ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

CHIPS DRYER APPLICATIONS USING LIQUID PETROLEUM GAS POWER

Fandri Christanto, Rasional Sitepu and Andrew Joewono
Department of Electrical Engineering, Widya Mandala Catholic University Surabaya, Kalijudan, Surabaya, Indonesia
E-Mail: Andrew_sby@yahoo.com

ABSTRACT

Chips are a snack that much-loved by the community. In the process of making chips require drying process. Drying is essentially an attempt to reduce the water content of the dried object. The method that can be used to remove the water content is the evaporation process. This method can take place when the drained object is subjected to a flowing heat. The evaporation method still used today is the conventional way of using sunlight. However, if there is no sunlight or even the rainy season arrives will affect the quality of the chips themselves. In this designed tool, a LPG gas dryer will be developed. This system consists of a DHT22 sensor, as an input to read the temperature and humidity values. Arduino microcontroller as main processor that will process input data from temperature and humidity sensor (DHT22). Output is a blower that is used to push hot air into space and when stepper motors open / close the flow of gas flow that causes fire. To make it easier for users to operate it, this tool has a start / stop button that is used to turn the tool on or off. The LCD display is used as an indicator to display the temperature and humidity values during the tool. The tool will stop automatically when the chip is dry. Test results from this thesis, indicating that the tool can die automatically when the dryer room has a humidity value of 15%. Once tested in its entirety, the dryer is able to dry the chips for 70 minutes. LPG fuel is able to do the drying process up to 3 times. Power consumption of 10W at standby and 71.5W when operating.

Keyword: dryer, chip, arduino microcontroller.

INTRODUCTION

Chips is one of the snack foods that are favored by almost all Indonesian people from children to adults and often used as a complement to various food dishes, or can be used only as a snack saja. Kerupuk also a food that still can not be separated from community life To be consumed, so the demand increases. To meet the demand, then the production of chips must be kept running. One of the most important processes in the production of chips is the drying process.

Drying is a process of removing water contained in a material. The drying process carried out by the chip business owner is generally still conventional, i.e. the sun. As a source of energy, the Sun is a very useful natural resource for humans and is a cheap source of energy because it does not have to pay to get it. The drying process is usually done in an open place so as to get direct sunlight. Given in Indonesia there are two seasons of rainy and dry season, then one of the things that become constraints in the production process of chips is the process of drying during the rainy season arrived. Drying process as well as a stage that greatly affects the quality of fried products from the chips themselves. Chips will be difficult to inflate when less dry. Chips with these conditions are highly avoided by the chip maker, because it will become very hard and the volume per unit of chips becomes small. This situation is also very detrimental to chip entrepreneurs and avoided by prospective buyers.

To cope with the drying process, it is necessary innovation to create a chipchip system in place of conventional drying. The system will utilize an Arduino microcontroller to be used as a primary processor or controller in the drying process, and LPG gas is used as an energy source to power a gas stove. It will be easier to dry the chips without having to worry about the rainy season.

LITERATURE REVIEW

In this design required a data processing system (microcontroller) and supporting components.

Temperature and humidity sensor (DHT22), DHT22 sensor is a digital sensor that can measure air temperature and humidity. DHT22 has very high reliability and excellent long term stability. This is due to digital acquisition module technology embedded in the sensor. In the sensor there is a capacitive humidity sensor and NTC temperature sensor that can be connected with microcontroller. DHT22 sensor specifications: Tegangan 3.3-6V DC.

- Consumption of current at intermediate measurement 1-1,5 mA
- Power consumption is very low
- Humidity measurement range: 0-100%RH
- Temperature measurement range: -40 sampai 80C
- Tolerance accuracy of humidity measurement: 2%RH
- Tolerance accuracy of temperature measurement: 0.5C
- Scanning time is 2 seconds

Arduino Uno microcontroller is a minimum board system of microcontroller that is opensource.Di in arduino board circuit there is ATmega328 series AVR microcontroller. This device has 14 pin I / O (6 pins of which can be used as PWM output), 6 analog input pin, USB connection, 16 MHz crystal oscillator, and reset. These pins contain everything needed to support the microcontroller. In Figure-2 are the physical shape and the parts of Arduino Uno.

VOL. 12, NO. 24, DECEMBER 2017 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

DHT22 pins	
1	VCC
2	DATA
3	NC
4	GND

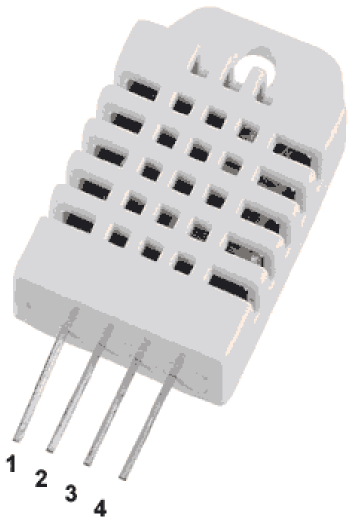


Figure-1. Physical and configuration pin DHT22 sensor.

Relays are electronic components in the form of electronic switch that is driven by electric current. In principle, the relay is a switch lever with wire windings on a nearby iron rod (solenoid). When the solenoid is fed by an electric current, the lever will be attracted by the magnetic force that occurs in the solenoid so that the switch contact closes. When the current is stopped, the magnetic force will be lost, the lever will return to its original position and the switch contact is opened again. Relays are usually used to control large electrical appliances (eg 4 amperes AC 220 volt electrical appliances) by using a small current or voltage (eg 0.1 amperes 12 volts DC).

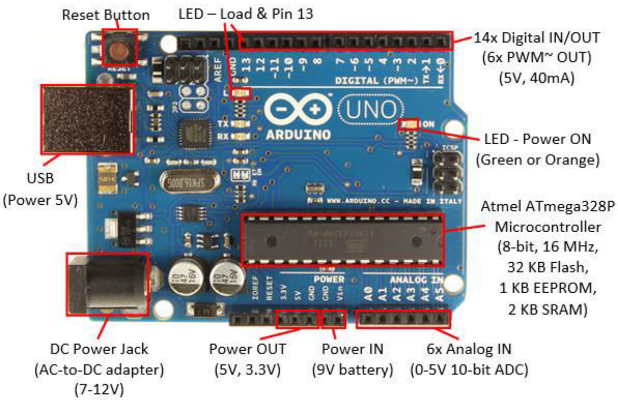
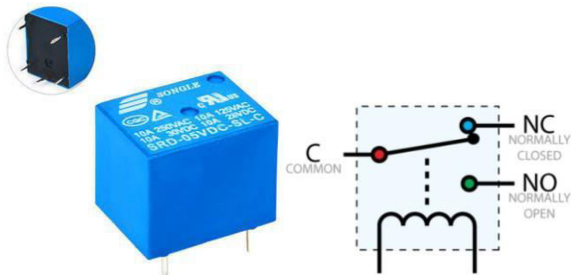


Figure-2. Ardunio Uno microcontroller.



(a) (b)

Figure-3. (a) Physical relay **(b)** SPDT relay symbol.

RESEARCH METHODOLOGY

This section discusses the design and manufacture of LPG gas-powered chips. Broadly speaking, the design of chip dryer system with LPG gas power is divided into two parts, namely the design of electronics and mechanical design. The overall tool block diagram of the system can be seen in Figure-4.

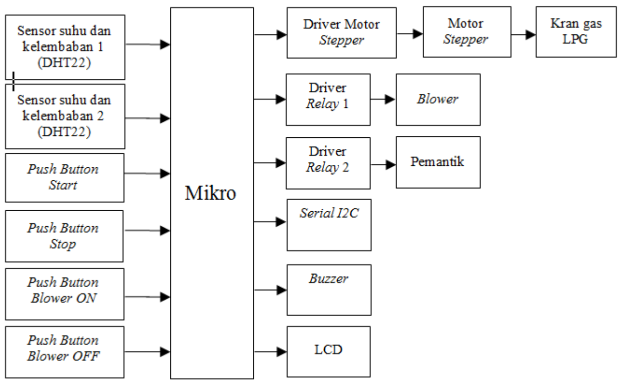


Figure-4. Block diagram device.

The chip dryer system uses a power supply from a 220 VAC power line which is then connected to a power supply circuit to produce 3VDC, 8 VDC and 12 VDC voltage outputs. In addition, the 220 VAC power supply is also used to supply the blower. This is because bloweryang used is an AC blower. While the voltage source of the power supply is used to supply the voltage in the stepper motor driver circuit, microcontroller and driver circuit. The microcontroller will process the value readings against the temperature and humidity sensors by performing some calculations.

The calculation by microcontroller is to calculate the average temperature and humidity value of two sensors in the drying chamber. After the average sensor value in the upper tray and bottom tray is obtained, the next process is programming to run the driver circuit according to the value already obtained. From here it is conditioned when the average humidity value in the drying chamber has not reached the specified humidity value (15%), the microcontroller will instruct the driver circuit to be active and to dry the process, and vice versa, if the average humidity value in the dryer room reaches the value Humidity 15% then the drying process will stop automatically.

VOL. 12, NO. 24, DECEMBER 2017 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

In performing chip drying based on the humidity value in the drying chamber, Arduino Uno microcontroller first initializes the port. If the start button is pressed, then the temperature and humidity sensor (DHT22), blower, lighters for 5 seconds, and stepper motor live to start the process of drying chips. When the tool does the drying process, the DHT22 sensor will read the temperature and humidity changes in the drying chamber. There are 2 sensors in the drying chamber, the upper and lower sensors. From the temperature and humidity values generated by the two DHT22 sensors the average calculation is performed. The average will meet the humidity limit in the designated drying chamber, which is 15%. The drying system keeps the drying process if the moisture average is still below the predetermined number (15%), but if the moisture average has reached 15% then the tool will stop automatically and buzzer will sound as indicator That the drying process has been completed. When the stop button is pressed, the stepper motor closes the gas valve so that the fire can die, so the drying process stops. This is done if in an emergency (emergency).

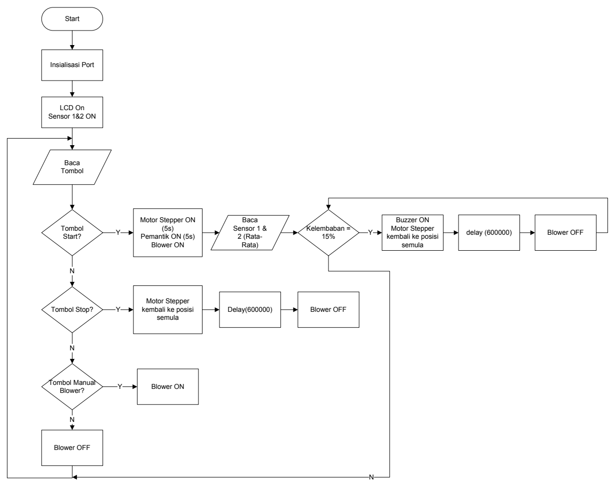


Figure-5. Dryer flowchart.

THE RESULT AND DISCUSSIONS

The design results in a drying chamber having 11 trays to accommodate 50Kg of chips (Figure-6), 2 temperature and humidity sensors (DHT22), 1 blower, 1 LPG, and 1 microcontroller. The sensor is used to read the temperature and humidity values in the drying chamber, the blower is used to conduct hot air in the drying chamber, LPG is used for fuel in the drying process, and the microcontroller as the main processor to run the dryer.

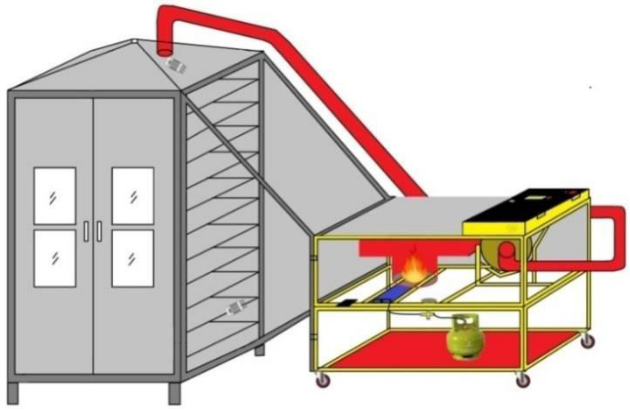


Figure-6. Overall dryer design.

Measurement of temperature and humidity sensors, This measurement aims to determine the accuracy of DHT22 sensor in reading temperature. Figure-7 is a temperature measurement scheme that has been done.

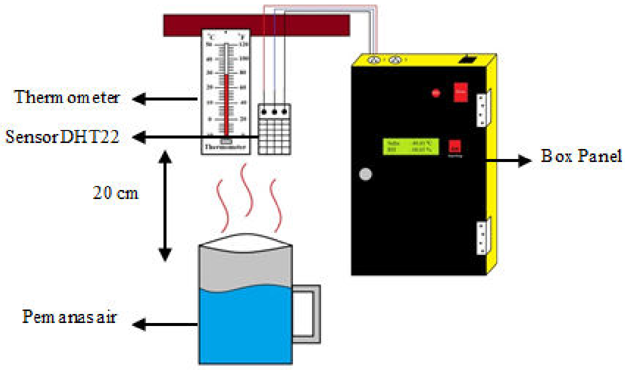


Figure-7. Temperature measurement scheme on DHT22.

Measurements were made by comparing the reading results of the 2 DHT22 sensors with the room thermometer (Corona), to obtain the percentage error (%). The percentage error can be calculated using the equation:

$$\%Error = \frac{\text{MeasureValue} - \text{ActualValue}}{\text{ActualValue}} x100\%$$

The smaller the percentage of error, then the sensor readings to the temperature more accurate. But on the contrary, the greater the percentage of error, the sensor readings to the temperature more inaccurate. Table-1 is the temperature measurement data on DHT22 sensor.

VOL. 12, NO. 24, DECEMBER 2017 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

Table-1. Temperature measurements on the DHT22 sensor.

Thermometer (^{0}C)	Sensor 1 (^{0}C)	% Error	Sensor 2 (^{0}C)	%Error
26	26.0	0.2	26.3	1.1
27	27.0	0.1	27.0	0.0
28	27.7	0.9	27.8	0.7
29	28.7	1.1	28.7	1.0
30	29.6	1.3	29.5	1.6
31	30.4	1.9	30.6	1.2
32	31.7	1.0	31.2	2.6
33	32.5	1.6	32.3	2.1
34	33.5	1.5	33.2	2.3
35	34.3	1.9	34.5	1.5
36	35.1	2.4	35.3	1.9
37	36.3	1.9	36.1	2.5
38	37.1	2.3	37.2	2.0
39	38.6	1.0	38.5	1.2
40	39.3	1.7	39.6	1.0
41	40.4	1.5	40.2	1.9
42	41.4	1.4	41.2	1.9
43	42.3	1.6	42.1	2.2
44	43.4	1.4	43.4	1.3
45	44.3	1.6	45.1	0.1
46	45.2	1.8	46.1	0.1
47	46.7	0.7	46.9	0.3
48	47.5	1.0	48.0	0.0
49	48.5	1.0	48.9	0.2
50	49.5	0.9	49.8	0.3
Average Error		1.3		1.3

From the above measurement table, the temperature ratio of each sensor with the measuring instrument (Thermometer) can be obtained graph as follows:

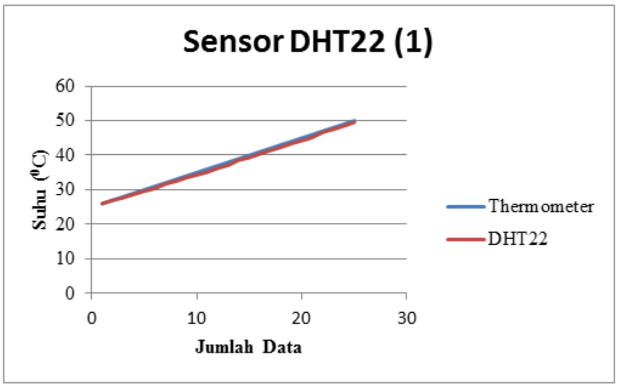


Figure-8. Graph of temperature comparison on sensor 1.

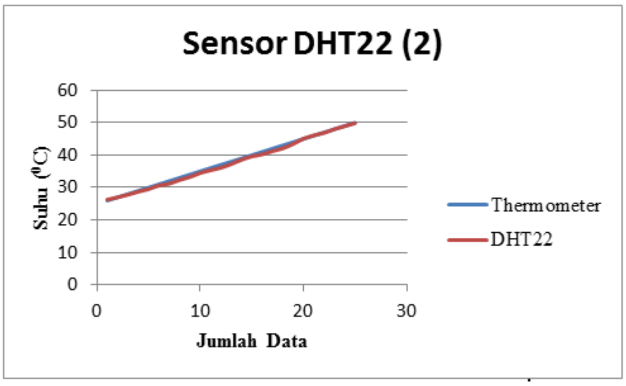


Figure-9. Graph of temperature comparison on sensor 2.

This measurement aims to determine the accuracy possessed by the DHT22 sensor in reading humidity (RH). Figure-10 is the moisture measurement scheme that has been done.

Measurements were made by comparing the reading results of 2 DHT22 sensors with hygrometer measuring instrument (EXTECH), so that the percentage error (%) was obtained. The percentage error can be calculated using the equation:

$$\%Error = \frac{\text{MeasureValue} - \text{ActualValue}}{\text{ActualValue}} x100\% \quad (1)$$

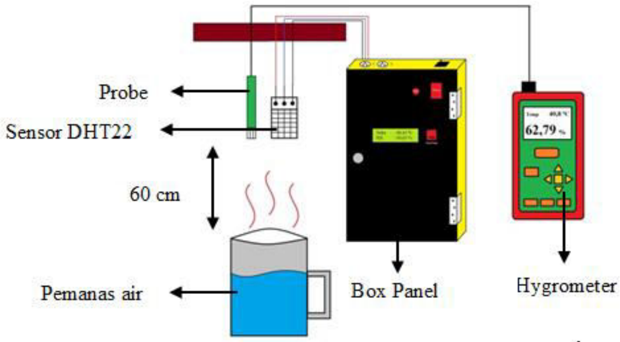


Figure-10. Humidity measurement scheme on DHT22.

The smaller the percentage of error, then the sensor readings against humidity (RH) more accurate. But on the contrary, the greater the percentage of error, the sensor readings against humidity (RH) more inaccurate. Table-2 is the measurement data of humidity (RH) on DHT22 sensors.

VOL. 12, NO. 24, DECEMBER 2017 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

Table-2. Measurement of humidity (RH) on DHT22 sensor.

Hygrometer (%RH)	**Sensor 1** (%RH)	**%Error**	**Sensor 2** (%RH)	**%Error**
63	62.3	1.1	64.1	1.7
65	64.1	1.3	65.5	0.7
67	66.7	0.4	66.8	0.3
69	67.5	2.2	67.6	2.0
71	72.2	1.6	72.0	1.4
73	74.3	1.8	75.7	3.7
75	76.5	1.9	78.6	4.8
77	78.9	2.4	80.0	3.9
79	84.1	6.5	81.2	2.7
81	81.4	0.5	84.7	4.5
83	86.9	4.7	86.8	4.5
85	88.4	4.0	88.5	4.1
87	83.3	4.2	87.4	0.5
89	86.6	2.7	87.4	1.8
91	89.0	2.2	89.6	1.6
93	91.5	1.6	92.0	1.1
95	93.8	1.3	90.5	4.7
97	94.3	2.8	94.5	2.6
99	96.1	2.9	95.5	3.5
Average Error		2.4		2.6

From the above measurement table, the humidity ratio of each sensor with measuring instrument (Hygrometer) can be obtained graph (Figure-11 and 12).

Testing is done by comparing the result between drying with conventional power (solar thermal) using a designed dryer. By doing this drying process will be obtained the amount of water content in the chips. By drying using conventional power (solar heat) it takes time for 8 hours. Drying test results with conventional power can be seen in Table-3.

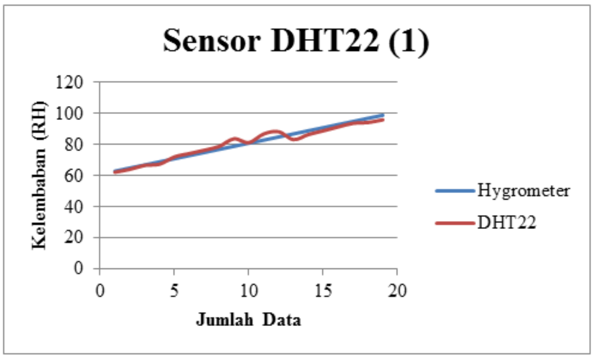


Figure-11. Graph of comparison of humidity on sensor 1.

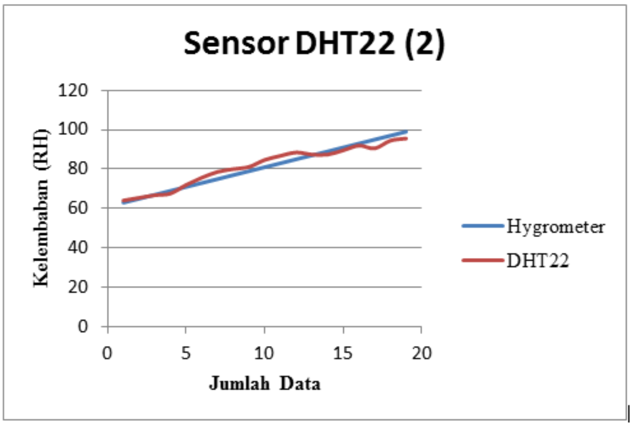


Figure-12. Graph of comparison of humidity on sensor 2.

Testing is done by comparing the result between drying with conventional power (solar thermal) using a designed dryer. By doing this drying process will be obtained the amount of water content in the chips. By drying using conventional power (solar heat) it takes time for 8 hours. Drying test results with conventional power can be seen in Table-3.

Table-3. Conventional drying test.

Tray	**Start weight** (gr)	**End weight** (gr)	**%Water content**
1	10.4	5	51.9

The drying process is also carried out with a desiccant designed. By drying using the designed dryers, the drying process takes only 70 minutes. Testing is done by placing chips at 5 points on each tray. It aims to know the fairness of hot air used to dry the chip. Figure-13 is a drying test scheme that has been done.

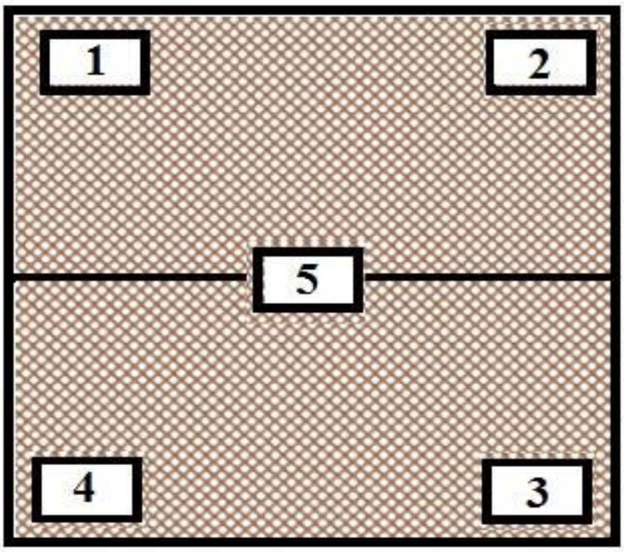


Figure-13. Drying testing scheme.

Drying test results with dryers can be seen in Table-4.

VOL. 12, NO. 24, DECEMBER 2017 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

Table-4. Drying test with dryer**.**

Tray	Start weight (gr)	End weight (gr)	%Water content
1	10.4	4.9	52.9
2	10.4	4.9	52.9
3	10.4	4.9	52.9
4	10.4	4.8	53.8
5	10.4	4.9	52.9
6	10.4	4.9	52.9
7	10.4	4.9	52.9
8	10.4	5	51.9
9	10.4	4.9	52.9
10	10.4	4.9	52.9
11	10.4	5.1	51.0

After doing the drying test in 2 ways, that is with conventional power (solar heat) and dryer which has been designed then can be calculated water content on chips that have been dried. The difference of moisture content resulting from the two ways has been done that is equal to 1 to 2%. Chips on trays 1 through 11 almost have the same moisture value. Chips that are dried using a tool that has been designed to have the same amount of water content using conventional power (solar heat). So the quality of the chips produced from these dryers will be the same as the drying that has been done before that is with the heat of the sun.

Dry chips can not be said to be an indicator that these dryers can be used for drying, but a frying test of chips that has been done with the drying process has been designed. This frying test aims to determine the condition of chips after the drying process. Test results of frying chips can be seen in Table-5.

Table-5. Pengujian penggorengan kerupuk.

Tray	Point	Chips morphologi	Frying results
1	1	Dry	Appropriate
	2	Dry	Appropriate
	3	Dry	Appropriate
	4	Dry	Appropriate
	5	Dry	Appropriate
2	1	Dry	Appropriate
	2	Dry	Appropriate
	3	Dry	Appropriate
	4	Dry	Appropriate
	5	Dry	Appropriate
3	1	Dry	Appropriate
	2	Dry	Appropriate
	3	Dry	Appropriate
	4	Dry	Appropriate
	5	Dry	Appropriate
4	1	Dry	Appropriate
	2	Dry	Appropriate
	3	Dry	Appropriate
	4	Dry	Appropriate
	5	Dry	Appropriate
5	1	Dry	Appropriate
	2	Dry	Appropriate
	3	Dry	Appropriate
	4	Dry	Appropriate
	5	Dry	Appropriate
6	1	Dry	Appropriate
	2	Dry	Appropriate
	3	Dry	Appropriate
	4	Dry	Appropriate
	5	Dry	Appropriate
7	1	Dry	Appropriate
	2	Dry	Appropriate
	3	Dry	Appropriate
	4	Dry	Appropriate
	5	Dry	Appropriate
8	1	Dry	Appropriate
	2	Dry	Appropriate
	3	Dry	Appropriate
	4	Dry	Appropriate
	5	Dry	Appropriate
9	1	Dry	Appropriate
	2	Dry	Appropriate
	3	Dry	Appropriate
	4	Dry	Appropriate
	5	Dry	Appropriate
10	1	Dry	Appropriate
	2	Dry	Appropriate
	3	Dry	Appropriate
	4	Dry	Appropriate
	5	Dry	Appropriate
11	1	Dry	Appropriate
	2	Dry	Appropriate
	3	Dry	Appropriate
	4	Dry	Appropriate
	5	Dry	Appropriate

Note: Appropriate = The result of the fryer with the dryer is the same as the frying when conventional drying (does not change the shape and taste of the chips).

CONCLUSIONS

From the results of design, manufacture and testing has been done, it can be concluded as follows:

a) Temperature and humidity sensors (DHT22) are able to read the temperature value with a percent error of 1.3% on sensor 1 and sensor 2.
b) Temperature and humidity sensors (DHT22) were able to read the humidity value with a percent error of 2.4% in sensors 1 and 2.6% in sensor 2.
c) Chips have a moisture content of 51.9% when dried with conventional power (solar heat), whereas when using a dryer the amount of moisture content in chips is 51-54%.
d) Dryer capable of drying chips without damaging the morphology of the chips themselves (not congealed).
e) The drying duration carried out by the dryer is only 70 minutes. Much faster when compared with using conventional power (solar heat) that is for 8 hours?
f) 3Kg LPG fuel can be used up to 3x drying process.
g) The system power consumption at standby is 10 watts. At the time of lighter ON of 126 watts. At the time of the blower ON, the required power is 71.5 watts.

REFERENCES

[1] Syafriyudin, Dwi Prasetyo Purwanto. 2009. Oven of ATMEGA 8535 Microcontroller Based Dryers Using Heater In Household Industry, Journal of Technology Institute of Science & Technology AKPRIND. 2(1).

[2] Unknown. 2012. Quick Overview Being a 3KG LPG Sub Agent. http://www.kerjausaha.com/2012/08/gambaran-singkat-menjadi-sub-agen-gas.html, (accessed29 November 2016).

[3] Unknown, 2016.Arduino Microcontroller Theory. https://www.arduino.cc/en/Main/Arduino BoardUno(accessed 08 November 2016)

[4] Aosong Electronics Co. 2012. Temperature and Humidity Module. DHT22 Produc Manual, Guangzhou, China.

[5] Kushgara. 2012. LCD (Liquid Crystal Display). http://www.engineersgarage.com/electronic-components/16x2-lcd-module-datasheet,(accessed 08 November 2016)

[6] Unknown. 2015. Working Principle of Motor Induction 1 Phase. http://www.insinyoer.com/prinsip-kerja-motor-induksi-1-fasa/, (accessed 15 November 2016)

[7] Unknown. 2015. Stepper Motor Theory: Types and Principles of Stepper Motors. http://zonaelektro.net/motor-stepper/, (accessed 06 Mei 2017).

[8] Bishop Owen.2004.Elementary Electronics. Jakarta: Erlangga.