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Design and Fabrication of Electric Shock Protector

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Abstract - *The first step in designing of electrical shock protector is the calculation of the isolation transformer specifications, namely determining the diameter of the wire and the number of turns because the greater the power to be secured, the larger the diameter of the winding wire and the greater the current flowing into the winding wire. While the number of turns on the primary and secondary sides will be less because the cross-sectional area of the core is enlarged, and the turns/volts are getting smaller. When it is loaded, the current flowing to the human body is greater when it is touched by the neutral cable, and when it is not loaded, the current flowing to the human body is greater when it is in contact with the phase cable. Body mass index affects the amount of resistance in the human body. The human body mass index and measure the leakage current flowing in the human body when loaded and unloaded with the condition of using footwear and not using footwear to obtain a comparison of the magnitude of the current between the phase and neutral cables and to obtain the effect of the body mass index with the existing resistance on the human body. Next, calculate the diameter of the winding wire, the cross-sectional area of the core and the number of turns on the isolation transformer to secure electrical power. From the calculation results of the isolation transformer specifications, the greater the power you want to secure, the larger the diameter of the coil wire will be because the current flowing into the winding wire also increases, while the number of turns on the primary and secondary sides will be less because the cross-sectional area of the core is enlarged and the windings/ volts is getting smaller. Body mass index affects the amount of resistance in the human body. When it is loaded, the current flowing to the human body is greater when it is touched by the neutral cable, and when it is not loaded, the current flowing to the human body is greater when it is touched by the phase cable.*

Keywords – *Electric, shock, transformer; current, resistance, wire.*

I. INTRODUCTION

The large number of deaths caused by accidents due to electric shock due to leakage of electric current in electrical installations both in households and in industry causes electricity to be a scary thing. The risk of human death is due to the flow of electric current into the human body and damage to two vital body functions, namely breathing and heart rate, while the risk scale is based on the rated current and the length of contact time/touch time. Although in the market there are many electric circuit breakers available, they are still slow in disconnecting the electric current, and there is still pain when electrocuted. Accident protection equipment due to electric shock can be installed in a home installation or activity room that uses a lot of electrical energy. The working principle of this protective device is if someone experiences a shock in phase conduction, then this protection device will work by sounding an alarm for 10 seconds (can be set) and will protect the electrical installation network if the phase or neutral cable experiences leakage current.

An accident protection device, due to electric shock, used as a separator/isolation of electric power is an isolation transformer, namely a transformer that has the same number of primary and secondary windings so that the primary voltage is equal to the secondary voltage. The design of the protective device in the secondary winding isolation transformer is made a little more of this in order to compensate for the amount of power loss that occurs. Many works on designing transformers have been performed by many researchers worldwide [Wang *et al.*, 2021. Leibl *et al*, 2017, Guillod *et al*, 2018, Rothmund *et al*. 2019]

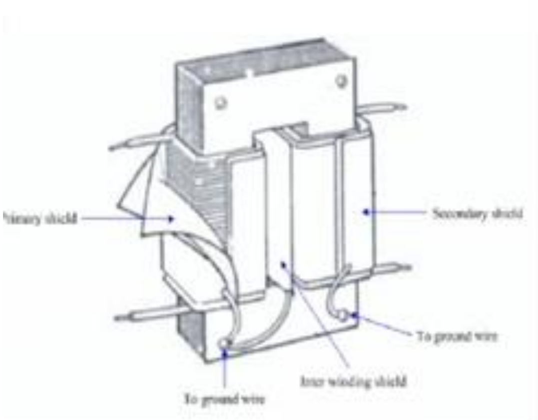

Fig. 1. Transformer isolation (https://elektronicaution.wordpress.com)

Making isolation transformers to determine transformer specifications based on the power to be secured. The calculation includes the diameter of the winding wire, the cross-sectional area of the core and the number of primary and secondary turns. The human body is physically a non-linear prisoner. There are three factors that determine the seriousness of electric shock to the human body, namely the amount of current flowing into the body, the amount of which is determined by the voltage and resistance of the body as well as other resistance that is part of the path, the flow of current in the body greatly determines the level due to electric shock and duration. The time of electric shock greatly determines the fatality due to electric shock. When humans are exposed to electric shocks, apart from cables, grounding systems and parts of other equipment, the human body is also part of the resistance of the circuit.

An electric shock can cause damage to the human body and even death (Odell *et al.*, 2016, Electric current that flows through important organs such as the heart and brain are very dangerous because it affects the work of these organs. An electric current heats up body tissues, causing them to burn. Generally, people can feel an electric current of 1 mA. Electric currents of several milliamps of amperage cause illness but rarely cause harm to a healthy person. Approaches to determine the limits of these currents are divided, among others, namely reaction electric currents, electric currents affecting muscles, and electric currents that can cause fainting and even death. There are two ways electric current can sting the human body, namely through direct and indirect touch.

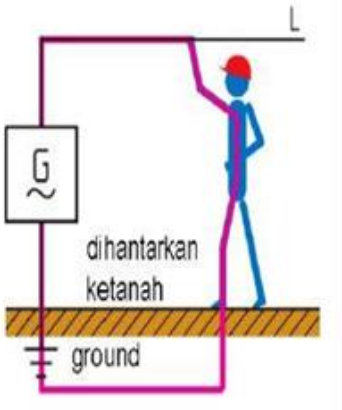

Fig. 2. Direct touching (http://blogunnes.ac.id)

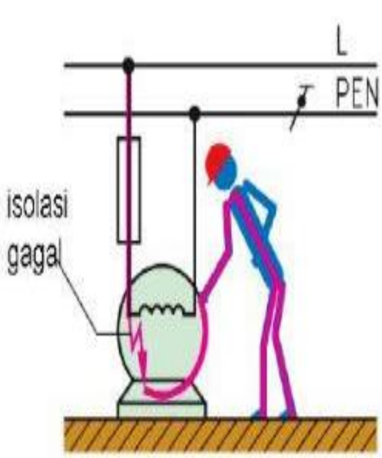

Fig. 2. Indirect touching (http://blogunnes.ac.id)

Each conductor has a resistance that varies in carrying an electric current, and the human body is a good conductor of electric current even though the human body has electrical resistance. Ff, the current flowing from the left hand to the right foot will have more resistance than the current flowing in two adjacent fingers. The body's greatest resistance lies in the skin. If the skin is dry, the resistance will be relatively higher and will reduce the danger of electric shock. But, to get a really dry skin condition is a rare thing. The tendency for everyone to sweat, even if only a little. Therefore it is assumed that the body is always wet, the electrical resistance is low. The resistance of the human body on dry skin conditions ranges from 1,000 to 100,000, while in wet skin conditions, it will decrease to 1,000. According to IEC 449, IEC60479, and PUIL 2000 (General Electrical Installation Requirements), the upper limit of the voltage range is 50 Volt alternating current 120-volt direct current.

Table 1. IEC364 provides data on the maximum time limit for disconnection from touch with voltage. Body mass index is a standard metric used to determine who is in the healthy and unhealthy weight group. Body mass index compares weight to height, calculated by dividing weight in kilograms by height in meters squared. Compare the results of the calculated body mass index with the weight categories listed below:

< 18.5 = Underweight
18.5– 22.9 = Normal weight
23– 29.9 = Excess body weight (obesity tendency)
>=30 = obesity

TABLE 1
Voltage and touching time (PUIL, 2000*)*

Touching Voltage (Volt)		Maximum Touch (second)
AC	DC	
< 50	< 120	-
50	120	5,00
75	140	1,00
90	160	0,50
110	175	0,20
150	200	0,10
220	250	0,05
280	310	0,03

II. MATERIALS & METHODS

The research method applied is to design the construction of accident protection equipment due to electric shock by utilizing an isolation transformer as an electric power separator, measuring leakage current in humans and calculating wire diameter, core cross-sectional area and the number of turns in the primary and secondary isolation transformers to determine power electricity to be secured. The design of accident protection equipment due to electric shock is used to protect humans from the dangers caused by electric shock. If a human is electrocuted, an electric current will flow through the human body to the ground (flowing additional current through the human). The design of accident protection equipment due to electric shock is used to protect humans from the dangers caused by electric shock. If humans are electrocuted, the electric current will flow through the human body to the ground, meaning that additional current flows through the human body, if the electric load is taken from the output of the protection device, the additional current will be detected. As an illustration of the design burden in making a simple 1-phase home electrical installation using 4 lamps, 2 single switches, 1 series switch and 2 sockets. The total electric current generated reaches 0.19 A. The design of accident protection equipment due to electric shock is used to protect humans from the dangers caused by electric shock. If a human is electrocuted, anelectric current will flow through the human body to the ground, if the electrical load is taken from the output of the protection device, the additional current will be detected

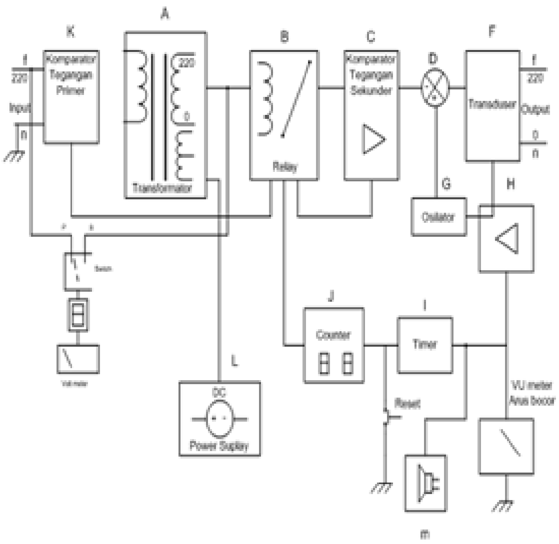

Fig. 3. **Block diagram and electric shock protector**

III. RESULTS & DISCUSSION

Table 2 shows the data on the results of measuring the resistance of the human body based on gender and age and under two conditions, namely normal conditions and sweating conditions. In Table 3. the data on the results of the tool test (Tool Reliability Test) is given, which provides an overview of the feasibility of the tool to avoid electric shock. Meanwhile, Analysis of the results of testing the reliability of the tool is also shown by the Two-Way Anova method, as shown in the Table. 4. Age group is very important in the sensory threshold, and intensity is related to age (Leitgeb *et al*., 2006) and changes in current and sensation of warmth until thermal effects result in a burn (Benmeir *et al*., 1993)

TABLE 2.
Resistance of the human body

Sex/ Age		Normal Resistance	Sweating Resístance	Current
Male		3246	2950	67,7 mA 74.5 mA
Age	10 -15			
	20 -30	2992	2650	73,5 mA 83 mA
Female		2992	2700	73,5 mA 81,4 mA
Age	10 -15			
	20 -30	2750	2400	80 mA 91,6 mA

TABLE 3.
Durability test

Age//Sex	Male		Female		Everage
15 - 25	1 2 1	1,333	3 1 2	2,0	10/6= 1,67
26 - 35	1 1 1	1	3 3 1	2,33	10/6= 1,67
36 - 45	1 1 2	1,33	1 1 3	1,667	9/6= 1,50
	11/9 = 1,22		18/9 = 2,00		4,84/3= 1.61

1 = Not feeling at all
2 = Feels a vibration at the tip of the finger
3 = Feels a vibration in the palm of the hand
Current = 450 VA, V = 240 Volts, A = 1.875 Ampere

TABLE 4.
Two-Way Anova

Age Group	Male	Female	Male + Female
1	1,333	2,00	1,67
2 3	1 1,333	2,33 1,667	1,67 1,50
Average	1,222	2,00	1,60

Between men and women, there was a slightly significant difference between P = 0.0761 (significantly different at the 7% level), as shown in Figure 4. Women are more sensitive to electric shock (2,000 while men (1,222), but still quite safe. The average score for all panellists is 1,611, still quite safe between female age groups.

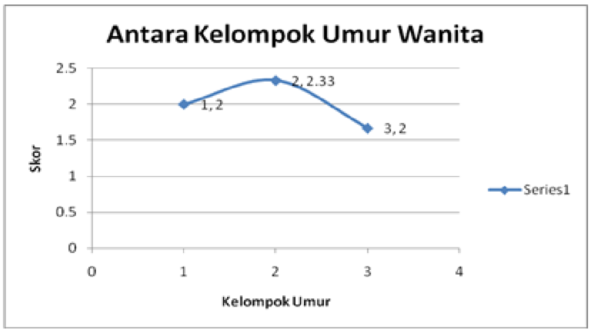

Fig. 4. Female group

From Figure 5, it can be seen that men in the age group (25 – 36 years) are the most resistant to electric shock (score 1), while in Figure 6, if you do not look at the gender of electric shock for all respondents, the age group (36 – 45) Years is the most resistant to electric shock. When compared to observations on body resistance with the results of tool reliability tests, there is a positive correlation that women are more sensitive than men. The high cost of installation in accordance with PUIL regulations (General Electrical Installation Regulations) causes electrical installations both in households and industries often to not follow PUIL regulations. The low level of security in electrical installations can be fatal, for example, causing a fire due to a short circuit or causing the death of a person who is electrocuted due to a leakage current. Technological innovation is needed to overcome this, namely by making a tool that can detect the occurrence of leakage current, and when it is detected that there is a leakage current, the tool will cut off the flow of electric current from PLN.

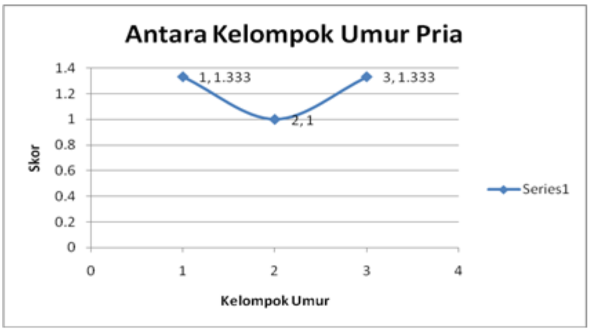

Fig. 5. Female group

Fig, 6, Male and female group

IV. CONCLUSIONS

It can be concluded that:

1. The use of an isolation transformer on a leakage current protection device that is installed in a 220 Volt house with a neutral conductor on the secondary side, the isolation transformer is not grounded (grounding), if a person is exposed to phase conduction, then the body that touches the earth is electrified into an open circuit so that there is no potential difference between the phase conduction and the ground.
2. Specifications for isolation transformers, if the power to be secured is greater, the diameter of the winding wire will increase. This is because the current that will flow into the winding wire also increases. The number of turns on the primary and secondary sides is getting less if the power to be secured is greater. This is because the cross-sectional area is increasing, and the turns/volts are decreasing.
3. The safety device/leakage current protection from the research has the advantage of being faster / sensitive in protecting the flow of electric current when compared to the PLN network safety switch protection device, or ELCB (Earth Leakage Circuit Breaker).

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