" I hereby declare that I have read through this report entitle "Study the Characteristic of Current Distribution On Water Due To Short Medium Spark Gap" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

Signature : ....

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STUDY ON THE CHARACTERISTIC OF CURRENT DISTRIBUTION ON WATER DUE TO SHORT MEDIUM SPARK GAP

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A report submitted in partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering (Industrial Power)

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2013

I declare that this report entitle " Study on the Characteristic Distribution On Water Due To Short Medium Spark Gap" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ....

Name : MUHAMMAD SYAFIQ BIN MOHD KAMAL

Date : ....

ACKNOWLEDGEMENT

First of all, I would like to I would like to express my deepest appreciation to all those who provided me the possibility to complete this report. A special gratitude I give to my final year project supervisor, Mr. Zikri Abadi Baharudin, whose contribution in stimulating suggestions and encouragement, helped me to coordinate my project. Secondly, I would also like to thank my family and friends who helped me a lot in finalizing this project and keep supporting in completing this report.

ABSTRACT

Electric current distribution on water is a phenomena that occur when any electric current source present on water and distribute the current in all possible way. As an example, the lightning strike on water, leaking under water cable and wet polluted insulator. The current that distribute on water could not only caused a lot danger to the life, but also to the equipment and material. Tidal wave generator safety are the main concern if the lightning strike at the sea. However, current discharge on water also could give benefit on water treatment.Current distribution on water depend on the water conductivity itself, as the higher salt concentration on water, the higher magnitude current could be draw. The experiment that has been set to observed current distribution on water consist of impulse voltage generator and water tank equipped with iron electrode. The tested water are tap water and saline solutions. The imitation of lightning are created using the impulse generator and the discharge are pointed at the water. The current measured by using Rogowski coil. The result show that current distribute by sprouting into a water , and the underwater current distribution is more higher than surface distribution. The dissolve salt in the liquid could also draw a higher magnitude of current. The measurement and observation could be improved by implementing high speed camera for observation purpose, and also the addition of Rogowski coil quantity could give more consistent and higher accuracy reading.

ABSTRAK

Penyebaran arus elektrik di dalam air adalah satu fenomena yang berlaku apabila mana-mana sumber arus elektrik wujud di kawasan berair dan arus akan tersebar dalam semua arah yang mungkin.Sebagai contoh, pancaran kilat di air, kebocoran kabel bawah air dan penebatan yang basah.Penyebaran arus elektrik di air bukan hanya berbahaya pada kehidupan, tapi juga pada peralatan. Keselamatan pada penjana ombak pasang surut adalah menjadi kebimbangan jika kilat menyambar pada air laut.Penyebaran arus elektrik pada ar bergantung pada kekonduksian air itu sendiri,dimana semakin tinggi kandungan garam dalam air, semakin tinggi arus yang boeh melalui air terbabit. Eksperimen yang ingin dijalankan adalah untuk melihat penyebaran arus elektrik di dalam air, menggunakan penjana voltan impuls dan tangki air yang siap dipasang elektrod.Fungsi penjana voltan impuls adalah untuk menghasilkan kilat tiruan dan mengaplikasikanya pada permukaan air.Dua jenis air akan dikaji tahap penyebaran arus ke atasnya,iaitu air paip dan air larutan garam.Penyebaran arus akan diukur menggunkan gelung Rogowski. Hasil eksperimen menunjukkan arus elektrik dalam air tersebar secara bercambah dan sebaran arus di bawah air lebih tinggi nilainya dari di permukaan.Nilai arus di dalam air yg dilarutkan garam juga dilaporkan lebih tinggi. Pemerhatian dan pengukuran semasa eksperimen boleh ditambah baik lagi dengan menggunakan kamera berkelajuan tinggi untuk pemerhatian,dan juga penambahan kuantiti Rogowski coil untuk mendapatkan bacaan yang lebih jitu dan konsisten.

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CHAPTER 1

INTRODUCTION

1.1 Motivation

The protection and precaution on current distribution in water is still does not consider a important things nowadays, although this phenomena is quite dangerous. A current could distribute on water from a lightning strike, leakage underwater cable, and even a existent of moisture on a insulators also could draw a current to travel through it, such as a corona effect. This incident could put a safety of living things and equipment at a risk, since a huge surge of current flow could lead to a death and huge equipment damages. To avoid that, a research regarding to this field must be done more and more, as it will provide steady data and analysis, for future development.

1.2 Problem Statement

Recently, the studies and information regarding the current distribution on water is available, but still lacking, if there are any. The focus more to the sea water current distribution analysis. Lightning strike is the common source that lead to current presence on the water, and it can caused a huge danger to the living things and any object. People that on the sea for swimming and equipment such as tidal wave generator exposed to lightning strike since it totally available on the water. Unfortunately, lightning does not strike on sea water only. It can be any type of water, since the water itself conduct electricity. Different water type has a different electric conductivity. Analysis on current distribution for different type of water is necessary, since this will provide a pathway to precautionary and protection act to avoid any accident and damages to occurs. Furthermore, application on current distribution also can be wider in industry and environment application such as water treatment and wet polluted insulator.

1.3 Objectives

The objectives of this project are :

- To develop a small scale model for monitoring and demonstrating a current distribution on water for analysis and learning purpose.
- To investigate the current distribution characteristic on the two different type of water
- To analyze the current distribution on water data base on the actual experiment and measurement.

1.4 Scope

The scope of this project is to analyze the current distribution on two different type of water. The small scale model is planned to be set up base on impulse voltages generator, that are connected to a water tank, as to monitor and measure a current distribution on water. Impulse voltages generator functioned is to generate imitation of the lightning strike. The impulse generator will generate up to 16 kV high voltage pulse and set to be strike on the water. The current distribution is set to be tested on two different type of water which is tap water and saline solution, which is a saline solution is prepared by dissolving salt into a water .The current is measured by using current measuring device (Rogowski coil) and experiment data will be presented by using digital oscilloscope with 8 bits resolution. The analysis is based on the experiment result and the observation during the experiment.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Current distribution in water studies is become important and its purposed can be useful in various applications. Several research and development show that current distribution process could be valuable for human, and also it could be exist in unexpected ways.

2.2 Current Distribution On Water Due to Lightning.

Lightning strike is the most common things that lead to the current distribute on water, as the lightning tend to strikes water surface as the water is a good electric conductor [2].This scenario exposing the people that in the water, such as a swimmer, to the electric shock that could causing a death [2]. Furthermore, lightning strike on the sea water also dangerous to tidal wave generator as it will damage the generator equipment, as the lightning strike will distribute a high surge current to all direction in water. However, the current will dissipate after a certain distance from the striking point, but the distance to dissipate is depend on water conductivity [2].

2.3 Water Conductivity

The current distribution on water are depend on the conductivity of the water itself, as the higher conductivity, the more current that can be through. Recent research [1,2] show that current distribution distance influence by the water conductivity. Dissolve salt in the water solution also decide how well water ability to distribute current.

From the table below, show the conductivity of different type of water that could be involved in this project. This data is according to Interim National Water Quality Standard Malaysia : Water Conductivity.

Table 2.1 : Water Conductivity table

Type of water	Conductivity (μS/cm)
Sea water (coastal)	33000
Sea water (open sea)	40000-50000
Tap water	200-1000

2.4 Electrical Discharge Application on Water Treatment

2.4.1 Water Electrode Ozone Generator

Regarding to [5], ozone can be useful in water treatment process. In industry, ozone is generated using an ozone generator. Ozone basically used to sever carbon bond, bleaching substance and killing microorganism in water. It is also powerful oxidant to chemically attack contaminant on water for treatment purposes. Electrical discharge on water can be related to ozone generation because the ozone production involve the passage of an oxygen-bearing gas through by electrical discharge. It is also called "silent" electrical discharge method, by applying an electrical discharge in a gap between concentric electrodes separated by a glass or ceramic dielectric barrier.[5]

The ozone production relatively simple process is when the air is drawn into the ozone generator, the electrical discharges that been applied will split the air oxygen (O2) molecules into single atom O. O2 is a molecules from the combination of 2 atoms (O) .However, some of the O atoms will react to another available O2 molecules to form an ozone (O3).

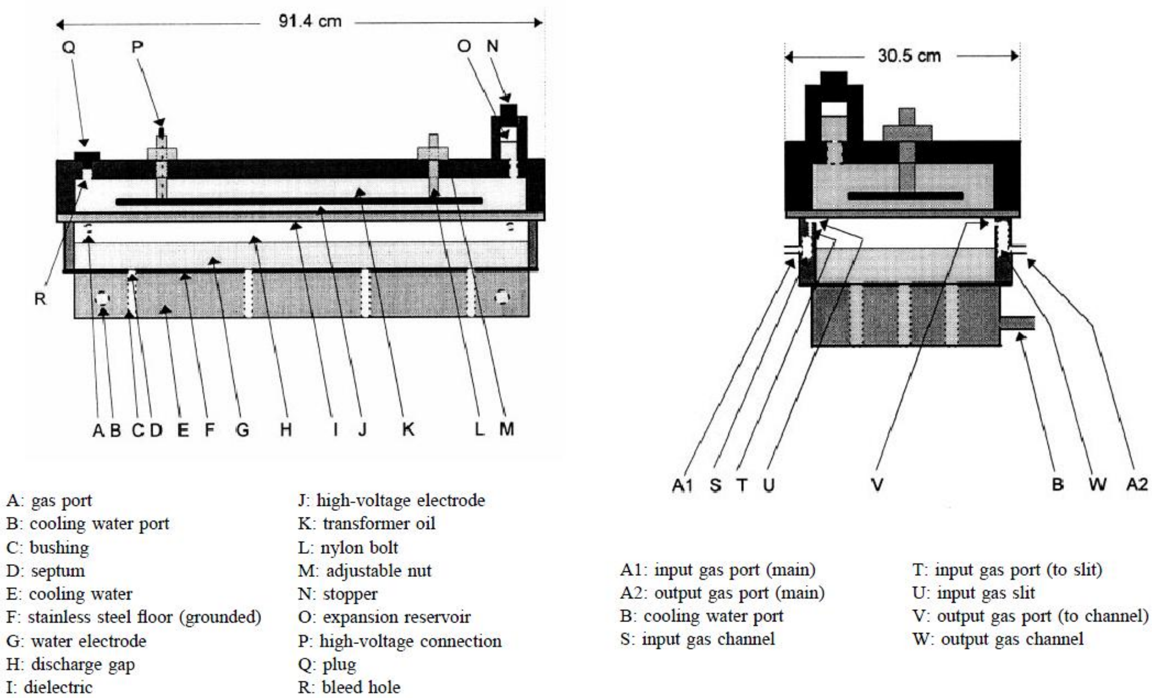

Figure 1 : Water Electrode Ozone Generator [5]

2.4.2 A Latest Development on Water Treatment using Electrical Discharges in Water

During this day, several research have been done as to improved water treatment quality. There is studies found in [4] that in certain condition, ozone usage in water treatment is less effectives as it is found difficult to treat the refractory organics in water. As it happen, the new method is to apply electrical discharge in bubbles in water to generate some other radical such as atomic oxygen, ozone, hydroxyl and hydrogen peroxide [4].Besides, there is also found that hydroxyl radical is the powerful and non-selective oxidant which have an ability to kill bacteria and oxidize organic compound [6].However this area of research are still developed as there are many unknown matters being concerned with the discharges phenomena in bubbles [4].

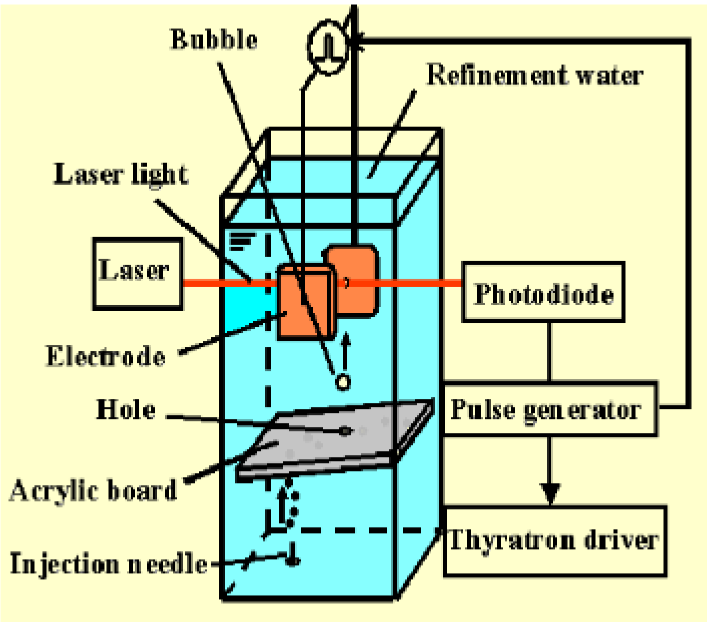

Figure 2 : Experiment setup for bubble on electrical discharge [4]

2.5 Local Discharge on Wet Polluted Insulator

According to [7], local discharge could be happen on the electrical insulators that exposed in a wet condition or a moisture. It is also called as wet polluted insulator. As an example, the wet transmission lines insulator and polluted transformer oil. It is known that local discharge propagates on wet polluted surface without drying the surface[7].Its mean, the discharge will be maintain, as the insulator is kept wet. An experiment in [7] has been conducted to gather information regarding local discharge on wet polluted insulator. The test is done by applying voltage on the electrolytic solution, which is represent the wet polluted insulator. The experiment used an electrolytic solution of aqueous solution of potassium chloride. The impulse voltages has been focused as to be related to lightning phenomena. The experiment setup is shown below.

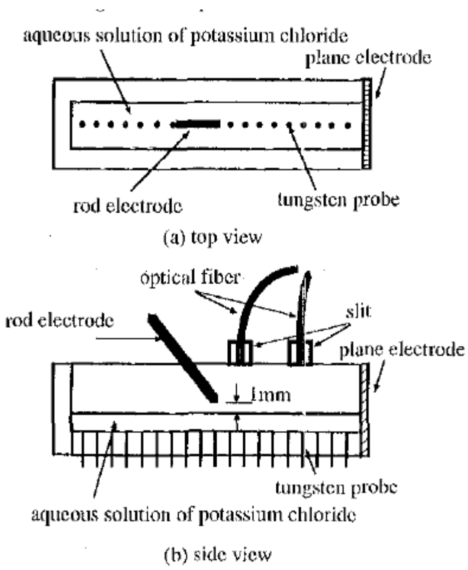

Figure 3 : Electrode system [7]

Tungsten probe at the bottom and plane electrode functioned to detect current distribution and propagation during the discharges occur. When the voltages is applied from the rod electrode, the local discharge occur between the rod electrode and solution surface .The experiment recorded that current flow through the solution surface and voltages difference occurs between the tungsten probe. The voltages difference were varies as the local discharges propagates.[7]

2.6 Rogowski Coil

Rogowski Coil is an electrical device used for measuring alternating current (AC) such as high speed transient; pulsed currents or fast changing current impulses. Rogowski coil is actually a coil of wire that wound on a non-magnetic material or air as a core and it has a constant cross sectional area [9]. The winding wire is lead from one end returning through the centre of the coil to the other end, so that both terminals are at the same end of the coil [8]. The free end of the coil is normally inserted into an electronic integrator circuit, as it will provide an output signal that is proportional to the measured current [8]. Like a CT's(current transformer), the conductor that carry measured current, or a primary conductor can be placed at the centre of the coil for measurement process. The Rogowski coil using a comparison principles, which at the coil and at the primary conductor. The voltage induced in the coil will be proportional to the rate of change of current in the primary conductor. The voltage that induced can connected to the electronic integrator. This will generate a signal in accordance with the changing current signal.

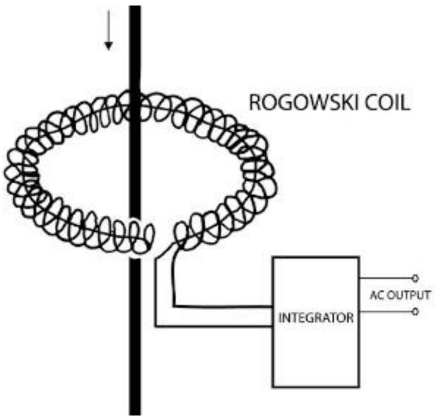

Figure 4 : Rogowski coil construction with electronic comparator [9]

2.7 Impulse Voltage Generator

2.7.1 Impulse Voltage

Impulse voltages is a transient voltage where its amplitudes may hugely exceed the peak values of the normal AC operating voltage, in other words, a very short high voltage surges. There is two common type of impulse voltages, which is both over voltages of lightning and switching. The lighting over voltages is a natural phenomenon, where it is a peak discharge in which charge accumulated in the cloud discharges into neighbouring cloud or ground [11]. Lightning over voltages is very sudden, unpredictable and could draw a large value of current and voltages in a short time which make it considerably more dangerous. Meanwhile, the switching phenomena is occur in the electrical system during the connection and disconnection of circuit breaker contact or due to interruption of fault [11]. The rate of voltage rise is usually proportional to the operating voltages. This two phenomena normally brought a temporary over voltages to the system, and a good insulation is essential for protection purpose.