UNIVERSITI PUTRA MALAYSIA

BREAKDOWN PERFORMANCE OF BACKFILL MATERIALS UNDER IMPULSE AND AC VOLTAGE CONDITIONS

VANESSA CAROLINA LAVERDE MILEO

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By

VANESSA CAROLINA LAVERDE MILEO

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilments of the Requirements for the Degree of Master of Science

July 2012

DEDICATIONS

To my Lord

To my mother, a combatant lady and my example of life and professionalism

To my supervisors, Assoc. Prof. Dr. Mohd Zainal Abidin Ab Kadir and Dr. Chandima Gomes for your continued support and dedication.

And lastly to my love, who supported me in all my decisions.

Abstract of thesis presented to the Senate of University Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman: Mohd Zainal Abidin Ab Kadir, PhD

Faculty: Engineering

Earthing means the connection of equipment through a conductor to ground. The soil is composed by many materials, which can be good or poor conductors of electricity. The earth as a whole is considered as a good conductor of electricity. Many electrical systems are prone to the risk of failure as a result of lightning strikes. It requires special arrangements to reduce the risk involved. A proper ground system is fundamental to this regulation. Lightning impulse has a steep upslope and is source of high frequency current. Special ground systems designs are needed and it is called impulse earthing. Nowadays, most engineers use backfill materials to reduce the ground resistance to low values. Backfill materials or additive fillers are used to refill the space in the vicinity of the electrode. They provide a low ground resistance value.

The different models which are available such as Liew and Darveniza, Cooray and colleagues, etc., with the aim to take into account the nonlinear effects due to soil ionization, will be mentioned in this research. Basically, they can be classified as the variable geometry approach and the variable soil conductivity approach. This non-linear behavior is due to the effects of two conduction processes: thermal and soil ionizations. In the thermal process, the temperature of soil increases through the low-energy absorption produced by the resistive heating. The soil ionization will increase the soil conductivity and reduce its resistivity, causing the resistance of the soil to decrease with increasing current.

This research focuses on the behaviour of dry sand, bentonite and cement under impulse and AC voltage conditions. The selections of materials were based on the availability and anticipation of the past research. There are many factors that could influence the experimental results such as weather, moist of the material, material availability, etc. The experiments were carried out at the TNB Research High Voltage Laboratory.

For impulse and AC testings, bentonite breakdown in early stages, unlike cement and air gap (impulse testing) and sand (AC conditions). During the alternative voltage testings for sand and bentonite, dust puffing out from the container and fulgurite formations were observed, this peculiarity is due to high temperatures in the backfill materials during soil ionization.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PRESTASI KEROSAKAN BAHAN SENDATAN DI BAWAH KEADAAN DEDENYUT DAN VOLTAN AC

Oleh

VANESSA CAROLINA LAVERDE MILEO

Julai 2012

Pengerusi: Mohd Zainal Abidin Ab Kadir, PhD

Fakulti: Kejuruteraan

Pembumian bererti sambungan peralatan melalui konduktor ke tanah. Tanah terdiri daripada banyak bahan-bahan yang boleh menjadi pengalir elektrik yang baik atau lemah. Bumi secara keseluruhannya dianggap sebagai satu konduktor elektrik yang baik. Banyak sistem elektrik terdedah kepada risiko kegagalan akibat daripada panahan kilat. Ia memerlukan perkiraan khas untuk mengurangkan risiko yang terlibat. Sistem pembumian yang betul adalah asas kepada peraturan ini. Dedenyut kilat mempunyai lereng atas yang curam dan sumber arus frekuensi tinggi. Reka bentuk sistem pembumian khas adalah diperlukan dan ia dipanggil pembumian

dedenyut. Kini, kebanyakan jurutera menggunakan bahan sendatan untuk mengurangkan rintangan tanah kepada nilai yang rendah.

Model yang berbeza yang ada seperti Liew and Darveniza, Cooray dan rakan-rakan dan lain-lain, dengan tujuan untuk mengambil kira kesan tak linear yang disebabkan oleh pengionan tanah, akan disebut dalam kajian ini. Pada asasnya, ia boleh dikelaskan sebagai pendekatan geometri berubah dan pendekatan kekonduksian tanah berubah. Tingkah laku bukan linear ini adalah disebabkan oleh kesan dua proses konduksi: pengionan termal dan tanah. Dalam proses haba, suhu meningkat tanah melalui penyerapan tenaga rendah yang dihasilkan oleh pemanasan rintangan. Pengionan tanah akan meningkatkan kekonduksian tanah dan mengurangkan kerintangan, menyebabkan rintangan tanah untuk mengurangkan dengan semasa yang semakin meningkat.

Kajian ini memberi tumpuan kepada sifat pasir kering, bentonit dan simen di bawah keadaan voltan yang berbeza. Pemilihan bahan berdasarkan ketersediaan dan jangkaan penyelidikan yang lepas. Terdapat banyak faktor yang boleh mempengaruhi keputusan eksperimen seperti cuaca, kelembapan bahan dan ketersediaan baha. Kajian ini telah dijalankan di Makmal Voltan Tinggi milik TNB Research. Bagi ujian dedenyut dan AC, bentonit rosak pada peringkat awal, tidak seperti simen dan ruang udara (ujian dedenyut) dan pasir (ujian AC). Semasa ujian voltan AC bagi pasir dan bentonit, habuk keluar dari bekas dan pembentukan fulgurite telah diperhatikan. Keanehan ini adalah kerana suhu yang tinggi dalam bahan sendatan semasa pengionan tanah.

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Lastly, to the TNBR Research Team for your kind collaboration.

I certify than an Examination Committee has met on 09 July 2012 to conduct the final examination of Vanessa Carolina Laverde Mileo on her thesis entitled "Breakdown performance of backfill materials under impulse and ac voltage conditions" in accordance with the Universities and University College Act 1971 and the Constitution of the University Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the student be awarded the Master of Science.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the **Degree of Master of Science**. The members of the Supervisory Committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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VANESSA CAROLINA LAVERDE MILEO

Date: 09th July 2012

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