd06 Gas Sensor Flowmeter
[4] Daryoko, M. "Electrolysis Efficiency in Platinum Nitric Acid Electrolysis Cells". 2008. Serpong: BATAN
[5] Fattah, Ahmad. "Comparing Variations in the Number of Electrodes with the Total Length of Wire on HHO Generators to Honda Karisma 125 Performance". 2012. Department of Machinery. Sepuluh Institute of Technology November.
[6] F. Afrizal, E. Komalasari, H. Gusmedi. "Design a Microcontroller-Based Current and Voltage Monitoring Tool with SMS Gateway". 2016. Lampung: Lampung University.
[7] Hovland F, R Rommetveit. “Analysis of Gas-Rise Velocities From Full-Scale Kick Experiments“. 1992. Washington DC : SPE Annual Technical Conference and Exhibition
[8] Junaidi. "ComputerizedV-R Meter Measuring Instrument for Characterization of Ni DAQ BNC-2110 Calibrated GasSensor". 2013. Lampung: University of Lampung.
[9] M. Princess, Zaini. "Development of Monitoring System on Building Automation System (BAS) Based on Web". 2015. Sumatra: Andalas University.
[10] N. Irma, A. Eko Putra,B. Nurcahyo Prastowo. "Prototype of Vervasis Netduino Plus Electric Power Measuring Device". 2015. Yogyakarta: Gajah Mada University.
[11] Nugroho HF, B Yunianto. "Testing the use of HHO Gas Genertaor Drycell Type Against the performance of engine work such asmotor". 2016. Semarang: Diponegoro University.
[12] Silaen and Kawano. "Optimization of HHO Gas Generator Type Wet Cell Dimensions 160x160 mm & 120x120mm with the Addition of Digital Pulse Width Modulation and Plate Neutral". 2014. Journal of Pomits Engineering. 1 (1). Sepuluh Institute of Technology November (Institut Teknologi Sepuluh Nopember Surabaya).
[13] Q. Caine, A. Judge S.F. "Design The Instrumentation of Electrical Voltage Measuring Instruments In Electrolyte Solutions Using Personal Computer (Pc) Based Electrodes With Arduino Uno R3". 2017. Medan: Medan State University.
[14] Yuli Prasetyo, Alfi Tranggono Agus Salim, et al. "Thermoelectric Characteristics of Tec Vary Types With Variations in Resistor Loading". 2019. Madiun: Madiun State Polytechnic (Politeknik Negeri Madiun).
[15] Yusuf Ahmad. "Comparison of Performance Characteristics of Hho Dry Cell Type Generator With Stainless Steel 316 Electrode and Titanium Electrode". 2019. Madiun: Madiun State Polytechnic (Politeknik Negeri Madiun).
[16] Alfi Tranggono Agus Salim, “Karakteristik Unjuk Kerja Generator Gas Hho Dengan Elektroda Titanium Dan Mengaplikasikan Pada Sepeda Motor 150cc Sistem Injeksi”. 2016. Surabaya: Sepuluh Institute of Technology November (Institut Teknologi Sepuluh Nopember Surabaya).
[17] Alfi Tranggono Agus Salim, R. Gaguk Pratama Yudha, Kanjeng Sunan Lawu, Ahmad Yusuf. “Performance Characteristics between Titanium and Stainless Steel Materials as Electrodes on Dry Cell Type HHO Gas Generator”. 2019. Madiun: Madiun State Polytechnic (Politeknik Negeri Madiun).