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Temperature Monitoring In Water Heating System Using Control Temperature with Pid Ziegler Nichols Method Web Based

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Abstract:

Many industries use heating for the production process. But the problem is that this heater must be controlled to its temperature so that the hot temperature in accordance with the desired, because if uncontrolled heat will lead to overheating and over pressure that will cause the production process to fail. To control the heater then used the on-off method and PID method which is a method to determine the precision of an instrumentation system with the characteristics of feedback on the system. On the control result using the on-off method to address the time when the process of heating water from the initial temperature of 36.69 to the desired temperature value 73 that is 8 minutes 14 seconds while in the heating process using PID from the initial temperature of 29.56 to the desired temperature value 73 that is 19 minutes 14 seconds. Temperature value can be seen in the web display either in the form of numbers with units of degrees Celsius or in the form of graphs. While the result of testing tool to user acceptance / respondent shows that variable of PU (X1) and variable of PEU (X2) to receipt of BITU (Y) user is acceptable. This is indicated by the reliability test with the value of croncbach's alpha PU 0.759> 0.60, PEU 0.669> 0.60, PU and PEU validity show r table value higher than t table, multiple linear regression tests PU (X1) and PEU (X2) to the receipt of BITU (Y) users shows significant value 0,000 <0.05, the summary summary model shows the value () = 0.262 and anova attributes the Sig value. F of 0.000 <α = 0.05.

Keywords — **Control System, PID, Node Mcu esp8266, Temperature, Monitoring.**

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I. INTRODUCTION

Many industries today take advantage of electronics advances for their production processes. As a result they do not require many employees for the production process. One example is an industry that needs a heater in its industrial process. The use of heaters in the industry does not detract from some of the flaws such as the heater is unable to get the optimum temperature that has been determined so that the industrial process is not running properly [1]. The need for increasingly advanced technology, demands the development of a reliable control system. A good control system is essential in improving efficiency in the production process. For example, temperature control automation in industry[2].

Along with the increasing technological developments, the technology used in automation control suhupun increasingly sophisticated. In this research we will create a miniature model of temperature controlling plant which is expected to help the use of temperature control at temperature setting on a water heating system and can be monitored directly through controller display as well as web display. In the case of temperature control or temperature control is one of the most important arrangements for building a device that can work automatically to control the temperature of the water heating system and monitor or monitor temperature, and provide continuous information. In temperature control often occur problems include:

1. Often overheating on the on-off method so that the temperature can not be adjusted according to the desired temperature, when the relay off the incoming voltage on the heater stopped but the heat is still up.

2. Often overpressure is caused by overheating on the on off method.

In addition to the above problems peneiti also igin know how to get the time required information in heating the water up to the desired temperature value, how to set the temperature on the water heater automatically, how to test the questionnaire about the tool made to the user using the Technology Acceptance Model (TAM) .

II. THEORETICAL BASIS

2.1 Literature Review

2.1.1 Temperature

Temperature measurement is a very important thing in industrial processes and often very much determines the process itself. There are various kinds of temperature detectors such as:

1. Temperature detector based on the expansion properties of solid, liquid and gas. This tool is called an expansion thermometer.
2. Temperature detector based on changes in the electrical properties of a substance, in case of temperature changes. This tool is called an electric thermometer (Electrical thermometer).
3. Temperature detector based on color change of substance at high temperature. This tool is called a pyrometer. This Pyrometer is only used on very high temperature measurements.

2.1.2 Electronic Control System

The current electronic controller is present in almost every control application. Therefore, the understanding of this controller becomes very important for the implementation of tasks in the field. In this electronic control system include the non-continuous controller (on-off method controller) and the continuous controller (PID method controller). These controllers are very popular in the industry because of the realization and reliability of their performance. Especially the continuous controller, although classified as conventional, but has advantages. This all makes most control practitioners very familiar with this type of continuous controller.

1. Proporsional Controller (P)

Proportional controller (P) is the development of a two-position (On-Off) controller. In the duaposition controller, the control output is 100% or 0% depending on the error signal or the incoming signal to the controller. If the error signal is greater than neutral area then the controller output is 100%, otherwise if the error signal is smaller than neutral area then the control output is 0%.

2. Integral Controller (I)

The integral controller (I) is the development of the P controller and the multi-position controller. Compared to P controller, this controller is able to eliminate static errors.

3. Deferensial Controller (D)

The output of the differential controller (derivative) depends on the "speed" of the error change. This controller can not be used alone because if the error is equal to zero or fixed then the controller output will be zero.Teori Ziegler Nichols.

2.1.3 Ziegler-Nichols theory is one solution to find the value of Kp, Ki, and Kd.

The value of PID is obtained from the experimental results with step unit input, the result will be formed curve in the form of letter S, If this curve is not formed then this method can not be applied. The S shape curve has characteristics with 2 constants, the time delay L and time constant T. Both parameters are obtained by drawing a tangential line at the inflection point of the S curve. [3].

2.1.4 Problem Solving Mindset

To build this research, the conceptual framework to be used is as follows:

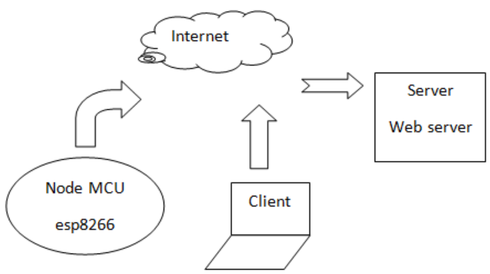

Figure 2.1 Concept of Mindset

III. SYSTEM DESIGN AND APPLICATIONS

3.1 Design

The design of this research is done by designing drawings of layout of components to be installed so that the application is not misplaced component placement. In the design process is also done wiring single line cable design of the tool that will be made with the aim of avoiding cabling errors that will result in short circuit that can cause damage to the component.

3.2 Testing Prototype / Model.

The prototype testing in this study was undertaken by configuring the apparatus and attempting to apply the on-off method and PID method on the temperature monitoring device made, whether the tool created could monitor the temperature change in the heater and detect the occurrence of the temperature heat degree change continuously and be able to reduce the occurrence overshoot.

3.2.1 Stages of Testing

1. Stage Design

In this step, hardware hardware preparation is needed to make temperature monitoring tool on heater water heater and checked on hardware that will be installed whether the hardware condition is in good condition or not, and done desaign drawing wiring on tool made for the process of making later no cabling errors occur which may result in damage to the hardware to be installed.

2. Tool Making Stage

In this stage is done assembly or hardware design that has been prepared to be made a device that is able to monitor temperature and control the temperature of the heater water heater.

3. Testing Phase

In the first phase, a temperature monitoring tool has been made using the on-off method, whether by using this method the temperature can be monitored in accordance with the planned. After that it is done to observe whether the heater condition will be off or on after set point temperature and hysteresis value or also called threshold value and lower threshold in specify.

In the second stage, a temperature monitoring tool was made using PID method and the parameter search method of kp, ki and kd using Ziegler Nichols method. Whether by using the method the temperature can be monitored in accordance with the planned, in addition to whether the application of this method can minimize the error and can reduce the overshoot.

In this third stage will be in the trial of tools and also questionnaires to respondents to convince respondents about the usefulness and benefits of tools made.

4. RESULT AND DISCUSSION

4.1 Analytical Work System Tool

In the system work tool and the selection of components to be used, calculation is required calculations such as power calculations, currents, and know the input voltage. Besides it should be taken into account other aspects such as, the availability of material from the supplyer, the availability of customer service if there is a problem with the material, and so forth. In the selection of this component is divided into 2 parts based on its function, namely the selection of control components and power components.

Power consumption:

1. Heater = 300 watt
2. Pilot lamp = 30 watt

The total calculated power consumption is 330 watts.

Where P = V x I

= 220 V x I = 330 watts

Then I = P / V

I = 330: 220 V I = 1.5 A

So, the incoming current limit on MCB 1 must be greater than 1.5 Ampere, and the selected MCA 2 A takes into account the current spikes when the start of the heater starts. Hardware components used in the manufacture of tools for temperature monitoring include:

Table 4.1 Table Component Temperature Monitoring Tool

No	Hardware Name	Spesification
1	Tempeatur Control	Autonics TZN4S-14R
2	Mcb	Schneider 2A
3	Selector Switch	CR 253
4	Relay	Omron 24 VDC
5	Kontaktor	Mitsubishi K12 220 V
6	Lampu Indikator	22 mm Led schneider
7	Rel Omega	standart
8	Stop Kontak	Broco 220 V
9	Electric Heater Cup	Steel EC-12
10	Rel Mcb Panel Alumunium	1.1 mm
11	Sensor Suhu	PT 100
12	Kabel	Kabel NYAF 220 V
13	Kabel	Utp
14	Node Mcu esp 8266	ESP 8266 V01 12E
15	Project Board	830 point
16	Resistor	4,7K
17	Sensor Suhu	DS 18B20

4.2 Testing Every Block

Tests on block-block function of circuit diagram work done to know whether work function work as expected. The block diagram can be seen in Figure 4.1.

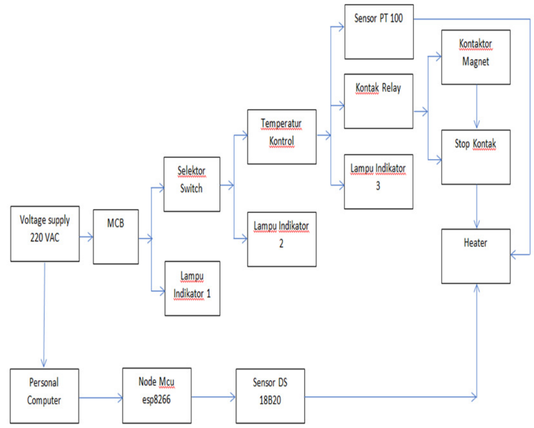

Figure 4.1 Chart Block Diagram

4.3 Test Results of the Temperature Monitoring Unit Temperature Control Circuit

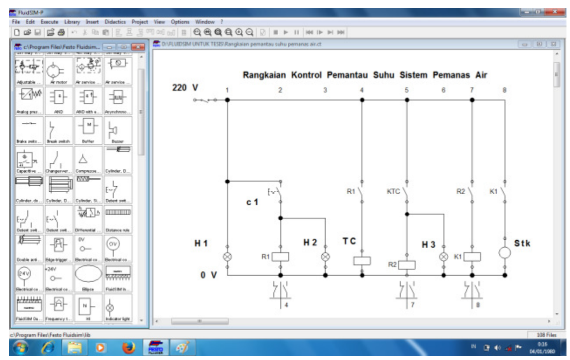

Figure 4.2 Results of Tool Control Circuits Temperature Monitor

4.4 Test Results Hardware Layout And Working Picture Temperature Monitoring Tool

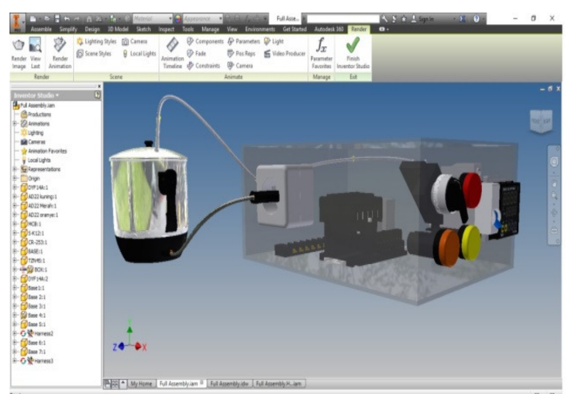

Figure 4.3 Isometric Hardware Layout

4.5 Application of On-Off Test Methods To Set Up The

Water Heater Temperature

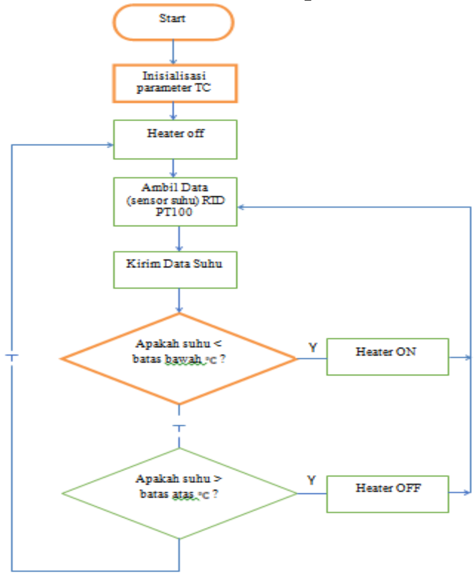

Figure 4.4 Diagram of On-Off Method

Table 4.2 Measured Temperature and Time taken When Heating Water Using On-Off

Tanggal	Waktu	Suhu Terukur °C
12/14/2017	8:56:11 PM	36.69
12/14/2017	8:56:26 PM	36.88
12/14/2017	8:56:41 PM	37.06
12/14/2017	8:56:56 PM	37
12/14/2017	8:57:13 PM	37
12/14/2017	8:57:29 PM	37.06
12/14/2017	8:57:46 PM	37.06
12/14/2017	8:58:01 PM	37.56
12/14/2017	08:58:16 PM	38.13
12/14/2017	8:58:32 PM	38.63
12/14/2017	8:58:47 PM	39.69
12/14/2017	8:59:03 PM	41
12/14/2017	08:59:18 PM	42.31
12/14/2017	8:59:33 PM	43.87
12/14/2017	8:59:48 PM	45.25
12/14/2017	9:00:04 PM	46.44
12/14/2017	9:03:38 PM	68.44
12/14/2017	9:03:55 PM	70.06
12/14/2017	9:04:10 PM	71.69
12/14/2017	9:04:25 PM	73.19

4.6 Application of PID Methods for Setting Water Heater Temperature

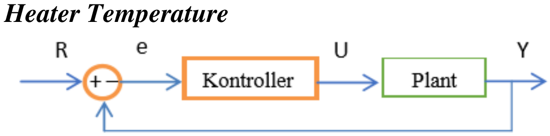

Figure 4.5 Diagram of PId Method

Table 4.3 Temperature and Measured Temperature When Heating Water Using PID Method

Tanggal	Waktu	Suhu Terukur°C
12/15/2017	8:45:39 PM	29.56
12/15/2017	8:45:54 PM	29.56
12/15/2017	08:46:09 PM	29.56
12/15/2017	8:46:24 PM	29.63
12/15/2017	08:46:40 PM	29.56
12/15/2017	8:46:55 PM	29.56
12/15/2017	8:47:10 PM	29.56
12/15/2017	8:47:25 PM	29.56
12/15/2017	08:47:40 PM	29.63
12/15/2017	8:47:56 PM	29.56
12/15/2017	9:03:55 PM	70.06
12/15/2017	9:04:10 PM	71.69
12/15/2017	9:04:25 PM	73.19

4.7 Performance Comparison of On-Off and PID Methods

In this test, the performance comparison of on-ff method with PID tool is set from 29 □ to 73 □ and is considered on each method method both on-off and also PID whether in the oversheating temperature which will cause overpressure or not, the following performance comparison of on-off and pid method.

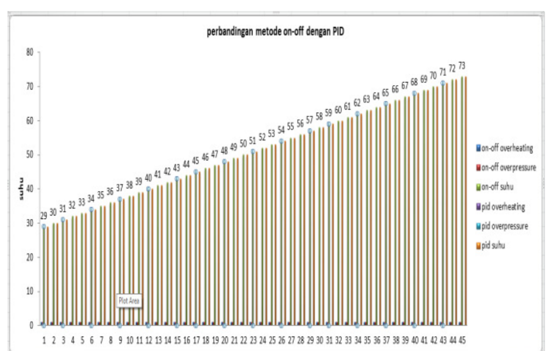

Figure 4.6 Comparison Chart On-Off Methodand PID

4.8 Testing of Node Based Temperature Data MCU Esp 8266

The following is a hardware design block diagram created in this study:

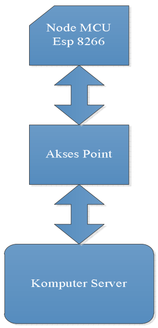

Figure 4.7 Tool Design Hard Block Diagram

The result of schematic design from testing esp8266 mcu node is as follows:

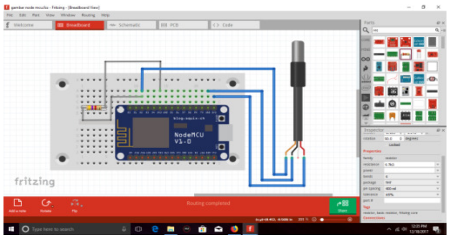

Figure 4.8 Schematic Node Mcu Esp8266 With Ds18b20 Sensor

4.9 Web Application Test Results

Testing is done by accessing the client computer, then the web page will be traced one by one to see if all web pages work properly without any error.

4.9.1 Main Page

This page is the page that will appear when first accessing the temperature monitoring web. This page contains a menu to access the other two menus.

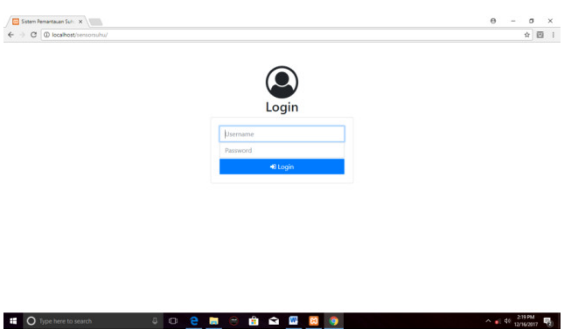

Figure 4.9 Views Main Page Login

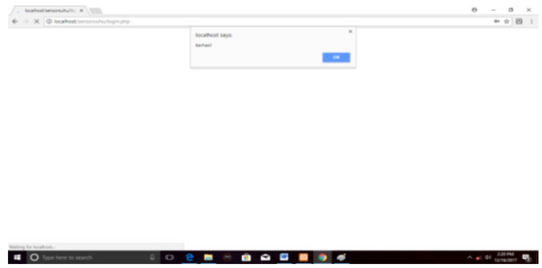

Figure 4.10 Views Page If Successful Login

4.9.2 Page Info Temperature and Graphic Data

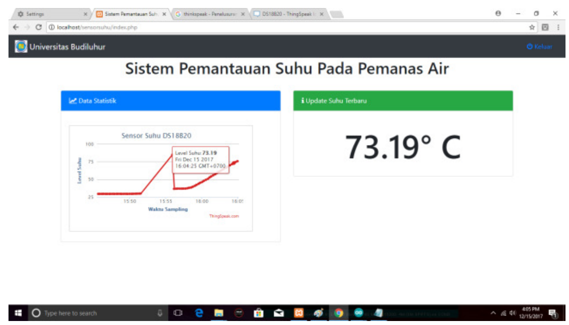

Figure 4.11 Views Page Info Temperature and Graphics Data

4.10 Results of Testing Tools On Respondents UsingThe TAM Method

In this study, researchers chose the TAM model as a theoretical foundation that has a strong ability to explain the use of technology by the user. This study uses 3 (three) variables that have been modified, namely: Perceived Usefulness as the first independent variable (X1), convenience (Perceived Ease of Use) as the second independent variable (X2), and acceptance of use (Behavior Intention to Use) water heater temperature monitoring system as related variables (Y) where according to TAM theory significantly variables utilization and ease variable affect the user acceptance in using water heater temperature monitoring tool.

4.10.1 Reliability Test Results

1. BITU Variable (Behaviour Intention to Use)

Table 4.4 Reliability Statistics variable BITU

Reliability Statistics

Cronbach's Alpha	N of Items
.641	8

2. PU Variable (Perceived Usefulness)

Table 4.5 Reliability Statistics PU

Reliability Statistics

Cronbach's Alpha	N of Items
.759	14

3. PEU Variable (Perceived Ease Of Use)

Table 4.6 Reliability Statistics PEU

Reliability Statistics

Cronbach's Alpha	N of Items
.669	13

4.10.2 Validity test results

Table 4.7 Comparison R Table with Coorected Item BITU Variable

No Pertanyaan	Corrected Items-Total Correlation	R tabel	Keterangan
P1	0,257	0,21	*Valid*
P2	0.325	0,21	*Valid*
P3	0,407	0,21	*Valid*
P4	0,330	0,21	*Valid*
P5	0,230	0,21	*Valid*
P6	0,298	0,21	*Valid*
P7	0,241	0,21	*Valid*

Table 4.8 .Comparison R Table with Coorected Item PU variable

No Pertanyaan	Corrected Items-Total Correlation	R tabel	Keterangan
P8	0,399	0,21	*Valid*
P9	0.582	0,21	*Valid*
P10	0,573	0,21	*Valid*
P11	0,577	0,21	*Valid*
P12	0,437	0,21	*Valid*
P13	0,702	0,21	*Valid*
P14	0,518	0,21	*Valid*
P15	0,435	0,21	*Valid*
P16	0,562	0,21	*Valid*
P17	0,555	0,21	*Valid*
P18	0,510	0,21	*Valid*
P19	0,567	0,21	*Valid*
P20	0,583	0,21	*Valid*

Table 4.9 Comparison R Table with Coorected Item PEU variable

No Pertanyaan	Corrected Items-Total Correlation	R tabel	Keterangan
P21	0,313	0,21	*Valid*
P22	0,596	0,21	*Valid*
P23	0,286	0,21	*Valid*
P24	0,422	0,21	*Valid*
P25	0,339	0,21	*Valid*
P26	0,273	0,21	*Valid*
P27	0,486	0,21	*Valid*
P28	0,263	0,21	*Valid*
P39	0,406	0,21	*Valid*
P30	0,263	0,21	*Valid*
P31	0,369	0,21	*Valid*
P32	0,289	0,21	*Valid*

4.10.3 Multiple Linear Regression Test Results

Table 4.10 Correlations

Correlations

		PU	PEU	BITU
PU	Pearson Correlation	1	.499**	.438*
	Sig. (2-tailed)		.000	.000
	N	60	60	60
PEU	Pearson Correlation	.499**	1	.448*
	Sig. (2-tailed)	.000		.000
	N	60	60	60
BITU	Pearson Correlation	.438**	.448**	1
	Sig. (2-tailed)	.000	.000	
	N	60	60	60

**. Correlation is significant at the 0.01 level (2-tailed).

4.10.4 Summary Model Test Result

Table 4.11 Model Summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.512a	.262	.236	1.995

a. Predictors: (Constant), PEU, PU

4.10.5 Anova (Analiysis of Variance) Test Result

Table 4.12 Anova

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	80.496	2	40.248	10.117	.000a
	Residual	226.754	57	3.978		
	Total	307.250	59			

a. Predictors: (Constant), PEU, PU

b. Dependent Variable: BITU

5 CONCLUSION

Sensory readings are carried out by measuring the temperature on the water being heated by the on-off method with the determination of setpoint input at a temperature monitoring device of 73 □ starting from the initial temperature of the measured water 36.69 □ to 73.19 □ the monitoring results from the measured initial temperature to the setpoint value require time 8 minutes 14 seconds. While the test results using PID method with the determination of setpoint input on temperature monitoring tool of 73 □ starting from the initial temperature of measured water 29.56 □ to 73.19 □ monitoring results from the initial temperature measured up to the setpoint value takes 19 minutes 14 seconds.

By using the PID method the temperature setting can be controlled automatically, visible on the system that will work if the temperature exceeds the setpoint or less than the specified setpoint.

The result of the testing of the tool on user acceptance / respondent shows that the variable of PU (X1) and variable of PEU (X2) to user acceptance is acceptable, this is indicated by reliability test, multiple linear regression test, summary and anova model. In the PU (X1) variable the reliability test shows the value of croncbach's alpha 0.759> 0.60 whereas in the PEU (X2) test the reliability test shows the value of croncbach's alpha 0.669> 0.60 and the validity test on the PU (X1) and PEU variables X2) shows the table r value is higher than the value of t table. In multiple linear regression test, the variable of PU utilization (X1) and ease of PEU (X2) on BITU (Y) user acceptance shows significant value 0,000 <0,05, which means that there is significant correlation between PU and PEU variables. In the model summary test, the value (R ^ 2) = 0.262 means that together X1 and X2 can explain the variation of Y change by 26.2%. In the Analysis of Variance (ANOVA) test the Sig value. F equal to 0.000 <α = 0,05 this means variables X1 and X2 have the same significant influence together to variable Y.

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