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Research Article

Analysis of the Influence of Residential Electrical Installation Errors on Prepaid Kwh Meter Errors in the PT PLN (Persero) ULP Stabat Area

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Abstract: There are several things that happen when customers use electricity with prepaid Kwh meters. One of the problems now is an error in the Kwh meter or commonly called Kwh tempering. This study uses an observation method by taking a sample of 2 houses that have tempering problems in their Kwh. The results of the study of the first house with 900 VA electricity power found a current leak of 0.3 A, and in the second house with 1300 VA electricity power found a grounding cable connected to the neutral cable which caused a limping load of 0.85 A.

Keywords: Grounding; Installation; Leakage Current; Tempering

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1. Introduction

Electricity is a vital need for the community, especially in supporting household and commercial activities. PT PLN (Persero) as a national electricity provider continues to strive to improve services, one of which is through the implementation of prepaid KWh meters. The use of prepaid KWh meters provides flexibility for customers to manage electricity consumption more efficiently. However, along with its use, problems arise related to inaccurate power measurements due to errors in electrical installations in customers' homes, especially those used in rural areas.

Karang Rejo Village is one of the areas with the majority of customers using prepaid KWh meters. Although this technology offers convenience, many customers complain about unreasonable spikes in electricity consumption. This is thought to be caused by errors in home electrical installations, such as loose cable connections or poor material quality. These errors can affect the measurement of power usage and harm customers and PLN.

Electrical installations that do not meet standards can cause serious problems, including disruption to power measurements by KWh meters, as well as increasing safety risks such as short circuits and fires. Therefore, this study aims to analyze the effect of electrical installation errors on electrical power measurements on prepaid KWh meters, with a case study in Karang Rejo Village. The results of the study are expected to provide recommendations for PT PLN and the community to improve the quality of installations and increase understanding of the importance of electrical installations that meet safety standards.

Home Kwh Meter Specifications with 900 VA Electric Power

Figure 1. Kwh Meter Cannet

Brand : Cannet
Type : DDSY832
Meter Number : 50173150769
Rate/Power : R1MT/900

Home Kwh Meter Specifications with 1300 VA Electric Power

Figure 2. Itron Brand Prepaid Kwh Meter

Brand : Itron
Type : 700 Java V1
Meter Number : 32146091650
Rate/Power : R1T/1300

Measuring Instrument Specifications

Figure 3. Hi Clamp Tester

Brand : Kyoritsu
Type : KEW 2007R
Capacity : 1000 A

2. Literature Review

This research was conducted based on previous research that was conducted as a comparison for the current research. Based on previous research conducted by F. Mustafa (2018), he wrote about the effect of kwh meter conditions during tempering. His research took 3 kwh meter samples and then measured them in tempering conditions and during normal conditions. The measured load also varies depending on the size of the load of each kwh meter. The result is that there is a loss experienced by PLN due to differences in measurements during tempering.

Akbara, Rialdo (2021) studied customer installation errors that resulted in abnormalities in PLN's kwh meters. The method used was to conduct comparative analysis and measurements between the CT 1 sensor and the CT 2 sensor. The results found a difference in the current flowing between the CT 1 sensor and the CT 2 sensor. Putra, I Wayan Sanjaya (2024), identified several types of disturbances that are often experienced by prepaid kwh meters. Some types of disturbances are kwh meter check, blank LCD, failed token, damaged keypad and burned kwh meter. The most common causes are installation errors, human error, and poor kwh quality.

Santoso (2022), researched current leakage in kWh meters which resulted in losses for customers. The causes of current leakage include weakened insulation strength of installation cables, non-standard electrical installations, old installations and the surrounding environment. The formula for calculating the amount of loss due to current leakage is:

cost/hour = kwh x rate
wh = V x I x 1 hour .

3. Method

Research Methods

The method used in this study is the observation method by directly measuring the amount of current used by customers in conditions when tempering occurs and when conditions are normal. The study was conducted by taking samples from 2 different houses. The first house is supplied with electricity with a 900 VA Kwh meter, while the second house is supplied with a 1300 VA Kwh meter.

Research Steps

The research was conducted by taking the following steps:

1. Taking measurements on the KWh meter during tempering
2. Finding the cause of tempering in home installations
3. Take measurements on the Kwh meter when conditions are normal.”

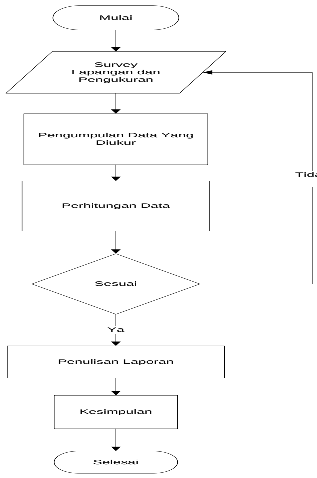


Figure 4. Research Flow

4. Results and Discussion

Results of Current (A) and Voltage (V) Measurements of 1-Phase Prepaid Kwh Meters for First Homes with 900 VA Power

Table 1. Conditions During Tempering (Abnormal Load) Measured Using a Clamp Meter

Electrical power	Voltage	Current Phase	Current Neutral
0	216 V	0.3 A	0.3 A
517W	216 V	2.3 A	2.6 A

Table 2. Conditions During Tempering (Abnormal Load) Measured Using a Kwh Meter

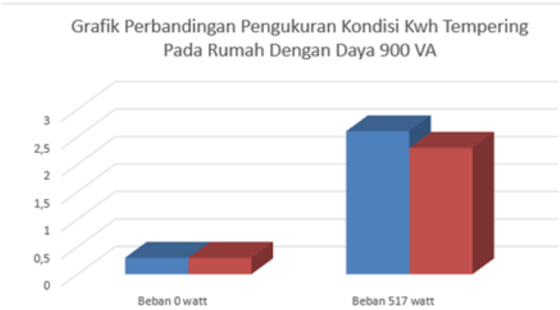
Electrical Power (47 Enter)	Voltage (41 Enter)	Current (44 Enter)
0	216 V	0.3 A
517W	216 V	2.6 A

Table 3. Conditions When Normal Measured with a Clamp Meter

Electrical power	Voltage	Current Phase	Current Neutral
0	216 V	0 A	0 A
517W	216 V	2.6 A	2.6 A

Table 4. Conditions When Normal Measured Using a Kwh Meter

Electrical Power (47 Enter)	Voltage (41 Enter)	Current (44 Enter)
0	216 V	0 A
517W	216 V	2.6 A



Judging from the measurement results, there is a current leakage that causes the load on the phase current to be lower than the load on the neutral current and when the load is 0 the measurement results should show the number 0, but the measurement results show the number 0.3 as shown in the table and graph above, This is what causes Kwh tempering. Because there is a difference in current of 0.3 A in the phase and neutral currents.

Results of Current (A) and Voltage (V) Measurements of Prepaid 1 Phase Kwh Meter for Second House with 1300 VA Power

Table 5. Conditions During Tempering (Abnormal Load) Due to the Presence of a Grounding Cable Connected to the Neutral Cable Measured Using a Clamp Meter

Electrical power	Voltage	Current Phase	Current Neutral
0	219 V	0 A	0 A
1.253 W	219 V	5.72 A	4.87 A

Table 6. Conditions During Tempering (Abnormal Load) Due to Grounding Cable Connected to Neutral Cable Measured Using a Kwh Meter

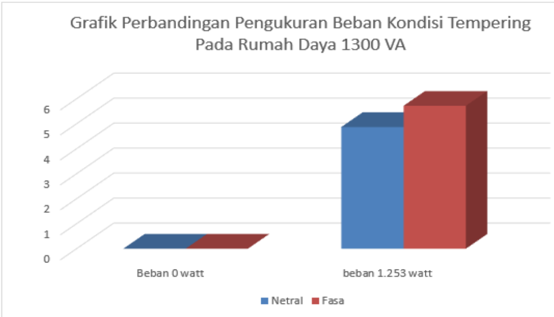
Electrical Power (47 Enter)	Voltage (41 Enter)	Current (44 Enter)
0	219 V	0.85 A
1.253 W	219 V	5.72 A

Table 7. Conditions When Grounding is Removed Measured Using a Clamp Meter

Electrical power	Voltage	Current Phase	Current Neutral
0	219 V	0 A	0 A
1.253 W	219 V	5.72 A	5.72A

Table 8. Conditions When Grounding is Removed Measured Using a Kwh Meter

Electrical Power (47 Enter)	Voltage (41 Enter)	Current (44 Enter)
0	219 V	0 A
1.253 W	219 V	5.72 A



From the results of the check, there is a ground cable connected to the neutral cable of the installation. It can be seen from the measurement results that there is a difference in the phase and neutral current loads. When the load condition is active, the neutral current does not measure optimally because there is a ground cable connected to the neutral, causing a limping load on the neutral current. The current difference is 0.85 A.

Results and Analysis

Tempering condition due to grounding

Grounding Function in Electrical Installations

The grounding system on electrical and electronic equipment is to provide protection to the entire system. A poor grounding system can damage electrical equipment. The function of grounding is in terms of safety, grounding functions as a conductor of electric current directly to the earth or ground when there is an insulation leak or spark in a short circuit. Second, lightning rod installation, the grounding system functions as a conductor of large electric current directly to the earth. Installation of grounding cables for home installations, and grounding for lightning rods must be installed separately. Third, as protection for electronic equipment or instrumentation so that it can prevent damage due to voltage leaks. And finally, grounding in the world of electronics functions to neutralize defects (noise) caused by either poor power or non-standard component quality.

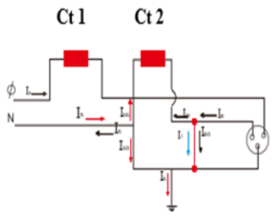


Figure 3. Current Cycle in Tempering Conditions due to grounding combined with neutral

The image is a picture of an abnormal current condition that causes the KWh meter to become tempered. From the image above, it can be seen that the neutral cable is connected to the grounding cable. This causes the current load on the neutral cable to be divided into the ground cable so that the measurement results are lopsided between the phase and neutral and cause the Kwh to become tempered. In this case, the large lopsided load is 0.85 A

The measurement results of the prepaid kWh meter using grounding connected to neutral show an error message showing a palm image as a warning. If an error occurs, the power used is not maximized, then there is a very big difference when the prepaid kWh meter is not using grounding or using grounding (can be seen in tables 5 and 7).

Table 5 shows that the cause of the prepaid kWh meter error is because the phase current is greater than the neutral current, which should be the same for both sensors.

Figure 5. Kwh Meter in Tempering Condition

The image above shows the condition of the Kwh meter while still tempering. It can be seen that there is still a palm symbol and the yellow indicator light is on, which indicates that there is an installation disturbance. For this case, it is the grounding that is connected to the neutral of the installation, because it causes the kwh meter to appear as a palm.

Figure 5. Kwh meter in normal condition

The image above shows that the Kwh meter is normal by removing the ground cable connected to the neutral cable. It can be seen that the palm symbol has disappeared and the indicator light has gone out.

Tempering Condition Due to Current Leakage

Leakage current is the current that flows in an electrical installation through electrical insulation or due to the channel capacitance for alternating voltage and conductor losses.

Factors that influence the magnitude of leakage current that occurs in electrical installations are system voltage, insulation strength, and channel capacitance.

Figure 6. Prepaid kWh Tempering Condition

Figure 7. Prepaid kWh Normal Condition

Isolation Power

Isolation is a property or material that can electrically separate two or more adjacent conductors so that there is no current leakage or flashover. The strength of the insulation depends on the age of the insulation. The longer an insulation is used, the more its quality will decrease. The chemical decline in the quality of insulating materials (deterioration) of their electrical characteristics is generally caused by heat, humidity, mechanical damage, overvoltage

Channel Capacity

The channel consisting of two or more wires that are given voltage will act like a capacitor. The capacitive nature between the two conductors will flow current if given alternating voltage. Home installations use alternating voltage, so the capacitance of the channel will cause leakage current. Leakage current caused by capacitance can be expressed by the equation (Smith, 1990).

I = C dv/dt …………….(1)

With :

I = Current (A)

C = Capacity (C)

dv/dt = Change in voltage over time

From equation (1) it can be seen that the current is directly proportional to the channel capacitance value and the magnitude of the voltage change that occurs over time.

Consumer Loss

Leakage current in household electrical installations is detrimental to consumers, which can be calculated per month as follows:

Cost/month = (cost/hour) x 24 hours x 30 days

Cost / hour = Kwh x rate …………(2)

Wh = V x I x 1 hour ………..(3)

With :

Wh = VA hour (VA hour)

Kwh = 1000 Wh

V = Voltage (Volt)

I = Current (Ampere)

Electricity Rate = 1500 Rupiah / Kwh

So the greater the leakage current that occurs in household installations, the greater the costs that consumers have to pay.

From the existing data with an electrical power of 900 VA, the current leakage is 0.3 A and the voltage is 226 V, so the consumer loss can be calculated as follows:

Wh = V x I x 1 hour
= 226 x 0.3 x 1
= 67.8 VA hour
= 67.8 x 10^(-3) Kwh

The hourly cost assuming usage above 80 Kwh is:

Cost / hour = Kwh x rate
= 67.8 x 10^(-3) x 1500
= 101,700 x 10^(-3)
= Rp. 101.7 ,-

Cost/month = (cost/hour) x 24 hours x 30
= 101.7 x 24 x 30
= Rp.73,224 .-

The additional monthly cost for a house with 900 VA power and a current leakage of 0.3 A is Rp. 73,224.

From here it can be concluded that the cause of tempering of the Kwh meter caused by leakage current can be detrimental to the customer.

Conclusion

Installations that cause Kwh to become tempering or error are due to biased current measurements or limping loads, either because the ground is united with the neutral or because of current leakage. If tempering is due to grounding united with the neutral, it will not harm the customer but will harm PLN if some of the installations used do not use neutral from PLN but neutral from grounding. If tempering is due to current leakage, it will absolutely harm the customer because of the current load that flows even though there is no usage used.

PLN customers can check the cause of Kwh tempering independently through their Prepaid Kwh meter by pressing code 44 enter in zero usage conditions, if the number that appears is not zero, it is certain that there is a current leak. But if the number that appears is zero, an ampere meter is needed for further checking.

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