GROUNDING RESISTANCE REDUCTION OF PARALLEL ROD ELECTRODE AT UIN SUSKA RIAU

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2

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GROUNDING RESISTANCE REDUCTION OF PARALLEL ROD ELECTRODE AT UIN SUSKA RIAU

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Grounding resistance uses ground rod electrode is influenced soil condition, soil structure, soil chemical composition, size and ground rod electrode placement. The grounding resistance should be made as small as possible and fulfill its standard (PUIL 2000) in order to flows fault current as well to ground. In this research to reduce grounding resistance at homogeneous kind of grounding resistance according without and used trench method is fullfilled salt and charcoal that is deepended on parallel rod electrode having the length of 0.5m. From result of measurement without Trench Methode, degradation of grounding resistance by 2, 3, and 4 parallel electrode equal to 46,13%, 63,75%, and 72,93%. While from result of calculation, there are degradation equal to 50%, 66,69%, and 74,98%. After Trench Methode with addition of salt and charcoal, degradation of grounding resistance from result of measurement equal to 85%, 88,81% and 91,97%. While from result of calculation got degradation equal to 85,96%, 90,67%, and 92,99%. The resulted of measurement agree with IEEE Standard 141-1993. This standard shows that the decrement of grounding resistance of one ground rod with chemical treatment will be in the range of 15% up to 90%.

Key words : trench methode, grounding resistance, parallel rod electrode

Introduction

Graunding system has't used when energy system stills has little capacity size (until year 1910). this matter can caused by at that moment if there are any disturbance to the ground in system, and where does disturbance current magnitude same or less than 5 ampere (hutauruk, 1991), so in condition such fire arch extinguished by itself.

Along with electricity load development then will increase to causes electric power system develop too like theirs fed and voltage so that fault current that flow to the ground will bigger and fire arch that appear can not extinguished self. this matter cause very hight transient voltage so that very dangerous for system, therefore, very be need plan a system that can overcome disturbance. system then known with grounding system.

One of the grounding system was done by plant ground rod electrode that functioned to decrease grounding resistance. Grounding resistance that fulfil standard safe is maked to anticipate disturbance. Grounding resistance must be small value so that can flow fault current well to the ground. Grounding resistance with ground rod electrode very depending of kind, condition, size with grounding electrode location.

To get lower kind of lower soil resistance , often tried with change soil chemical composition. some ways often done with give salts in soil near grounding electrode, give water or wet soil, or give special treatment with gives ingredient or certain

materials among others natrium chloride, sulphate magnesium, chloride calcium, bentonite, and charcoal. Based on IEEE standart 141-1993 declare to decrease grounding resistance value can be done with change soil chemical composition revolves 15% up to 90%.

Grounding Resistance have value as small as possible so that can flow fault better to the ground. Grounding Resistance with electrode of rod very depended to type, condition, size measure and also the way of location electrode.(Eduful, Cole, & Okyere, 2009; IEEE 81, 2012; Khan, Qureshi, Malik, & Pazheri, 2011; Rio & Bambang, 2014).

To get lower resistivity especially for land with high ground resistance, often tried by change ground chemical composition. (Al-Ammar, Khan, Malik, & Wani, 2010; Eduful et al., 2009; Hu et al., 2012; Khan, Malik, Qureshi, & Pazheri, 2010; Zhaosheng, Cheng, Zhongyi, Zhenhua, & Yanxin, 2011).

Giving bentonite to circle trenc method in certain depth with outside radius variation and bentonite trenc depth, electrode depth, and radius in constant was got decrease grounding resistance (Harnoko, 2003)

Herman (2006) declare to a size mass economical bentonite, in certain soil resistance, with diameter 18.8 mm, radius in 0.23 m, radius outside 0.83 m with depth trench bentonite 0.2 m and long electrode 1 m would get depreciation maximal grounding resistance.

In this research is effort to reduces grounding resistance was done with deep to plant ground rod electrode and change soil chemical composition with bentonite, method that used to reduce value grounding resistance a ground rod electrode by using circle trench method. in this research is called with circle trench method because trench geometry that is made formed full circle, with give bentonite at around trench. Analysis varians two directions applieds to prove there or not influence change high trench bentonite towards grounding resistance.

Grounding Resistance

Grounding system is protection system fault current that can cause gradien voltage between devices , device with soil and also gradien voltage in itself soil surface. In big system haven't grounding system for example in system delta, fault current at electric power system is relative big (>5 ampere) so that electricity arch can not extinguished self that cause the happening of soil arch, in system have grounding system phenomenon can be minimized , besides with grounding syatem at a power system can limit voltage in fasa well so grounding system is of the key factor in protection electric power system.

Ground Rod Electrode

Ground rod electrode is conductor that planted in soil and make direct contact with soil. Purpose Direct contact conduct can flow current as well possible if havent fault so that current can be flow to the ground.

A Resistance ground rod electrode planted soil surface vertical (Hutauruk, 1991)

$$R_p = \frac{\rho}{2\pi L}\ln\left(\frac{4L}{a}-1\right) \text{ (for L>>a)}\ldots\ldots \quad (1)$$

with

Rp = grounding resistance (Ω)
ρ = resistivity soil (Ωm)
a = radius electrode (m)
L = Electrode depth (m)

Formula (1) is used to determine grounding resistance value with opinion that soil resistivity value at place uniform measurement.

Soil Resistivity

Balance factor between grounding resistance and capacitance at around it is soil resistivity that represented with ρ. Resistivity value in limited depth region is not same. Several factors that influence resistivity of soil that is:

a. soil structure condition among like the geology structure are loamy, marshland, stony soil, sandy soil, peat soil and extra.

b. chemical element that implied in soil, like salt, metal, and another minerals.
c. climate conditon, wet or dry.
d. soil temperature and soil kind

Soil resistivity value varies depend on soil composition likes included in Table 1 (Pijpaert, 1999).

Tabel 1 Soil Resistivity Value

Kind of soil	Soil Resistivity (Ω-m)
Swamp	10 – 40
clay dan farmste	20 – 100
wet sand	50 – 200
wet gravel	200 – 300
dry sand/gravel	<10000
stony soil	2000 – 3000
sea water dan fresh water	10 – 100

Soil Resistivity Measurement

Soil resistivity measurement usually done with three-point methode. for example there three ground rod electrode with rod 1 the resistance wants to measuresed and rod 2 and 3 as ground rod assistant also not yet known the resistance, like in pigure 1. Resistance of ground rod 1 can be made:

$$R_{12} + R_{13} - R_{23} = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

with

R_{12} = electrode resistance 1 and 2
R_{13} = electrode resistance 1 and 2
R_{23} = electrode resistance 2 and 3

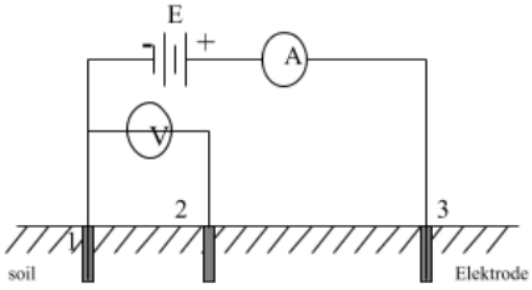

Figure 1. Soil Resistivity Measurement series with Three Point Method

Salt and Charcoal for Grounding Resistance Reduction

a. Salt

In general there is two type land;ground type that is bargaining and briny , when is briny making of grounding will far easier because salt content in it, where itself salt represent media conductor of good electrics but the nature of other is corrosive. Its meaning that the salt content easy to make any metal is broken.

b. Charcoal

Treatment of chemistry to land felt cheap and compatible applied as resolving solution to land with high resistivity. The methode is conducted by giving materials of reduction, is used charcoal to low ground resitivitas. Nature of absorbent charcoal of damp water from the air, later then discharging it at condition of dry, so that making it function as regulator of good dampness.

Grounding Resistance with Trench Methode

For the equation of electrode resistance which around filled with charcoal and salt can be expressed with the following formula is based to standard of IEEE (Roy B. Canpenter, Jr, 2007 :

$$R_b = \frac{1}{2\pi L}\left(\rho\left(\ln\frac{8L}{D_b}-1\right)+\rho_b\left(\ln\frac{8L}{d}-1\right)-\rho_b\left(\ln\frac{8L}{D_b}-1\right)\right) \quad \ldots(3)$$

with
R_b = Grounding Resistance with (Ω)
ρ_b = Low Material Resistivity (Ωm)
ρ = Ground resistivity (Ωm)
D_b = Trench diameter (m)
d = electrode diameter (m)
L = planted electrode length (m)

Material and Method

Research Material

The Material was used in this research:

1. ground rod Elektrode with long 0.5 m amount 15
2. Salt : 100 kg
3. Charcoal : 200 kg

Device that used

1. One set Earth Resistance Tester tipe 3235 JEW from buatan German that use grounding resistance measurement
2. Hammer, jumper, sack and another addition device that need.
3. scales with scale maks. 50 kg for surveyor mass salt and charcoal measurement

Research Methode

To get grounding resistance to location research at UIN Suska Riau, so was done step as follows:

1. This research is done at condition doesn't happen rain that is at dry season so that soil at research location in a condition dry, this done to watch over data accuracy.
2. For grounding resistance value uniform, so necessary done soil resistivity measurement around research location, then determined location genuinely has uniform soil resistivity for three ground rod locations .
3. Plant single and parallel ground rod electrode with depth 0.5 m without trench
4. Measures grounding resistance for 2, 3, and 4 parallel electrode with three points method with alliterations 5 times then taken the average. the average value be compared with grounding resistance after be used salt and charcoal .
5. Make trench for all location likes in Figure 2, trench is given salt and charcoal. So Measure grounding resistance for 2, 3, and 4 parallel rod electrode with depth 0.5 m

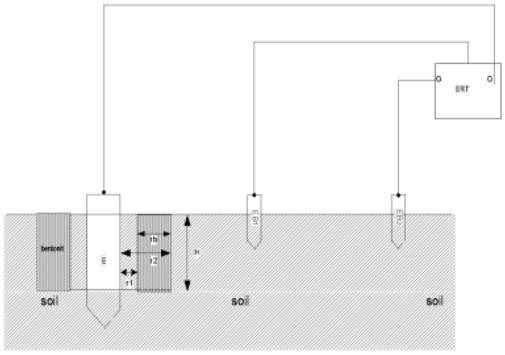

Figure 2. Grounding Resistance Measurement with Salt and Charcoal

Result and Analysis

Measurement Result

Tabel 2. Grounding resistance rod electrode before Trench Methode

Amount of rod electrode	Grounding Resistance Rp (Ω)					Average Rp (Ω)	% Degradation Rp(Ω)
	Measurement						
	1	2	3	4	5		
1	1120	1120	1120	1120	1120	1120	0,00
2	603	603	604	604	603	603,4	46,13
3	405	407	406	406	406	406	63,75
4	302	302	303	304	305	303,2	72,93

Electrode radius (a) = 3,175 mm
Depth electrode (L) = 0,5 m
Kind of soil: sand/ dry gravel

Tabel 3. Grounding Resistance measurement after Trench Methode

Amount of rod electrode	Grounding Resistance Rp (Ω)					Average Rp (Ω)	% Degradation Rp (Ω)
	Measurement						
	1	2	3	4	5		
1	403	403	403	404	403	403,2	64,03
2	168	169	168	168	168	168,2	85,00
3	125	125	125	126	126	125,4	88,81
4	90	90	90	90	90	90	91,97

Hb =0,5 m

rb =0,3 m

Tabel 4. Percentage of degradation grounding resistance

Amount of rod electrode	Average Rp (Ω) before trench methode	Average Rp (Ω) after trench methode	% Degradation Rp (Ω)
1	1120,00	403,20	64,00
2	603,40	168,20	72,12
3	406,00	125,40	69,11
4	303,20	90,00	70,32

Calculation Result

Tabel 5. Calculation of Grounding resistance rod electrode before Trench Methode

Amount of rod electrode	Rp (Ω)	% Degradation Rp(Ω)
1	1121,6	0,00
2	560,8	50,00
3	373,6	66,69
4	280,6	74,98

Tabel 6. Grounding Resistance calculation after Trench Methode

Amount of rod electrode	Rp (Ω)	% Degradation Rp (Ω)
1	315,4	71,86
2	157,4	85,96
3	104,6	90,67
4	78,6	92,99

Tabel 7. Percentage of degradation grounding resistance

Amount of rod electrode	Average Rp (Ω) before trench method	Average Rp (Ω) after trench methode	% Degradation Rp (Ω)
1	1121,60	315,40	71,88
2	560,80	157,40	71,93
3	373,60	104,60	72,00
4	280,60	78,60	71,99

Analysis

Based of data result of measurement and calculation of grounding resistance value (Rp), effect of influence of change of electrode amount before and after making of grounding resistance value will smaller if parallel amount of electrode also increase.

Comparison of measurement result and result calculation of parallel and single rod electrode land, before and after trench methode show there are difference between result of calculation and measurement. Difference of result because of grounding resistance influenced by materials of reduction salt and charcoal, cause of difference of result also earn because of difference of compound content which there are in salt and charcoal, from theory, explain that materials of reduction in area investigation, chemical analysis have looking like, only its different just water content.

Difference of result also can be caused by difference of land, ground type, chemical element in land, ground like metal, other chemical compound and salt, influence of temperature and also influence of dampness around ground location.

Conclusion

1. Result of measurement and calculation of grounding resistance value (Rp), effect of influence of change of electrode amount before and after making of grounding resistance value will smaller if parallel amount of electrode also increase.
2. From result of measurement without Trench Methode, degradation of grounding resistance by 2, 3, and 4 parallel electrode equal to 46,13%, 63,75%, and 72,93%. While from result of calculation, there are degradation equal to 50%, 66,69%, and 74,98%. After Trench Methode with addition of salt and charcoal, degradation of grounding resistance from result of measurement equal to 85%, 88,81% and 91,97%. While from result of calculation got degradation equal to 85,96%, 90,67%, and 92,99%.

Recomendation

This research was done at dry season at soil condition really dry. This aim for accurate data

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