MyHVnet

Newsletter

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MyHVnet is the abbreviated name for Malaysian High Voltage Network – a networking group for high voltage engineering in Malaysia.

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MyHVnet Colloquium Successfully Held

KAJANG, 12 August 2024 – The 2024 Malaysian High Voltage Network (MyHVnet) Colloquium, organised by MyHVnet and the Institute of Electrical and Electronics Engineers (IEEE) Dielectrics and Electrical Insulation Society (DEIS) Malaysia Chapter, with co-organisers including the IEEE Young Professionals, Universiti Tenaga Nasional (UNITEN), and various IEEE student branches, was successfully held on 12 August 2024 at the Admin Building, UNITEN, Kajang, Selangor. The one-day event aimed to foster networking among academicians, industrialists, and students, with a total of 60 attendees, 40 of whom were IEEE members.

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Group photo during colloquium.

IEEE DEIS Malaysia Chapter AGM

KUALA LUMPUR, 18 January 2025 – The 2025 Annual General Meeting (AGM) of the Institute of Electrical and Electronics Engineers (IEEE) Dielectrics and Electrical Insulation Society (DEIS) Malaysia Chapter was successfully held in hybrid mode on 18 January 2025 (Saturday) at the Kuala Lumpur Convention Centre (KLCC) and online Google Meet concurrently. The meeting was attended by 20 active IEEE DEIS Malaysia Chapter members. The meeting started at 9 am and was

(continued on page 6…)

Group photo.

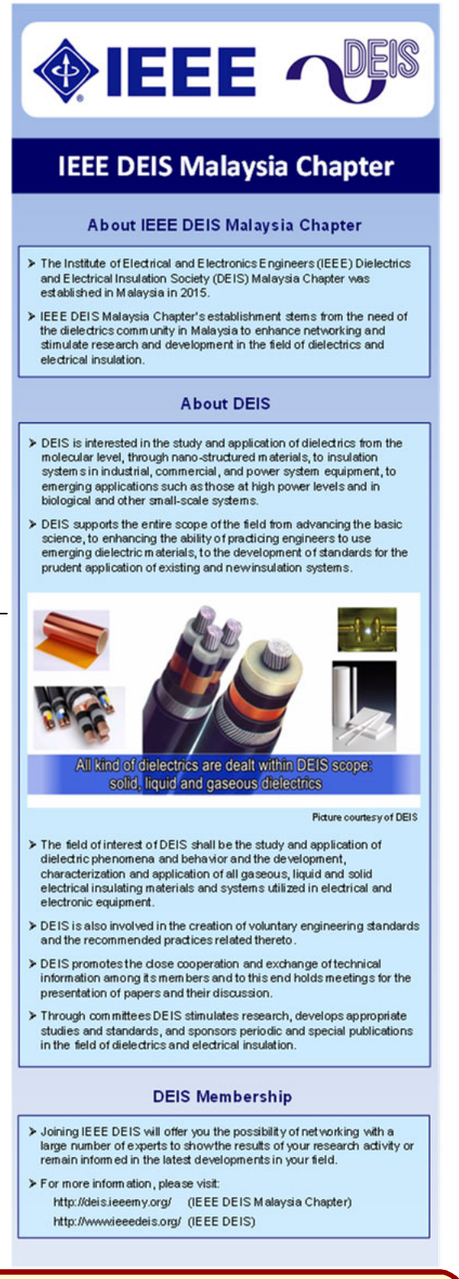
About IEEE DEIS Malaysia Chapter

MALAYSIA, 01 January 2025 – The IEEE Dielectrics and Electrical Insulation Society (DEIS) Malaysia Chapter was established in Malaysia in May 2015 with the aims to enhance networking and stimulate research and development in the field of dielectrics and electrical insulation in Malaysia. Its field of interest is in line with that of DEIS, i.e., the study and application of dielectric phenomena and behavior and the development, characterization and application of all gaseous, liquid and solid electrical insulating materials and systems utilized in electrical and electronic equipment. Through committees, IEEE DEIS Malaysia Chapter hopes to promote the close cooperation and exchange of technical information among its members.

Those joining DEIS will have the possibility of networking with a large number of experts worldwide, including Malaysia (through IEEE DEIS Malaysia Chapter), to show the results of their research activity or remain informed in the latest developments in their field. For more information, please visit:

http://deis.ieeemy.org/ (IEEE DEIS Malaysia Chapter)

http://www.ieeedeis.org/ (IEEE DEIS)


IEEE DEIS Malaysia Chapter

About IEEE DEIS Malaysia Chapter

- The Institute of Electrical and Electronics Engineers (IEEE) Dielectrics and Electrical Insulation Society (DEIS) Malaysia Chapter was established in Malaysia in 2015.
- IEEE DEIS Malaysia Chapter's establishment stems from the need of the dielectrics community in Malaysia to enhance networking and stimulate research and development in the field of dielectrics and electrical insulation.

About DEIS

- DEIS is interested in the study and application of dielectrics from the molecular level, through nano-structured materials, to insulation systems in industrial, commercial, and power system equipment, to emerging applications such as those at high power levels and in biological and other small-scale systems.
- DEIS supports the entire scope of the field from advancing the basic science, to enhancing the ability of practicing engineers to use emerging dielectric materials, to the development of standards for the prudent application of existing and newinsulation systems.

All kind of dielectrics are dealt within DEIS scope: solid, liquid and gaseous dielectrics

Picture courtesy of DEIS

- The field of interest of DEIS shall be the study and application of dielectric phenomena and behavior and the development, characterization and application of all gaseous, liquid and solid electrical insulating materials and systems utilized in electrical and electronic equipment.
- DEIS is also involved in the creation of voluntary engineering standards and the recommended practices related thereto.
- DEIS promotes the close cooperation and exchange of technical information among its members and to this end holds meetings for the presentation of papers and their discussion.
- Through committees DEIS stimulates research, develops appropriate studies and standards, and sponsors periodic and special publications in the field of dielectrics and electrical insulation.

DEIS Membership

- Joining IEEE DEIS will offer you the possibility of networking with a large number of experts to showthe results of your research activity or remain informed in the latest developments in your field.
- For more information, please visit:
  http://deis.ieeemy.org/ (IEEE DEIS Malaysia Chapter)
  http://www.ieeedeis.org/ (IEEE DEIS)

News on MyHVnet

In case you missed the previous news on Malaysian High Voltage Network (MyHVnet), Issues 1 to 9 of MyHVnet Newsletter (an initiative for the dissemination of high voltage related news, with particular emphasis on MyHVnet's activities) can be downloaded from the following link:

http://ivat.utm.my/myhvnet/news/


MyHVnet Newsletter

Technical Visit to 500/275kV Substation

Technical Talk on Transformer Technology


MyHVnet Newsletter

2023 MyHVnet AGM

Technical Visit to TNB Research

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High Voltage Research Networking

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The event began with a welcome address by the Chairman of MyHVNet, Ir. Dr. Mohd Aizam Talib, and the Chairman of IEEE DEIS Malaysia Chapter, Assoc. Prof. Ir. Dr. Hazlee Azil Illias, followed by an informal networking session tailored for young professionals. The session focused on career development and opportunities within the IEEE ecosystem. Membership drives and technical society booths were also set up to promote IEEE and DEIS memberships.

Membership drive.



Some photos during parallel sessions.

The colloquium featured two technical talks on high voltage engineering, delivered by Ir. Muhammad Haízuddin Mohamad and Associate Professor Ir. Ts. Dr. Lau Kwan Yiew. The topics covered were "Cross-country fault phenomena – case study" and "Embracing Sustainability through Advancements of Dielectric Materials."


Photo of Dr. Hazlee, Ir. Haizuddin, Dr. Lau, and Dr. Aizam (from left to right).

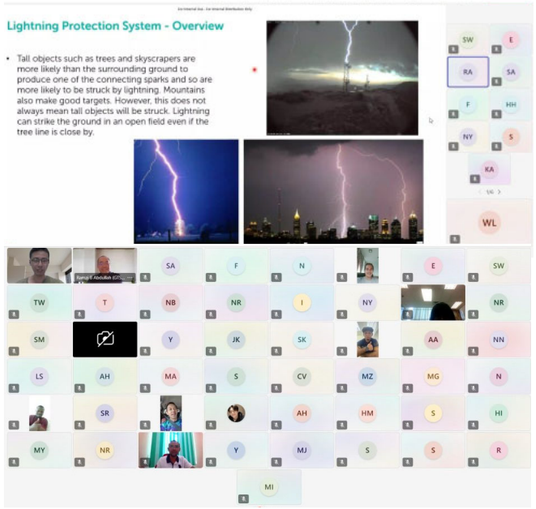
Parallel sessions were conducted, allowing researchers and engineers to present their findings on various high voltage topics, such as insulation, electrical discharges, lightning, transformers, and grounding systems. Each session had 10-11 presentations, providing ample opportunities for professional networking and engagement.


Some photos during award presentation session.

Ir. Ts. Dr. Wooi Chin Leong, Universiti Malaysia Perlis.

Industrial Practice and Incident Related to Lightning Protection and Grounding Systems

ARAU, 16 November 2024 – The Faculty of Electrical Engineering and Technology (FKTE) Postgraduate Academy, in collaboration with Universiti Malaysia Perlis (UniMAP), the Institute of Electrical and Electronics Engineers (IEEE) Dielectrics and Electrical Insulation Society (DEIS) Malaysia Chapter, and PETRONAS, successfully organised an online webinar entitled "Industrial Practice and Incident Related to Lightning Protection and Grounding Systems" on 16 November 2024. The session, held on Microsoft Teams, was attended by 60 participants, including postgraduate students and academic staff.



Screenshot of the webinar.

The invited speaker, Mr. Ramzi Abdullah, a Staff Engineer at PETRONAS with over 20 years of experience in the oil and gas sector, shared his expertise on lightning protection and grounding systems. His talk covered best practices, common incidents, design considerations, and regulatory compliance in industrial applications, sparking an engaging discussion during the questions-and-answers session.

The webinar received an overwhelmingly positive response, with participants praising the speaker's in-depth knowledge and the relevance of the topic. FKTE Postgraduate Academy extends its gratitude to all contributors for making this event a success.

Ir. Ts. Dr. Wooi Chin Leong, Universiti Malaysia Perlis.

Technical Symposium on Ester Oil

PUTRAJAYA, 12 June 2024 – Four new academic staff memners of the Institute of High Voltage and High Current (IVAT), Universiti Teknologi Malaysia, namely, Dr. Norhafezaidi Mat Saman, Dr. Noor Syazwani Mansor, Dr. Nor Aqilah Mohamad, and Dr. Aizat Azmi, participated in a technical symposium entitled "From Nature to Power: Transforming Grid with Ester Oil" at Le Meridien Hotel, Putrajaya. The symposium was organised by TNB Labs Sdn. Bhd. in collaboration with the International Council on Large Electric Systems (CIGRE), Universiti Teknikal Malaysia Melaka (UTeM), Power Transcoteq and Services Sdn. Bhd., and Apyree Sdn. Bhd.


Dr. Syazwani, Dr. Norhafezaidi, Dr. Aqilah, and Dr. Aizat (from left to right)

The main aim of the symposium was to exchange knowledge and information on the technology, performance and advantages of green alternative oils to optimise the operation, maintenance, and condition of transformers. Topics covered included the exploration of ester-based transformer oils with enhanced performance and sustainability, electrical properties of palm oil and rice bran oil for transformer applications, and the potential of used cooking oil as low viscosity dielectric liquid for transformers.

The participation of IVAT's staff members in the symposium allowed them to gain invaluable insights into the use of sustainable oil in revolutionising the power grid, understand environmental responsibility in the future of power lines, and network with industry leaders. This is in line with IVAT's commitment to raise the awareness of its staff members with regard to the research and development capabilities in high voltage related industries. The symposium served as an excellent platform for the discussion of high voltage related research and development, a key focus that Malaysian High Voltage Network (MyHVnet) has consistently emphasised.

Assoc. Prof. Eur. Ing. Ir. Ts. Dr. Lau Kwan Yiew, Universiti Teknologi Malaysia.

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Technical Visit to National Energy Centre

KAJANG, 12 August 2024 – A visit to a new industrial related laboratory named National Energy Centre (NEC) was participated by members of Malaysian High Voltage Network (MyHVnet) on 12 August 2024. This cutting-edge facilities within NEC are designed to support advanced research and development in high-voltage and related industrial technologies. The visit provided the participants with:

- Guided Tour: A comprehensive walkthrough of the buidling showcasing the latest equipment and research capabilities.
- Live Demonstrations: Insight into ongoing experiments and projects, emphasizing practical applications in high-voltage engineering and electrical systems.
- Networking Opportunity: Engage with leading researchers, Universiti Tenaga Nasional (UNITEN) faculty, and industry professionals to discuss collaborations and advancements.
- Question-and-answer Session: An interactive session to address queries about the laboratory's purpose, functions, and future research directions.


Photo during visit.

This visit aligns with the mission of MyHVnet to bridge the gap between academic research and industrial applications, fostering innovation and knowledge sharing in the high-voltage domain.

Dr. Thien Yee Von, Tunku Abdul Rahman University of Management and Technology.

Research Collaboration between UiTM and UMHVL in High Voltage

KUALA LUMPUR, 30 May 2024 – An academic staff and 2 final year project undergraduate students from the College of Engineering, Universiti Teknologi MARA (UiTM) Shah Alam visited the Universiti Malaya High Voltage Laboratory (UMHVL) at the Department of Electrical Engineering, Faculty of Engineering, Universiti Malaya on 28 May 2024. The main purpose of the visit was to enhance research collaboration between UiTM and UMHVL in the field of high voltage engineering.

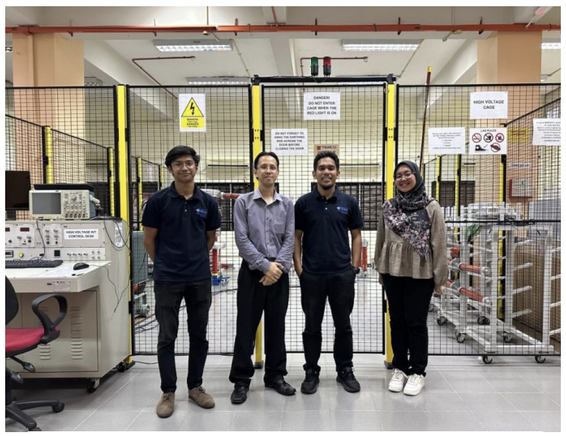


Photo during visit.

During the visit, the Head of UMHVL, Assoc. Prof. Ir. Dr. Hazlee Azil Illias, who is also the Chair of the Institute of Electrical and Electronics Engineers (IEEE) Dielectrics and Electrical Insulation Society (DEIS) Malaysia Chapter and the Counselor of the IEEE Universiti Malaya Student Branch, introduced the facilities available at UMHVL and explained the activities carried out at the laboratory and the laboratory safety requirement. The delegates were brought to UMHVL to gain a better insight into the laboratory. After that, a discussion was held between Ir. Dr. Hazlee and Ts. Dr. Nik Hakimi Nik Ali from UiTM, who is also a member of the DEIS Malaysia Chapter, to update on the ongoing research collaboration and to establish future research project collaboration.

Assoc. Prof. Ir. Dr. Hazlee Azil Illias, Universiti Malaya.

IEEE DEIS Malaysia Chapter Committee 2025-2026

… (continued from page 1)

chaired by Chapter Chair Prof. Ir. Dr. Hazlee Azil Illias. The meeting began with an opening remark by the Chair, followed by the endorsement of the 2024 AGM minutes.

Discussion during the meeting.

The meeting then continued with the presentation of the chapter's activities by Secretary Ir. Ts. Dr. Wooi Chin Leong. Next, Treasurer Ts. Dr. Nik Hakimi Bin Nik Ali presented account matters. The meeting continued with the election of the 2025 committee members of the IEEE DEIS Malaysia Chapter, summarised as follows:

Past Chair:
Prof. Ir. Dr. Hazlee Azil Illias

Chair:
Assoc. Prof. Ir. Dr. Norhafiz Azis

Vice Chair:
Assoc. Prof. Ir. Dr. Mohd Fairouz Mohd Yousof

Secretary:
Ir. Ts. Dr. Wooi Chin Leong

Treasurer:
Dr. Nik Hakimi Nik Ali

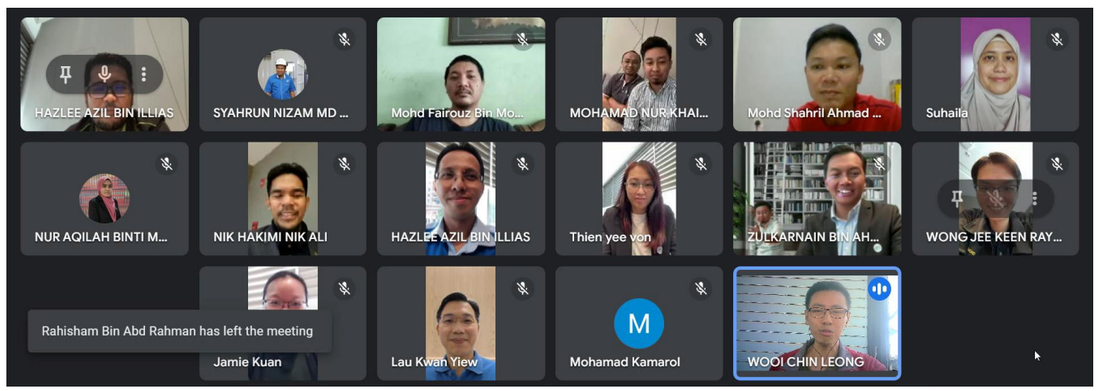
Executive Committee:
Dr. Thien Yee Von
Ir. Ts. Dr. Mohd Shahril Ahmad Khiar
Ir. Ts. Dr. Raymond Wong Jee Keen
Assoc. Prof. Ts. Dr. Mohamad Nur Khairul Hafizi Rohani
Dr. Suhaila Sulaiman
Dr. Nur Aqilah Mohamad

Auditors:
Dr. Kuan Tze Mei
Assoc. Prof. Ir. Ts. Dr. Syahrun Nizam bin Md Arshad @ Hashim

Lunch after the meeting.

The new Chapter Chair, Assoc. Prof. Ir. Dr. Norhafiz Azis, later delivered his welcoming speech to the new committee line-up and made a brief planning for the activities in 2025. Dr. Norhafiz is hopeful that the DEIS Malaysia Chapter will continue to contribute actively in the field of dielectrics and electrical insulation and looking forward to lead the DEIS Malaysia Chapter to a greater height.

Dr. Thien Yee Von, Tunku Abdul Rahman University of Management and Technology.



Some participants who joined the online meeting.

PhD Opportunities: University of Malaya High Voltage Research Group

UNIVERSITI MALAYA

Greetings,

We are pleased to invite applications for PhD study at University of Malaya High Voltage Research Group (UMHVRG). The scopes of the projects include but are not limited to:

- Partial discharge measurement and simulation
- Dielectric material characterisations
- Artificial intelligence techniques in condition monitoring
- Optimisation techniques in high voltage equipment parameters' estimation
- Other high voltage engineering studies

STUDY MODE: Full-time research (Minimum 2 years, maximum 4 years)

REQUIREMENT:

- Academic qualification:
  - [Bachelor's Degree in Electrical Engineering with CGPA ≥ 3.7 or equivalent] OR;
  - [Bachelor's Degree in Electrical Engineering with CGPA ≥ 3.0 or equivalent] AND [Master by research in Engineering OR Master by Coursework in Engineering with CGPA ≥ 3.00]
- Self-funded or sponsored
- Proficient in English language (written and spoken)
- Pleasant personality, hardworking and self-motivated
- Ability to carry out research work independently, quickly and efficiently
- Willing to write review and research papers

Advantages of pursuing PhD in UMHVRG:

- Widely experienced supervisors
- Great high voltage laboratory facilities
- Excellent working environment
- Friendly and helpful colleagues
- Top-class facilities in University of Malaya
- Become a Graduate Research Assistant with a salary up to RM 3,200 per month

Interested candidate please send your resume with academic transcripts and research proposal to Associate Professor Ir. Dr. Hazlee Illias at h.illias@um.edu.my anytime throughout the year.

For more information about University of Malaya High Voltage Laboratory, please visit http://umhvl.um.edu.my

For more information about the application of PhD study at the University of Malaya, please visit https://www.um.edu.my/doctorate

Thank you.

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Research Engagement in Solar Energy

ARAU, 03 November 2025 - From 31 October to 2 November 2024, a delegation from the Gansu Natural Energy Research Institute (GNERI), China, visited the Faculty of Electrical Engineering and Technology (FKTE) at Universiti Malaysia Perlis (UniMAP). Comprising four esteemed members, including Assoc. Prof. Ma Hongruo, Prof. Chen Zuoyan, Prof. Liu Gang, and Prof. Han Lijuan, the visit aimed to foster research collaborations, particularly in solar energy and energy storage, and to explore UniMAP's solar research laboratories and solar pump research site.

The visit began with the delegation's arrival in Alor Setar on 31 October, followed by their transport to Putra Regency Hotel and a welcoming dinner. On 1 November, the programme included a welcome speech by the representative of the Electrical Department and the Institute of Electrical and Electronics Engineers (IEEE) Dielectrics and Electrical Insulation Society (DEIS), a sharing session between researchers, and a guided tour of FKTE's solar research laboratory and UniMAP library. In the afternoon, the delegation visited the solar pump research site in Kg. Kersek, Mata Ayer, and concluded the day with a dinner in Perlis. The final day included a tour of various sites in Perlis before the delegation's departure. The visit was highly successful in strengthening international research collaboration in renewable energy and showcasing UniMAP's research capabilities. This engagement is expected to pave the way for future partnerships between UniMAP and GNERI.

Group photo.

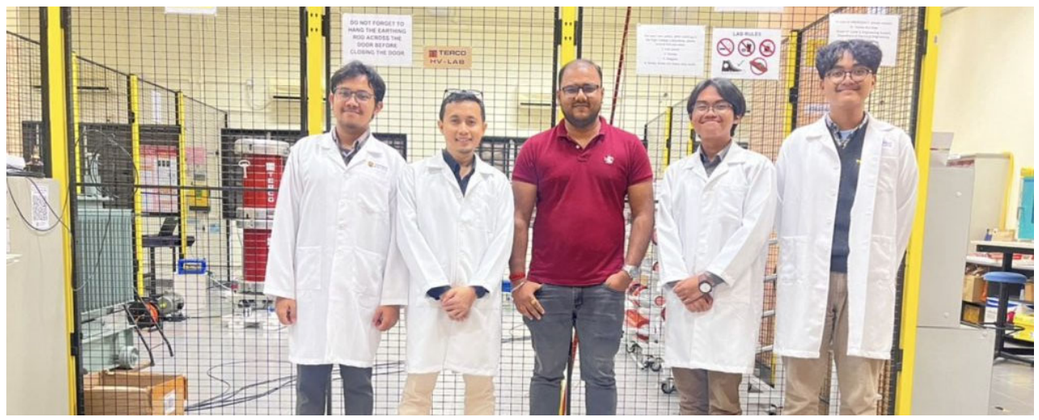
Ir. Ts. Dr. Wooi Chin Leong, Universiti Malaysia Perlis.

Student Mobility Attachment Program Visit to UMHVL

KUALA LUMPUR, 10 May 2024 – Three students under the 2024 Student Mobility Attachment Programme at the Faculty of Engineering visited the Universiti Malaya High Voltage Laboratory (UMHVL) at the Department of Electrical Engineering, Faculty of Engineering, Universiti Malaya on 9 May 2024. The visit was part of their activities under the programme and to expose them to high voltage engineering field. The students were supervised by Prof. Ir. Dr. Ngoh Gek Cheng and co-supervised by Angky Wahyu Putranto from the Department of Chemical Engineering.

During the visit, one of the UMHVL members, Dr. Saurabh Dutta, who is also a postdoctoral researcher under the Faculty of Engineering, explained the activities carried out at the laboratory and the laboratory safety requirements. After that, the students visited UMHVL to gain a better insight into the laboratory.

Assoc. Prof. Ir. Dr. Hazlee Azil Illias, Universiti Malaya.


Group photo.

Installation of Solar Panel at Tuba Island, Malaysia

LANGKAWI, 26 February 2024 - Tuba Island, situated near Langkawi Island in Malaysia, boasts a vibrant fishing community. Accessible by a 45-minute boat ride from Kuala Perlis Jetty or a mere 15 minutes from Tuba Island itself, the island's east coast hosts a bustling fishing village. The community hall, originally constructed by the Department of Fisheries Malaysia, serves as a central hub for daily activities and occasional community gatherings.

In 2023, management of the hall transitioned to Koperasi Komuniti Kepulauan Tuba & Selat (KOPTUBAS), prompted by the need for electrical infrastructure. With no existing power supply, KOPTUBAS embarked on a fundraising campaign to install a solar system, ensuring basic electrical amenities such as fans and lighting.

Recognising the importance of this initiative, several lecturers from Universiti Malaysia Perlis identified the project as suitable for the Institute of Electrical and Electronics Engineers (IEEE) Humanitarian Technologies Board (HTB) Special Interest Group on Humanitarian Technology (SIGHT) application. Following discussions with KOPTUBAS representatives, project details were meticulously reviewed and refined.

Various photos during the programme.

There were 3 teams take caring the installation: (i) Team 1 worked on wiring installation and install inverter, lighting and socket inside the community hall, (ii) Team 2 worked on roof top solar panel installation, where this team got to fix the racking system and fix the solar panel on the roof top, and (iii) Team 3 fixed the rest of works, signboard, closed-circuit television (CCTV) installation and power meter installation. There was also another media team working with video and picture capturing.

Ir. Ts. Dr. Wooi Chin Leong, Universiti Malaysia Perlis.

Taylor's University Visit to UMHVL

KUALA LUMPUR, 21 May 2024 – An academic staff and 15 students from Taylor's University Malaysia visited the Universiti Malaya High Voltage Laboratory (UMHVL) at the Department of Electrical Engineering, Faculty of Engineering, Universiti Malaya on 21 May 2024. The visit was part of their educational activities. During the visit, members of UMHVL, Nasiru Yahaya Ahmed and Ciptian Weried Priananda, who are also members of IEEE Universiti Malaya Student Branch, explained the laboratory safety requirements and demonstrated high impulse voltage generation to the visitors.

Assoc. Prof. Ir. Dr. Hazlee Azil Illias, Universiti Malaya.

Group photo.

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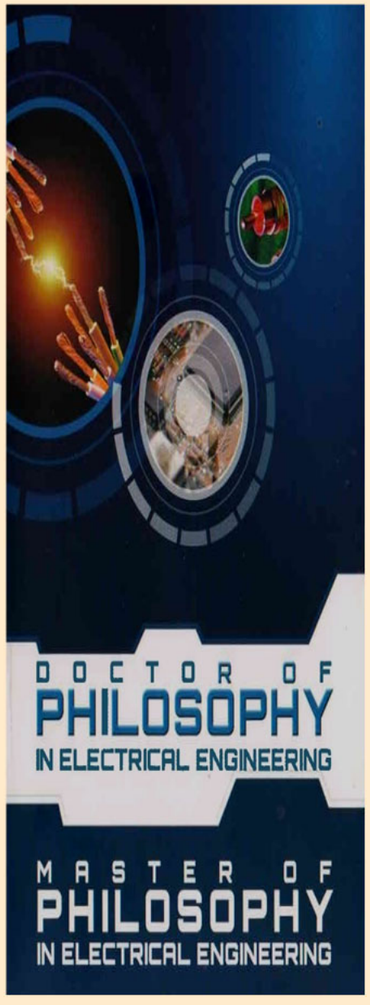
Pursue Your Postgraduate Studies at UTM IVAT

The Institute of High Voltage and High Current (IVAT), Universiti Teknologi Malaysia (UTM), welcomes applications for Doctor of Philosophy (PhD) and Master of Philosophy (MPhil) studies to undertake research projects at IVAT. The themes of the projects include:

- Lightning characterisation, monitoring and detection
- Electromagnetic compatibility and interference
- Partial discharge detection and measurements
- Plasma and ozone generation applications
- Supercapacitors in high voltage applications
- Dielectrics and electrical insulating materials



Admission Requirements:

- PhD:

  Entry to the programme requires a Master degree in Electrical Engineering or equivalent from UTM or other Institution of Higher Learning recognised by UTM. First-class Bachelor graduates (CGPA ≥ 3.67/4.00) may apply for a fast-track PhD (terms & conditions apply)

- MPhil:

  Entry to the programme requires a Bachelor degree in Electrical Engineering or equivalent from a tertiary institution recognised by UTM, with a minimum CGPA of 3.00/4.00 for fresh graduates, or a minimum of 2.50/4.00 with four (4) years experience as an Electrical Engineering practitioner

- English Requirement for International Students:

  All international students must have a valid two-year old IELTS certificate an IELTS Band 6.0

Why Study at IVAT?

- Our field of electrical and electronic engineering is ranked Top 100 in the world (according to QS World University Rankings by Subject 2024)
- Our high voltage laboratory is the largest in Malaysia
- We have well-equipped high voltage facilities
- We have widely experienced supervisors working on a variety of high voltage related research and development
- We have dedicated student working areas for office and laboratory work

To Apply:

- Please send your resume with academic qualifications, transcripts and research proposal to ivat@utm.my anytime throughout the year. You may also directly contact the respective project supervisors at IVAT.

For more information about IVAT, please visit: http://ivat.utm.my/

For more information about UTM's postgraduate programmes, please visit: http://admission.utm.my/

UTM UNIVERSITI TEKNOLOGI MALAYSIA

Institute of High Voltage and High Current IVAT

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2024 MyHVnet Colloquium

MyHVnet Colloquium is a key event organised by Malaysian High Voltage Network (MyHVnet). The colloquium is held biennially to promote networking among academic staff, students, and industrialists for the effective communication of high voltage related research and development. The 2024 MyHVnet Colloquium was held at Universiti Tenaga Nasional on 12 August 2024. The 2024 MyHVnet Colloquium is the fifth colloquium organised by MyHVnet since its informal inception in 2015 by members from various Malaysian organisations, including TNB Research Sdn. Bhd., Universiti Malaya, Universiti Sains Malaysia, Universiti Putra Malaysia, Universiti Teknologi Malaysia, Universiti Teknikal Malaysia Melaka, Universiti Malaysia Pahang, Universiti Malaysia Perlis, Universiti Malaysia Sabah, Universiti Tun Hussein Onn Malaysia, and Universiti Tenaga Nasional. In the 2024 MyHVnet Colloquium, lightning, insulation and electrical discharges, transformers, electromagnetic compatibility and conductors, and grounding systems have been selected as the main topics of interest. The list of extended abstracts is as follows. Details of the abstracts can be found on pages that follow.

Assoc. Prof. Eur. Ing. Ir. Ts. Dr. Lau Kwan Yiew, Universiti Teknologi Malaysia.

NO.	TITLE	MAIN ORGANISATIONAL AFFILIATION
A001	TRANSFORMER BUSHINGS HEALTH INDEX BASED ON CONDITION MONITORING INFORMATION	TNB LABS SDN. BHD.
A002	PROPAGATION OF ELECTRICAL TREE IN SIR UNDER DIFFERENT POLARITY OF REPETITIVE LIGHTNING IMPULSE SUPERIMPOSED DC VOLTAGE	UNIVERSITI SAINS MALAYSIA
A003	DC BREAKDOWN STRENGTH OF POLYPROPYLENE BLENDS	UNIVERSITI TEKNOLOGI MALAYSIA
A004	OPTIMIZATION OF PARTIAL DISCHARGE DENOISING METHOD FOR SWITCHGEAR INSULATION MATERIAL	UNIVERSITI MALAYA
A005	INFLUENCE OF TiO2 NANOCOMPOSITE ON AC BREAKDOWN STRENGTH OF XLPE	UNIVERSITI TEKNOLOGI MALAYSIA
A006	SITE SELECTION FOR EARTHING DESIGN IMPLEMENTATION TO MITIGATE CORROSION IN INUNDATED SOILS IN TNB	TENAGA NASIONAL BERHAD
A007	DC BREAKDOWN PROPERTIES OF POLYPROPYLENE BLENDED WITH PROPYLENE-BASED ELASTOMER	UNIVERSITI TEKNOLOGI MALAYSIA
A008	PARTIAL DISCHARGE FAULT DIAGNOSIS FOR ROTATING MACHINES USING CONVOLUTIONAL NEURAL NETWORK	UNIVERSITI MALAYA
A009	SURFACE CONDITION ASSESSMENT AND AGEING ANALYSIS OF FAILED COMPOSITE INSULATORS	TENAGA NASIONAL BERHAD
A010	AC BREAKDOWN VOLTAGE TEST OF VEGETABLE OILS ANALYSE BY AI-DRIVEN STATISTICAL ANALYSIS	UNIVERSITI SAINS ISLAM MALAYSIA
A011	EVALUATION OF LIGHTNING IMPACT ON DOUBLE CIRCUIT TRANSMISSION LINES: A COMPARISON BETWEEN SIMULATED AND ACTUAL DATA	UNIVERSITI MALAYA
A012	COMPARISON OF FRA SIGNATURES IN MOTORS WITH IDENTICAL NAMEPLATES	UNIVERSITI TUN HUSSEIN ONN MALAYSIA
A013	SIMPLIFICATION OF FOOTING RESISTANCE MEASUREMENT FOR TRANSMISSION TOWERS IN DIFFICULT TERRAINS	TENAGA NASIONAL BERHAD
A014	ANALYZING CORROSIVE SULPHUR ISSUE IN TRANSFORMER USING DIELECTRIC RESPONSE TECHNIQUE	UNIVERSITI PUTRA MALAYSIA
A015	DESIGN INSPECTION OF CONFORMAL ANTENNA FOR NONINVASIVE DETECTION OF HIGH VOLTAGE INSULATION DEFECTS	UNIVERSITI MALAYA
A016	PREDICTION OF HEALTH INDEX FOR ON LOAD TAP VHANGER BASED ON DGA DATA USING STATISTICAL DISTRIBUTION MODELS	UNIVERSITI PUTRA MALAYSIA
A017	SIMULATION STUDY ON THE MAXIMUM PHOTOVOLTAIC (PV) INJECTION AT 11/0/4.33kV SUBSTATION IN MALAYSIA	UNIVERSITI PUTRA MALAYSIA
A018	TIME DIFFERENCE OF ARRIVAL TECHNIQUES ON PARTIAL DISCHARGE LOCALIZATION IN SUBSTATION USING PARTICLE SWARM OPTIMIZATION	UNIVERSITI MALAYA
A019	UV-VIS ASSESSMENT OF RETROFILLED AGED MINERAL OIL WITH SYNTHETIC ESTER OIL	UNIVERSITI TEKNIKAL MALAYSIA MELAKA
A020	RELATIONSHIP BETWEEN FILLER CONCENTRATION OF SILICONE RUBBER AND ITS WEIGHT LOSS, TRACKING LENGTH, AND DEPTH.	UNIVERSITI TEKNIKAL MALAYSIA MELAKA
A021	OPTIMIZATION OF DISTRIBUTION SYSTEM RELIABILITY AGAINST LIGHTNING	UNIVERSITI MALAYSIA PERLIS
A022	LIGHTNING PROTECTION AND EARTHING ASSESSMENT ON BATTERY CHARGER FAILURE IN A SWITCHING SUBSTATION	TENAGA NASIONAL BERHAD
A023	PERFORMANCE OF WOOD ASH WITH SODIUM CHLORIDE MIXTURE AS GROUNDING ENHANCEMENT MATERIAL	UNIVERSITI MALAYSIA PERLIS
A024	DYNAMIC LINE RATING FOR UNDERGROUND CABLES: CORRELATING AMPACITY SIMULATIONS WITH REAL-TIME TEMPERATURE MEASUREMENTS	UNIVERSITI TEKNOLOGI MARA
A025	TRANSIENT VOLTAGE ANALYSIS ON GRID-CONNECTED SOLAR PV SYSTEM DUE TO LIGHTNING	UNIVERSITI MALAYSIA PERLIS
A026	PROGRESSION OF ATMOSPHERIC LIGHTNING DISCHARGES	KINDAI UNIVERSITY
A027	AC BREAKDOWN VOLTAGE OF VEGETABLE COOKING OIL IN THE PRESENCE OF HEMATITE, ZINC OXIDE, AND NICKEL OXIDE	UNIVERSITI TEKNOLOGI MARA
A028	DEVELOPMENT OF LIGHTNING OBSERVATIONS FOR FLASH FLOOD FORECASTING IN MELAKA	UNIVERSITI TEKNIKAL MALAYSIA MELAKA
A029	DESIGN OF A BROADBAND INTERFEROMETER SYSTEM FOR CAPTURING VERY HIGH-FREQUENCY RADIATION FROM LIGHTNING EVENT	UNIVERSITI TEKNIKAL MALAYSIA MELAKA
A030	THE RELATIONSHIP ANALYSIS BETWEEN LIGHTNING FLASHES WITH METOROLOGICAL PARAMETERS	UNIVERSITI TEKNIKAL MALAYSIA MELAKA
A031	DESIGN AND COMPARISON OF SLOW ANTENNAS FOR LIGHTNING MEASUREMENT SYSTEM	UNIVERSITI TEKNIKAL MALAYSIA MELAKA
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TRANSFORMER BUSHINGS HEALTH INDEX BASED ON CONDITION MONITORING INFORMATION

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Abstract **–** This paper presents the establishment of Health Index of the transformer bushing through the application of condition monitoring data. The condition parameters data extracted from utility maintenance data and were analysed in this study. The samples were from population of transformer bushings with the age range between 1 and 25 years. Results of the condition assessment on individual transformer bushings were analyzed and transformer bushings health index was formulated to provide engineering solutions and asset management direction.

Keywords – transformer bushings, health index, asset management

INTRODUCTION

Transformer bushings are essential and highly important elements of a transformer. Bushings are employed in a wide range of equipment, including transformers, breakers, and reactors. The expense associated with a bushing is merely a small portion of the overall cost of a power transformer.

However, bushing failures are responsible for a significant proportion (30 to 35%) of forced outages among large power transformers [1, 2]. Approximately 50% of bushing failures lead to an explosion and/or fire [1]. These failures have the potential to cause harm to nearby equipment and pose a risk to personnel who are in proximity at the time of the failure. The occurrence of such disastrous failures has raised concern among utility companies worldwide. The concern is heightened by the fact that many bushings may be nearing the end of their operational lifespan due to the aging of their base equipment.

The main purpose of this study is to include the establishment of Health Index which could provide a much clear and accurate representation of the actual transformer bushings conditions.

METHODOLOGY

HI compound method is used on this paper in order to generate the health index.

For this method, the parameter as follows:

a) Condition data: referring to necessary tests performed to the transformer to evaluate its condition.

b) Condition function: referring to the assigned value on a range, given to a specific test, e.g. if a test gives a very bad result the assigned value will be the lowest possible,on the other hand if the result is the best possible the assigned value will be the highest possible of the range select.

c) Weight: it depends on the importance of the test performed on the transformer and its relevance towards its diagnosis.

HI of a transformer bushing is calculated with the following equation, on which every parameter and factor used for the formulation of its actual state of operation it is taken into.

$$HI = \frac{\sum_{j=1}^{n} K_j HIF_j}{\sum_{j=1}^{n} 4K_j} \times 100\%$$

where:

HIF j = Health Index factor of each parameter, assigned according to the performed test.
K j = Weight factor assigned to each parameter, goes from 1 to 10 regard the importance of the test results on the condition of the transformer.
n = Number of tests used.
4 = HIF j maximum value of each parameter.

The most common technique for assessing the condition of a bushing is the dissipation factor (DF) / power factor (PF) and capacitance measurement. Test results are then compared to nameplate values or previous tests. Increases or decreases from reference values are usually an indication of contamination and/or deterioration of the insulation system.

Dielectric Dissipation Factor/Power Factor

Bushing power factor test is done to provide information on the electrical insulating system of both the main and tap capacitance (C1 & C2).

Power Factor measurements provide insights into the condition of the insulation material within the transformer bushing. By quantifying the dielectric losses, it helps evaluate the integrity and health of the insulation.

Capacitance measurements

Capacitance measurements provide valuable information about the condition of the insulation between the conductor and the bushing's outer surface. Changes in capacitance values over time can indicate insulation degradation, such as moisture ingress, aging, or contamination, which may compromise the integrity of the bushing.

The main capacitance, C1, of a bushing is the capacitance between the high-voltage conductor and the voltage tap or test tap. The tap capacitance, C2, of a capacitance graded bushing is the capacitance between the voltage tap and mounting flange (ground).

RESULTS AND DISCUSSION

The evaluation of transformer bushing health index is in ongoing process in assessing critical parameters i.e Power Factor and capacitance measurements. Data analysis will determine their condition, deciding the maintenance decisions. This ongoing study aims to optimize transformer bushings performance and prevent electrical system disruptions through proactive maintenance strategies.

CONCLUSION

Through condition assessment methodology, utility was able to plan and implement a life management program for its transformer bushings. With the use of transformer bushings health index (HI), utility was also able to perform a more effective and consistent assessment on the entire transformer population. HI has become a tool not only in determining the correct remedial actions but also in prioritizing the most appropriate engineering solutions.

REFERENCES

[1] Gupta, B.K., Densley, J. and Narang, A. (2009) 'Condition assessment of oil-paper insulated bushings', 2009 IEEE Electrical Insulation Conference

[2] Yuan, Y. et al. (2020) 'Condition assessment on the 500kV OIP bushings of power transformer', 2020 IEEE International Conference on High Voltage Engineering and Application (ICHVE)

PROPAGATION OF ELECTRICAL TREE IN SIR UNDER DIFFERENT POLARITY OF REPETITIVE LIGHTNING IMPULSE SUPERIMPOSED DC VOLTAGE

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Abstract – This paper presents the propagation of electrical tree in silicone rubber (SiR) under different polarity of 21kV lightning impulse (LI) superimposed 4kV DC voltage . The results reveal that electrical tree length propagates longer towards ground electrode at 500 shots of positive LI compared with that negative LI. The branch type tree with longer and broader tree width regularly appeared for positive LI shot while, shorter tree length and narrow tree width can be observed frequently under negative LI shot. This result suggests that the possibility of tree breakdown due to the electrical tree propagates across the gap under positive LI superimposed DC is higher than negative polarity of LI.

Keywords –Electrical tree, Lightning Impulse

INTRODUCTION

Presently SIR is well applied as among the best high voltage cable accessories insulation since it offers excellent electrical properties for extensive range of voltage and temperature used. Beside AC stresses, the cable and it accessories (cable joint) also may expose the stress from lightning strike which could be the issue contribute to the generation of electrical tree and finally courses the ruin and failure to the insulation system [1]. Nevertheless, the effect of lightning strikes to the underground cable joint for HVDC application is rarely stated. Thus, this paper presents the phenomenon of electrical tree growth process in SiR under different polarity of LI superimposed DC voltage.The effect of positive and negative LI superimposed DC volatge within 500 numbers of LI shot are discussed.

METHODOLOGY

Block test specimen with a dimension of 20mm x 14mm x 1mm were arranged. A needle electrode with diameter of 0.25mm with 30 degree tip angle and 5µm tip radius was placed with 2mm gaps between needle tip to grounded electrode. All the samples were tested individually until 500 shots of LI with the interval shot of 1 second per applied voltage.

RESULTS AND DISCUSSION

Two different pattern of electrical tree propagation can be monitored within 500 of LI shots as shown in Figure 1. Under positive 21kV LI, the tree structure tend to appear in branch type tree with longer tree length and broader tree width compared to negative 21kV LI which the tree formation appearded with shorter tree length and tiny tree width. At 100 shots of positive LI, the tree length abruptly increase with narrow tree width as well as less of side branches monitored. At 300 shots, it is observed that the tree length keep increasing and a few of side branches appeared at the tree main branches. At 500 of LI shots, the tree length did not change drastically but the path of electrical tree become darker with broader tree width and more of side branches initiated at tree main branches.

(a) +21kV LI superimposed 4kV DC

(b) -21kV LI superimposed 4kV DC

Figure 1: Electrical tree growth process

At 100 shots of negative 21kV LI, three main channels of electrical tree initiated at needle tips electrode with short electrical tree length observed. At 300 shots of LI, it can be seen that another side branch appeared at one of the three main channels. At 500 of shots, the tree length keep increasing and propagates proportionally to ground electrode. However, it is observed that under negative 21kV LI, the attainment of tree length is shorter and the appearences of side branches not clearly can be seen compared to positive 21kV LI.

CONCLUSIONS

The effect of different polarity of LI superimposed DC volatge in SiR has been investigated. It can be seen that under positive 21kV LI superimposed 4kV DC, electrical tree length propates further and branch tree type can be observed frequently. While under negative polarity of LI, less numbers of tree branches appeared with shorter tree length and narrow tree width can be seen.

ACKNOWLEDGEMENTS

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REFERENCES

[1] M. Asif, H. Y. Lee, K. H. Park, A. Shakeel, and B. W. Lee, "Assessment of overvoltage and insulation coordination in Mixed HVDC transmission lines exposed to lightning strikes," Energies, vol. 12, no. 21, 2019, doi: 10.3390/en12214217.

DC BREAKDOWN STRENGTH OF POLYPROPYLENE BLENDS

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Abstract – This paper investigates the direct current (DC) breakdown strength of polypropylene (PP)/elastomer blends containing 20 wt% of propylene based elastomer (PBC) and ethylene based elastomer (EBC). The outcome reveals that the DC breakdown value of PP/elastomers can be comparable with XLPE. This indicated that PP blended with 20 wt% of PBC and EBC can be a good alternative to crosslinked polyethylene (XLPE) in term of DC breakdown strength.

Keywords – Polypropylene, elastomer, copolymer, breakdown strength

INTRODUCTION

To date, polypropylene (PP)/elastomer blends have been intensively explored by researchers due to the potential benefits of PP blends compared to crosslinked polyethylene (XLPE). Polymer blending with elastomers has been demonstrated to be an efficient way of softening and improving the properties of various materials, hence enhancing the flexibility of standalone PP [1]. Furthermore, thermoplastic elastomers have been blended with PP to enhance the mechanical flexibility of PP [2]. Therefore, the current work was conducted to investigate the effect of PP blending with 20 wt% of elastomers, i.e., propylene based elastomer (PBC) and ethylene based elsatomer (EBC) in term of direct current (DC) breakdown strength compared to XLPE.

METHODOLOGY

XLPE, a reference material in this research, was composed of 98 wt% of low density polyethylene (LDPE) and 2 wt% of dicumyl peroxide (DCP). PP, used as a base material in PP blends, was a PP homopolymer (PPh). The elastomers used were PBC and EBC with a content of 20 wt%. The samples were blended using a Brabender melt mixer. A Carver hydraulic press was then used to produce thin films of the samples. A Baur high voltage test set was utilized for breakdown testing. For each breakdown measurement, DC voltage of 2 kV per 20 s was employed until breakdown.

RESULTS AND DISCUSSION

The results showed that PP had the highest DC breakdown value (376 kV/mm) compared to XLPE and PP/elastomer blends. The addition of 20 wt% of PBC to PP resulted in a slightly higher DC breakdown value (344 kV/mm) compared to XLPE (324 kV/mm). The

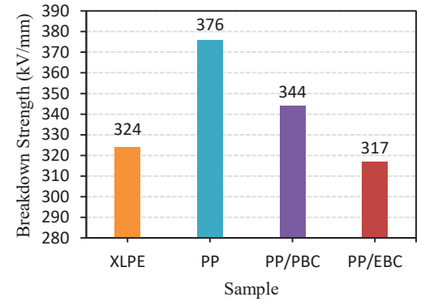

Figure 1: DC breakdown strength of XLPE, PP, PP/PBC and PP/EBC

DC breakdown value of PP blended with 20 wt% of EBC was similar (317 kV/mm) to XLPE.

CONCLUSIONS

This research shows that PP/PBC demonstrate better DC breakdown strength compared to XLPE while PP/EBC show comparable DC breakdown strength with XLPE. Therefore, PP/elastomer blends can be used as good alternatives to XLPE.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Y. Gao, J. Li, Y. Li, Y. Q. Yuan, S. H. Huang, and B. X. Du, "Effect of elastomer type on electrical and mechanical properties of polypropylene/elastomer blends," in *2017 International Symposium on Electrical Insulating Materials (ISEIM)*, 11-15 Sept. 2017 2017, vol. 2, pp. 574-577, doi: 10.23919/ISEIM.2017.8166554.

[2] Y. Zhou, J. He, J. Hu, X. Huang, and P. Jiang, "Evaluation of polypropylene/polyolefin elastomer blends for potential recyclable HVDC cable insulation applications," *IEEE Transactions on Dielectrics and Electrical Insulation,* vol. 22, no. 2, pp. 673-681, 2015, doi: 10.1109/TDEI.2015.7076762

OPTIMIZATION OF PARTIAL DISCHARGE DENOISING METHOD FOR SWITCHGEAR INSULATION MATERIAL

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Abstract – In this work, an optimized discrete wavelet transform (DWT) was developed to denoise the noisy partial discharge (PD) signals. Particle swarm optimization (PSO) was adopted to find the optimal thresholds. Then, the denoised signals were classified by k-nearest neighbors (KNN). The results show that PSO-DWT denoising method has better denoising accuracy than the unoptimized DWT, with improvement by 35.23%.

Keywords – Partial discharge, electrical insulation, wavelet transform, artifiicial intelligence

INTRODUCTION

Insulation material degradation stemming from PD is a major factor in power equipment failure [1]. External electromagnetic interference introduces noise, compromising the accuracy of PD diagnosis, thus, addressing PD noise suppression is crucial. However, traditional DWT the empirical method to determine the wavelet threshold has room for improvement. Thus, particle swarm optimization was applied to determine the optimal threshold for DWT.

METHODOLOGY

In this work, four types of partial discharge models were created to represent corona discharge, surface discharge, floating electrode discharge and void discharge. Noise-free PD signals were collected through the PD experiment and the white noise was added to replicate noisy PD signals. Then, PSO was used to optimize DWT to denoise the noisy data by finding the optimal threshold. Subsequently, KNN was used to classify PD signals denoised by optimized and unoptimized DWT.

RESULTS AND DISCUSSION

The KNN classifier was trained by noise-free data and tested with denoised data. A 10-fold cross-validation technique was employed. As shown in Table 1, it can be seen that the classification accuracy of PSO-DWT denoised PD signal is from 68.06% to 79.44%, the precision is from 65.60% to 83.63%, the recall is from 65.36% to 91.66% and the F1-score is from 65.47% to 87.46%. Comparing the results in Table 1 with Table 2, it can be seen that the improvement of PSO-DWT method over the unoptimised DWT is around 29% for the accuracy, 26% for the precision, 24% for the recall and 25% for the F1-score.

Table 1: KNN classification results of PSO-DWT denoised PD signals

SNR (dB)	Accuracy	Precision	Recall	F1-score
-2	68.06%	68.07%	67.23%	67.65%
-1	68.65%	67.68%	66.43%	67.00%
0	68.24%	65.60%	65.35%	65.47%
+1	73.50%	82.27%	89.30%	85.64%
+2	79.21%	83.63%	91.60%	87.43%
+3	79.44%	83.63%	91.66%	87.46%
+4	72.38%	81.75%	88.81%	85.13%
+5	76.80%	83.02%	90.63%	86.66%

Table 2: KNN classification results of the unoptimised DWT denoised PD signals

SNR (dB)	Accuracy	Precision	Recall	F1-score
-2	43.29%	53.52%	57.23%	55.26%
-1	42.98%	53.06%	56.07%	54.51%
0	41.81%	47.31%	55.16%	50.55%
+1	44.63%	53.76%	57.77%	55.72%
+2	44.71%	50.10%	57.80%	53.61%
+3	44.71%	45.11%	57.80%	50.72%
+4	44.88%	53.86%	57.87%	55.80%
+5	45.24%	47.79%	58.06%	52.16%

CONCLUSIONS

In this work, a PSO-optimized DWT denoising method was successfully proposed and the effect of the proposed method has been investigated. The obtained results show that the accuracy, recall, precision and F1-score improved after optimiztion of DWT threshold, where the highest accuracy improvement can reach up to by 35.23%. Thus, PSO-optimized DWT denoising method has a better denoising effect than unoptimized DWT denoising method.

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REFERENCES

[1] N. Zhou, Y. Xu, S. Cho, and C. T. Wee, "A Systematic Review for Switchgear Asset Management in Power Grids: Condition Monitoring, Health Assessment, and Maintenance Strategy," *IEEE Transactions on Power Delivery,* pp. 1-15, 2023, doi: 10.1109/tpwrd.2023.3272883.

INFLUENCE OF TiO2 NANOCOMPOSITE ON AC BREAKDOWN STRENGTH OF XLPE

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Abstract - Cross-linked polyethylene (XLPE), is a popular choice for high-voltage underground cables. This study examined the electrical characteristics of XLPE nanocomposites including different proportions of Titanium Dioxide, TiO_2 nanofiller. The loading concentration of nanofillers varies across different studies, typically at levels of 0 weight percent (wt%), 1 wt%, 2 wt% and 3 wt%. The results show that the XLPE containing 2wt% TiO_2 has the highest AC breakdown strength compared with others.

Keywords – Cross-linked polyethylene, Titanium Dioxide, nanocomposites, AC breakdown strength,

INTRODUCTION

The objective is to develop a novel insulation system capable of accommodating unique electrical stress, enhancing the cable insulator's capabilities, which is of significant importance [1]. Hence, the breakdown strength is an essential characteristic to consider during the production of secure and reliable high-voltage cables [1]. Therefore, in this paper, the investigation on the AC breakdown strength of XLPE containing various concentrations of TiO2 nanofiller has been performed. The concentrations of TiO2 nanofiller in XLPE were varied from 1 wt%, 2wt% and 3wt%. The AC breakdown strength of XLPE/ TiO2 nanocomposites was evaluated compared to those of plain XLPE.

METHODOLOGY

The initial step involved blending XLPE with TiO2 using Brabender. Then, pressed it with the setting of 130℃ for 2 minutes and 3.5 tonnes for 3 minutes with same temperature.Then, followed by a 2-minute delay at 180℃ for the cross-linked pre-heat session. This procedure was performed to assure the acquisition of a sample with a thickness of 100±10 µm. Lastly, injected the sample with each increment being 1 kV, every 20 seconds, until the breakdown occurred

RESULTS AND DISCUSSION

The result of AC breakdown strength (ABS) with respect to filler concentration of TiO2 nanofillers in XLPE is shown in Fig. 1. The result shows that the ABS for TiO2 nanofillers are increased with the filler concentration up to 2wt%. The ABS start to decrease as the filler concentration exceeded 2wt% but still higher than unfilled XLPE. Adding 2 wt% TiO_2 nanofiller to XLPE might reduce the distance between particles in the nanocomposite. Additionally, the addition of a higher percentage of nanofiller content can also lead to a reduction in the breakdown strength. The cause of this situation could be attributed to the aggregation and inadequate dispersion of the mixed substance. The interfacial region of XLPE overlaps with the high surface area of TiO_2, resulting in a reduced interphase volume in the polymer nanocomposite [2].

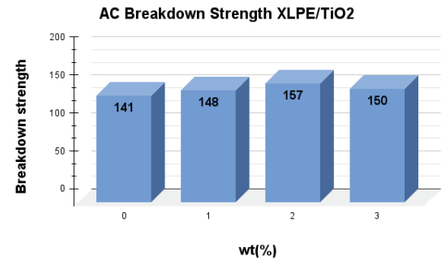

Figure 1 : Variation in AC breakdown strength with respect to filler concentration in XLPE with TiO_2 nanofillers

CONCLUSIONS

The influence of TiO2 nanofiller incorporation in XLPE on ABS has been studied.. It can be concluded that the addition of 2 wt% of TiO_2 nanofiller in XLPE had improved the ABS of the nanocomposite. The ABS for 1.0wt%, 2.0wt% and 3.0wt% TiO_2 nanofiller in XLPE are 5.67% , 11.34% and 6.38% higher than the pure XLPE.

ACKNOWLEDGEMENTS

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REFERENCES

[1] N. M. K. Abdel-Gawad, A. Z. E. Dein, D. E. A. Mansour, H. M. Ahmed, M. M. F. Darwish, and M. Lehtonen, "Enhancement of dielectric and mechanical properties of Polyvinyl Chloride nanocomposites using functionalized TiO2 nanoparticles," IEEE Transactions on Dielectrics and Electrical Insulation, vol. 24, no. 6, pp. 3490-3499, 2017, doi: 10.1109/TDEI.2017.006692.

[2] Abdelrahman Said, Amira Gamal. Nawar, Elsayed Alaa. Eldesoky, Samir Kamel, Mousa Awdallah. Abd-Allah. Enhancing the High Voltage XLPE Cable Insulation Characteristics Using Functionalized TiO2 Nanoparticles. American Journal of Polymer Science and Technology. Vol. 6,No. 3, 2020, pp. 21-31. doi: 10.11648/j.ajpst.20200603.11

SITE SELECTION FOR EARTHING DESIGN IMPLEMENTATION TO MITIGATE CORROSION IN INUNDATED SOILS IN TNB

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Abstract **-** Soil sampling was performed in selected grid areas across four regions in Peninsular Malaysia, involving five transmission towers per region, with three samples collected per tower. The selected sites included diverse inundated areas such as flood-prone zones, regions with high groundwater tables, paddy fields, wetlands, beaches, areas near drains, islands, and plantations. After GIS mapping and soil series characterization, 20 of the 35 identified sites were sampled, providing a comprehensive overview of the soil types and conditions in these varied environments.

Keywords – Corrosion, inundated soil, earthing design

INTRODUCTION

In recent years, the issue of corrosion in earth electrodes buried within the TNB Grid's infrastructure has become a matter of increasing concern. With the grid's critical role in supplying electricity across various regions, ensuring the reliability and performance of tower earthing systems is paramount. The corrosive impact of inundated soils poses a significant threat to the structural integrity of these earth electrodes. Instances of corrosion-related degradation and the subsequent loss of earthing capabilities have not only led to operational challenges but have also raised safety concerns.

METHODOLOGY

i. Criteria for Selection:

The selection of sites is based on transmission towers located in inundated areas such as flood-prone zones, regions with high groundwater tables, paddy fields, wetlands, beaches, areas near drains, islands, and plantation areas.

ii. Soil Sampling Specifications and Procedures:

The specifications and procedures for soil sampling were identified and established during this project.

iii. Site Selection and Sampling:

A comprehensive list of selected sites provided by TNB was collected and examined. These sites were divided into four regions in Peninsular Malaysia. A total of 60 samples were collected, with 5 sites in each region and 3 replicates per site.

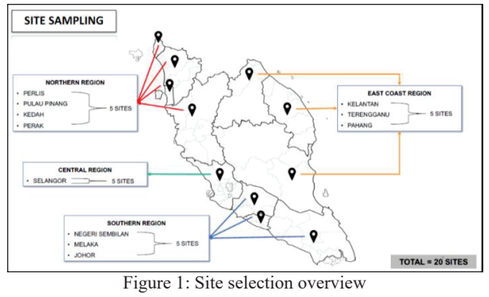

Figure 1: Site selection overview

RESULTS AND DISCUSSION

The site selection process encompassed four main regions in Peninsular Malaysia, each designated with specific geographical areas. Region 1, comprising Selangor, Putrajaya, and Kuala Lumpur, represented the central region. Region 2, encompassing Negeri Sembilan, Melaka, and Johor, constituted the southern region. Region 3, consisting of Kelantan, Terengganu, and Pahang, denoted the east coast. Region 4 covered Perak, Kedah, Penang, and Perlis in the northern part of Peninsular Malaysia.

CONCLUSIONS

In total, 35 sites were initially identified based on criteria related to inundation, as reported and shortlisted by Grid Maintenance from each of the specified regions. However, due to accessibility challenges, soil sampling was conducted at only 20 of these sites. Before commencing the soil sampling, the project employed a geographic information system (GIS) mapping approach to characterize the soil series and potential soil types at each of the selected locations.

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REFERENCES

[1] K. S. Lock, “Lightning protection, earthing and surge protection of base transmission stations,” 2011 7th Asia-Pacific International Conference on Lightning, APL2011, pp. 436–440, 2011, doi: 10.1109/APL.2011.6110161.

DC breakdown properties of polypropylene blended with propylene-based elastomer

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Abstract **–**As the energry consumption increases rapidly, the employment of cross-linked polyethylene (XLPE) cables may encounter challenges due to its limited operating temperature. Alternatively, polypropylene (PP) is a potential candidate for cable insulation due to its high thermal endurance and being more environmental friendly compared to XLPE. This paper reports on the direct current (DC) breakdown properties of PP blended with propylene-based elastomer (PBE), using a melt blending method. The DC breakdown strength was analysed by using Weibull statistical analysis. The results show that the breakdown strength of PP is not signifcantly affected when blended with up to 20 wt% of PBE.

Keywords – polypropylene, elastomer, propylene-based elastomer, blending, breakdown

INTRODUCTION

In the future, the use of cross-linked polyethylene (XLPE) as power cable insulation may pose challenges due to its restricted operating temperature, which does not surpass 90 °C [1]. Futhermore, recycling XLPE remains challenging. Thus, many ongoing research aims to find more efficient solution for overcoming these issues. Polypropylene (PP) is viewed as a promising alternative for conventional XLPE because PP can endure high temperatures (up to 170°C), withstand high voltages, and most importantly, PP can be recycled with ease compared to XLPE. However, PP needs further modifications as PP alone is too stiff for cable extrusion. Recently, vaious types of elastomers have been investigated for incorporation with PP. Each type of elastomer imparts distinct performance attributes to the PP blend systems. In this work, proylene-based elastomer (PBE) are employed in PP blend system and the direct current (DC) breakdown properties are investigated.

METHODOLOGY

The host polymer used in this study was PP homopolymer (Titanpro 6531 M) from Lotte Chemical Titan. The elastomer used to alter the properties of PP was PBE (Vistamaxx 6202) from ExxonMobil. PP and PBE was blended through a melt-mixing process by using a Brabender mixer at 180 °C with 50 rpm for 10 min. The DC breakdown strength were conducted in line with ASTM D3755 standards. The collected data were analyzed using Weibull distribution analysis.

RESULTS AND DISCUSSION

Figure 1 shows the DC breakdown properties of PP and PP/PBE blends at different weight percentages. The breakdown strength of PP was 353 kV/mm. It is noteworthy that the breakdown strengths of PP/PBE blend at 5 wt% (353 kV/mm), 10 wt% (348 kV/mm) and 20 wt % (329 kV/mm) were comparable to PP when considering Weibull uncertainties. The breakdown strength slightly reduced as the amount of PBE increased to 30 wt% (314 kV/mm) and 40 wt% (278 kV/mm).

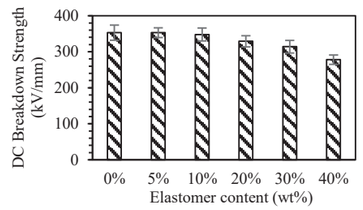

Figure 1: DC breakdown strength of PP/PBE blends

CONCLUSIONS

The use of PBE in PP blend system shows promising breakdown properties under DC field. Incorporating PBE up to 20 wt% does not significantly impact the breakdown strength of PP. Hence, the study of PP/PBE blend is promising as a future sustainable solution.

ACKNOWLEDGEMENTS

This work was financially supported by Ministry of Higher Education Malaysia through the Fundamental Research Grant Scheme (FRGS/1/2023/TK07/UTM/02/21) and Universiti Teknologi Malaysia (UTM) through the UTM Fundamental Research Grant (Q.J130000.3823.22H34).

REFERENCES

[1] E. Khouildi *et. al,* “Investigating thermal effect on a XLPE power cable,” *Indonesian Journal of Electrical Eng and Computer Science* 2017.

PARTIAL DISCHARGE FAULT DIAGNOSIS FOR ROTATING MACHINES USING CONVOLUTIONAL NEURAL NETWORK

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Abstract **–** This work presents an approach of convolutional neural netowrk (CNN) to automate the diagnosis of partial discharge faults in rotating machines. By creating six artificial defects through a simplified model, the approach effectively detects and classifies critical indicators of insulation deterioration. The CNN-based model achieves a high accuracy of 99%, demonstrating its unparalleled efficacy in fault detection.

Keywords – Condition monitoring, convolutional neural network, partial discharge, rotating machines, electrical insulation

INTRODUCTION

Partial discharge (PD) in rotating machines refers to localized breakdowns of insulation materials, often occurring within the stator windings or rotor bars. These discharges can manifest as bursts of electrical energy or sparks within the insulation system [1]. PD faults pose significant risks to operational reliability and safety in rotating machines, such as motors and generators. Furthermore, PD activity tends to increase over time, exacerbating the risk of failure if not addressed promptly [2].

METHODOLOGY

Figure 1 depicts the experimental setup utilizing the simplified model specimen. The Phase Resolved Partial Discharge (PRPD) patterns are collected and structured into a dataset for the classification process. To simplify the specimens, a single stainless steel cylinder covered with resin and semiconductive tape is employed for simplicity in fabrication. The six artificial defects are created inside the primary insulation, representing the configuration utilized from the actual insulation system.

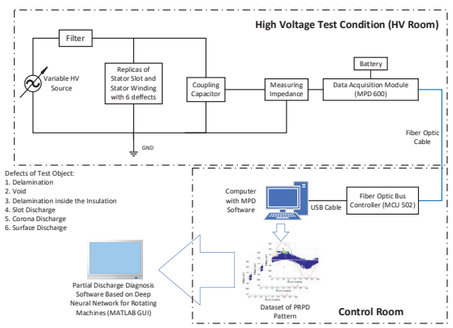

Figure 1. Experimental Setup

RESULTS AND DISCUSSION

CNN was emplyed to diagnose and classify PRPD patterns from various single defects on the samples of rotating machines. Five-fold cross-validation was applied as a validation method. The accuracy results are depicted by the confusion matrix as shown in Figure 2.

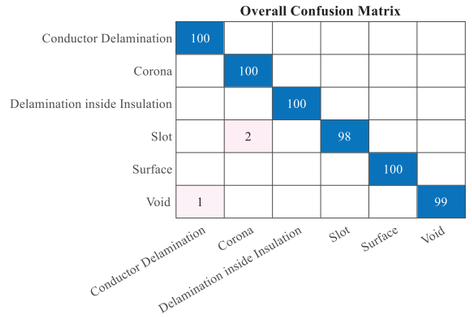

Figure 2. Confusion matrix of CNN

CONCLUSIONS

Convolutional Neural Network (CNN) managed to achieve a high accuracy of classifying different defect types for insulation of a rotating machine, which is up to 99%. Future work will involve integrating multi-source defect combinations to automatically classify the defect types using PRPD patterns and CNN.

ACKNOWLEDGEMENT

The authors thank the Ministry of Science, Technology and Innovation (MOSTI), Malaysia for supporting this work through MOSTI TeD 1 Grant (TDF06221586, account no.: UM.0000107/HMT.SF).

REFERENCES

1. Mantach, S., et al., *Unsupervised Deep Learning for Detecting Number of Partial Discharge Sources in Stator Bars.* IEEE Transactions on Dielectrics and Electrical Insulation, 2023: p. 1-1.
2. Nair, R.P. and S.B. Vishwanath, *Identification of Simultaneously Active PD Sources in Stator Insulation Using Variable Frequency Excitation.* IEEE Transactions on Dielectrics and Electrical Insulation, 2021. 28(2): p. 646-653.

Surface Condition Assessment and Ageing Analysis of Failed Composite Insulators

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Abstract - This study investigates the surface condition and ageing of failed composite insulators (CI) used in TNB Grid. CI play a critical role in maintaining electrical grid reliability, yet their performance can degrade over time due to environmental and biological factors. This paper presents the findings from a comprehensive analysis involving defect identification, biological contamination assessment, wettability tests, thermal and elemental analyses, and mechanical testing. The results highlight significant variations in the degradation patterns of CIs based on their environmental exposure, with implications for their maintenance and replacement strategies.

Keywords – Composite Insulators, Surface Condition, Ageing Analysis, HV Transmission

INTRODUCTION

Composite insulators (CI) are vital components in HV transmission, designed to withstand various environmental stresses while maintaining insulation performance. However, over time, these CIs can experience degradation due to factors such as weathering, biological contamination, and mechanical wear [1]. Understanding the ageing processes and surface condition of CIs is crucial for predicting their service life and ensuring grid reliability. This study focuses on the physicochemical properties, hydrophobicity, thermal stability, mechanical properties, and ageing mechanisms of CIs in the TNB Grid system.

METHODOLOGY

The study involved multiple stages of investigation:

- Defect Inspections
- Biological and Wettability Analysis
- Thermal and Elemental Analysis
- Mechanical Analysis

RESULTS AND DISCUSSION

Defect Inspections:

The inspection revealed various common defects among the samples, including cracks, discoloration, and biological growth, particularly algae.

Biological and Wettability Analysis:

Biological tests showed minimal bacterial and fungal growth, but significant algae presence was noted, especially on samples from seaside areas, as in Figure 1. Wettability tests indicated a loss of hydrophobicity in samples with biological contamination, leading to increased wettability (hydrophilic surfaces) [2].

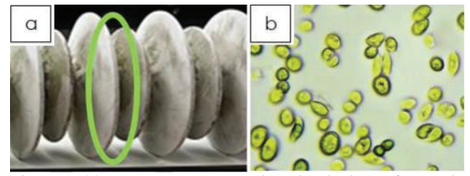

Figure 1: (a) Green spots appeared on the shed's surface and (b) Microscope image of algae

Thermal and Elemental Analysis:

Thermal analysis showed varying degrees of degradation, with samples from industrial areas exhibiting higher thermal stability. Elemental analysis indicated differences in contamination and degradation patterns based on the location of the CIs.

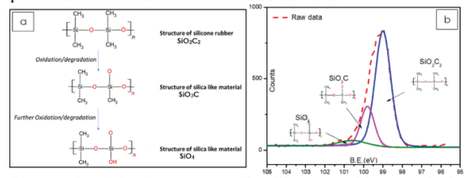

Figure 2: (a) Structures of silicone rubber and its oxidation/degradation products, (b) Deconvolution of silicon peak from XPS spectra from surface of failed CIs

Mechanical Analysis:

Mechanical testing demonstrated that the core strength remained largely intact, but the sheath and shed showed varying degrees of mechanical wear, impacting overall insulator performance.

CONCLUSIONS

This study provides a comprehensive assessment of the surface condition and ageing of CI in TNB Grid. The findings highlight the impact of environmental exposure on CI degradation, with significant implications for maintenance practices. Future research should focus on developing more resilient CI materials and improved maintenance protocols to enhance the longevity and reliability of HV transmission systems.

REFERENCES

[1] HJ Kim, SS Kim, SM Park & SJ Song, "Degradation characteristics of silicone rubber insulators for outdoor applications" IEEE Transactions on Dielectrics and Electrical Insulation, vol.26(4), pp.1122-1130, 2019
[2] R Hackam "Outdoor HV composite polymeric insulators" IEEE Transactions on Dielectrics and Electrical Insulation, vol.6(5), pp.557-585, 1999

AC BREAKDOWN VOLTAGE TEST OF VEGETABLE OILS ANALYSE BY AI-DRIVEN STATISTICAL ANALYSIS

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Abstract **-** This paper discusses the statistical analysis of the breakdown voltage of mineral oil (MO), palm oil (PO), rice bran oil (RBO), and a combination of PO and RBO. The AC breakdown voltage was tested in accordance with the IEC 60156 standard using VDE electrodes set at a gap of 2.55mm. The statistical analysis was conducted using artificial intelligence (AI).

Keywords – Mineral Oil, Palm Oil, Rice Bran Oil, Statistical Analysis, AC Breakdown Voltage

INTRODUCTION

Transformers are essential for distributing electrical energy in power networks, traditionally using hydrocarbon mineral oil (MO) for insulation [1]. However, MO presents environmental and operational challenges like contamination, degradation, high maintenance costs, flammability, and toxicity. Researchers are exploring sustainable alternatives like natural ester oils (NEO) from renewable sources, which are biodegradable, safer, and have better fire resistance. This research aims to develop palm oil (PO) and rice bran oil (RBO) to replace MO.

METHODOLOGY

In this research, the oils were measured and going through the pre-treatment process. Then, the AC breakdown voltage (BDV) was tested in accordance with the IEC 60156 standard [2] using VDE electrodes set at gap of 2.5 mm. The statistical analysis was conducted using Python, Utilizing its reliable libraries commonly used in AI and machine learning for data analysis and visualization.

RESULTS AND DISCUSSION

Figure 1 shows the result of the AC BDV test of the six oil samples. Rice bran oil is the most effective replacement for mineral oil, offering a 29% performance improvement. Additionally, mixtures of 0.7% palm oil, 30% RBO, and 50% palm oil with rice bran oil enhance performance by 6.9% and 6.69%, respectively.

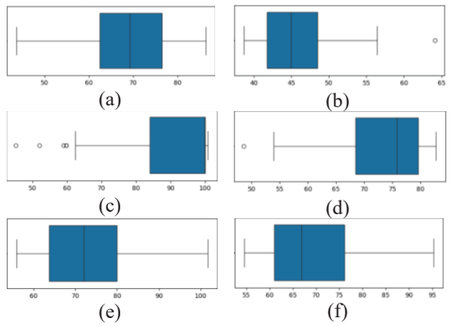

Figure 1: Boxplots for AC BDV of (a) Mineral Oil, (b) Palm Oil, (c) Rice Bran Oil (RBO), (d) 50% Palm Oil and Rice Bran Oil, (e) 70% Palm Oil, 30% Rice Bran Oil, (f) 30% Palm Oil, 70% Rice Bran Oil.

CONCLUSIONS

RBO is a promising option to consider as a substitute for MO in transformers. The AC breakdown voltage of RBO is the highest, followed by 70% PO 30% RBO, 50% PO and RBO, 30% PO 70% RBO, MO and PO.

ACKNOWLEDGEMENTS

The authors would like to thanks the Islamic Science University of Malaysia for their support in this study.

REFERENCES

[1] M. Taufiq Ishak, N. Sabrina Suhaimi, M. Hayati Abdul Hamid, N. Suhaimi, and F. Ridzuan Hashim, “Electrical Performance of Palm Oil and Rice Bran Oil as Transformer Insulating Liquid ,” *International Journal of Engineering & Technology*, no. January 2018, pp. 344–347, 2018, doi: 10.14419/ijet.v7i4.33.26063.

[2] (IEC), I. E. C. (2018). IEC 60156. *61010-1 © Iec:2001*, *3*.

EVALUATION OF LIGHTNING IMPACT ON DOUBLE CIRCUIT TRANSMISSION LINES: A COMPARISON BETWEEN SIMULATED AND ACTUAL DATA

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Abstract **–**Lightning-induced overvoltage is a potential cause of power outages in transmission lines, especially in the tropical countries. The use of transient analysis software to model and evaluate the performance of the actual transmission system is crucial for designing an effective protection system. In this study, an Electromagnetic Transient Program (EMTP-RV) model for a typical 275 kV double-circuit transmission line was assessed during lightning overvoltage scenarios. To validate the effectiveness of EMTP, actual tripping results from six distinct locations within Peninsular Malaysia were compared with the simulated results. The analysis revealed an average difference of 6.0% in voltage magnitudes, along with observed similarities in waveform patterns.

Keywords – Back flashover, shielding failure, overvoltages, lightning, transmission lines.

INTRODUCTION

Lightning strikes, occurring naturally, are typically associated with unsafe overvoltage, leading to a significant proportion of power outages worldwide. Nations with a high frequency of lightning occurrences are particularly susceptible to this overvoltage effect, resulting in approximately 40 % to 70 % of transmission line disruptions [1]. To improve the design of effective protection measures, it is imperative to utilize advanced transient software for modeling and evaluating the transmission system.

METHODOLOGY

The transmission system under investigation was modeled and simulated using EMTP, following the guidelines provided in [1]. To simplify the analysis, a system comprising nine towers was selected, with the lightning strike directed on the fifth tower. The effective height of the towers is 39.65 m, with a spacing of 300 m between adjacent towers and a distance of 30 km between the last tower and the substation. Additionally, the model incorporated various system components such as voltage supply, line conductors and shield wires, insulator strings.

RESULTS AND DISCUSSION

The results of the transmission line performance for both the simulated and actual data are presented. The waveform and magnitude comparisons due to shielding failure and back flashover trippings for locations 1 and 6 are respectively shown in Fig. 1 and Fig. 2. Observations found a similar waveform pattern and less than an 8 % difference in voltage magnitudes before and after the fault. Also, as shown in Table 1, results from all six locations indicated a 6 % overall difference in voltage magnitude. This comparison can only be found in few references [2].

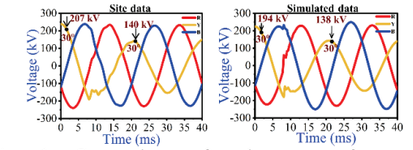

Fig. 1: Comparison of voltage waveforms and magnitudes due to shielding failure at location 1

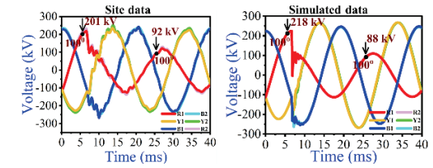

Fig. 2: Comparison of voltage waveforms and magnitudes due to back flashover at location 6

Table 1: Comparison of voltage magnitudes for the six distinct locations

Flashover type	Fault location	Angle (°)	Voltage magnitude (kV)				Percentage difference (%)	
			Actual data		Simulated data			
			Pre-fault	After fault	Pre-fault	After fault	Pre-fault	After fault
Shielding failure	1	30	207	140	194	138	6.3	1.4
	2	60	235	115	223	105	5.1	8.7
	3	60	239	99	223	105	6.7	5.7
Back flashover	4	30	206	95	195	93	5.3	2.1
	5	100	218	65	212	62	2.8	4.6
	6	100	201	92	218	88	7.8	4.3

CONCLUSIONS

This study evaluated the lightning performance of a typical 275 kV double circuit transmission line using EMTP. Analyzing the simulated flashover waveforms and magnitudes in comparison to actual fault data collected from six different sites, it is observed that there is a consistent flashover pattern with approximately 6.0 % overall variance in voltage magnitudes.

ACKNOWLEDGEMENT

The authors thank the Ministry of Science, Technology and Innovation (MOSTI), Malaysia for supporting this work through MOSTI TeD 1 Grant (TDF06221586, account no.: UM.0000107/HMT.SF).

REFERENCES

[1] S. Abd Halim, H. A. Illias, N. H. N. Hassan, H. Mokhlis, and V. Terzija, "Lightning back flashover tripping patterns on a 275/132 kV quadruple circuit transmission line in Malaysia," *IET Science, Measurement & Technology,* vol. 10, no. 4, pp. 344-354, 2016.

[2] S. de Castro Assis, W. do Couto Boaventura, J. O. S. Paulino, and R. L. Markiewicz, "Lightning Performance of Transmission Line with and without Surge Arresters: Comparison between a Monte Carlo method and field experience," *Electric Power Systems Research,* vol. 149, pp. 169-177, 2017/08/01/ 2017, doi: https://doi.org/10.1016/j.epsr.2017.04.012.

COMPARISON OF FRA SIGNATURES IN MOTORS WITH IDENTICAL NAMEPLATES

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Abstract - Three-phase induction motor (TPIM) is one of the most important and expensive equipment in many industries. Frequency response analysis (FRA) is a new method that is being proposed to assess the condition of windings in induction motors. This paper investigates whether motors with identical nameplates exhibit the same FRA signatures or if there are discernible differences. To address this, FRA signatures were measured from two actual TPIMs with identical nameplates. Measurements were taken between the same phases (U_1, U_2). The results from both motors were plotted and analyzed, revealing that motors with the same specifications have identical FRA signatures. These findings reinforce the reliability of FRA as a diagnostic tool for condition monitoring and early fault detection in motors.

Keywords–Condiction monitoring, Frequency response analysis, Faults analysis, Induction motors,

INTRODUCTION

Three-phase induction motors (TPIMs) are most widely utilized in modern industrial applications. Since these machines are also prone to different faults, detecting faults in the stator winding early is essential to prevent severe failures and schedule timely machine servicing or replacement. Frequency response analysis (FRA) is a crucial tool for detecting different types of electrical and mechanical failures within transformers [1]. Many papers have investigated using FRA for induction machine diagnoses [2]. What is currently lacking is an investigation of the FRA signature of motors with identical nameplates. To address this, the paper considers the FRA measurements of two TPIMs with the same nameplates.

METHODOLOGY

A frequency analyzer was used to measure the FRA. The test involved two motors, each with a power rating of 7.5 HP, having 4 poles and identical specifications. Initially, the FRA was measured for Motor A, followed by the same for Motor B. The results were then plotted using MATLAB to observe differences between the two motors' FRA signatures.

RESULTS AND DISCUSSION

The FRA signatures from two three-phase induction motors with a power rating of 7.5 HP and identical nameplates are shown in Figure 1. The results revealed consistent signatures between both motors' phases (U1, U2). This consistency suggests that motors with identical specifications exhibit similar electrical characteristics. The slight variation is attributed to the Slight differences in manufacturing processes that can lead to small variations in motor components, such as winding resistance, inductance, and capacitance.

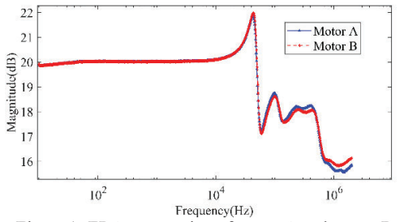

Figure 1: FRA comparsion of motor A and motor B.

CONCLUSIONS

The results of this study could potentially lead to the development of a standardized fingerprint for motors. This standardization could significantly boost the efficacy of FRA as a diagnostic tool for early fault detection and condition monitoring in motors. However, further research is essential to validate these findings across various motor types and specifications.

ACKNOWLEDGEMENTS

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FRGS/1/2022/TK07/UTHM/03/31.

REFERENCES

[1] M. F. M. Yousof, S. Al-Ameri, H. Ahmad, H. A. Illias, and S. N. M. Arshad, “A new approach for estimating insulation condition of field transformers using FRA,” *Advances in Electrical and Computer Engineering*, vol. 20, no. 1, pp. 35–42, 2020.

[2] R. Khan, M. F. M. Yousof, R. Abd-Rahman, S. M. Al-Ameri, and N. Azis, “Impact of the Rotor on FRA Signatures and its Implications for Motor Health Assessment,” in *2024 International Conference on Green Energy, Computing and Sustainable Technology (GECOST)*, 2024, pp. 364–369. doi: 10.1109/GECOST60902.2024.10474882.

Simplification of Footing Resistance Measurement for Transmission Towers in Difficult Terrains

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Abstract - The accurate measurement of Tower Footing Resistance (TFR) is critical for the maintenance and safety of transmission towers, particularly in difficult terrains such as urban areas, mountains, and swamps. Traditional methods like the Fall-of-Potential (FOP) require significant separation distances between measuring probes and the earthing system, which is often impractical in such terrains. This study investigates alternative methods to simplify TFR measurement. By conducting simulations using CDEGS and validating with field measurements, correction factors for various earthing designs and probe distances were determined. The results indicate that reliable TFR measurements can be achieved with reduced separation distances, providing a practical solution for TNB Grid's practice.

Keywords – TFR, Transmission Towers, Difficult Terrains, Fall-of-Potential Method, CDEGS

INTRODUCTION

The Tower Footing Resistance (TFR) is a key parameter that impacts the performance and safety of transmission towers, particularly in terms of lightning protection and fault current dissipation. Accurate measurement of TFR is essential for effective maintenance and safety assurance. Traditional methods such as the Fall-of-Potential (FOP) method require large separation distances between measurement probes and the tower footing, which can be challenging in terrains with physical constraints such as urban areas, mountains, and swamps [1]. This paper aims to develop and validate simplified methods for TFR measurement that are suitable for difficult terrains.

METHODOLOGY

The study involved both simulation and field measurement phases to develop and validate correction factors for simplified TFR measurement methods.

Simulation Using CDEGS: The separation distances between the measurement probes and the earthing systems were varied to simulate different practical scenarios.

Field Measurements: TFR was measured using both the traditional FOP method and the proposed simplified methods. Both results were compared to validate the accuracy of the correction factors developed from the simulations.

RESULTS AND DISCUSSION

Simulation Results

Effect of Probe Distance: Shorter probe distances resulted in higher measured resistance values due to limited soil volume being assessed. Correction factors were necessary to adjust these values to reflect true TFR.

Impact of Earthing Design: Different earthing designs exhibited varying sensitivities to probe distance changes. For instance, the diamond configuration showed more stability in TFR measurements across different probe distances compared to the standard counterpoise design.

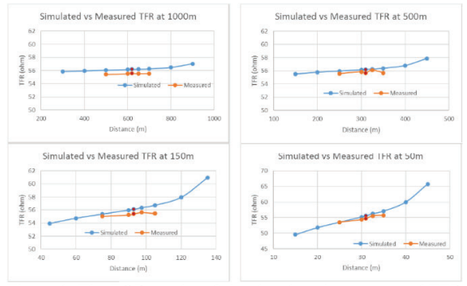

Figure 1: The FOP graphs of simulated against measured TFR for 275kV BTRK-TPAH T197. The plots show good agreement for all separation distance.

Field Measurement Results

Accuracy of Simplified Methods: TFR values obtained using the simplified methods, with corrected values, closely matched those from the traditional FOP method.

Practicality in Difficult Terrains: The simplified methods proved to be practical and effective in terrains where traditional methods were challenging to implement. For example, in hilly and swampy areas, the use of reduced probe distances with correction factors provided reliable TFR measurements[2].

CONCLUSIONS

By using CDEGS simulations to derive correction factors, reliable TFR measurements can be achieved with reduced separation distances between probes. These methods offer practical solutions for maintaining transmission tower safety and reliability in challenging environments.

REFERENCES

[1] K.Schwarz & S.Mertens "Evaluation of Footing Impedance of Transmission Line Towers," *IEEE Transactions on Power Delivery*, vol.32(1), pp.236-244, 2017

[2] J.M.Fernandez & L.Santiago "Impact of Terrain Conductivity on Grounding System Performance," Journal of Electrical Engineering, vol.69(6), pp.449-456, 2018

ANALYZING CORROSIVE SULPHUR ISSUE IN TRANSFORMER USING DIELECTRIC RESPONSE TECHNIQUE

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Abstract – This paper presents the experiment to find the coleration between dielectric response and the existance of corrosive sulfur in insulation paper. Studies highlight FDS's potential in predicting copper sulfide expansion and monitoring transformer parameters [1]. Adjusting dibenzyl disulfide (DBDS) concentration offers insights into Cu2S accumulation, hinting at the possibility of developing a comprehensive database for estimating Cu2S deposition accurately [2].

Keywords – Frequency Dielectric Spectroscopy (FDS), dibenzyl disulfide

INTRODUCTION

The presence of corrosive sulfur compounds in insulating oils affects copper conductors, metal surfaces, and paper insulation. This interaction leads to sulfur corrosion, which manifests as solid contaminants inside failed power transformers. The main purpose of this study is to identify is there any correlation between the existance of corrosive sulfur and FDS response.

METHODOLOGY

Figure 1 shows the filtering oil samples through a 0.25 µm membrane filter and subsequent drying in an oven at 85°C for 48 hours ensures the removal of contaminants and moisture.

Figure 2 shows the sample of kraft paper that undergoes thorough drying at 105°C for 48 hours before impregnation with the copper conductor to minimize moisture contact.

The addition of dibenzyl disulfide (DBDS) to the oil samples facilitates controlled sulfur deposition. Thermal aging experiments, conducted at 150°C for varying durations, mimic real-world transformer conditions, allowing for the assessment of material degradation over time.

Figure 3 shows the setup of FDS measurement for the experiment.

The sample will also send for EDX measurement. this test being conducted just to confirms the existence of copper sulfide (Cu2S).

Figure 1: Oil filtration process

Figure 2: Sample of new paper during drying process

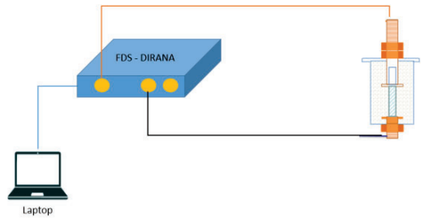

Figure 3: FDS Setup

RESULTS AND DISCUSSION

Based from the observation of the FDS response as shown in table 1.0, it is observed that there is a correlation between capacitance & the sulfide especially between 0.1Hz to 0.01 Hz With the increase of aging duration, the capacitance value decreases.

Table 1 RLC parameters of the HV winding of the transformer.

Day	Sample	Frequency (0.1Hz)		Frequency (0.01Hz)	
		C (nF)	e ‘	C (nF)	e ‘
2	A	12.399	5.40E+02	199.555	8.69E+03
4	B	8.448	3.25E+02	147.862	5.70E+03
6	C	3.019	2.52E+02	50.598	4.22E+03
8	D	2.135	2.14E+02	31.501	3.15E+03

CONCLUSION

Based form the EDX test result, it is shown that, the aging of paper insulation with transformer oil contain DBDS led to the deposition of sulfur on the surface of the insulation paper. There are correlation between the number of aging days with the capacitance and permittivity between 0.1 Hz to 0.01Hz. The combination of new paper & affected papers with DBDS and its effect to dielectric response will be study in the future.

REFERENCES

[1] P.S.Amaro, A.F.Holt, M.Facciotti Impact of Corrosive Sulfur in Transformer Paper,” *Electrical Insulation,Ottowa,2013*.

[2] Akshatha A, Anjana K, Ravi Kumar A, Shyam Kumar Ch. and J. Sundara Rajan “Understanding Copper Corrosion due to Sulphur in oil of Large Transformers by different approaches”

DESIGN INSPECTION OF CONFORMAL ANTENNA FOR NON-INVASIVE DETECTION OF HIGH VOLTAGE INSULATION DEFECTS

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Abstract **–** A conformal antenna operating at ultra-high frequency (UHF) range is proposed to detect partial discharge (PD) in high-voltage equipment. An elliptical radiating patch and a partial ground plane are used to achieve ultra-wideband (UWB) characteristics. The proposed UHF antenna has a compact area of 23.7 × 22.9 cm^2 and covered a bandwidth of 0.527~3.13 GHz. The antenna-width is bent ±60° to test its conformal characteristics.

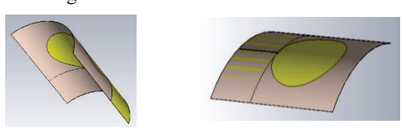
Keywords – Conformal antenna, HV insulation defects, partial discharge, UHF antenna, ultra-wideband

INTRODUCTION

The partial electric field inside or on the surface of the insulator can concentrate to an extreme degree, causing a damaging electrical event known as partial discharge (PD). PD occurs in UHF range (0.3~3 GHz) and may accelerate the degradation of insulation, which could result in a permanent damage of high voltage euipment [1]. It is problematic to use rigid UHF antenna as an internal PD detection sensor in high voltage equipment such as GIS. This problem can be solved by implementing conformal UHF antenna as a PD detection sensor [2].

METHODOLOGY

The UHF antenna is designed on a low-cost substrate Rogers RT5880 of dielectric constant, ε_r = 2.2 and a thickness of 0.5 mm. RT5880 has bending capability that means it is a suitable substrate to be used in conformal antenna design. The radiating patch has elliptical shape with horizontal and vertical diameters of 157.3 mm and 119.2 mm respectively. The ground plane is designed as a partial ground to achieve monopolar characteristics. The thickness of the patch and the ground plane is 0.035 mm. RT5880 substrate is used to test the conformal properties of the proposed antenna shown in Fig. 1.



(a) **(b)**

Figure 1: Antenna structure bent at (a) +60° and (b) -60°.

RESULTS AND DISCUSSION

The antenna can radiate within 0.527~3.13 GHz, i.e. 2603 MHz bandwidth without bending. When the structure is bent at +60° and -60°, the antenna covers 2779 MHz and 2549 MHz repectively, remaining S_{11} below -10 dB. S_{11} and gain curves are shown in Fig. 2 and Fig. 3 respectively. The simulation result shows greater possibilities for conformal application of the antenna to detect high voltage insulation defects.

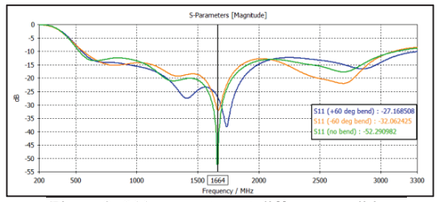


Figure 2: S11 parameters at different conditions

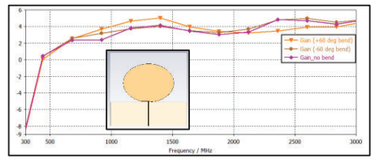


Figure 3: Gain VS Frequency plot

CONCLUSIONS

A new UHF conformal antenna sensor is proposed for PD detection. Simulation of the antenna exhibits promising performance even when it is bent. It covers a larger bandwidth in the UHF band which can ensure better PD detection. Experimental analyses will be performed in suitable testing condition in future to further assess its reliability.

ACKNOWLEDGEMENTS

This work was funded by the Universiti Malaya (UM), Malaysia through the UM International Collaboration Grant of IMG003-2023, and RU Geran - Fakulti Program of GPF008A-2023.

REFERENCES

[1] J. Tian, G. Zhang, C. Ming, L. He, Y. Liu, J. Liu, and X. Zhang, "Design of a Flexible UHF Hilbert Antenna for Partial Discharge Detection in Gas-Insulated Switchgear," *IEEE Antennas and Wireless Propagation Letters,* vol. 22, no. 4, pp. 794-798, 2023.

[2] X. Hu, G. Zhang, X. Liu, K. Chen, and X. Zhang, "Design of High-Sensitivity Flexible Low-Profile Spiral Antenna Sensor for GIS Built-in PD Detection," *Sensors (Basel),* vol. 23, no. 10, May 13, 2023.

PREDICTION OF HEALTH INDEX FOR ON LOAD TAP CHANGER BASED ON DGA DATA USING STATISTICAL DISTRIBUTION MODELS

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Abstract **–** This research investigates the prediction of the health index for On Load Tap Changers (OLTCs) using Dissolved Gas Analysis (DGA) data and statistical distribution models. By analyzing historical DGA data, we aim to develop a predictive model that accurately assesses OLTC health. The study employs various statistical distributions, such as Weibull and Log-Normal models, to estimate health indices. Our approach leverages Maximum Likelihood Estimation (MLE) and Bayesian inference for parameter estimation. The results are expected to enhance OLTC maintenance strategies by providing reliable health assessments, thereby improving operational reliability and reducing maintenance costs

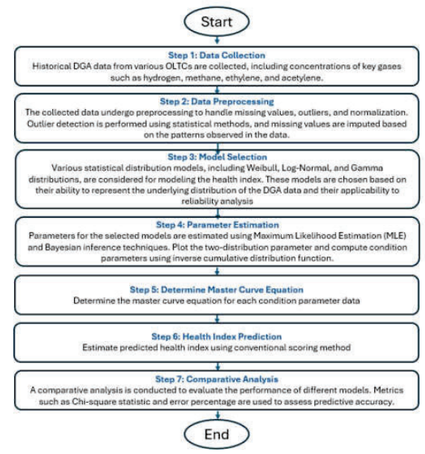
Keywords – statistical distribution model; health index; maximum likelihood estimate; Bayesan inference

INTRODUCTION

On Load Tap Changers (OLTCs) are crucial in power transformers for regulating voltage and maintaining stability. Their reliability is vital, as failures cause major disruptions and costly repairs. Predictive maintenance, forecasting potential failures, is increasingly important for OLTC reliability [1]. Dissolved Gas Analysis (DGA) assesses transformer oil and detects OLTC faults [2]. Analyzing gas concentrations helps infer OLTC health, but accurately predicting health indices from DGA data is challenging. Traditional methods may miss complex relationships between gases and OLTC health. This research uses statistical models to predict OLTC health indices from historical DGA data [3], aiming for robust, accurate assessments to enhance maintenance and reliability.

METHODOLOGY

The research methodology comprises several key steps: data collection, data preprocessing, model selection, parameter estimation, determiantion of equation, health index prediction and comparative analysis.



RESULTS AND DISCUSSION

We aim to develop a predictive model that accurately estimates the health index of OLTCs using DGA data. The chosen statistical model is expected to show high accuracy, indicated by low mean squared errors and high R-squared values. We'll compare model performance and discuss practical implications for maintenance scheduling and operational efficiency. Accurate health predictions can improve maintenance strategies, and the health index will be categorized for easier reference and decision-making.

% HI	Condition	Expected useful life	Request	Color band
86 - 100	Very good	More than 15 years	Normal maintenance	Blue
71 - 85	Good	More than 10 years	Normal maintenance	Green
51 - 70	Regular	Up to 10 years	Increase diagnostic tests	Yellow
31 - 50	Poor	Less than 10 years	Start planning a replace or rebuild considering the risk	Orange
0 - 30	Very poor	End of useful life	Immediately assess risk	Red

CONCLUSION

This research is expected to make a significant contribution to predictive maintenance for OLTCs by introducing a reliable method for health index prediction based on DGA data. The developed model will assist in proactive maintenance decision-making, thereby enhancing the operational efficiency and lifespan of OLTCs. Future work will focus on integrating these models with real-time monitoring systems to facilitate continuous health assessment and further improve maintenance practices.

REFERENCES

[1] Yahaya, M. *et al.* (2018) 'A maintenance cost study of Transformers based on Markov model utilizing frequency of transition approach', *Energies*, 11(8), p. 2006. doi:10.3390/en11082006.

[2] A. Naderian, S. Cress, R. Piercy, F. Wang, and J. Service, "An approach to determine the health index of power transformers," in Conference Record of IEEE International Symposium on Electrical Insulation, 2008.

[3] Mohd Selva, A. *et al.* (2021) 'Application of statistical distribution models to predict health index for condition-based management of Transformers', *Applied Sciences*, 11(6), p. 2728. doi:10.3390/app11062728.

SIMULATION STUDY ON THE MAXIMUM PHOTOVOLTAIC (PV) INJECTION AT 11/0/4.33kV SUBSTATION IN MALAYSIA

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Abstract **–** This paper presents one of the result of the power simulation study performed at one of substation in Malaysia . This paper focuses on the simulation of the scenario where the maximum photovoltaic is injected to the 11/0.433kV substation and the impact on the voltage is observed. The network is modelled based on the actual parameters at site where the input parameters such as power and voltage are based on collected data over period of time.

Keywords – Network Simulation, Photovoltaic (PV)

INTRODUCTION

In the recent published National Energy Transition Roadmap (NETR) Roadmap [1], the govermerment of Malaysia are providing various incentives in order to increase the amount of Distributed Energy Resources (DER) particularly on the installation of photovolthaic (PV) solar panel that produce small amount of power into the distribution network. As this initiative is strategic for the country in the long term, there is need to assess the impact of rapid penetration of this scenario on the grid operation. There are various possible scenarios could possible occur, and need to be carefully considered. In this study, the simulation focuses on the scenario where the maximum photovoltaic is injected and the impact on the network is observed and analysed.

METHODOLOGY

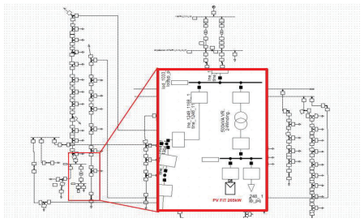

Figure 1 Modelling the Circuit using DigSilent Software

Based on Figure 1, source of medium voltage 11kV originally in the PSS Adept format and converted to DigSilent Power Factory. Simulation study requires quasi-dynamic simulation function in DigSilent Power Factory Network model validation was carried out by carrying out load flow calculation by using both PSS Adept software and DigSilent Power Factory software, and each node voltage was compared for validation purposes. Input parameters are based on real data various scenarios are simulated.

RESULTS AND DISCUSSION

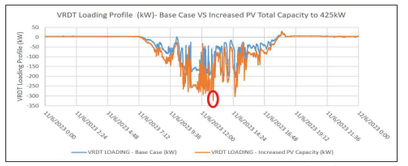

Figure 2 Power Variation With Maximum 425kW from PV

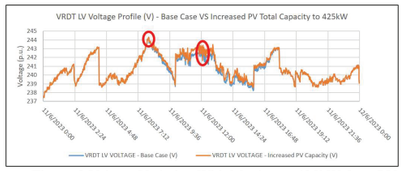

Figure 3 Voltage Variation With Maximum 425kW from PV

Figure 2 and Figure 3 below shows the power & voltage variation when Maximum 425kW injection of PV injectedThe result from simulated scenarios are the following :

- Maximum reverse power flow for base case : -204.38 kW
- Maximum reverse power flow for 0 Load : -323.29 kW
- Maximum voltage for base case : 244.18 V
- Maximum voltage for 0 Load : 244.3 V
- Maximum voltage increase due to solar generation : 1.03 V (242.29 V ~ 243.32 V) or 0.43% increase

CONCLUSION

From the simulation result, it is found that the maximum PV injection of 425kW in this case study have minimal impact on the voltage and will not violates the voltage requirements.

REFERENCES

[1] National Transition Energy Roadmap (NETR) Kementrian Ekonomi Malaysia

[2] Suruhanjaya Tenaga – Grid Code for Peninsular Malaysia

TIME DIFFERENCE OF ARRIVAL TECHNIQUES ON PARTIAL DISCHARGE LOCALIZATION IN SUBSTATION USING PARTICLE SWARM OPTIMIZATION

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Abstract **-** This study compares the Partial Discharge (PD) localization accuracy of different Time Difference of Arrival (TDOA) approaches, including first peak, energy accumulation, cross-correlation (CC), and generalized CC (GCC). The experiment involved recording TDOA and using Particle Swarm Optimization (PSO) for benchmarking. Results show that the first peak detection method has superior localization accuracy, with the Root Mean Square Error (RMSE) remaining under 0.06, highlighting its effectiveness in precise localization tasks.

Keywords – Partial Discharge, TDOA, Localization, Optimization Algorithm, Substation

INTRODUCTION

Partial discharge (PD) is an insulation defect in high voltage equipment. Detecting and locating PD in substations is vital for timely maintenance and preventing failures [1]. Locating PD involves solving TDOA equations, with accurate TDOA calculation being crucial for effective PD localization [2]. This study compares the localization accuracy of different TDOA formulation approaches, including first peak detection, energy accumulation, CC, and GCC, aiming to identify the most accurate method for PD localization, thereby optimizing TDOA-based systems and enhancing maintenance strategies in high voltage equipment.

METHODOLOGY

PD signals at different locations were measured. For TDOA, the signal arrival was processed using:

1. First peak: calculated based on the differences in the detected first peak times.
2. Energy accumulation: similar to the first peak approach, where the peaks were obtained from the energy-time plot instead of voltage-time plot.
3. CC: calculating the dot product of one signal with time-shifted versions of the other signal.
4. GCC: applying a weighting function to the signals' frequency-domain representations follow by calculating the dot product of one signal with time-shifted versions of the other signal.

PSO is employed to calculate the PD source localization by solving the TDOA equations. The optimization algorithm iteratively searches for the source location within the searched space. The localization error is computed as in RMSE between estimated and actual PD location.

RESULTS AND DISCUSSION

As shown in figure 1, the RMSE for first peak detection was the lowest compared to other methods at the three different locations. However, it requires manual peak selection and calculation of the peak difference, whereas other TDOA approaches perform this automatically.

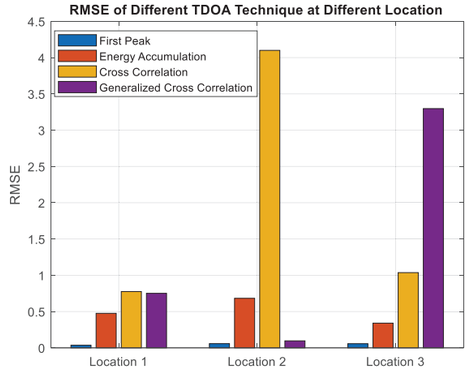

Figure 1: Localization Performance using PSO.

CONCLUSIONS

This study provides a comparison of various TDOA formulation approaches, namely first peak, energy accumulation, CC, and GCC, in terms of their localization accuracy. It was determined that the first peak detection method significantly outperforms the other approaches, and consistently maintained a localization error under 0.06, demonstrating its high effectiveness and precision, reinforcing its suitability for a wide range of real-world scenarios where precise positioning is crucial.

ACKNOWLEDGEMENTS

This research was funded by the Ministry of Higher Education Malaysia via Fundamental Research Grant Scheme (FRGS/1/2022/TK07/UM/02/57).

REFERENCES

[1] R. He, J. Yan, D. Zhao, L. Lu, and Y. Geng, "Gas-insulated switchgear partial discharge acoustic–electric joint localisation method based on the Salp Swarm Algorithm and least squares estimation," *Measurement,* vol. 225, p. 114020, 2024/02/15/ 2024, doi: https://doi.org/10.1016/j.measurement.2023.114020.

[2] H. H. Sinaga, B. T. Phung, and T. R. Blackburn, "Partial discharge localization in transformers using UHF detection method," *IEEE Transactions on Dielectrics and Electrical Insulation,* vol. 19, no. 6, pp. 1891-1900, 2012, doi: 10.1109/TDEI.2012.6396945.

UV-VIS ASSESSMENT OF RETROFILLED AGED MINERAL OIL WITH SYNTHETIC ESTER OIL

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Abstract **-** Retrofilling aged mineral oil (AMO) with ester oils is currently being explored as a potential alternative for prolonging the lifespan of transformers. In retrofilling, up to 10 % of AMO is mixed with new oil. It is expected that the mixing of the oils may impact the performance of the ester oil. In this paper, the aged mineral synthetic ester retrofilled oil (AMO/SE) was evaluated using UV-Vis spectra in order to assess its degradation status. Four different proportions of AMO, i.e. 3 %, 5 %, 7 % and 9 % were chosen for the retrofilling process.

Keywords – Retrofilling, power transformer, synthetic ester, mineral oil, UV-Vis spectra

INTRODUCTION

Retrofilling is the process of replacing aged insulating oil in an existing transformer with new insulating oil [1]. During this process, the aged oil inside the transformer tank must be drained before being replaced with new oil. However, a small amount of the original liquid may remain in the inaccessible regions of the transformer even after the draining process. Previous studies indicated that typically up to 10 % of the original oil remains in the transformer tank [2]. This remaining oil will eventually mix with the fresh oil, thereby affecting the dielectric properties of the new oil. In this paper, UV-Vis spectroscopy was used to evaluate the degradation status of the retrofilled oil. This method can somewhat assist utilities for assessment of the condition of transformer.

METHODOLOGY

New mineral oil (MO) and synthetic ester oil (SE) was firstly filtered and undergoing nitrogen purging. Following that, the mineral oil was subjected to thermally aged in a vacuum oven at 130 ℃ for 150 hours. In the retrofilling procedure, the treated SE oil was heated at 60 ℃. The MO and SE oils were then mixed without using a stirrer and AMO/SE sample was left for 24 hours before testing. The UV-Vis spectra of the retrofilled oil samples was obtained using UV-visible spectrophotometer with a wavelength range of 190-1100 nm to assess the degradation status of the AMO/SE oil.

RESULTS AND DISCUSSION

Figure 1 presents the absorbance spectra for new SE and different mixing ratios of AMO/SE oil. These spectra demonstrate a gradual increase in absorbance as the proportion of AMO rises. This finding is in accordance with the Beer-Lambert relation, which postulates that the absorption of UV-Vis light is directly proportional to the concentration of the sample. Therefore, the degradation of retrofilled AMO/SE increase as the concentration of decay products increases.

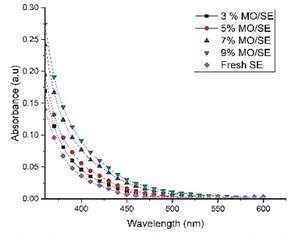

Figure 1: Absorbance spectra for new SE oil and retrofilled AMO/SE oil.

CONCLUSIONS

The UV-Vis absorption spectra of retrofilled AMO/SE oil samples exhibited a gradual shift towards higher absorbance and longer wavelengths with an increase in the proportion of AMO.

ACKNOWLEDGEMENTS

Thanks to UTeM and Ministry of Higher Education, Malaysia for supporting Fundamental Research Grant Scheme (FRGS/1/2020/FKE-CERIA/F00415).

REFERENCES

[1] Cigre A2.35 Working Group, “Experiences in service with new insulating liquids,” 2010.

[2] I. Fofana, V. Wasserberg, H. Borsi, and E. Gockenbach, “Retrofilling conditions of high-voltage transformers,” *IEEE Electrical Insulation Magazine*, vol. 17, no. 2, pp. 17–30, 2001.

RELATIONSHIP BETWEEN FILLER CONCENTRATION OF SILICONE RUBBER AND ITS WEIGHT LOSS, TRACKING LENGTH, AND DEPTH.

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Abstract **–** An analysis was conducted on samples of silicone rubber (SiR) with varying filler concentrations to evaluate their performance using the Incline Plane Tracking (IPT) test. The results were analyzed using a linear regression graph. A reduction in weight loss percentages was observed as the filler increased. Additionally, as the filler concentration increases, the tracking depth increases and the tracking length decreases.

Keywords – Silicone Rubber, Alumina Trihydrate, tracking length, weight loss, tracking depth

INTRODUCTION

A pure silicone rubber (SiR) has weak resistance against tracking and erosion [1]. Hence, an appropriate filler such as alumina trihydrate (ATH) is needed to enhance its performance. This study investigates the effects of varying ATH filler ratios on SiR blends during a rapid aging test of Inclined Plane Tracking (IPT) testing. The tests were done in accordance with the standard BS EN 60587. The weight loss, tracking depth, and length of the samples were measured afterward. The chosen ATH filler range is 10-50 pphr.

METHODOLOGY

The samples were tested via IPT test under a constant voltage of 3.5kV for 6 hours, as stated in the BS EN 60587 standard. The obtained results were analysed using linear regression plot to determine the relationship between filler concentration and SiR performances in terms of weight loss, tracking length, and depth.

RESULTS AND DISCUSSION

During the IPT test, tracking, DBA, and corona caused the sample to erode. The eroded mass represents the weight loss of samples, highlighting the severity of the aging for each sample. In Figure 1, with every 10 pphr increase of filler, the weight loss was associated with a reduction of 0.0021%. There is a trend of reduction in weight loss as the filler amount increases Additionally, there is a pattern noticed that as filler increases, the tracking length decreases and tracking depth increases. The presence of filler makes the erosion more focused instead of spreading. It was also reported that samples with ATH filler yielded shorter tracking length than the pure samples, indicating that filler inhibits tracking [2]. In another finding, the tracking length seems shorter as the ATH filler concentration increases [3]. These findings are worth noting as most findings focus on the weight loss of samples or the tracking depth.

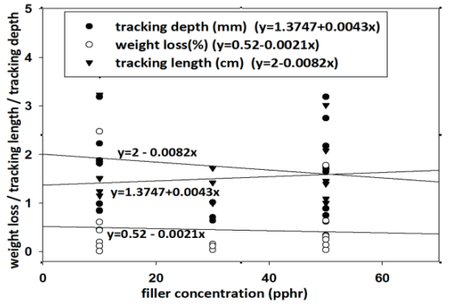

Figure 1: The results for the weight loss percentage, tracking length and depth of SiR samples..

CONCLUSIONS

The presence of filler in SiR helps to improve the resistance of SiR against tracking and erosion. Hence, preventing the tracking path from forming and therefore reducing the chance of high leakage current values, higher degradation, and breakdown of the insulator.

REFERENCES

[1] H. Khan, M. Amin, and A. Ahmad, "Characteristics of silicone composites for high voltage insulations," *Rev. Adv. Mater. Sci.*, vol. 56, no. 1, pp. 91–123, 2018, doi: 10.1515/rams-2018-0040.

[2] I. Khan, M. A. Abid, Z. Ullah, and A. Rashid, "Effect of filler on solid insulator surface and tracking length in high voltage systems," *Eng. Appl. Sci. Lett.*, vol. 2, no. 2, pp. 37–42, 2019, doi: 10.30538/psrp-easl2019.0019.

[3] S. Sun, M. Zhao, F. Chen, Z. Wu, and J. Wang, "Investigation of the Tracking and Erosion Resistance of a Ceramifiable Filler System for Silicone Rubber Composites," *IEEE Trans. Dielectr. Electr. Insul.*, vol. 29, no. 3, pp. 933–938, 2022, doi: 10.1109/TDEI.2022.3173519.

OPTIMIZATION OF DISTRIBUTION SYSTEM RELIABILITY AGAINST LIGHTNING

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Abstract— This study presents the Dandelion Optimizer (DO), inspired by the life cycle of the dandelion plant, for optimizing the placement of lightning protection systems (LPS) in an 81-bus radial distribution network. The objective is to minimize the System Average Interruption Frequency Index (SAIFI) and Momentary Average Interruption Frequency Index (MAIFI). Numerical simulations validate the effectiveness of DO, taking into account the lightning flashover rate and LPS configuration. Comparative analysis shows DO's superior performance, achieving a 6.16% reduction in reliability indices, outperforming the Grey Wolf Optimizer of 6.14% and Dragonfly Algorithm of 5.14%, with faster convergence and better local optima detection.

Keywords – Lightning protection system, Flashover rate, SAIFI, MAIFI, Dandelion Optimizer

INTRODUCTION

Lightning significantly influences electricity distribution in power systems, directly affecting overhead lines and causing outages, while also inducing overvoltage through ground strikes. Thus, researchers worldwide focus on enhancing distribution reliability to mitigate weather-induced outages [1]. Extensive research highlights lightning's propensity to disrupt power systems, causing frequent outages [2]. As such, optimizing system resilience against lightning-induced interruptions remains a critical pursuit.

METHODOLOGY

The study uses the DO algorithm to optimize the reliability of an 81-bus radial distribution system with different LPSs which involves soil resistivities ranging from 100 to 2000 Ωm [3]. The results are compared with those from GWO and DA algorithms. The optimization model considers soil resistivity under each distribution line section and flashover rates (flashes/100 km/yr) under each LPS configuration (j), as shown in Table 1, both of which impact SAIFI and MAIFI.

Table 1: Flashover Rate Due To Lightning

Pole Structure	Grounding Topology	j	Soil Resistivity (Ωm)				
			100	500	1000	1500	2000
No LPS		1	112	125	161	179	205
Wire guard	1 vertical rod	2	110	114	116	121	123
	2 vertical rods	3	108	113	116	120	123
Franklin Lightning Captor	1 vertical rod	4	110	119	144	157	176
	2 vertical rods	5	110	119	144	157	176

RESULTS AND DISCUSSION

Test case in Table 2 displays that DO has the minimum worst and best SAIFI and MAIFI after applying 10 LPSs. The best SAIFI and MAIFI of the DO are 4.255 int./yr and 21.275 int./yr where both had the highest reduction by about 6.16% from the unprotected distribution system's reliability indices 4.535 int./yr and 22.672 int./yr. Followed by GWO and DA, which were reduced by 6.14% and 5.14% respectively. The GWO and DO have a higher consistency in this case than DA, in which the mean and standard deviation are lower.

Table 2: Simulation Result For Test Case

Algorithm	Best		Reduct. (%)	Mean		Std. Dev	
	SAIFI (int./yr)	MAIFI (int./yr)	SAIFI & MAIFI	SAIFI	MAIFI	SAIFI	MAIFI
GWO	4.256	21.281	0.061	4.272	21.361	0.012	0.061
DA	4.302	21.508	0.051	4.348	21.742	0.020	0.101
DO	4.255	21.275	0.062	4.274	21.368	0.012	0.058

CONCLUSIONS

The study concludes that the DO is a promising optimization algorithm for optimizing LPS placement in radial distribution networks, minimizing SAIFI and MAIFI. The algorithm's fast convergence and ability to identify promising regions for optimal solutions make it a suitable choice for real-world applications.

ACKNOWLEDGEMENTS

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REFERENCES

[1] The White House, *Economic Benefits of Increasing Electric Grid Resilience to Weather Outages*, Executive Office of the President, 2013, July.

[2] Uglešić, I., Milardić, V., Franc, B., et al. "Correlation between lightning impacts and outages of transmission lines." In *CIGRE C4 Colloquium on Power Quality and Lightning*, pp. 1-10. 2012.

[3] Tang, J. W., Wooi, C. L., Tan, W. S., et al. "Optimization of Distribution System Reliability Using Dandelion Optimizer." *2023 Innov. Power Adv. Comput. Techn. (i-PACT)*, pp. 1-8. IEEE, 2023.

LIGHTNING PROTECTION AND EARTHING ASSESSMENT ON BATTERY CHARGER FAILURE IN A SWITCHING SUBSTATION

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Abstract **–** This paper aims to discuss lightning protection and earthing system assessment of a switching substation in a distribution network that frequently faces battery charger failures. Analysis of the fault event and lightning correlation for the failure has given preliminary valuable results in determining the cause of battery charge failure and hence recommendations for improvement can be made to improve the reliability of the equipment.

Keywords – Lightning protection, Distribution Network, Battery charger failures, Substation, Power System

INTRODUCTION

Lightning protection systems and earthing system assessments on substations frequently facing battery charger failure are part of initiatives taken to increase the reliability of equipment in the system. TNBR has carried out a comprehensive assessment of such work on a 33kV switching substation located in Negeri Sembilan.

METHODOLOGY

The research methodology carried out includes site inspections and measurements of the substation's lightning protection system and earthing installation, fault event and lightning event correlation analysis, and simulation of the effects of nearby lightning strikes on the substation using specialized software.

RESULTS AND DISCUSSION

Site inspections and measurements of the substation earthing system were carried out and results were presented. The measured earthing resistance using the Fall of Potential method (IEEE 81) is 0.271Ω. The corresponding earthing grid resistance for the SSU is below 1.0Ω, which is the minimum requirement for substation earthing grid resistance in TNB. Fault event and lightning event correlation analysis were carried out. Only one event may have suggested that the failure may be due to excessive voltages from the nearby lightning strike (Figure 1).

Study on the effects of nearby lightning strikes with an average current of 16.47kA were carried out using specialized software Current Distribution, Electromagnetics, Grounding and Soil Structure Analysis Software (CDEGS). Possible touch voltage, step voltage and surface potential resulting from the strikes were simulated as shown in Figure 2 and 3.

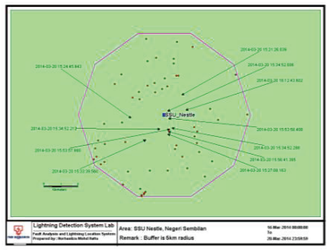

Figure 1: Historical lightning strike activities

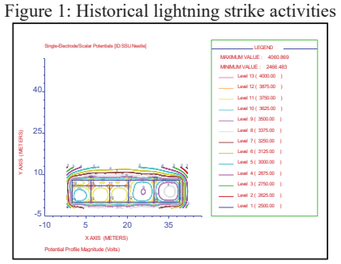

Figure 2: Surface potentials within the substation vicinity due to lightning strikes

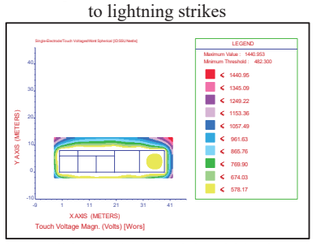

Figure 3: Possible touch potentials within the substation vicinity due to lightning strikes

CONCLUSIONS

In summary, the project has successfully investigated the failures of battery chargers in a switching substation focusing on its lightning protection and earthing system installed. The recommendation for improvement is part of the initiatives to enhance work management and to increase the system reliability & efficiency.

REFERENCES

[1] IEEE Standard 80, Guide for Safety in AC Substation Grounding
[2] IEEE Standard 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

PERFORMANCE OF WOOD ASH WITH SODIUM CHLORIDE MIXTURE AS GROUNDING ENHANCEMENT MATERIAL

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Abstract - This research investigates the effectiveness of Wood ash and Sodium Chloride (NaCl), compared to conventional Bentonite. Experiments involved filling holes with 10 kg of bentonite, Wood ash, and various mixtures of Wood ash and NaCl (7 kg wood ash + 3 kg NaCl, 8 kg wood ash + 2 kg NaCl, 9 kg wood ash + 1 kg NaCl), using a reference hole without enhancement material. Copper earth rods were used, and the fall of potential method was employed over 12 weeks. Results showed that the 7 kg Wood ash + 3 kg NaCl mixture performed similarly to 10 kg of bentonite, achieving a 62% and 62.7% reduction in ground resistance, respectively. This indicates that a carefully mixed combination of Wood ash and NaCl can be a viable alternative to bentonite.

Keywords – Grounding system, grounding enhancement materials.

INTRODUCTION

Material reduction method of reducing grounding resistance utilises enhancement materials to treat the surrounding soil, this paper distinctly concentrates on utilising material-based enhancement materials like Wood ash and Sodium Chloride (NaCl) as substitutes for the conventional natural-based enhancement material, Bentonite.

METHODOLOGY

Copper rods, 1.5 meters in height and 0.012 meters in diameter were inserted into the soil at a depth of 1.4 meters, spaced 5 meters apart. Circular trenches, 0.12 meters wide and 0.5 meters deep, were dug around each electrode. Each trench was filled with 10 kilograms of specific materials

RESULTS AND DISCUSSION

By week 12 the grounding system with 10 kg of Bentonite performed best with 62.7%. A close second was the system using a mix of 7 kg Wood ash and 3 kg NaCl, which reduced resistance by 62%. Other combinations of Wood ash and NaCl also reduced resistance effectively: 8 kg Wood ash + 2 kg NaCl by 58.4%, 9 kg Wood ash + 1 kg NaCl by 56.96%, and 10 kg Wood ash by 46.77% as shown in Table 1 below.

Table 1: Grounding Resistance for 12 Weeks

Material	Bentonite	Wood - ash	Soil	7kg Wood -ash +3kg NaCl	8kg Wood ash +2kg NaCl	9kg Wood ash + 1kg NaCl
Resistance(Ω)	5.2	7.4	13.9	5.3	5.8	6.0

CONCLUSIONS

The results indicate that a carefully formulated mixture of Wood ash and NaCl can be an effective alternative to bentonite.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the financial support in the form of a publication incentive grant from Universiti Malaysia Perlis (UniMAP). Besides, this work also acknowledges the support from the Ministry of Higher Education Malaysia through the Fundamental Research Grant Scheme (FRGS) under a grant number of FRGS/1/2022/TK08/UNIMAP/02/72.

REFERENCES

[1] Hossain, M. S., Ahmed, R., & Hossain, S. (2021). Design and optimization of substation grounding grid for ensuring the safety of personnel and equipment. Journal of Electrical Power & Energy Systems, 5(1), 71-80)
[2] Wan Ahmad, W. F. H., Abdul Rahman, A. H., Jasni, J., & Ab-Kadir, M. Z. A. (2023). Performance of Bentonite and Peat Moss Mixtures as Grounding Enhancement Materials. APL 2023 - 12th Asia-Pacific International Conference on Lightning,https://doi.org/10.1109/APL57308.2023.10181741

Dynamic Line Rating for Underground Cables: Correlating Ampacity Simulations with Real-Time Temperature Measurements

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Abstract **–** Sturdy underground power cables are essential infrastructure, and extensive research has aimed to ensure reliable and efficient electricity transmission across various terrains. Consequently, Dynamic Line Rating (DLR) has become a solution for cable systems, overcoming the limitations of Static Line Rating (SLR). It offers a more adaptable and efficient approach to managing the capacity of cables. This study aims to bridge the gap in the development of models for DLR and improve accuracy through a correlation study between load profiles and corresponding temperature measurements. The results will then be validated through an experimental setup. Thus, a dynamic line rating topology for underground cables based on simulation and real-time measurement is proposed.

Keywords – Ampacity, dynamic line rating, thermal model, heat, temperature.

INTRODUCTION

In sustainable energy systems, robust underground power cables are crucial for reliable and efficient electricity transmission across diverse terrains. Extensive research has focused on optimizing these cables to meet the growing demand for secure electricity [1]-[3], particularly with the rise of renewable energy and smart grids [4]-[11] which have increased the need for dependable underground cable networks.

One solution to enhance these systems is the implementation of Dynamic Line Rating (DLR). Unlike Static Line Rating (SLR), which sets a constant maximum current capacity based on worst-case scenarios, DLR adjusts the capacity dynamically based on real-time load and environmental conditions [12]-[16]. This study aims to tackle the challenges associated with DLR, such as the complex heat transfer analysis of underground cables, the impact of cable load profiles on temperature measurements, and the need for thorough comparative studies between simulations and experimental data for dynamic current rating.

METHODOLOGY

In this study, a thermo-electric equivalent circuit model representing one-dimensional heat distributions will be developed and analyzed to determine the amount of heat loss due to increased loading currents according to N-1 contingency conditions. Extending from the traditional thermal model guided by IEC 60853-2, the thermal model in this study will utilize the method of partitioning the insulation layer and sheath layer into several subcomponents as presented in [7], [17].

The second part of this work focuses on mathematically modeling the ampacity of underground cables. This part of the study investigates the maximum current that an underground cable can carry based on the type of installation, specifically for cables laid in tunnels. The simulation results will then be compared and validated against real-time measurements.

RESULTS AND DISCUSSION

A comprehensive underground cable thermal model as presented in [7], [17] is expected to be developed in this study to accurately describe the heat transfer based on loading currents. The blown line in Figure 1 depicts the conductor temperature as a step response from an input current that is step-changed from 1449 A to 1903 A, which is an increase of 30% ampacity. Up until it surpasses the steady state limit (90 °C), the conductor temperature trails the step line current by 14 minutes. Furthermore, in order to mitigate the overload on the transmission line cable, we can increase the control time margin to 101 minutes if the conductor's temporary temperature limit of 105 °C can be used.

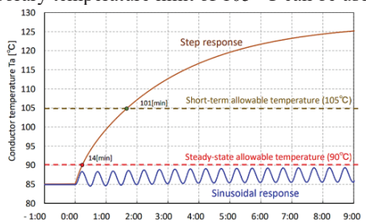

Figure 1: Expected conductor temperature output that refered from [17].

CONCLUSIONS

By improving the understanding of heat transfer, developing accurate temperature models, and validating simulations with experimental data, this research will ultimately contribute to more efficient and reliable underground cable networks, supporting the Sustainable Development Goals (SDGs).

ACKNOWLEDGEMENTS

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REFERENCES

[1] J. Li, F. Yang, Z. Fang, X. Lu, and R. Hu, "Assessment on capacity expansion of AC XLPE cable under DC operation with the constraint of temperature and electric field intensity," *IET Generation, Transmission and Distribution*, vol. 16, no. 13, pp. 2612–2622, Jul. 2022, doi: 10.1049/gtd2.12476.

[2] D. Kalmar, D. Szabo, G. Gocsei, and B. Nemeth, "Extension of dynamic line rating models with the effect of conductor aging," in *2022 8th International Youth Conference on Energy, IYCE 2022*, Institute of Electrical and Electronics Engineers Inc., 2022. doi: 10.1109/IYCE54153.2022.9857524.

[3] K. Wang and K. Kopsidas, "A Power System Reliability Framework Considering Soil Drying-Out Effect on Underground Cables," *IEEE Transactions on Power Systems*, 2023, doi: 10.1109/TPWRS.2023.3321537.

[4] Hideharu Sugihara and Tsuyoshi Funaki, "Fundamental Analysis of Electrothermal Coordination of Underground Cables toward High-Penetration Renewable Generation," *2018 IEEE Power & Energy Society General Meeting (PESGM)*, pp. 1–5, 2018.

[5] B. O. Ngoko, H. Sugihara, and T. Funaki, "Effect of Dynamic Line Ratings on Optimal Dispatch Considering Uncertainty Costs due to Intermittent Renewable Energy," in *IFAC-PapersOnLine*, Elsevier B.V., Jan. 2018, pp. 185–190. doi: 10.1016/j.ifacol.2018.11.699.

[6] A. Michiorri, R. Currie, P. Taylor, F. Watson, and D. Macleman, "DYNAMIC LINE RATINGS DEPLOYMENT ON THE ORKNEY SMART GRID," in *21st International Conference on Electricity Distribution*, Germany: CIRED, Jun. 2011.

[7] H. Sugihara and T. Funaki, "Analysis on temperature dependency of effective ac conductor resistance of underground cables for dynamic line ratings in smart grids," in *Proceedings - 21st IEEE International Conference on High Performance Computing and Communications, 17th IEEE International Conference on Smart City and 5th IEEE International Conference on Data Science and Systems, HPCC/SmartCity/DSS 2019*, Institute of Electrical and Electronics Engineers Inc., Aug. 2019, pp. 2637–2643. doi: 10.1109/HPCC/SmartCity/DSS.2019.00370.

[8] Y. Li, Q. Chen, G. Strbac, K. Hur, and C. Kang, "Active Distribution Network Expansion Planning With Dynamic Thermal Rating of Underground Cables and Transformers," *IEEE Trans Smart Grid*, vol. 15, no. 1, pp. 218–232, Jan. 2024, doi: 10.1109/TSG.2023.3266782.

[9] D. Enescu, P. Colella, A. Russo, R. F. Porumb, and G. C. Seritan, "Concepts and methods to assess the dynamic thermal rating of underground power cables†," *Energies (Basel)*, vol. 14, no. 9, May 2021, doi: 10.3390/en14092591.

[10] O. D. Ariza Rocha, K. Morozovska, T. Laneryd, O. Ivarsson, C. Ahlrot, and P. Hilber, "Dynamic rating assists cost-effective expansion of wind farms by utilizing the hidden capacity of transformers," *International Journal of Electrical Power & Energy Systems*, vol. 123, p. 106188, 2020, doi: https://doi.org/10.1016/j.ijepes.2020.106188.

[11] A. Dogan, "Analyzing flexibility options for microgrid management from economical operational and environmental perspectives," *International Journal of Electrical Power and Energy Systems*, vol. 158, Jul. 2024, doi: 10.1016/j.ijepes.2024.109914.

[12] S. Bustamante *et al.*, "Thermal behaviour of medium-voltage underground cables under high-load operating conditions," *Appl Therm Eng*, vol. 156, pp. 444–452, Jun. 2019, doi: 10.1016/j.applthermaleng.2019.04.083.

[13] M. Mroz, G. J. Anders, and E. Gulski, "Soil Dryout in the Vicinity of Cables with Cyclic Load Installed in a Backfill," *IEEE Transactions on Power Delivery*, vol. 38, no. 2, pp. 1267–1276, Apr. 2023, doi: 10.1109/TPWRD.2022.3211851.

[14] O. E. Gouda and G. F. A. Osman, "Algorithm for load cycling correction to minimise the dry zone influences on the cross-linked polyethylene (XLPE) cable insulation," *IET Generation, Transmission and Distribution*, vol. 14, no. 21, pp. 4684–4693, Nov. 2020, doi: 10.1049/iet-gtd.2020.0406.

[15] D. A. Giglio and F. De Leon, "Dynamic Thermal Model for Different Size Trefoil Power Cables with Various Loads in Non-Forced-Ventilated Tunnels," *IEEE Transactions on Power Delivery*, vol. 38, no. 2, pp. 1286–1296, Apr. 2023, doi: 10.1109/TPWRD.2022.3212376.

[16] T. M. Z. Elsharkawy, G. F. A. Osman, and W. A. A. Salem, "The effect of nonlinear loads on the underground distribution cables: a case study," *Journal of Electrical Systems and Information Technology*, vol. 9, no. 1, Oct. 2022, doi: 10.1186/s43067-022-00061-2.

[17] Hideharu Sugihara and Tsuyoshi Funaki, "Fundamental Analysis of Electrothermal Coordination of Underground Cables toward High-Penetration Renewable Generation," in *IEEE Power & Energy Society General Meeting (PESGM)*, Portland, 2018, pp. 1–5.

TRANSIENT VOLTAGE ANALYSIS ON GRID-CONNECTED SOLAR PV SYSTEM DUE TO LIGHTNING

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Abstract— The utilization of solar photovoltaic (PV) systems for electricity generation in Malaysia is increasingly common. However, these systems face a notable vulnerability to lightning strikes. This study investigates the impact of lightning strikes on grid-connected solar PV systems lacking adequate lightning protection. Emphasis is placed on evaluating transient voltages that could potentially cause damage to the PV modules.

Keywords – Grid-connected solar PV system, Lightning impact, Transient voltage analysis

INTRODUCTION

The solar PV system in Malaysia is at a higher risk of being struck by lightning because it is situated in a vast, open space. Malaysia, being located near the equator, receives intense sunlight and experiences frequent thunderstorms, with approximately 180-260 days of thunderstorms annually [1]. These lightning strikes have the potential to interfere with and harm the electronic elements of the solar PV system, resulting in decreased efficiency and monetary setbacks [2].

METHODOLOGY

In the PSCAD/EMTDC simulation, 200 µs duration of run, 0.1 µs solution time step, and 0.1 µs channel plot step were used. A grid-connected solar PV system with a maximum voltage of 75 V_{DC} was developed which consists of 5,500 solar PV modules connected to an inverter to convert DC to AC for the load and grid. A lightning current with an 8/20 µs waveshape was modelled to strike between the PV array and the inverter. The transient voltage was observed and compared with the withstand voltage in Table 1.

Table 1: Impulse withstand voltage for electronic components [3]

Column 1	2	3	4	5	6
System Voltage (V) (7.3.7.2)	Impulse Withstand Voltage (V)				Main Circuits Temporary Overvoltage (peak/rms) (See NOTE 5)
	Overvoltage Category				
	I	II	III	IV	
50 V_{rms} or 71 V_{dc}	330	500	800	1500	1770/1250
100 V_{rms} or 141 V_{dc}	500	800	1500	2500	1840/1300
150 V_{rms} or 213 V_{dc}	800	1500	2500	4000	1910/1350
300 V_{rms} or 424 V_{dc}	1500	2500	4000	6000	2120/1500
600 V_{rms} or 849 V_{dc}	2500	4000	6000	8000	2550/1800
1000 V_{rms} or 1500 V_{dc}	4000	6000	8000	12,000	3110/2200

NOTE 1 Interpolation is not permitted in main circuits but is permitted in other circuits.
NOTE 2 The last rows only apply to single-phase systems, or to the phase-to-phase voltage in three-phase systems
NOTE 3 Column 6, temporary overvoltage, only applies to main circuits.
NOTE 4 PV circuits are in general OVCII with a minimum impulse voltage of 2500 V-see 7.3.7.1.2b.
NOTE 5 Three values are derived using the formula (1200 V + system voltage) from IEC 60664-1.

Description: V_{rms} = root-mean-square voltage, V_{dc} = direct current voltage, OVCII = Overvoltage category II.

RESULTS AND DISCUSSION

Table 2 presents the transient voltage outcomes for a solar PV system experiencing lightning strikes between the PV array and the inverter, with varying peak current amplitudes. These results were compared to the system's impulse withstand voltage. Given that the PV array's impulse withstand voltage is 500 V, it is evident that the recorded voltages surpass this 500 V threshold when the current reaches or exceeds 80 kA. Consequently, the solar PV modules are damaged when subjected to lightning strikes with a peak current of 80 kA and an 8/20 µs lightning current waveform.

Table 2: Voltage measurement (V_{pv}) at lightning current amplitude (I_0)

I_0 (kA)	10	20	30	40	50	60	70	80
V_{pv} (V)	123.34	182.55	241.77	300.98	360.19	419.38	478.40	536.39

CONCLUSIONS

Lightning strikes pose a significant threat to solar PV systems in Malaysia due to frequent thunderstorms and high radiation levels. Simulations reveal that currents exceeding 80 kA cause voltage surges, damaging PV modules. Thus, implementing lightning protection systems is crucial to mitigate damage by controlling current and transient voltage levels during lightning events.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Bahari, N., Mohammad, S. A., Esa, M. R. M., Ahmad, M. R., Ahmad, N. A., & Malek, Z. A. "Analysis of lightning flash rate with the occurrence of flash floods and hailstorms in Peninsular Malaysia." *J. Atmos. Sol.-Terr. Phys.* 250 (2023): 106121.

[2] Ahadi, A., Ghadimi, N., & Mirabbasi, D. "Reliability assessment for components of large scale photovoltaic systems." *J. Power Sources* 264 (2014): 211-219.

[3] MS IEC 60664-1, "Insulation Coordination for Equipment Within Low-Voltage Systems - Part 1: Principles", *Malaysian Standard*, 2014.

PROGRESSION OF ATMOSPHERIC LIGHTNING DISCHARGES

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Abstract - Phenomena related to atmospheric lightning discharges, including lightning strikes and cloud discharges, were historically considered mysterious and even objects of worship. Since Benjamin Franklin's demonstration in the mid-18th century that lightning discharges are electrical phenomena within clouds, significant research has led to a comprehensive understanding of these events. This study discusses the progression of stepped leaders in negative polarity lightning, aiming for a deeper understanding using VHF broadband interferometer. The findings suggest that stepped leaders do not progress in sudden large jumps but rather through continuous, bidirectional leader progression, culminating in a recoil streamer-like event observable as stepped leader progression.

Keywords – Lightning discharge, leader progress, VHF broadband interferometer, recoil leader, bidirectional leader

INTRODUCTION

Atmospheric lightning discharges, historically enigmatic and objects of reverence, are now understood as electrical phenomena within clouds. Subsequent research, leveraging advancements in optical observation technologies from boys camera and streak camera to high-speed cameras has understood the progression scenarios of lightning discharges, including corona discharge initiation, streamer progression, stepped leader progression, return strokes, dart leaders, and subsequent strokes. These scenarios are corroborated by electromagnetic wave observations, forming a common understanding within atmospheric electricity research. The contribution is also significant in the verification of discharge progression scenarios by VHF broadband interferometer observations[1].

METHODOLOGY

In this study, the progression of stepped leaders leading to negative cloud-to-ground(CG) lightning strikes is specifically dealt with, aiming to understand the observed continuous leader progression in detail. A modification of a VHF broadband interferometer has been developed to continuously record digital data rather than being triggered by VHF pulses. This development, facilitated by advances in digital streaming technology, aimed to capture both large and small amplitude pulses radiated from the leader tip to improve the understanding of lightning discharge phenomena.

RESULTS AND DISCUSSION

The continuous recording VHF broadband interferometer observations revealed that stepped leaders do not only progress in abrupt but also large jumps through continuous, slow bidirectional leader progression. In addition this, large jumps progression appears as a sudden jump, or "recoil leader," when the positive breakdown reaches a negative charge region, supporting the model proposed by Brook and Kitagawa[2]. Thus, the classical understanding of stepped leader progression as rapid advancement following pauses is not entirely accurate.

CONCLUSIONS

The findings challenge the traditional understanding of stepped leader progression, showing that the process involves continuous bidirectional leader advancement rather than sudden jumps. This new insight from VHF broadband interferometric observations not only suggests the possibility of refining the knowledge of negative polarity leaders, but also renewing the understanding of the development of positive polarity leaders, which may be further revealed by future continuous record observations.

REFERENCES

[1] M. Akita, M. Stock, Z. Kawasaki, P. Krehbiel, W. Rison, and M. Stanley, "Data processing procedure using distribution of slopes of phase differences for broadband VHF interferometer," Journal of Geophysical Research, vol. 119, pp. 6085–6104, May 2014.

[2] N. Kitagawa and M. Brook, "A comparison of intracloud and cloud-to-ground lightning discharges," Journal of Geophysical Research, vol. 65, no. 4, pp. 1189–1201, April 1960.

AC BREAKDOWN VOLTAGE OF VEGETABLE COOKING OIL IN THE PRESENCE OF HEMATITE, ZINC OXIDE, AND NICKEL OXIDE

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Abstract – This study explores the AC breakdown voltage (AC-BDV) performance of vegetable cooking oil mixed with Iron Oxide Hematite (α-Fe_2O_3), Zinc Oxide (ZnO), and Nickel Oxide (NiO). Using the One Minute Power Frequency Test and X-ray diffraction (XRD) analysis, we found that α-Fe_2O_3 and ZnO significantly improved the oil's AC-BDV, with α-Fe_2O_3 at 0.01g/ml achieving the highest breakdown voltage of 13.525 kV. These findings suggest that α-Fe_2O_3 based nanofluids can be a sustainable alternative to mineral oil in transformers.

Keywords – Nano Fluids, Transformer Oil, X-ray Diffraction, AC Breakdown Voltage, Nano Particles.

INTRODUCTION

Transformers rely on high-quality insulating oils, typically mineral oil (MO), which poses environmental concerns due to its non-biodegradability. Recent research indicates that nanoparticles such as Fe_3O_4, Al_2O_3 and ZnO, can enhance the dielectric properties of insulating oils [1]. This study investigates vegetable cooking oil as a biodegradable alternative, improved with nanoparticles, to enhance transformer insulation performance [2].

METHODOLOGY

This study comprehensively investigated the effects of α-Fe_2O_3, ZnO, and NiO nanoparticles on the AC-BDV of vegetable cooking oil. XRD analysis ensured uniform purity of NPs. The One Minute Power Frequency test was employed to measure the AC-BDV of the oil samples at different nanoparticle concentrations [2].

RESULTS AND DISCUSSION

The AC-BDV of vegetable cooking oil was tested with different nanoparticles and concentrations. Figure 1 shows that NFs with α-Fe_2O_3 at 0.01g/ml showed the highest AC-BDV of 13.525 kV, enhancing insulating properties significantly. ZnO also improved dielectric strength, while NiO reduced it. XRD analysis confirmed the crystalline structure of the NPs, crucial for dielectric enhancement [2].

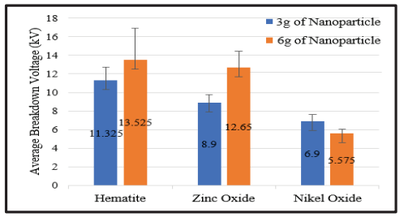

Figure 1: Average breakdown voltage of vegetable cooking oil incorporate with different types of nanoparticles.

CONCLUSIONS

This study shows that adding α-Fe_2O_3 nanoparticles in vegetable oil significantly improve AC-BDV, making it a sustainable alternative to MO for transformer insulation. NiO was found unsuitable. Proper nanoparticle dispersion and purity are essential for optimal performance.

ACKNOWLEDGEMENTS

The authors thank the School of Electrical Engineering, UiTM, for the provided facilities.

REFERENCES

[1] Sobhy. S. Dessouky, S. A. M. Abdelwahab, and M. Shaban, "Effect of titanium oxide nanoparticles on breakdown strength of transformer oil," in *2017 Nineteenth International Middle East Power Systems Conference (MEPCON)*, IEEE, Dec. 2017, pp. 538–542. doi: 10.1109/MEPCON.2017.8301233.

[2] N. S. Suhaimi, M. T. Ishak, A. R. A. Rahman, M. F. Md. Din, M. Z. Z. Abidin, and A. K. Khairi, "A Review on Palm Oil-Based Nanofluids as a Future Resource for Green Transformer Insulation System," *IEEE Access*, vol. 10, pp. 103563–103586, 2022, doi: 10.1109/ACCESS.2022.3209416.

DEVELOPMENT OF LIGHTNING OBSERVATIONS FOR FLASH FLOOD FORECASTING IN MELAKA

Harry Sucitra Roslan[1,*], Mohd Riduan Ahmad[1], Antony Sumardi[1], Shamsul Ammar Shamsul Baharin[1], Mawarni Mohamed Yunus[1], Nor Azlan Mohd Aris[1], Ho Yih Hwa[1], Takeshi Morimoto[2], Yuji Takayanagi[2]

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Abstract - This study is carried out at Melaka which are prone to flash floods. The analysis of these storms lightning data from fast-antenna (FA) system were used together with a satellites radar echo of a constant altitude plan position indicator (CAPPI), satellite images of cloud top height from Himawari-8 and Magnetic Direction Finder (MDF).

Keywords – Flash floods; Lightning activities; Lightning location;

INTRODUCTION

According to a report by the Malaysian Meteorological Department, Malaysia experiences frequent lightning and thunderstorms, averaging over 200 thunder days annually [1]. There is a correlation between lightning and rainfall, which can lead to the occurrence of flash floods [2]. However, in Malaysia there is less attention is given to correlation of lightning flash flood. Hence, in this work, an investigation is made based on several parametric studies.

METHODOLOGY

The radar data have been collected from the Malaysia Meteorological Department (MMD). The timing for system setup was determined using a Global Positioning System (GPS). Thus, a magnetic direction finder technique (MDF) has been used to locate the lightning strikes.

RESULTS AND DISCUSSION

A summary of the results for all parametric studies is depicted in Figure 1. In quadrant 3, it indicates that heavy rainfall does not necessarily imply there is a lot of cloud activity.

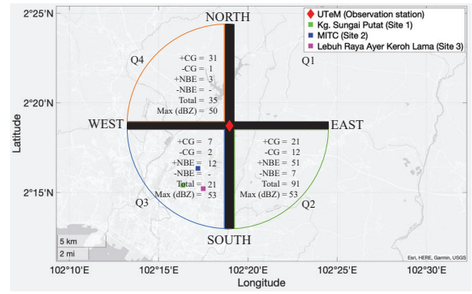

Figure 1: Summary of lightning activities in every quadrant.

CONCLUSIONS

The results have shown that each parameter considered poses a great significant for correlation of lightning flash rates and flash flood.

ACKNOWLEDGEMENTS

This research work is supported by SATREPS (GERANANTARABANGSA-SATREPS/2023/ FKEKK/A00052, A00045, A00047, A00039) in collaboration between Ja-pan Science and Technology Agency (JST, JPMJSA2210) and JICA. It is also promoted by Ministry of Higher Ed-ucation (MOHE) in Malaysia. The authors express their gratitude to Universiti Teknikal Malaysia Melaka, Uni-versiti Tenaga Nasional, and Kindai University for their collaboration and support.

REFERENCES

[1] N. Yusop, M. R. Ahmad, T. S. Ching, S. A. S. Baharin, M. R. M. Esa, and M. A. B. Sidik, "Correlation analysis between lightning flashes and rainfall rate during a flash flood thunderstorm,",2022,doi:10.11591/ijeecs.v28.i3.pp 1322-1329.

[2] N. Bahari, S. A. Mohammad, M. R. Mohd Esa, M. R. Ahmad, N. A. Ahmad, and Z. A. Malek, "Analysis of lightning flash rate with the occurrence of flash floods and hailstorms in Peninsular Malaysia," *J. Atmos. Solar-Terrestrial Phys.*,vol.250,no.May,p.106121,2023,doi:10.1016/ j.jastp.2023.106121.

Design of a Broadband Interferometer System for Capturing Very High-Frequency Radiation from Lightning Event

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Abstract **-** This paper presents the design of a broadband interferometer system for detecting very high-frequency (VHF) radiation emitted during lightning events, installed on the rooftop of the Faculty of Electronics and Computer Technology and Engineering (FTKEK) at Universiti Teknikal Malaysia Melaka (UTeM). The system comprises three VHF antennas configured to form two equal-length orthogonal baselines of 15 meters and one fast antenna is use to provide triggers for recording the time series data. VHF antenna operates over a frequency range of 20 MHz to 80 MHz, with a center frequency of 50 MHz.

Keywords: Broadband Interferometer, Lightning Event, Very High Frequency

INTRODUCTION

By using interferometer techniques on very high-frequency (VHF) antennas, the direction of the lightning event can be determined. In this paper, the VHF interferometer are install at the rooftop of Faculty of Electronics and Computer Technology and Engineering (FTKEK) at Universiti Teknikal Malaysia Melaka (UTeM).

METHODOLOGY

There are four antenna use in this project which are one fast antenna and 3 VHF antenna. The fast antenna is used to trigger the digitizer to record data. Three VHF antenna is arrange in two equal-length orthogonal baseline [1] of 15 meters and the received signals were band-limited to 20–80 MHz before digitization [1]. The digitizer is connects to a computer via USB and the GPS is used to obtain accurate timing for each event with an accuracy of ±6 ns.

RESULTS AND DISCUSSION

The fast antenna and the VHF antenna waveform are produced when the digitizer is triggered. As shown in Figure 1, the negative cloud-to-ground waveform characteristic are produce at channel A (FA) with a duration of 36.12ms. The VHF antenna wave are also produce along with fast antenna that can be use for further process.

In this setup, the wide noise present in the signal is ±80mV, which exceeds the expected noise level of ±30mV. The noise can originate from various sources such as environmental noise, electronic components, improper grounding, and reflected signals from buildings. To achieve a low-noise signal, it is essential to ensure proper location, grounding, and the use of high-quality components.

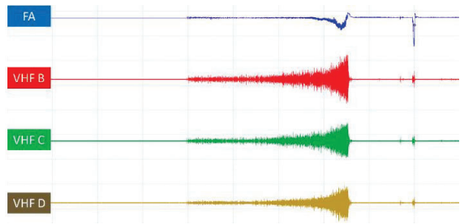

Figure 1: Output waveform

CONCLUSIONS

By detecting the location or direction of the lightning flash using VHF interferometer method [1], it can give an early warning and monitoring of developing thunderstorms [2]. Enhanced localization and early detection of lightning significantly contribute to public safety by enabling timely warnings and preventive measures.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Stock, M., Akita, M., Krehbiel, P., Rison, W., Edens, H., & Kawasaki, Z. (2014). Continuous broadband digital interferometry of lightning using a generalized cross-correlation algorithm. Journal of Geophysical Research Atmospheres, 119(6), 3134-3165.

[2] Morimoto, T. et al. (2023) 'Real-time lightning 3D imaging and forecasting project for sustainable and reliable supply of energy and storm disaster early warning "SATREPS project in Malaysia"', Proceedings of the XXXVth URSI General Assembly and Scientific Symposium – GASS 2023

THE RELATIONSHIP ANALYSIS BETWEEN LIGHTNING FLASHES WITH METOROLOGICAL PARAMETERS

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Abstract **–**This study investigates the relationships between cloud top height, rainfall rate, and lightning flash rate over Melaka area. Experiments have been conducted by using fast electric field, constant altitude plan position indicator (CAPPI) radar data and himawari satelite. It is found that lightning flash usually correspond well with the strong convection.

Keywords –Cloud top height, Fast field, Reflectivity value

INTRODUCTION

In [1]-[2], the correlation between lightning activity and converctive rain over Equatorial Africa have been done. The study shows a very strong correlation between them with a correlation coefficient almost reach 1.0 (very high correlation.

METHODOLOGY

The system conducted using two different parallel system that is the lightning measurement system and meteorological measurement system. The lightning measurement system involve two sub-system which is fast antenna and electric field mill. Fast antenna is used to determine the type of lightning captured. For the meteorological measurement system, it involved the measurement data from Malaysia Meteorological Department (MMD). The downloaded data having an interval of 10 minutes per data both CAPPI and cloud top height. All the data obtained is being pre-process and analyzed using MATLAB software.

RESULTS AND DISCUSSION

During a lightning storm on 3 to 4 May 2024, there was a heavy rain and thunder storm recoded from 22:30:00 until the next day on 4 May 2024 at 11:00:00 in Melaka. Through fast field antenna system, the lightning data was observed and classified through the PicoScope software. In parallel with the system, the meteorological data recorded a very significant reflectivity value with the altitude of the cloud.

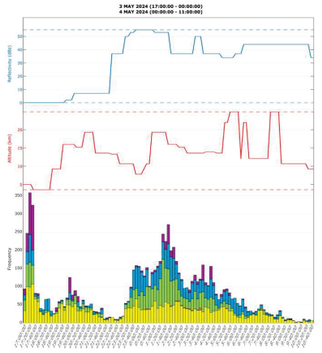

Figure 1: Lightning measurements system with meteorological parameters

CONCLUSIONS

The significant elevation of the cloud height in kilometers during the transition of the reflectivity value from light to heavy rainfall with the cummulative lightning flash rate indicate that the convective rain having a strong relationship.

ACKNOWLEDGEMENTS

This research work is supported by SATREPS (GERAN ANTARABANGSA SATREPS/2023/FKEKK/A00052, A00045, A00047, A00039) in collaboration between Japan Science and Technology Agency (JST, JPMJSA2210) and JICA. It is also promoted by the Ministry of Higher Education (MOHE) in Malaysia. The author express their gratitude to Universiti teknikal Malaysia Melaka, Universiti Tenaga Nasional, and Kindai University for their collaboration and support.

REFERENCES

[1] N. K. Emmanuel et. al "Study of the correlation between lightning activity and convective rain over Equatorial Africa," in *ICLP 2022 - 36th International Conference on Lightning Protection*, Institute of Electrical and Electronics Engineers Inc., 2022.

[2] S. L. Solimine et. al "Relationships between intense convection, lightning, and rainfall over the interior Congo Basin using TRMM data," *Atmos Res*, vol. 273, Aug. 2022.

DESIGN AND COMPARISON OF SLOW ANTENNAS FOR LIGHTNING MEASUREMENT SYSTEM

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Abstract **-** This paper presents the design and comparison of two slow antenna systems. The vertical electric field from lightning was captured by fast antenna (FA) and two slow antennas (SA) lightning measurement systems. The decay time constant for the FA was 13m seconds, while for SA it was 10 seconds. The results indicate that the SA with 1GΩ resistor value are much more sensitive compared to slow antenna with 100MΩ resistor value.

Keywords – Antenna, Global Positioning System, Magnitude, Reversal Distance

INTRODUCTION

Negative cloud-to-ground (-CG) lightning flashes are a type of lightning discharge that occur during thunderstorms, where negatively charged within a thundercloud are transferred to the ground. Electric field from lightning consist of several components such as radiation, static and inductive [1]. All this components can be observed by low frequency sensors.

METHODOLOGY

A lightning measurement station was established, comprising a fast antenna (FA) and two slow antenna (SA) systems with decay time constants of 13 milliseconds and 10 seconds, respectively. The system was successfully set up at Universiti Teknikal Malaysia Melaka (UTeM), located in Malacca, Malaysia (2°18′50.41°N, 102°19′6.9°E).

RESULTS AND DISCUSSION

The design of the slow antennas was conducted using Multisim 13.0 software. The slow antenna buffer circuits, each with difference resistor (R) and capacitor (C) value at the input of the OPA633KP, were configured with resistor values of 100MΩ and 1GΩ. From the successful recorded data, there are slightly difference in magnitude of the slow antennas waveform that was recorded from lightning measurement system. The magnitude differences between the waveforms from both slow antennas were measured and statistically compared.

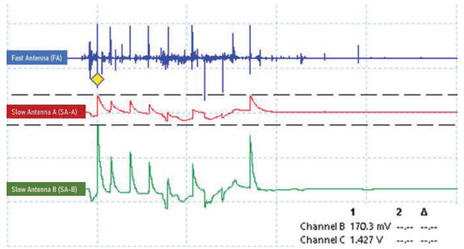

Figure 1: A negative cloud-to-ground with multiple return strokes captured by FA and two SA

CONCLUSIONS

This study presents observations of waveform magnitude based on the different designs of slow antennas for a lightning measurement system. The measurement results indicate that the slow antenna with a 1GΩ resistor value is significantly more sensitive compared to the slow antenna with a 100MΩ resistor value.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Shoory, Abdolhamid, et al. "On the measurement and calculation of horizontal electric fields from lightning." IEEE transactions on electromagnetic compatibility 53.3 (2011): 792-801.

DEVELOPMENT OF A UHF INTERFEROMETER SYSTEM FOR MICROWAVE RADIATION EMITTED BY LIGHTNING FLASH

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Abstract **-** Recent studies showed that electron avalanches peak around 1 GHz based on simulations, but few real measurements exist for lightning radiation at 0.925 GHz. This study introduces ultra-highfrequency (UHF) interferometer system to capture and analyze microwave radiation from lightning. The system uses three sets of parallel antennas with the center frequency of 0.925 GHz, 5-meter baseline, and a 40 MHz bandwidth, covering 800 to 1050 MHz. It effectively maps UHF radiation from Narrow Bipolar Events (NBEs) in tropical lightning, demonstrating the interferometer's capability to capture and analyze real lightning flashes.

Keywords – Lightning Flash; Ultra-High Frequency; Microwave Radiation; Stepped Leader

INTRODUCTION

This study introduces the development of a UHF interferometer system designed to capture microwave radiation emitted by lightning flashes. The system uses three small air-gap parallel antennas resonating at 0.925 GHz, with a 5-meter baseline. By focusing on Narrow Bipolar Events (NBEs) in tropical lightning, the system aims to enhance the understanding of these emissions [1], demonstrating the potential for accurately capturing and analyzing real lightning flashes.

METHODOLOGY

A new design of the circular parallel antenna is being used in the UHF interferometric system to observe the charge movement of stepped leaders and NBEs. The UHF interferometer will be deployed on the faculty rooftop which consists of 2 baselines that are separated by 5-meter distance. The movement of UHF radiation sources associated with the lightning flashes could be observed with parameters such as elevation and azimuth of the lightning flashes [2].

RESULTS AND DISCUSSION

Once the lightning data is collected, it is upsampled to double the rate, reaching 2.5 GS/s (gigasamples per second). This process enhances the clarity and detail of the data. Subsequently, the upsampled data undergoes filtering with a band-pass filter that retains frequencies between 800 to 1050 MHz. This filtering isolates the specific signals of interest, removing any noise or irrelevant frequencies as shown in Figure 1. Through these steps, the signals produced by lightning are accurately captured which can proceed to the lightning mapping process.

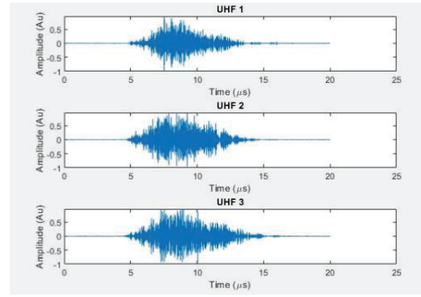

Figure 1: The lightning data from the UHF interferometer

CONCLUSIONS

Based on the results, an interferometer is used to observe the charge movement to study the characteristics of lightning discharges inside the thundercloud. Moreover, this study shows that electron avalanches intensely emit in microwave bands during lightning flashes.

ACKNOWLEDGEMENTS

This research is supported by SATREPS (GERAN ANTARABANGSA-SATREPS/2023/FKEKK/A00052, A00050, A00048, A00044) and 20230901JICA in collaboration between Japan Science and Technology Agency (JST, JPMJSA2210) and Japan International Cooperation Agency (JICA).

REFERENCES

[1] S. A. S. Baharin et al., “Very high-frequency radiation emitted by negative narrow bipolar events occurred over Malacca Strait”, J. Atmosres. Vol. 259, p. 1364, 2024.

[2] M. H. M. Sabri et al., “Microwave Radiation Associated with Lightning Initiation Events of Negative Cloud-to-Ground Flashes,” Atmosphere, vol. 13, no. 9, p. 1454, 2022.

Analysis of electric field behavior for wind turbine blades under the influence of various gas

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Abstract **-** Wind turbines are a crucial renewable energy source. The composition of atmospheric gases surrounding installed wind turbines can significantly influence the intensification of the electric field generated by lightning strikes. This research investigates the initiation and propagation of the electric field in various gases, including O_2, N_2, Ar, Ne, and SO_2. To understand the electric field behavior on turbine blades, this study uses the Finite Element Method to examine the impact of these gases on lightning strikes affecting carbon fiber wind turbine blades. The findings indicate that N_2 and air yield similar results, given that nitrogen constitutes 72% of air. Therefore, this study demonstrates that the presence of different gases can alter the strength of the electric field.

Keywords – Lightning protection, Electric Field, Wind Turbine Blade

INTRODUCTION

Wind turbines differ from conventional electricity infrastructures by being located in windy regions and having an average height exceeding 100 meters [1], [2], [3]. Consequently, their exposed location, height, and complex terrain make wind turbines particularly susceptible to lightning strikes. This study examines the electric field distribution on turbine blades under various gases, including O_2, N_2, Ar, Ne, and SO_2. By employing the Finite Element Method, this research analyzes the electric field's time-dependent distribution under impulse voltage. FEM is used to obtain approximate solutions to boundary value problems involving partial differential equations and mathematics [3].

METHODOLOGY

Throughout the modeling process, both three-dimensional and two-dimensional geometric designs are utilized. Figure 1(a) illustrates the complete project model, with dimensions set at 300×300×2000 m.

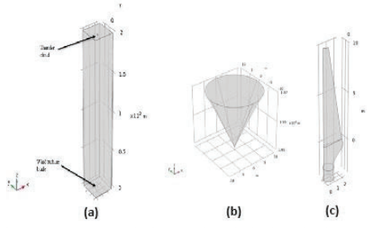

Figure 1: Geometry design (a) the whole domain (b) Terminal cone (c) Wind turbine blade

The height of the thundercloud is positioned 2 Km above the wind turbine blade. Figure 1(b) depicts the cone of the top cuboid used to simulate the thundercloud background. In Figure 1(c), the dimensions of the wind turbine blade are specified as 2×1×10 m, and the material properties of the blade are defined as carbon fiber [3].

RESULTS AND DISCUSSION

In this study, the analysis of results is based on the duration of impulse voltage, ranging from 0 s to 60 µs.

Figure 2 presents the graph of the electric field norm versus time for various gases. The simulation results indicate that the electric field norm for air and N_2 is identical. When N_2 and O_2 are combined, the electric field norm is lower than that of N_2 alone. According to the graph, SO_2 contributes the highest maximum electric field norm, reaching 1700 MV/m.

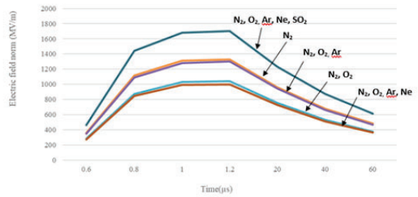

Figure 2: Plot graph of electric field norm vs time with various gas

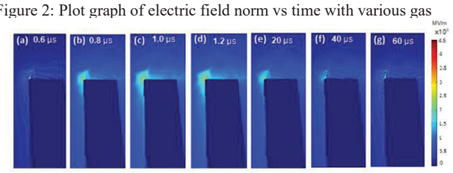

Figure 3: Simulation result under gas O2, N2, Ar, Ne, and SO2 showing e-field changes at the blade's tip.

Figure. 3 shows the strength of the electric field norm versus arc length under various gases. This result's combination type of gas is O_2, N_2, Ar, Ne and SO_2.

CONCLUSIONS

Applying various gases to the modeling domain can alter the electric field strength between the blade and the thundercloud. Among all the gas mixtures used in this modeling, the inclusion of SO_2 significantly impacts the electric field strength. For instance, when O_2, N_2, Ar, and Ne are applied to the domain, the electric field strength measures 1000 MV/m. However, the addition of SO_2 to the same mixture increases the electric field strength to 1700 MV/m.

ACKNOWLEDGEMENTS

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REFERENCES

[1] O. Apata and D. T. O. Oyedokun, “An overview of control techniques for wind turbine systems,” Sci. African, vol. 10, p. e00566, 2020, doi: 10.1016/j.sciaf.2020.e00566.

[2] R. D. Goud, R. Rayudu, C. P. Moore, and T. Auditorey, “An Evaluation of Potential Rise in a Wind Turbine Generator Earthing System During a Direct Lightning Strike,” Proc. Conf. Ind. Commer. Use Energy, ICUE, vol. 2018-Octob, no. October, 2019, doi: 10.23919/ICUE-GESD.2018.8635648

[3] S. S. Wahdain, A. I. Mohamed, M. H. Sulaiman, M. R. Daud, and R. M. T. R. Ismail, “Analysis of electric field behaviour for wind turbine blades under the influence of various gas,” Prz. Elektrotechniczny, vol. 99, no. 7, pp. 29–33, 2023, doi: 10.15199/48.2023.07.06.

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About MyHVnet

High voltage research and development activities continue to prosper in Malaysia due to rapid urbanisation across the country. Each year, an enormous amount of expenditure is allocated for the development of high voltage infrastructure and its relevant expertise to ensure its sustainability. This indirectly leads to an increasing number of players, both at the university and industry levels. While this certainly brings positive impact to the field of high voltage engineering, it can, sometimes, be difficult for interested parties to approach the right experts in a specific high voltage related area, e.g., lightning protection, condition monitoring and diagnosis, and insulation design. Consequently, more effective research and development activities related to high voltage engineering may have been hindered.

To address the above issue, the possibility of setting up an informal networking group relevant to high voltage engineering has been looked into. This leads to the idea of the establishment of Malaysian High Voltage Network (MyHVnet) in 2014. MyHVnet will hopefully serve as a "one-stop" platform for members from various organisations (universities and industries) across Malaysia for the effective communication of high voltage related research and development.

The main objectives of the establishment of MyHVnet are:

i) To serve as a platform for the discussion of high voltage related research and development among member organisations.

ii) To raise the awareness of the research and development capabilities of member organisations to high voltage related industries.

iii) To lobby for high voltage related research funding.

Group photo during technical visit to the National Energy Centre in 2024.

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