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Utilization Semi Cylindrical Capacitor for Measuring Starch Content Thai Type Cassava

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Abstract

It has been realized that the measurement of the Thai type of cassava starch uses a semi-cylindrical capacitor has been done. This measurement is carried out by providing an input signal to the semi-cylindrical capacitor plate using the IC XR-2206 oscillator with a frequency of 100 kHz. The output signal from the capacitor is in the form of an AC voltage which is then forwarded to the full wave rectifier circuit. The output voltage of the rectifier is a DC voltage, and the results are displayed using a DSO oscilloscope. Cassava starch content was measured by the specific gravity method, and the stress was measured using a semi-cylindrical capacitor. In measuring the starch content, the starch content was 19.12 - 28.76% (range 9.64%) and gave an output voltage of 7.53 - 7.89 V (range 0.36 V). Using the linear regression method, the characteristic equation V = 0.035 KP + 6.871, and the correlation value was equals to 0.985.

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Abstract

Telah direalisasikan pemanfaatan kapasitor semi silinder untuk pengukuran kadar pati singkong jenis Thailand. Pengukuran ini dilakukan dengan memberikan sinyal masukan ke pelat kapasitor semi silinder menggunakan osilator IC XR-2206 dengan frekuensi sebesar 100 kHz. Sinyal keluaran dari kapasitor berupa tegangan AC yang kemudian diteruskan ke rangkaian penyearah gelombang penuh. Tegangan keluaran dari penyearah merupakan tegangan DC dan hasilnya ditampilkan menggunakan DSO osiloskop. Kadar pati singkong diukur menggunakan metode specific gravity dan tegangannya diukur menggunakan kapasitor semi silinder. Pada pengukuran kadar pati singkong diperoleh kadar pati 19.12 - 28.76% (range sebesar 9.64 %) dan memberikan tegangan keluaran 7.53 - 7.89 V (range sebesar 0.36 V). Dengan menggunakan metode regresi linier diperoleh persamaan karakteristik V = 0.035 KP + 6.871 dan nilai korelasi sebesar 0.985.

1. Introduction

Cassava's Name, Latin *Manihot utilizing* or *Manihot esculenta Crantz*, is one spreading plants almost all over the world, like the continents of Asia, Africa, and America (Bargumono & Wongsowijaya, 2013; Ministry Agriculture, 2018). Cassava production in Indonesia occupies the third position globally, with total production reaching 20.93 million tons per year (FAO, 2017). Lampung, one of the provinces in Indonesia that became a biggest cassava producer should be capable of giving suitable income to the farmer. The primary factor influencing a farmer's income is the quantity of the commodity produced and its price. Due to starch characteristics, harvested cassava needs to be set up to standard (Sagala & Suwarto, 2017).

The starch content of cassava generally is measured by *method-specific gravity*. In this method, levels of starch were obtained by comparing weighing results mass of cassava when in the air within the water (Apriliana, 2018), then counting the percentage rate the starch use equality empirical from Sungzikaw (2008). The percentage rate of contained starch inside determines the quality of cassava. Method-*specific gravity* owns high enough accuracy but is still not efficient enough. Because the relative tool size is big, it cannot stand its shock. The measurement time is relatively long, requires lots of water, and requires a trained operator.

Based on the description of push writer for making measuring tools rate starch that can use quickly and does not require large tools, making it easier and more efficiently used in the field. This research utilizes plate semi-cylindrical capacitors adapt to form tubers cassava. This method is faster than only measuring the output voltage

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capacitor. Structure A capacitor comprises two fruit plate conductors separated by a material nonconductor or dielectric. In it is tubers cassava used as an ingredient dielectric filler capacitor. If the rate of starch changes, then characteristic dielectric materials also change. as a result mark sensor capacitance also changes (Susilo, 2016).

Chen developed the semi-cylindrical capacitor as the sensor (Chen et al., 2012; Chen et al., 2014) and successfully tested for groundwater level sensors with the result that is, and capacitance tested soil compared straight with soil water content (Das et al., 2014). Besides that, research with semi-cylindrical capacitors has also been used to characterize rock *shale gas* and *sandstone* (Taufik, 2016) and characterize level sweetness fruit oranges (Naisa, 2019). With thereby utilization, plate semi-cylindrical capacitors can become method fast and efficient measurements used by farmers to determine the rate at starch cassava.

2. Method

This research was done by designing and arranging a semi-cylindrical capacitor device consisting of from supply power, XR-2206 IC oscillator, plate semi-cylindrical capacitors, and rectifier signal conditioners wave fully. Then, do testing and data collection to know the characteristics semi-cylindrical capacitor as a level sensor starch cassava

2.1. Design System

Block diagrams study the characterization of the semi-cylindrical capacitor as a level sensor starch cassava can be seen in **Figure 1.**

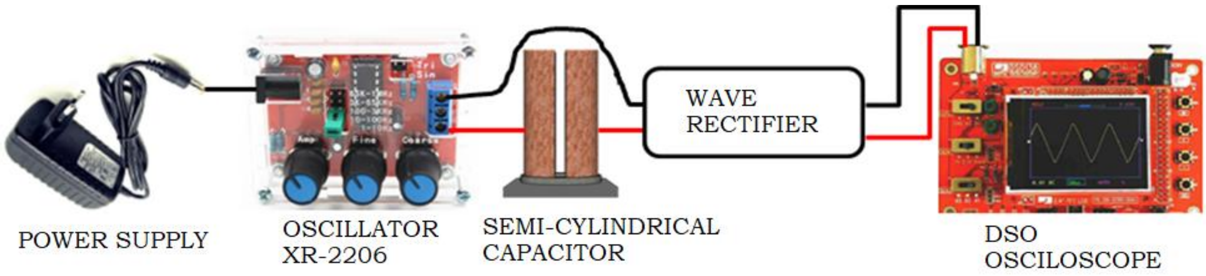


Figure 1. Block diagram research.

Research tool suite supplied from supply power 12 V and current 3 A. The input signal on the capacitor plate uses an oscillator with IC XR-2206. The output signal from the semi-cylindrical capacitor is an AC signal, which is then forwarded to the circuit rectifier wave full. The voltage output from the rectifier wave full is DC voltage to be displayed using a DSO oscilloscope. The schematic series in this study can be seen in **Figure 2.**

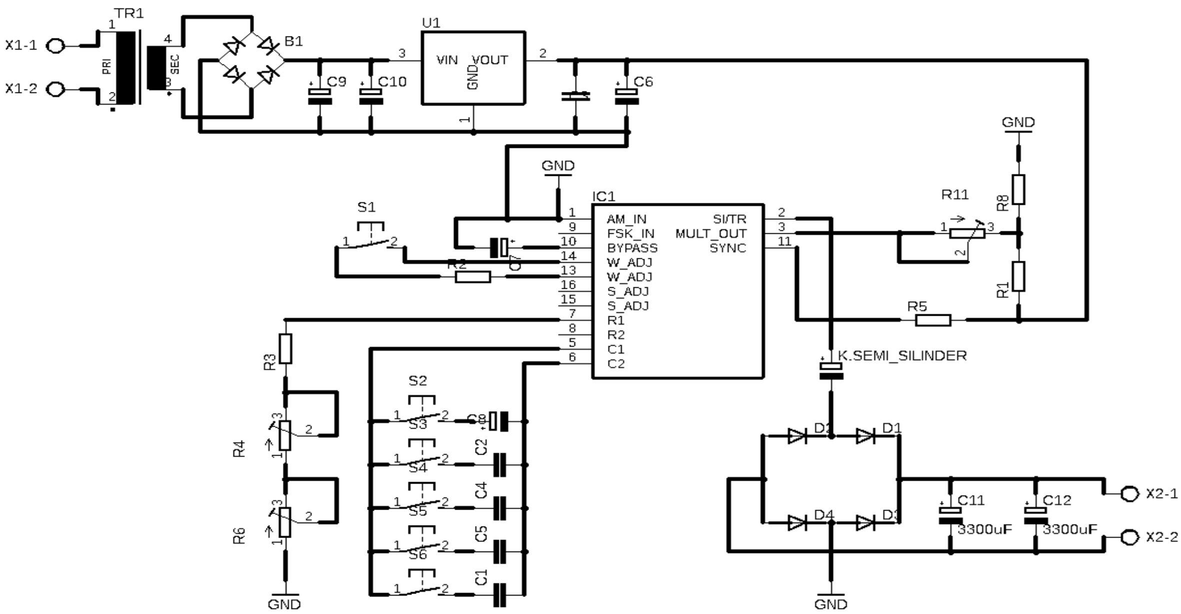


Figure 2. Research tools scheme.

F**igure 2** shows that the tool in this study comprises a power supply circuit, an oscillator XR-2206, plate semi-cylindrical capacitors, and full wave rectifiers.

Suite Power Supply. Supply Power functions as a supplier voltage all over the network. This section comprises a tr transformer, circuit rectifier waves, and IC regulators, as shown in **Figure 3.**

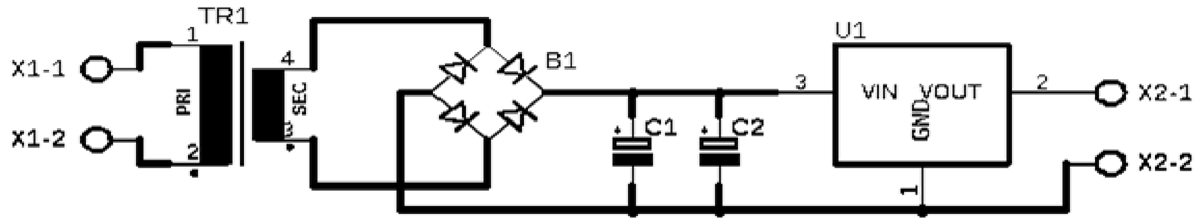


Figure 3. Suite supply Power.

Transformer stepdown used for lower voltage from grid PLN 220 V AC to be AC voltage value low ie 5-12 *V.* Diode a bridge function rectify the AC signal to DC, then filtered by a capacitor For minimize remaining AC waves. Regulator IC 7809 is used to produce a voltage output of 12 Volts. In this research, the power supply has an output voltage of 12V and a powerful 3A current.

Suite XR-2206 IC oscillator. The oscillator is an AC voltage signal generator connected to a semi-cylindrical capacitor. The form wave from the IC XR-2206 oscillator is sinusoidal with a frequency of 100 kHz. At the same time, the voltage supply (*Vcc)* is 12 Volts. **Figure 4** shows the form Suite oscillator with the XR-2206 IC.

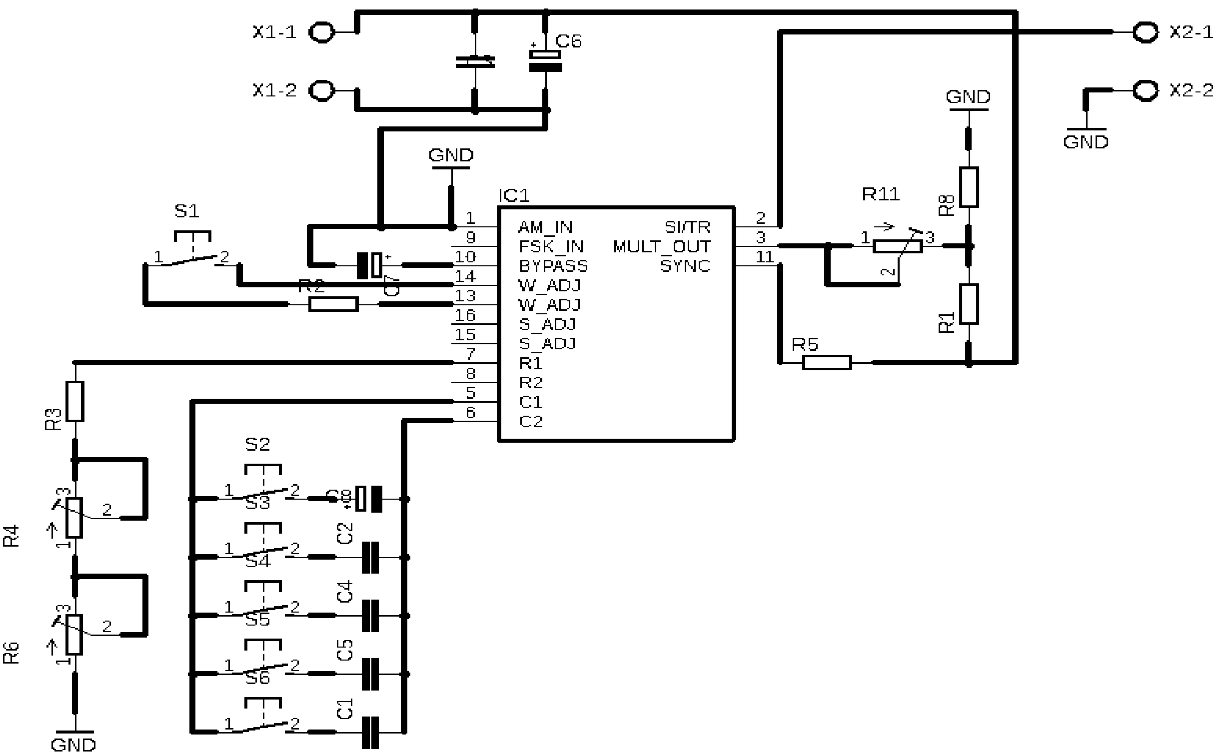
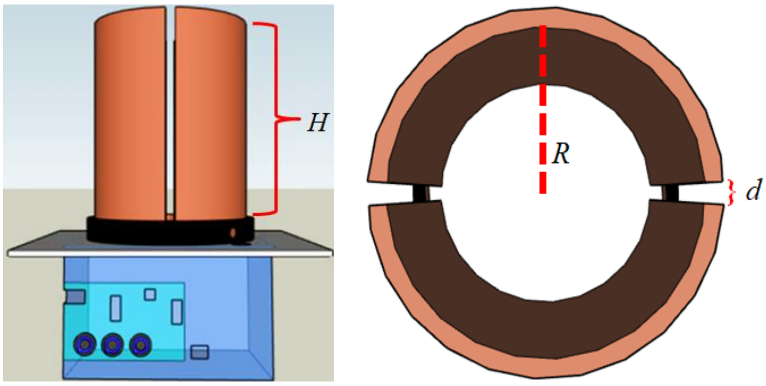


Figure 4. Suite o IC XR - 2206 sillator.

To produce the desired frequency value switch, we must be installed in the required frequency value *range. Figure 4 shows that switch S1 functions as a switch to generate sinusoidal waves.* Switch S2 functions to generate frequency values 1 – 10 Hz. Switch S3 functions to generate frequency values 10 – 100 Hz. Switch S4 functions to produce a frequency value of 100 – 3,000 Hz. Switch S5 functions to produce a frequency value of 3 – 65 kHz, and switch S6 functions to produce a frequency value of 65 – 1,000 kHz.

Plate Semi Cylindrical Capacitor. In this research tool, plate capacitors are made of plate copper. Then formed be semi-cylindrical with a size length (*H)* is 5 cm, a width (*l)* is 4.5 cm, a radius (*R)* is 1.5 cm, and a gap between the plates (*d)* is 0.1 cm, as shown in **Figure 5** below.



(a) (b)

Figure 5. Tool scheme (a) front view, (b) view top.

Cassava root cut to semi-cylindrical size plate using an iron pipe with a diameter of 3 cm and a length of 5 cm. Then sample tubers of cassava were squeezed using a second plate. With thereby mark, capacitance on both plates can is known using **Equation 1.**

$$C = \frac{\pi R H \varepsilon_0 \varepsilon_1}{2R\,sin\,\theta + d} \quad \textbf{(1)}$$

with C is capacitance (F), R is the radius plate (m), H is high platen (*m*), $\varepsilon_0$is permission room vacuum (8.854 x 10 $^{-12}$ F/m), ε_1 is constant dielectric cassava (F/m), θ is the corner between the radius and horizontal plane of the area curved (^{0}), and d is the distance between the second plate (m). **Equation 1** indicates that if constant dielectric cassava turns, then mark its capacitance will change too.

Wave Rectifier Circuit. Wave rectifier circuit g is a circuit that functions to convert AC to DC. Form this circuit can see in Figure 6. The type of Suite rectifier used in this research is rectifier wave full.

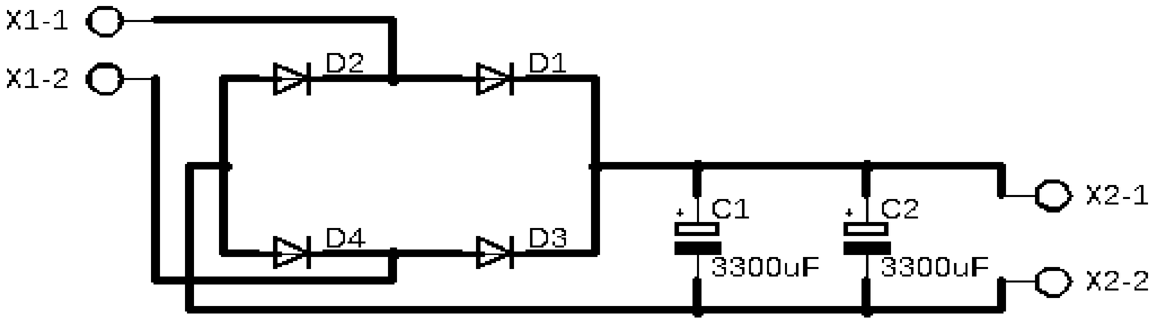


Figure 6. Wave rectifier circuit.

Full wave rectifier circuit In this study, four ordinary diodes are assembled into a *bridge diode.* Fruit capacitors of 3300 uF are arranged in parallel. In the circuit, two filters are added.

2.2. Testing and Data Retrieval

The initial test was to measure the cassava starch content using *specific gravity*. This test was carried out to determine the levels of cassava starch. Furthermore, measure the voltage output of research tools. Testing is done to determine the value voltage output from the tool-based change mark rate of the starch. Data from the second measurement is then plotted in graphical form so that the relationship between voltage and voltage can be known rate starch obtained from the measurement results.

2.3. Linear Regression Analysis and Coefficients Correlation

Linear regression is a technique used to get a relationship model between variable bound (*respond)* with variable free (*predictor)* (Harlan, 2018). At the same time, coefficient correlation (*$R^{2)}$* was used to show level suitability obtained linear relationship from data variation with range value 0-1. If R^2 was closer to 1, then the equality obtained line is more in line with the data (Effendi, 2019). According to Melinda (2020), linear equation regression and coefficient correlation can count using **Equation 2** and **Equation 5.**

$$y = bx + a \quad \textbf{(2)}$$

The variable y represents the mark voltage output from the rectifier signal conditioner wave full, and variable x represents the mark rate starch (KP). In **Equation 2**, *the response* given (*y)* is the result of the sum between constants (*a)* and coefficients regression or slope line (*b)* with variable *predictors* (*x*). *a* and *b* values from **Equation 2** can count use **Equation 3** and **Equation 4.**

$$a = \frac{(\sum_{i=1}^{n} y_i)(\sum_{i=1}^{n} x_i^2) - (\sum_{i=1}^{n} x_i)(\sum_{i=1}^{n} x_i y_i)}{n(\sum_{i=1}^{n} x_i^2) - (\sum_{i=1}^{n} x_i)^2} \quad (3)$$

$$b = \frac{n(\sum_{i=1}^{n} x_i y_i) - (\sum_{i=1}^{n} x_i)(\sum_{i=1}^{n} y_i)}{n(\sum_{i=1}^{n} x_i^2) - (\sum_{i=1}^{n} x_i)^2} \quad (4)$$

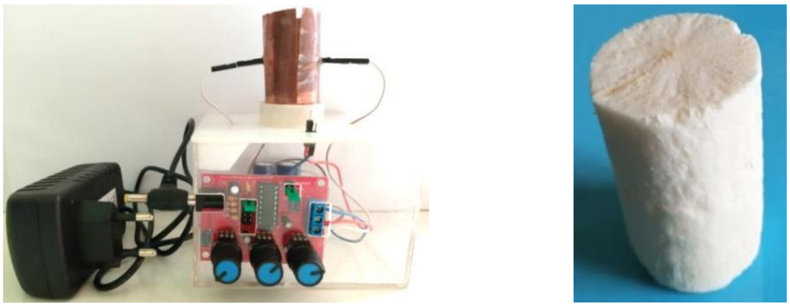
Coefficient correlation ($R^{2)}$ can be counted using **Equation 5.**

$$R = \frac{\sum_{i=1}^{n} x_i y_i}{\sqrt{\sum_{i=1}^{n} {x_i}^2}\sqrt{\sum_{i=1}^{n} y_i^2}} \quad (5)$$

3. Results and Discussion

3.1. Tool Realization

The realization of semi- cylindrical capacitor device can be seen in **Figure 7.**



(a) (b)

Figure 7. (a) Realization semi-cylindrical capacitors and (b) realization test sample.

In **Figure 7** (a), there is a plate designed with conductive use material copper with a size of 5 cm long and 4.5 cm wide for each plate. The second plate was arranged to form a semi-cylinder with a gap of 0.1 cm and a diameter of 3 cm. In **Figure 7** (b), it can be seen that cassava used a printed cylinder with a diameter of 3 cm and a height of 5 cm. Before being measured with semi-cylindrical capacitors, cassava was first dried using tissue. It is done so that the water envelops its tubers cassava and does not follow measured on the tool.

3.2. *Specific Gravity* Test

Method-*specific gravity* is used as a reference or comparison in measuring the rate of starch cassava Measurement is made by weighing mass tubers cassava in air and mass in water. Measurement-specific gravity can be seen in Figure 8. In the *specific gravity test*, measurement mass was done using scales brand digital hanging Lesindo *type* LS-03 with a capacity maximum of 50 kg—basket the scales used own 20 cm in diameter and 15 cm in height. The bucket used For holding water on balance mass cassava in water has a diameter of 40 cm and a height of 60 cm with a volume of water of about 70 liters.

(a) (b)

Figure 8. Weighing mass cassava (a) in air and (b) in water.

Data is collected by choosing eight tubers of cassava in good condition from types of Thailand at different ages. On each selected tuber, clean first of attached ground. Cassava root is cut into parts in order to be able to fill in basket scales well. Cassava root weighed under conditions in air and in water position hovering. From the measurement, data mass did, the calculation use **Equation 6** and **Equation 7** to get the value rate starch cassava.

$$SG = \frac{Ma}{Ma - Mw} \tag{6}$$

$$Kp = (112{,}1 \; x \; SG) - 106{,}4 \tag{7}$$

with SG as *specific gravity,* KP is rate starch (%), Ma is mass cassava in the air (kg), and Mw is mass cassava in water (kg) (Sungzikaw, 2008). Measurement results rate starch cassava use method *specific gravity* can see in **Table 1.**

Table 1. Measurement results rate starch cassava method *specific gravity.*

No.	the third tuber	Ma (Kg)	Mw (Kg)	SG	CP (%)
1.	1	0.975	0.090	1.101	19.12
2.	2	1,240	0.115	1.102	19.18
3.	3	0.885	0.090	1.113	21.45
4.	4	0.700	0.080	1,129	24.76
5.	5	0.755	0.090	1,131	25.25
6.	6	0.760	0.090	1,134	25.85
7.	7	0.860	0.105	1,139	26.84
8.	8	0.735	0.095	1.148	28.76

3.3. Semi Cylindrical Capacitor Test

Measurement was furthermore done using sample tubers of cassava with a frequency of 100 kHz. **Figure 9** is a realization measurement of the semi-cylindrical capacitor using material dielectric tubers cassava.

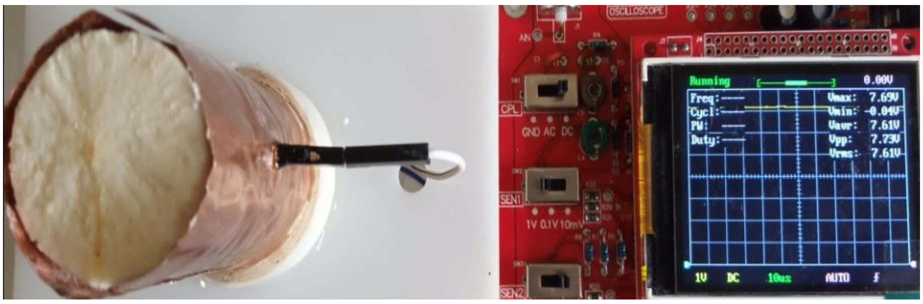


Figure 9. Measurement semi-cylindrical capacitor with tubers cassava.

From measurements, use semi-cylindrical capacitor data obtained as in **Table 2.**

Table 2. Measurement data rate starch and tension with the semi-cylindrical capacitor.

No.	Ma (Kg)	Mw (Kg)	SG	CP (%)	Voltage (V)

1.	0.975	0.090	1.101	19.12	7.53
2.	1,240	0.115	1.102	19.18	7.57
3.	0.885	0.090	1.113	21.45	7.61
4.	0.700	0.080	1,129	24.76	7.73
5.	0.755	0.090	1,131	25.25	7.77
6.	0.760	0.090	1,134	25.85	7.77
7.	0.860	0.105	1,139	26.84	7.81
8.	0.735	0.095	1.148	28.76	7.89

From **Table 2**, measurement results are visible voltage use of a semi-cylindrical capacitor at a 100 kHz range of 0.36 V (7.53 - 7.89 V). While the measurement results rate starch use specific gravity ranges from 9.64 % (19.12 – 28.76 %). These data show that the more tall rate of starch, the more tall mark the obtained voltage. **Table 2** data is by the results stated by Susilo (2016). In his research, he measures cassava water content using the principle frequency to voltage, showing that increasing Lots content solids (low water content and high starch high) then mark the voltage the more considerable.

The measurement results are in **Table 2**, plotted into the chart showing the connection between voltage to rate starch cassava with uptrend as shown in **Figure 10.** on the chart, the obtained linear equality regression and value coefficient the regression.

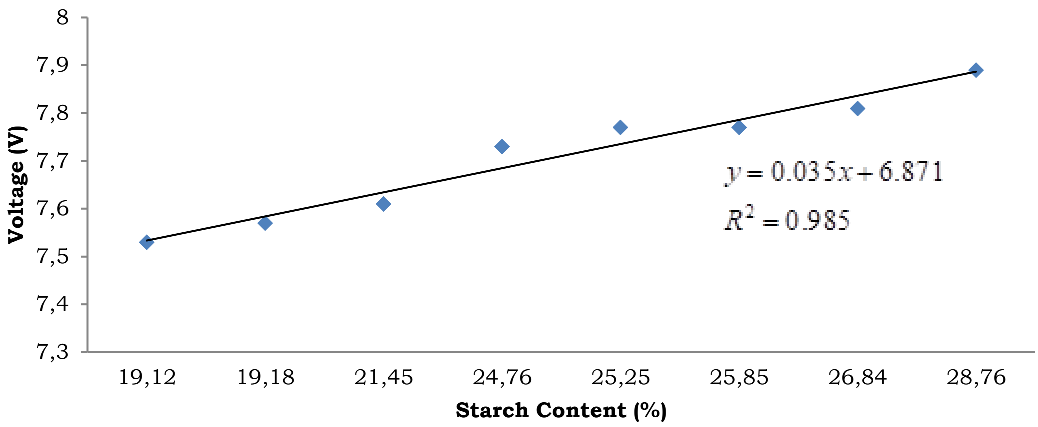


Figure 10. Chart connection between voltage to rate starch.

Figure 10 shows linear equality regression and coefficients correlation (R^2). The equality of this linear regression was computed using **Equation 2, Equation 3,** and **Equation 4.** Results from the calculation can be seen in **Equation 8.**

$$y = 0.035x + 6.871 \quad \textbf{(8)}$$

In **Equation 7**, variable y represents the mark voltage output from the rectifier signal conditioner wave full, and variable x represent the mark rate of the starch so that the similarities can be written down like **in Equation 9.**

$$V = 0.035\ KP + 6.871 \quad \textbf{(9)}$$

This research's coefficient correlation (R^2) was counted using **Equation 5,** and its results of 0.985 (close to 1). It means measurement use of semi-cylindrical capacitors at levels starch 19.12 – 28.76 % (*range* of 9.64 %) gave mark voltage output 7.53 – 7.89 V (*range* of 0.36 V) and has a correlation tall that is of 0.985.

4. Conclusion

Based on the results of the tests and discussions that have been done can conclude that assembled semi-cylindrical capacitors with rectifier signal conditioner voltage give linear response output to rate starch cassava on measurement rate starch cassava of 19.12 - 28.76%, semi-cylindrical capacitors give voltage output of 7.53 - 7.89 V. With use method linear regression is obtained equality characteristics $V = 0.035\ KP + 6.871$ and value correlation of 0.985. This correlation shows that the rate starch cassava's connection is strong with the voltage supplied by the semi-cylindrical capacitor.

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