THESIS

THE STUDY OF LIGHTNING PEAK CURRENT AND TYPES, CASE STUDY IN PALEMBANG, INDONESIA

Prepared to Meet the Requirements for Obtaining a Bachelor's Degree Engineering in the Department of Electrical Engineering, Faculty of Engineering Universitas Sriwijaya

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ELECTRICAL ENGINEERING MAJOR

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VALIDITY SHEET

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APPROVAL

I, as supervisor hereby declare that I have read and agree to this thesis and in my view the scope and quality of this thesis is sufficient as the thesis for undergraduate students (S1) :

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All praise is due to Allâh, the Lord of the Worlds

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The author realizes that in the preparation of this thesis there are still many shortcomings. Therefore, constructive criticism and suggestions from all parties are very much expected. Hopefully this final project can be useful for all of us.

Palembang, July 2023

Writer

ABSTRACT

THE STUDY OF LIGHTNIG PEAK CURRENT AND TYPES, CASE STUDY IN PALEMBANG, INDONESIA

(Muhammad At-Thoriq Annajmustsaqib, 03041181924018, 2023, xiv + 55 Pages. + Attachment)

The discussion of the peak current of lightning strikes is very important for research. Prevention of threats that can be caused by very high lightning strikes is an important thing to research. The peak current of lightning strikes is the main parameter in studying and understanding the characteristics of lightning and the impact on human life and safety. This research was conducted using a Parallel Plate Antenna with a Fast Field Buffer Sensor, which was imaged through the Picoscope 5000 and Picoscope Software through a Personal Computer. The data to be processed is obtained from the Class 1 Climate Station of the South Sumatra Meteorology, Climatology and Geophysics Agency (BMKG). Furthermore, the data will be selected with the data obtained by the Measurement Station at Sriwijaya University at a radius of 50 kilometers. In this study, 29 out of 80, 883 BMKG data recorded by Unsri station will be the main data measured and analyzed for lightning type. 1 CG positive type lightning, 2 CG negative type lightning, 4 IC positive type lightning, and 22 IC negative type lightning were obtained. The value of the peak current of a lightning strike is obtained by taking into account the value of lightning velocity, induced voltage which is converted into the Electric Field Value.

Key words : Lightning Peak Current; Lightning Types; BMKG; picoscopes; MATLAB;

ABSTRAK

KAJIAN ARUS PUNCAK SAMBARAN PETIR DAN TIPENYA, STUDI KASUS DI PALEMBANG, INDONESIA

(Muhammad At-Thoriq Annajmustsaqib, 03041181924018, 2023, xiv + 55 Halaman. + Lampiran)

Pembahasan arus puncak sambaran petir sangat penting untuk diteliti. Pencegahan ancaman yang dapat ditimbulkan oleh sambaran petir yang sangat tinggi merupakan hal yang penting untuk diteliti. Arus puncak sambaran petir merupakan parameter utama dalam mempelajari dan memahami karakteristik petir serta dampaknya terhadap kehidupan dan keselamatan manusia. Penelitian ini dilakukan dengan menggunakan Antena Parallel Plate dengan Fast Field Buffer Sensor yang dicitrakan melalui Picoscope 5000 dan Software Picoscope melalui Personal Computer. Data yang akan diolah diperoleh dari Stasiun Iklim Kelas 1 Badan Meteorologi Klimatologi dan Geofisika (BMKG) Sumatera Selatan. Selanjutnya data tersebut akan diseleksi dengan data yang diperoleh Stasiun Pengukuran Universitas Sriwijaya pada radius 50 kilometer. Dalam kajian ini, 29 dari 80.883 data BMKG yang terekam stasiun Unsri akan menjadi data utama yang diukur dan dianalisis jenis petirnya. Didapatkan 1 petir tipe positif CG, 2 petir tipe negatif CG, 4 petir tipe positif IC, dan 22 petir tipe negatif IC. Nilai arus puncak sambaran petir diperoleh dengan memperhitungkan nilai kecepatan petir, tegangan induksi yang diubah menjadi Nilai Medan Listrik.

Kata kunci: Arus Puncak Sambaran Petir; Tipe – tipe Petir; BMKG; *Picoscopes*; MATLAB;

STATEMENT OF PUBLICATION CONSENT FOR ACADEMIC INTERESTS

As an academic member of Sriwijaya University, who signed below:

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For the sake of scientific development, agree to Sriwijaya University **The Non-exclusive Royalty-Free Right for my scientific work** entitled, “The Study of Lightning Peak Current and Types, Case Study in Palembang, Indonesia" along with existing devices.

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LIST OF TERMS

Amplitude	:	Non-negative scalar measurement of the oscillation magnitude of a wave
Axis Scaling	:	Axis scale
Bandwidth	:	Frequency band width
Breakdown	:	Translucent electricity
Buffer-Circuits	:	Support chain
Cg-Flash	:	Lightning cloud to the ground
Channels	:	Channel
Coaxial Cable	:	Coaxial cable
Bolts From The Blue	:	Faster type of normal IC lightning strike
Comulonimbus	:	Abbreviated CB are vertical, towering clouds that are very tall, dense, and involved in thunderstorms and other cold weather
ElectricField	:	The region of space around an electrically charged particle or object where the charges experience a force
electrons	:	Subatomic particles are negatively charged and are often written as e-
Electromagnetic	:	A type of magnet in which a magnetic field is generated by an electric current
Fast-Field	:	The electric field is dominated by the radiation component
Field Mill	:	Measuring instrument for electric fields
Flash	:	Lightning strike
Flat Metallic Plate	:	Metal flat disc
Flat Plate Antennas	:	Flat dish antenna
Intra-Cloud	:	Lightning strikes that occur within clouds
leader	:	The heat generated by the plasma filament is generated when many ribbons join together in a small air space

Lightning Flash	:	Lightning flash
Lightning Mapping	:	Lightning strikes the map
Low Frequency	:	Frequency with Wavelength 30 MHz - 300 MHz
Magnetic Direction Finder	:	One of the lightning location system methods has the basic principle of two vertical orthogonal loops arranged with a North-South (NS) and East-West (EW) plane orientation.
Magnetic Fields	:	The area around a moving magnetic material or electric charge where magnetic forces act
Matlab	:	A programming platform specially designed for engineers and scientists to analyze and design the systems and products that change our world
Meteorology	:	The science that studies the earth and its symptoms, which are related to the earth's components in the form of gas or commonly called air
Tri Polar Charge	:	Type of payload in the cloud
noise	:	Noise signals that are acoustic, electrical, or electronic in nature present in a system.
Parallel Plate Antenna	:	Parallelized dish antenna
Peak Amplitude	:	Overshoot / Peak Amplitude Ratio
Point Discharge	:	Load discharge point
Picoscope	:	The perfect PC oscilloscope for measuring and testing virtually any electronic component and circuit in any modern vehicle
Pre-Triggers	:	The time the delay trigger starts to activate
Picoscope	:	The perfect PC oscilloscope for measuring and testing virtually any electronic component and circuit in any modern vehicle
ReturnStroke	:	Kickback
Rise Time	:	Time interval when the position is up
sampling	:	Sample selection
Single	:	Single

Slow-Field	:	The electric field is dominated by static and induced components
Thunder Storm	:	Thunderstorm
Transmitters	:	A device that converts changes in the sengsing element into signals that can be decoded by the controller
Triggers	:	Trigger
Triple Charges Structure	:	Three charge center structure consisting of positive charge center, negative charge center, positive charge pocket.
Very High Frequency	:	Frequency with Wavelength 30 MHz - 300 MHz
Very Low Frequency	:	Frequency with Wavelength 3 - 30 kHz

NOMENCLATUR

µs	: Microseconds
A	: Ampere
BMKG	: Meteorology Climatology and Geophysics Council
C/m	: Coulombs/meter
CG – Flash	: Cloud-to Ground Flash
CH	: Channels
CID	: Compact Intra Cloud
DC	: Direct Current
EES	: Electrical Energy and Safety
EM – Field	: Electromagnetic-Field
HF	: High Frequency
I	: Intermediates
IB	: Initial Breakdown
IC - Flash	: Intra-Cloud Flash
kA	: Kilo Ampere
m/s	: meters/second
NBEs	*: Narrow Bipolar Events*
PC	: Personal Computers
V/m	: Volts per Meter
Vm	: Voltmeter
m/s	: meters/second

CHAPTER I
INTRODUCTION

1.1 Background

Lightning is one of the most fantastic natural phenomena in the world.Lightning begins with a flash of light, followed by a roar. The difference in arrival time is due to the difference between the speed of sound and also the speed of light. Indonesia as a country with a tropical climate, has a fairly high annual rainfall [1]. Based on the map of the distribution of lightning strikes issued by the Meteorology, Climatology and Geophysics Agency (BMKG) in 2019, several areas of Indonesia have an average strike of more than 800,000 times. High intensity lightning spread over most of Java Island, parts of Sumatra Island, parts of Kalimantan Island, and several other areas [2]. Palembang City is located in South Sumatra Province, Indonesia. Geographically, the coordinates of Palembang City are around 2.9900° S south latitude, 104.7560° East longitude. The high intensity of lightning strikes in an area is not only determined by geographic coordinates, but also influenced by factors such as weather patterns, topography and local climate. However, because Palembang is located in the tropics with relatively high rainfall throughout the year, there is generally a fairly high potential for lightning strikes [3].

Lightning is one of the natural events, in the form of a discharge of electric charge with a fairly high current and is transient (brief) that occurs in the atmosphere. The reason is the accumulation of positively (+) and negatively (-) charged free ions in the atmosphere, especially in Cumulonimbus (CB) clouds. These electric ions are generated by friction between water vapor particles in the clouds and this ionization event is caused by changes in the form of water starting from liquid to gas or vice versa, even solid (ice) to liquid. Lightning occurs due to

a potential difference between the two mediums which results in a transfer of charges to reach equilibrium. The amount of energy from the release of the charge causes thunder or lightning, which is a series of very strong light, heat and sound. When the accumulation of electric charge in the cloud has enlarged and stabilized, the electric jump that occurs will spread to other masses with electric fields. The difference in electrical voltages during lightning is in excess of several million volts [4][5].

Lightning can cause severe damage to property. Lightning occurs when a region of the atmosphere acquires a sufficiently large electric charge to cause an electrical disturbance. It has been reported that there are 2000 thunderstorms in progress at any time producing 100 lightning strikes to the ground per second or 8 million per day.The higher the intensity of lightning causes the potential risk of danger posed to also increase, in fact, several incidents of lightning strikes resulted in damage to infrastructure and death. To reduce and minimize the risk of harm from lightning activity (mitigation), lightning protection or protection is needed [6][7]. This has become a significant threat to many countries. Many tropical countries, some of the southern US states, Japan, and parts of Australia, experience fairly frequent annual lightning events [8].

Based on where it occurs, lightning can be divided into two types, namely Cloud to Ground flash (CG-flash) and Cloud flash. Cloud-to-Ground flash (CGflash) is a lightning flash that occurs between the center of charge on the tripole *structure*in the cloud to the ground CG-flash which carries a positive charge downward towards the ground is referred to as the positive CG-flash, while the CG-flash is carrying a negative charge towards the ground is a negative CG-flash.. Cloud Flash divided into 2 namely Cloud to Cloud (Inter Cloud) flash and Intra-Cloud (IC) *flash. CloudFlash*it also consists of a normal IC-flash and a special type of IC-Flash known as Narrow Bipolar Events (NBEs) / Narrow Bipolar Pulse *(NBP)*. NBEs also have two types according to the polarity of the emission region known as Positive Positive Bipolar Events (+NBE) and Narrow Negative Bipolar Events (–NBE) [5].

To detect and measure the generated electromagnetic field by a flash of lightning on the IC-flash. Remote sensing (sensor) can be used. The sensor is used to detect the radiation component of a lightning flash is an electric field antenna system that operates from a few hertz to megahertz. Several types of sensors include: (a) vertical whip *antenna*; (b) field mills; and (c) flat plate antenna, which has been later developed into a parallel plate antenna. Measurements in order to observed the behavior of the changing electric field generated by the flash The lightning was recorded using the parallel-plate-antenna method connected to the buffer-circuit (slow-field and fast-field systems), in case certain slow-field systems are used as a method for estimating distances from the ongoing lightning flash that occurred ranged under 30 km from the station recording [9], while the fast-field is used for observing the values of *amplitude*as well as the rise time of a series of processes that occur behind the mechanism the occurrence of lightning flashes specifically on the characteristics of NBEs.

At present, case studies regarding lightning strikes show a progressive status, in various countries research on lightning strikes continues to be carried out, referring to the urgency that is currently increasing, in line with scientific developments and the needs of industrial safety. Lightning Peak Current and Types is one of the topics discussed, starting from the Berger Polishing method applied at Mount San Salvator, Switzerland, to measurements with the Magnetic Tape Peak Current at Mount Tangkuban Perahu, West Java.

1.2 Problem Statement

Currently, it is very important to know the urgency of knowledge about lightning, especially in tropical areas such as Palembang, Indonesia which has quite high rainfall. With so many cases of danger due to lightning strikes occurring, research on recordings of lightning strike waves is very important to study. Through the wave of lightning strikes we can measure the Peak Current of Lightning Strikes and we can also identify the type of lightning strike. This is what makes the study of Lightning Peak Current and Types very interesting to discuss.

This study refers to research conducted by F. Rachidi et al who measured the peak current by converting the Electric Field value using Formulas (1) and (2) in his journal [10]. In measuring the value of the electric field, this study also refers to the research of Sulaiman et al, using Formulas (3), (4), and (5) in their research [11].

Therefore, the Palembang region, Indonesia, which is included in a tropical climate which has quite high rainfall, is a potential area for research on peak currents of lightning strikes and classification of types of lightning. This research is expected to contribute to design standards for lightning rods in the tropics, especially Palembang. Indonesia.

1.3 Objectives

The objectives in this study are:

1. To calculate the peak current value of a lightning strike in Palembang, Indonesia.
2. To get the type of lightning based on lightning strike wave data in Palembang, Indonesia.
3. To provide information on standard strength of lightning rods in Palembang, Indonesia.

1.4 Scope of Works

The scope of this research is:

1. Lightning strike data to be tested comes from the Indonesian Meteorology, Climatology and Geophysics Agency (BMKG) on 21-28 February 2023.
2. The data to be measured and analyzed is selected data from the BMKG recorded within a 50 km radius by the Parallel Plate Antenna Sensor at the Measurement Station, Faculty of Engineering, Sriwijaya University.

3. The Peak Lightning Current measurement is related to the distance of the lightning strike from the Measurement Station, and the induced voltage value is processed into an Electric Field value using Formulas (1) and (2) from the research of F. Rachidi et al.[10], and Formulas (3), (4), (5) from the research of Sulaiman et al[11], which will produce the Peak Lightning Current value.
4. Lightning Type Identification uses the manual method based on the Peak Lightning Current by observing the Lightning Waveforms obtained.
5. Data on the distance to the lightning strike location is obtained from the coordinates of the lightning strike points listed in the BMKG data.

1.5 Hypothesis

In this research, the researcher hypothesizes that the intensity of lightning strikes recorded in the Palembang region will be dominated by the Cloud Flash / IC Flash type of lightning. Additionally, the peak current of lightning strikes with the highest value will originate from the Cloud to Ground Flash type of lightning. The researcher also hypothesizes that the distance of the strikes affects the peak current value of lightning strikes; the closer the distance of the strike, the greater the peak current value of the lightning strikes.

1.6 Thesis Structure

The structure in the authorship of this proposal is as follows:

CHAPTER I INTRODUCTION

This chapter discusses the research background, problem Formulation, research objectives, scope of work, and writing systematics.

CHAPTER II LITERATURE REVIEW

This chapter discusses the basic theory related to lightning strikes, lightning location systems, and interferometric methods.

CHAPTER III RESEARCH METHODOLOGY

This chapter contains the place, time, equipment used, series of experiments, testing procedures, data collection techniques and data processing used in the preparation of the final project and explains in general about the research process to be carried out.

CHAPTER IV RESULTS AND DISCUSSION

This chapter describes the results of the data that have been identified and analyzed as well as discussion.

CHAPTER V CONCLUSIONS AND RECOMMENDATIONS

This chapter is a conclusion from the results of the research that has been presented in CHAPTER IV and suggestions put forward related to the research that has been done.

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