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PREFACE

Prof. Yasuhiro TANAKA

Five years history for relationship with Asian countries as a chair of Technical Committee of Dielectrics and Insulating Materials in IEEJ

From June 2013 to June 2018, I was a chair of Technical Committee of Dielectrics and Insulating Materials in IEEJ for five years. During this 5 years, the committee organized ISEIM (International Symposium on Electrical Insulating Materials) twice in 2014 (Niigata) and 2017 (Toyohashi), and I was a general chair of both symposiums. On the symposiums, the Technical Committee has created some new attempts to encourage the research activities in our field, and it seemed to be effective especially for Asian researchers, because many participants in the symposiums were from Asian countries. So, here I would like to introduce our effort to establish some new trends originated in the symposiums.

In ISEIM 2014, a new working group named ***APIANS*** (Analysis for Polymeric Insulating materials using Advanced Numerical Simulation) has been established, then a workshop and a special session for this theme were held in 2014 and 2017, respectively. This kind of approach to evaluate the materials was novel at that time, and it had been rear opportunity that specialist for that came together. Thanks to the specialists, many participants, especially young researchers, could know a new possibility in their future works. After the workshop, the number of the papers related to the above theme on journals and conferences has rapidly increased, as you know. I think the workshop must be trigger to increase. In the symposium, a special session for ***space charge*** and a demonstration session for PEA (pulsed electro-acoustic) method were also held. The number of the papers related to PEA method also increased in recent years and the method becomes popular and ordinary technique to evaluate the dielectric materials. I think the above sessions must contribute such trend.

In ISEIM 2017, a workshop named “Advanced ***Nanodielectrics*** -Fundamentals and Applications” has been carried out using a book published by Japanese investigation committee, and many participants discussed actively. I believe that the book and the workshop must contribute the today’s active research situation on the nanodielectrics in our field.

As mentioned above, the Technical Committee of DEI in IEEJ has attempted to create the new trend intentionally using the symposium, and the most of attempts has been accepted by many young researchers, especially in Asian countries. I believe that the successive committee members must continue such attempts in the future symposium. Anyway, I think the success of the symposiums were supported by participants, especially from Asian countries, and finally, I would like to express my sincere appreciation to the participants and cooperator for our activities.

Dr. Yasuhiro TANAKA

Former chair of Technical Committee of DEI in IEEJ
Professor of Tokyo City University, Japan

OUTLINE OF TECHNICAL COMMITTEES IN IEEJ

Dielectrics and Electrical Insulation (DEI)

Chairperson: Naoki Hayakawa (Nagoya Univ.)
Secretaries: Yoitsu Sekiguchi (Sumitomo Electric Industries)
Toshihiro Takahashi (CRIEPI*)
Assistant Secretaries: Yuuji Hayase (Fuji Electric)
Yoshinobu Murakami (Toyohashi Univ. of Tech.)
*CRIEPI: Central Research Institute of Electric Power Industry

The Technical Committee on Dielectrics and Electrical Insulation (**TC-DEI**) has a long history from 1970. The TC-DEI has a new season from June 2018 with a new chairperson of Prof. Naoki Hayakawa at Nagoya University, a new secretary of Dr. Toshihiro Takahashi at CRIEPI and a new assistant secretary of Dr. Yoshinobu Murakami at Toyohashi University of Technology. The activity of the TC-DEI has been covering mainly solid and composite dielectric materials and their technologies.

Organized events by TC-DEI

The important activity of TC-DEI is the annual domestic Symposium on Electrical and Electronic Insulating Materials and Application in Systems (SEEIMAS).

The 49th SEEIMAS was held at the Center for Information Technology of Ehime University from September 10th to 12th, 2018. Total 120 persons participated in this year's symposium, as shown in Fig.1, in order to share their experiences and discuss the latest developments and future challenges confronting the field. The number of presented papers was 81 in total, which increased by 20 papers, compared with the previous SEEIMAS in 2016, and is close to the highest number in the history of SEEIMAS. The symposium covered the topics of diagnostic techniques, inverter surge and partial discharge phenomena, functional and new materials. Especially in this year's symposium, the joint session with the Technical Committee on Electrical Wire and Power Cable (TC-EWC) was held and their transversal subjects such as insulating materials, partial discharge measurement and insulation diagnosis for power cables and latest development of superconducting cables were presented and discussed.

The Ieda Memorial Award was given to Prof. Naohiro Hozumi at Toyohashi University of Technology. The Yahagi Memorial Award was given to Dr. Tetsuo Yoshimitsu at Toshiba Mitsubishi-Electric Industrial Systems Corporation.

The next SEEIMAS will be held as its 50th anniversary at Nagoya University from September 17th to 19th, 2019, where some memorial lectures will be planned. Following the 50th SEEIMAS, the 32nd Young Researchers' Seminar will also be held in

Fig.1. Group photo in the 49th SEEIMAS at Ehime University

Nagoya area on September 19th and 20th, 2019. In 2020, the 51th SEEIMAS will be held as the 9th International Symposium on Electrical Insulating Materials (ISEIM) at Waseda University, Tokyo, in September 2020 after the 32nd Olympic and Paralympic Games.

Investigation Committees run by TC-DEI

Adding to organize some events, the TC-DEI runs Investigation Committees (IC's) that organize several technical meetings in a year.

The following 2 IC's finished their investigation research activities in 2018 and their technical brochure will be published soon:

(1) Advancing Tailor-made Composite Insulation Materials (07/2015-06/2018, Chairperson: Toshikatsu Tanaka, Waseda University)
(2) Electrical Insulation Technologies under Cryogenic Temperatures (10/2015-09/2018, Chairperson: Naoki Hayakawa, Nagoya University)

The following 3 IC's are on-going in their investigation research activities:

(3) Insulation Diagnosis Technologies for Electric Power Apparatus and Equipment Using New and Practicable Insulation Materials (04/2017-03/2020, Chairperson: Yoshiyasu Ehara, Tokyo City University)
(4) Standardization of Calibration and Advanced Measurements for Space Charge Distribution at High Temperature using Pulsed Electro-acoustic Method (04/2017-03/2020, Chairperson: Yasuhiro Tanaka, Tokyo City University)
(5) Advanced Nanomaterials and Nanostructure Control for Innovative Organic Devices and Life Science (07/2017-06/2020, Chairperson: Keizo Kato, Niigata University)

The following 2 IC's will start their investigation research activities soon:

(6) Application of Quantum Chemical Calculations in the Field of Electrical and Electronic Insulating Materials (12/2018-11/2021, Chairperson: Satoshi Matsumoto, Shibaura Institute of Technology)
(7) Electrical Insulation Reliability of Power Module (12/2018-11/2021, Chairperson: Masahiro Kozako, Kyushu Institute of Technology)

Electrical Discharges(ED)

Chairperson: Akiko Kumada (The University of Tokyo)
Secretary: Hiroshi Kojima (Nagoya University)
Assistant Secretaries: Yasushi Yamano (Saitama University)
Naohiko Shimura (Toshiba Corporation)

The Technical Committee on Electrical Discharge (TC-ED) belongs to the Fundamentals and Materials Society of the IEE Japan. The origin of the TC-ED is the Expert Committee on Electrical Discharges, which was established in January 1954. That is, the TC-ED has supported the development of science and technologies on electrical discharges in Japan for a long time.

The main purpose of the TC-ED is the wide promotion of the research activities concerning to a variety of electrical discharges in vacuum, gas, liquid and on surfaces of materials and their applications to high technologies, especially aiming an environmentally sustainable technology for the next generation.

Investigation committees, which are the affiliates of the TC-ED, are established to survey the up-to-date research subjects. The activities of these committees usually continue for three years. Each committee generates very useful technical report at the end of the active period.

In 2018, out technical committee has one investigation committee entitled as “Recent Topics in Insulation of Converter-fed Rotating Machines” The committee is established from December 2018 to November 2021, and the chair is Prof. Kumada in The University of Tokyo. The increased use of motor adjustable speed drives has raised concerns about the adverse effects of the distorted voltage waveform of the converter on the insulation of the machine. Under these circumstances, Relevant IEC standards are being reviewed one after another. This investigation committee will investigate current situation of higher voltage-class power modules, current introduction situation of converter-fed motor technology in industry such as EV, relevant studies on partial discharge test method based on understanding of discharge phenomenon, relevant studies related to material degradation due to such partial discharges.

The TC-ED organizes about six domestic technical meetings on electrical discharges every year. In these meetings, nearly 200 papers are presented from both academic and industrial sides. The technical meeting is also useful to train and encourage young researchers including students. Every year, about 10 young researchers receive Young Researchers Prize from Technical Society of Fundamentals and Materials and IEEJ. The domestic technical meetings are sometimes co-organized by other Technical Committees such as Dielectrics and Electrical Insulation, Pulse

Electromagnetic Energy, Plasma Science and Technology, High Voltage Engineering, and Switching and Protecting Engineering. As joint technical meeting with TC-High Voltage Engineering and TC-Switching and Protecting Engineering, IWHV2018 (Int'l Workshop on High Voltage Engineering) was held from Nov. 2 to 3.

The TC-ED also contributes to organize an annual young researcher seminar in cooperation with the Institute of Engineers on Electrical Discharges in Japan for encouraging the young researchers in the field of electrical discharges. The seminar consists of lectures by a senior researcher, poster presentation by the participants, and the visit tour to the facilities. About 30 young researchers and engineers participate in the seminar and discuss vigorously the topics for two days.

In this decades, TC-ED has held domestic technical meetings and international conferences in corporation with TC-Pulse Electromagnetic Energy and TC-Plasma Science and Technology. As these tree TCs have many common research topics, we have decided to integrate these technical committees from the viewpoint of effectively utilizing limited resources

The TC-ED is to be dissolved at the end of December 2018, and from January 2019, a new TC on Electrical Discharge & Plasma and Pulsed Power will be launched.

Plasma and Pulsed Power (PPP)

Chairperson: Koichi Takaki (Iwate University)
Vice-Chairperson: Tatsuru Shirafuji (Osaka City University)
Secretary: Toru Sasaki (Nagaoka University of Technology)
Secretary: Ryuta Ichiki (Oita University)

Technical Committee on Plasma and Pulsed Power (TC-PPP) in Institute of Electrical Engineers of Japan (IEEJ) was newly founded by integrating TC-PST (Plasma Science and Technology) and TC-PEE (Pulsed Electromagnetic Energy) in 1st January 2018. This new committee covers the research field related to the science and technologies of plasma and pulsed power. Recently, low-temperature atmospheric pressure plasma is utilized various applications such as environmental protection, agriculture, biology, and medicine. By the modification of pulsed electromagnetic energy (pulsed power technologies), the low temperature plasmas can be produced easily not only in the atmospheric pressure gas but under multi-medium conditions such as underwater, mist containing gas and liquid surface. A large volume, atmospheric pressure low temperature plasmas are utilized for decomposition of toxic gases, ozone synthesis and harmful bacteria inactivation. The underwater discharge plasmas can be utilized for cleaning the water environment, synthesis of composite material particles, and promotion of plant growth.

The major activity of TC-PPP is to collect the cutting-edge science and technology through the activity of the investigation committees and to organize several technical meetings to exchange information on plasma and pulsed power science and technology. The activities are as follows: In 2018, we organized the kick-off symposium of the new committee during the period of the annual meeting of IEEJ which was held in March 14-16, 2018, at Ito Campus, Kyushu University in Fukuoka prefecture (Fig. 1). Following that, we had three technical meetings in May at Yamagata University in Yonezawa, in August at Saitama University in Saitama, and in October at Oita University in Oita. Each meeting usually has 20–40 oral presentations. The oral presentations by young researchers including undergraduate and graduate students are strongly encouraged, and they are nominated for young presentation award. Some of the technical meetings are jointly organized with the Technical Committees on Electrical Discharges (TC-ED).

Fig. 1. A photograph of TC-PPP kick-off symposium in the annual meeting of IEEJ at Kyusyu University.

Organization of international workshops as a co-host is other important activity of the TC-PPP. In July 29 - August 1, 2018, the TC-PPP co-hosted an international workshop of the 10th International Workshop on Plasma Scientech for All Something (PLASAS-10) at Dalian University of Technology, Dalian, China. The next workshop will be held in Japan in May, 2019 at Gifu University. The chair of the PLASAS-11 is Prof. Kousaka in Gifu University. In December of last year 2017, the TC-PST and TC-PEE (before the integration to TC-PPP) were co-host an international symposium of the 10th Asia-Pacific International Symposium on the Basics and Applications of Plasma Technology (APSPT-10) at Chung Yuan Christian University, Taoyuan, Taiwan, together with the APSPT International Organizing Committee, the TC-ED, and the JSPS 153 Committee. The APSPT has ever been held every two years in Taiwan over 16 years to promote fundamental and applied plasma researches for scientists and engineers in Japan and Taiwan. The next APSPT-11 will be held in Japan again, in December 12-14, 2019 at Kanazawa. The chair of the APSPT-11 is Prof. Tanaka in Kanazawa University, who was the former chairperson of the TC-PST.

Recently, the TC-ED and TC-PPP had decided to integrate these technical committees for further development of science and technology of electrical discharge, plasma and pulse power, because recent research activities on plasma and pulsed power technology strongly relating to electrical discharge technologies which include electrical insulation, void and dielectric barrier discharges, surface discharge and calculation of electrical field distribution in multi-medium and complex geometry high-voltage area. The TC-ED and TC-PPP will be reorganized as The Technical Committee on Electrical discharge, Plasma and Pulsed power (TC-EPP) in January 2019. The newly organized TC-EPP will hold the kick-off symposium during the period of the annual meeting of IEEJ which will be held in March 12-14, 2019, at Hokkaido Science University in Sapporo. This symposium will be co-hosted with the Technical Committees on Dielectrics and Electrical Insulation (TC-DEI), on Static Apparatus (TC-SA), on Switching and Protecting Engineering (TC-SP), and on High Voltage Engineering (TC-HV).

Electrical Wire and Cables (EWC)

Chairperson: Naohiro Hozumi (Toyohashi University of Technology)
Secretaries: Hiroshi Nishino (Fujikura, Ltd.)
Kouji Miura (SWCC Showa Cable Systems Co., Ltd.)
Yoshihisa Nagoya (Furukawa Electric Co., Ltd.)
Kenichi Furusawa (Sumitomo Electric Industries, Ltd.)

Technical Committee on Electrical Wire and Cables (TC-EWC) is a committee organized in the IEEJ Power and Energy Society, and is comprised of members from cable manufacturers, power utilities, railway companies, universities and related research institutes such as Japan Electric Cable Technology Center (JECTEC) and Central Research Institute of Electric Power Industry (CRIEPI).

The technical committee organizes technical meetings to provide an opportunity to present technical achievements and to promote R&D activities in this field. The technical committee so far held technical meeting as a joint meeting of TC-DEI(Technical Committee on Dielectrics and electrical insulation) and TC-EWC, on ‘Insulation performance and aging in cable systems, electrical properties of dielectric and insulating materials’ in November, 2018. The technical committee will also hold 2 more technical meetings in Japanese FY2018, one of which will be jointly organized by TC-DEI and TC-EWC. The topics of the technical meetings will be ‘Technological trends in diagnostics and maintenance in cables and wires’ and ‘Technology trends in cable and wire systems (product technology, aging mechanism clarification, diagnostics, evaluation, judgement methods)‘.

In addition to organizing technical meetings, forums and symposia, the technical committee supervises investigation committees dealing with subjects related to electrical wire and cables. Two investigation committees are progressing in FY2018 on the following subjects, respectively, i.e. ‘Technology transition and issues in distribution insulating wires and cables and their accessories responding to environmental usage’, and ‘Status Quo and technology trends in power transmission cables’.

At the conference of IEEJ in September 2018, the technical committee held a symposium on ‘Technology transition and issues in distribution insulating wires and cables and their accessories responding to environmental usage’.

The technical committee also organizes a technical visit to the company. This year the technical committee members visited Hamamatsu Photonics K.K. on December 10th, 2018.

IEC TC 112 Japanese National Committee

Chairperson: Hiroya Homma (CRIEPI*)
Vice-chairperson: Hisaaki Kudoh (The University of Tokyo)
Secretary: Hiroaki Uehara (Kanto Gakuin University)
Associate Secretary: Kenichi Yamazaki (Toshiba)
*CRIEPI: Central Research Institute of Electric Power Industry

IEC TC 112 deals with many international standards and specifications on “Evaluation and qualification of electrical insulating materials and systems”. TC 112 was established in 2005 based on the part of TC 15 and TC 98. TC 98 and the related sub-group in TC 15 were disbanded to the establishment of new technical committee. TC 112 Japanese National Committee (JNC) was also established in 2005 to correspond to the activities in TC 112 and to concern with related Japanese standards.

TC 112 involves eight working groups (WG) and dealing with more than 50 standards. TC 112 JNC includes eight corresponding WGs and one more WG that relates with the Japanese Industrial Standards (JIS). The WG structure of TC 112 JNC is shown in Table 1. Three conveners of the eight international WGs are now taken by Japanese, WG2 and WG7: Dr. Hisaaki Kudoh, and WG8: Prof. Yasuhiro Tanaka. In this reason, Japanese members are very active in this standard region.

Table 1 WG structure of TC 112 JNC

WG	Subject
1	Thermal endurance
2	Radiation
3	Electrical strength
4	Dielectric/resistive properties
5	Tracking
6	General methods of evaluation of electrical insulation
7	Statistics
8	Various material properties
9	Japanese Industrial Standards (JNC only)

From September 17 to 21, 2018, IEC TC 112 Meeting was held in Vienna, Austria, and meetings of WGs were held during the weeks. 6 experts from JNC participated in the TC 112 meetings including the Plenary, Advisory group and WGs meetings.

Mr. Roger Wicks (US) had to retire as Chairman after the maximum service time of 9 years at the end of September 2018 and Prof. Johan Smit (NL) was elected as the new Chairman from 1st October 2018.

The next meetings of TC112 will be held in Shanghai, China from October 14 to 18, 2019.

Recent standards discussed in TC112 are partly listed:

WG1: IEC 60216-3: Electrical insulating materials - Thermal endurance properties - Part 3: Instructions for calculating thermal endurance characteristics.

IEC 60216-5: Electrical insulating materials - Thermal endurance properties - Part 5: Determination of relative thermal endurance index (RTE) of an insulating material.

IEC 60216-6: Electrical insulating materials - Thermal endurance properties - Part 6: Determination of thermal endurance indices (TI and RTE) of an insulating material using the fixed time frame method.

Submit a Review Report related to IEC/TR 60216-7-2 was approved by the plenary meeting (PL: Jun Haruhara of JNC).

WG2: IEC/TR 61244-4: Effects of radiation under non-ambient environments; Effect of temperature.

IEC/TR 61244-5: Effect of kids of radiation, will be prepared as a new Technical Report (PL: Toshitaka Oka of JNC).

WG3: IEC/TR 62039 Ed.2: Selection guide for polymeric materials for outdoor use under HV stress. Proposal to move this document to WG5 was approved by the plenary meeting.

New items related to “Measurement of retention of hydrophobicity under combined stress” and “Coatings for insulators and electrical apparatus for outdoor use under HV stress” were discussed as TRs in WG5.

WG4: IEC 62631-3-1: Dielectric and resistive properties of solid insulating materials Part 3-1: Determination of resistive properties (DC methods) – Volume resistance and volume resistivity, general method (PL: Jun Haruhara).

IEC 62631-3-2: Dielectric and resistive properties of solid insulating materials Part 3-2: Determination of resistive properties (DC methods) – Volume resistance and volume resistivity, Surface resistance and surface resistivity (PL: Jun Haruhara).

IEC 62631-3-4: Dielectric and resistive properties of solid insulating materials - Part 3-4 Method of test for electrical resistance and resistivity of insulating materials at elevated temperatures.

New work related to IEC 62631-2-2 for high frequencies was approved (PL: Yoshiaki Yamano of JNC).

WG5: IEC 60112: Method for the determination of the proof and the comparative tracking indices of solid insulating materials.

IEC 60587: Electrical insulating materials used under severe ambient conditions - Test methods for evaluating resistance to tracking and erosion.

WG6: IEC 61857-32: Electrical insulation systems - Procedures for thermal evaluation - Multifactor evaluation by diagnostic procedures.

IEC 61857-33: Electrical insulation systems - Procedures for thermal evaluation - Multifactor evaluation with increased factors at elevated temperature.

IEC 61857-41: Electrical insulation systems - Procedures for thermal evaluation - Part 41: Specific requirements for electrical insulation systems for use in dry-type high-voltage transformers with operating voltages of 1kV and above.

IEC/TR 61858-3: Electrical insulation systems - Thermal evaluation of modifications to an established electrical insulation system (EIS) - Part 3: Clarification of major and minor components.

WG7: IEC/TR 60493-3: Guide for the statistical analysis of aging test data - Minimum specimen numbers at different test conditions with given experimental data.

WG8: IEC/TR 62836: Measurement of internal electric field in insulating materials - Pressure wave propagation method.

IEC/TS 62758: Calibration of space charge measuring equipment based on the pulsed electro-acoustic (PEA) measurement principle.

CIGRE SC D1 Japanese National Committee
(Materials and Emerging Test Techniques)

Chairperson: Tsuguhiro Takahashi (CRIEPI)
Secretary: Toshiaki Rokunohe (Hitachi, Ltd.)
Akiko Kumada (The University of Tokyo)

CIGRE (International Council on Large Electric Systems) has 16 Study Committees (SC) belonging to each of following 4 categories: A (Equipment), B (Subsystems), C (Systems) and D (Horizontal). Among them, our SC D1 has a horizontal character and contributes to other CIGRE SC's. The activity of CIGRE SC’s is principally research oriented one.

SC D1 has now following 5 Advisory Groups (AG): Strategic and Customer AG, Tutorial AG, AG D1.01 (Liquid and impregnated insulation systems), AG D1.02 (High voltage and current testing and diagnosis) and AG D1.03 (Solid materials) SC D1 consists of these AGs and following 24 WGs.

[Liquid & impregnated systems] JWG A2/D1.46 (Field experience with transformer solid insulating ageing markers), JWG D1/A2.47 (New frontiers of DGA interpretation for transformers and their accessories), JWG A2/D1.51 (Improvement to PD measurements for factory and site acceptance tests of power transformers), WG D1.65 (Mechanical properties of insulating materials and insulated conductors for oil insulated power transformers), WG D1.68 (Natural and synthetic esters - Evaluation of the performance under fire and the impact on environment), WG D1.70 (Functional properties of modern insulating liquids for transformers and similar electrical equipment).

[Testing & Diagnosis] WG D1.50 (Atmospheric and altitude correction factors for air gaps and clean insulators), WG D1.54 (Principles and methods to measure the AC and DC resistance of conductors of cables and overhead lines), WG D1.60 (Traceable measurement techniques for very fast transients), WG D1.61 (Optical corona detection and measurement), WG D1.63 (Partial discharge detection under DC stress), WG D1.69 (Guidelines for test techniques of High Temperature Superconducting (HTS) systems), WG D1.72 (Test of material resistance against surface arcing under DC).

[Gases] JWG D1/B3.57 (Dielectric testing of gas-insulated HVDC systems), WG D1.66 (Requirements for PDM systems for gas insulated system), WG D1.67 (Dielectric performance of non-SF6 gases and gas mixtures for gas-insulated systems).

[Solids] JWG D1/B1.49 (Harmonized test for the measurement of residual inflammable gases in insulating materials by gas chromat), WG D1.56 (Field grading in electrical insulation systems), WG D1.58 (Evaluation of dynamic hydrophobicity of polymeric insulating materials under AC and DC voltage stress), WG D1.59 (Methods for dielectric characterization of polymeric insulating materials for outdoor applications), WG D1.62 (Surface degradation of polymeric insulating materials for outdoor applications), WG D1.64 (Electrical insulation systems at cryogenic temperatures), WG D1.71 (Understanding and mitigation of corrosion), WG D1.73 (Nanostructured dielectrics: Multifunctionality at the service of the electric power industry).

The preferential subjects for the 2018 SC D1 Paris group discussion meeting were PS1: HVDC Insulation Systems (Measurement methods for validating electrical field simulations, New diagnostics for maintenance, Experience and requirements for new test procedures and standards)[7 papers, 7 prepared contributions], PS2: Materials and Ageing (New stresses, e.g. from power electronics, Higher stress operating environment, e.g. compact applications, Materials with lower environmental footprint) [9 papers, 14 prepared contributions], and PS3: Testing, Monitoring and Diagnostics (Experience and added value from online monitoring systems, Reliability of equipment and systems for testing, monitoring and diagnostics, Advanced condition assessment)[23 papers, 20 prepared contributions].

From Japan, following 2 papers were accepted: "Insulation Characteristics in DC-GIS: Surface charge phenomena on epoxy spacer and metallic particle motions" by T. Yasuoka, Y. Hoshina, M. Shiiki, M. Takei, A. Kumada, K. Hidaka (PS1), "Advanced techniques in impulse testing method of electric power equipment" by S. Okabe, T. Tsuboi, E. Hino, K. Inami, H. Koyama, M. Hikita (PS3), and 3 prepared contributions were presented (, one was by Prof. Okubo of Aichi Institute of Technology for PS2 and two were by Mr. Kuroda of NGK for PS2 and PS3).

The next meeting is scheduled to be held in New Delhi, India on November 18-22, 2019, together with SC A2 and B2. The Japanese National SC D1 will hold 2 meetings for its preparation.

Dr. Tsuguhiro Takahashi
Central Research Institute of Electric Power Industry (CRIEPI)
2-6-1 Nagasaka, Yokosuka-shi, 240-0196 Japan
E-mail: shodai@criepi.denken.or.jp
TEL: +81-70-5587-8439

Conference Records

3rd International Conference on Condition Assessment Techniques in Electrical Systems (CATCON 2017, Nov. 2017, India)

1. Introduction

The 3rd International Conference on Condition Assessment Techniques in Electrical Systems has been hosted by Department of Electrical Engineering, Indian Institute of Technology Ropar during 16th to 18th November 2017. The conference was previously hosted by CPRI, Bangalore in 2015 and was organized by Jadavpur University, in 2013. Compared to the past versions, the present conference received about double the number of technical research papers in the condition monitoring of power equipment, an area which is attracting growing importance in developing countries like India and China.

After successful completion of 3rd CATCON 2017, the 4th CATCON venue was decided. It will be held in Indian Institute of Technology Chennai in year 2019. The main concern of CATCON 2017 is to build a platform between scientists, researchers, industrial engineers and students to share their technical knowledge to develop the society.

Organizing committee comprises a balanced combination of experts from the industries and academia. Along with this, different experts had been invited for the invited lectures, plenary talks to put forth their experience in the respective field. As far the papers are concerned, about 216 manuscripts were received out of which only 86 manuscripts had been selected, after a thorough revision. Apart from this 5 tutorials lectures, 6 plenary talks and 8 invited talks were organized for the benefit of attendees. As anticipated, 3rd CATCON saw participation from different regions of the globe. The country wise detail of participants has been tabulated in table 1.

2. Opening session

The first day (16/11/2017) saw intensive technical discussions during five tutorials (table 2) .Dr. Subrat Kumar Sahoo and Dr. Santanu Singha (ABB Sweden), Prof. Yasuhiro Tanaka (Tokyo City University), Prof. S. V. Kulkarni (IIT Bombay), and Prof. Aiman El-Hag (American University of Sharja) shared their knowledge in their respective field

Table 1 Distribution of papers from different Countries

No.	Country	Papers/ presenters
1.	India	73
2.	China	11
3.	Japan	7
4.	Saudi Arabia	3
5.	Australia	3
6.	Germany	1
7.	Sweden	4
8.	Kazakhstan	1
9.	United Kingdom	1
10.	South Africa	1

Fig 5. Group photo of participants of CATCON 2017.

Fig 9: Pof. S.K.Das (Director IIT Ropar) inauguration speech

Table 2 Tutorials sessions

Speaker	Affiliation	Title
Dr. Subrat Kumar Sahoo,	ABB, Sweden	Asset management in a renewable world: challenges and opportunities
Prof. Yasuhiro Tanaka,	Tokyo City Univ.	Space Charge Accumulation in Insulating Materials for HVDC observed using PEA Method
Prof. Ayman Hassan El-Hag,	American Univ of Sharjah	Smart Monitoring of Outdoor Insulators
Dr. Santanu Singha,	ABB, Sweden	Recent trends in electrically insulating liquids and their application related challenges
Prof. S.V. Kulkarni	Indian Inst. Tech. Bombay, India	Modelling of transformers for diagnostic and transient studies

Fig. 1. Prof. Yasuhiro Tanaka during tutorial session.

3. Sessions and papers

The second day (17/11/2017) saw three plenary sessions. The highly experienced, and worldwide renowned Prof. L. A. Dissado, (University of Leicester, UK) gave his presentation on the *Insulation ageing and unsolved problems*. He discussed about the different ageing parameters involved in polymer degradation and its characteristics. Along with this, Prof. L. Satish (IISc Bangalore) talked about the Frequency response analysis in transformers Also Prof. Toan Phung (UNSW Australia), Prof. Sivaji Chakravorty (Director, NIT Calicut), Prof. Tatsuki Okamoto (Tohoku University, Japan and member of CRIPI Japan) and Prof. Sarathi Ramanujam (IIT Madras) shared their experience on relevant research topic as detailed in table 3. The day also saw 50 technical paper presentations from India and abroad, held in three parallel sessions. The sessions went up to 7.00 PM in night,

Fig 3. Prof. L. A. Dissado during plenary lectures.

Table 3 Plenary Lectures sessions.

Speaker	Affiliation	Title
Prof. L. A. Dissado	Univ. of Leicester,U.K.	Insulation ageing: An unsolved problem
Prof. L. Satish	IISc, Bangalore, India.	Frequency response analysis - some recent advances
Prof. Sivaji Chakravorti	NIT Calicut, India	Moisture in oil-paper insulation of transformers
Prof. Tatsuki Okamoto.	Tohoku Univ. Sendai City, Japan	Partial discharge characteristics on applied sine wave voltage frequency with IEC(B) electrode system
Prof. B. Toan. Phung	Univ. of New South Wales, Australia.	Cavity discharge behaviours under trapezoid-based voltage at very low frequency
Prof. R. Sarathi	Indian Inst. Tech. Madras, India	Understanding the dielectric properties of pressboard material thermally aged in dibenzyl disulphide (DBDS) included transformer oil

Fig 3. Prof. B. Toan. Phung during paper presentation.

Fig 4. Questionnaire session during technical presentation.

Fig 7. Odissi dancer Padmashri Geeta Mahalik with guest

Fig 8. Photo during banquet

Table 4 Invited Lectures sessions.

Speaker	Affiliation	Title
Prof. Nandini Gupta,	IIT, Kanpur, India	Estimation of the interface in nanocomposites
Prof. Udaya Kumar	IISc, Bangalore, India	Numerical modelling issues in field computation for certain insulation problems
Prof. N K Kishore	IIT Kharagpur, India	Battery management- crucial need for grids of tomorrow
Prof. Naoshi Hirai	Waseda Univ Tokyo, Japan.	Degradation behaviour and mechanisms of several polymeric insulating materials exposed to heat and radiation
Prof. R.K. Jarial	NIT Hamirpur, India.	An overview of ongoing and futuristic trends of R & D areas in power transformer diagnostics at TIFAC core nit hamirpur
Dr. Subba Reddy B	IISc, Bangalore, India	Insulators for UHVAC and DC transmission
Prof. Saibal Chatterjee	NERIST Nirjuli, Arunachal Pradesh, India	Modelling of hybrid electric field for parallel operation of HVDC and HVAC transmission lines using comsol multiphysics
Prof. Prof. N K Roy	NIT, Durgapur, INDIA	ICT/IOT enabled high voltage laboratory facilities for quality education
Prof. Ganesh B. Kumbhar	IIT-Roorkee, India	Field-circuit coupled formulation for analysis of transformers and electrical machines.
Prof. Arijit Basuray	Jadavpur Univ. Kolkata, India	Study of insulation and winding integrity of transformer and motor under pulsed power application
Prof. P. Purkait	St. Thomas College Kolkata, India	Cole-Cole representation of transformer oil-paper Insulation dielectric response

4. Last day papers session and banquet

The last day had seen the invited talk sessions from Prof. Nandini Gupta (IIT, Kanpur), Prof. Udaya Kumar (IISc, Bangalore), Prof. Naoshi Hirai (Waseda University Tokyo, Japan). Prof. N K Kishore form IIT Kharagpur, and Prof. Subba Reddy B from IISc, Bangalore. The sessions was followed by 36 technical papers presentations followed by a Banquet. Participants enjoyed the local cuisines along with the Bhangra dance of Punjab (Figure (6))

5. Closing ceremony

Prof. Sarit Kumar Das emphasized the importance of the conference and described it as one of the true international conferences being held at IIT Ropar in leading research and technology. The head of the department of Electrical Engineering, said that it is the first conference of the Department of Electrical Engineering, IIT Ropar, and a great success. The day ended with a cultural program on Odissi dance by Padmashri Geeta Mahalik and inauguration of the conference by the Director, IIT Ropar as shown in figure (7).

Fig 6.Punjabi Bhangra dance.

Fig 10. From left to right (a) Prof. Udaya Kumar (Technical Committee Member), (b) Prof. C.C. Reddy (Conference Chair), (c) Prof. Sivaji Chakravorti (General Chair), (d) Prof. L. Satish (Technical Chair).

6. Remarks

The conference was sponsored by IEEE DEIS, IEEE Delhi Section, DEI Chapter of IEEE Kolkata Section, CPRI, Bender India, Agmatel, Megger India Ltd and many other industries and organized by IIT Ropar.

C C Reddy
Conference Chair
CATCON 2017,
Associate Professor,
Department of Electrical Engineering,
IIT Ropar
Email: reddy@iitrpr.ac.in

The 12th International Conference on the Properties and Applications of Dielectric Materials (ICPADM 2018, May, 2018, China)

The 12th International Conference on the Properties and Applications of Dielectric Materials (ICPADM) was held in Xi'an, China, May 20-23, 2018. ICPADM started in Xi'an in 1985 with the initial aim to provide a venue for Chinese electrical insulation and dielectrics researchers to communicate their research activities with the rest of the world. The ICPADM is held every three years and after the 1st and 6th ICPADM held in Xi'an, the 12th ICPADM came back to Xi'an again. The conference was organized by Xi'an Jiaotong University and sponsored by the IEEE / DEIS.

Preconference Activities on Sunday the 20th include two workshops with topics of "Ageing of Dielectrics" chaired by Hugh Zhu from Doble Engineering Company in USA and "Advanced Power Cable" chaired by Lisheng Zhong from Xi'an Jiaotong University in China. A welcome buffet reception was held in the evening of May 20th.

Shengtao Li, general chair delivers a welcome speech.

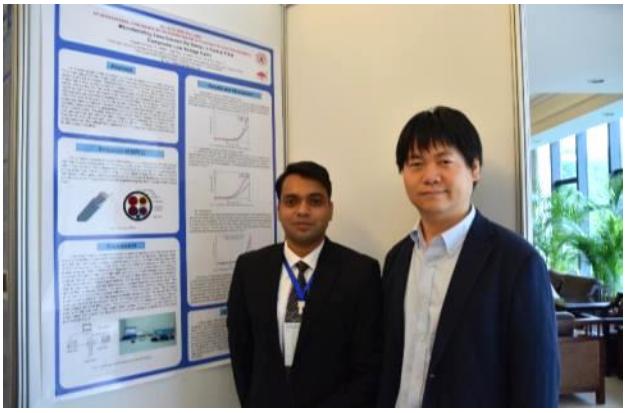

Liu Ziyu Memorial speech award to Yasuhiro Tanaka.


The conference venue

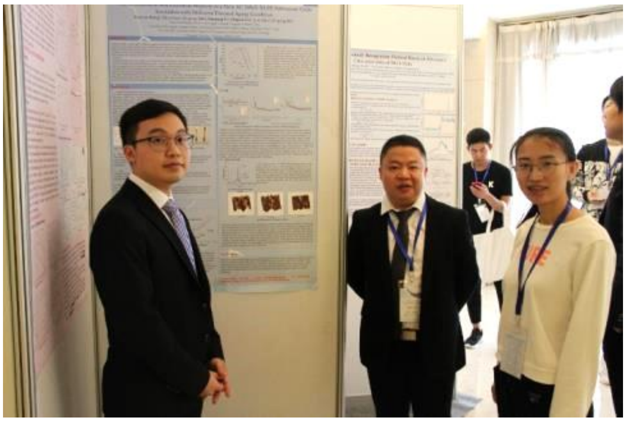

Shengtao Li, Harjo Suwarno and Guanjun Zhang at registration d*esk.*

In the opening ceremony on Monday 21th, welcome addresses were given by Mingzhe Rong, the vice president of Xi'an Jiaotong University, Qingquan Lei, Academician of Chinese Academy of Engineering and Shengtao Li, the conference chair. The ICPADM 2018 *Liu Ziyu Memorial Lecture* was delivered by Yasuhiro Tanaka from Tokyo City University. The lecture discussed space charge distribution measurement using PEA method encounter with unexpected behavior.

Session invited speech award to Toshikatsu Tanaka.



Ahsan Ashfaq and his poster with Dr. Yu Chen



Xiaojun Wang and his poster with young researchers

Three students awarded travel support stipends.

Four students awarded best paper awards.

In addition to the memorial lecture, plenary lectures were given over the following two days by Jinliang He (Tsinghua University) on progress in eco-friendly high voltage cable insulation materials, Gilbert Teyssedre (Laplace, CNRS and University of Toulouse) on interface tailoring for charge injection mitigation in insulators, Gary Stevens (Gnosys Global Ltd.) on developments in functional materials for extended performance dielectrics and Goerge Chen (University of Southampton) on polypropylene laminated paper insulation for HVDC power cables. A total of 448 papers were submitted to the conference and 261 from 21 different countries were selected for presentations at the conference. A total of 98 papers were presented over 12 oral sessions and the remaining 163 papers over 6 poster sessions. The papers were grounded into 10 topic areas: nano-technology and nano-dielectrics, monitoring and diagnostics, ageing and life assessment, space charge, partial discharge, insulators and insulation in equipment and systems, conduction and breakdown and surface phenomena, modelling and simulation, bio-dielectrics and ecofriendly dielectrics, new materials and a special topic of electrical insulation systems at cryogenic temperature. Social events included a technical visit of BYD Auto Co., Ltd followed by a banquet in the conference venue.

During the closing ceremony, awards were presented for the four best student papers (two oral and two poster), and three student travel support stipends were given.

Group photo of volunteers

Group photo of conference attendees

7th International Condition Monitoring and Diagnosis (CMD2018, Sep., 2018, Australia)

The International Condition Monitoring and Diagnosis (CMD) conference was established with the aim of building a platform for academia, industry, technology providers, consultants, and experts in power engineering to discuss and share ideas, present results, reflect on past experiences and discuss future trends and technology in the electric power apparatus monitoring, fault diagnosis and asset management. With the global trend to establish smart grids with intelligent on line monitoring and self-healing techniques, the topics covered in this conference have become multidisciplinary of engineering including power, communication and information technology.

The 7th International Condition Monitoring and Diagnosis 2018 (CMD 2018) Conference was held in the beautiful city of Perth, Australia, from 23rd to 26th September 2018. The conference chairman is *Associate Professor Ahmed Abu-Siada*.

Fig.1. Conference Opening Session

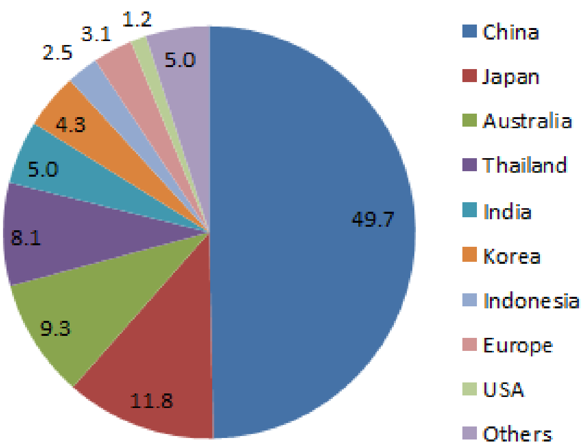


Fig.2. Percentage of participants' country origin

The conference received 230 submissions from 27 countries. All papers were peer reviewed by at least 2 independent reviewers. 156 papers (67.8%) from 17 countries were finally accepted and registered. There was an interest from industry delegates in Australia to attend the conference events with no papers. Overall, 180 delegates attended the conference events (161 registered people plus 19 invited delegates). All papers were scheduled for oral presentations in 24 technical sessions over the 3 days of the conference (no poster sessions).

The conference was sponsored by Curtin University, IEEE DEIS Society, Omicron (Germany), Engineers Australia, Electrical Energy Society of Australia (EESA), Perth Convention Bureau, IEEE PES (WA chapter), and AmpControl (Australia).

The Tutorial Sessions were held on Sunday 23rd September at the Hyatt Regency hotel. The first tutorial (morning), presented by Dr. Chandima Ekanayake and Dr. Dan Martin of the University of Queensland, covered the topic of Modern Condition Monitoring Techniques for Power Transformer. The second tutorial (afternoon), presented by Dr. Wojciech Koltunowicz and Dr. Wenyu Guo of Omicron, covered the topic of Partial Discharge Monitoring and Diagnosis in Transformers, Rotating Machines, GIS and Cables.

The Technical Sessions were held on the campus of Curtin University during the three days from 24th to 26th September. The programs comprised 4 keynote speeches, and 24 oral sessions. The oral sessions were arranged three in parallel, the session topics shown in Table 1. In particular, the topic on Partial Discharge was the most popular with 26 papers presented over 4 sessions.

CMD 2018 featured the following 5 eminent speakers:

1. *Prof. Hulya Kirkici*, University of South Alabama, Mobile Alabama, USA, "The Need for Testing, Diagnostics and Failure Investigations of Power Cables in a Smart Grid Era"
2. *Dr. Wojciech Koltunowicz*, OMICRON Energy Solutions GmbH, Berlin, Germany, "Increase of Operation Reliability of HV Apparatus through PD Monitoring"

Table 1. List of topics, number of sessions and papers

A. Partial Discharge	4	26
B. Power Transformers	3	20
C. Electrical Machines	1	6
D. Power Cables	3	20
E. Space Charge	2	12
F. Transmission Lines	1	6
G. Insulation Materials	3	20
H. Gas Insulated Substation	1	6
I. Sensors & Measurements	3	20
J. Fault Identification	1	6
K. Condition Monitoring	1	6
L. Asset management & Remaining Life	1	6
Total	24	154

3. *Prof. Syed Islam*, Federation University, Ballarat, Australia, “A Journey on FRA for Fault Detection in Power Transformers Offline to Online – Challenges and Opportunities”
4. *Dr. Robert Fleming*, former Co-Editor-in-Chief of the IEEE Electrical Insulation Magazine, Australia, “Some common errors in experimentally-based scientific papers”
5. *Prof. Shengtao Li*, Xi’an Jiaotong University, Xi’an, China, “CMD Past, Present and Future - History of CMD conference”.

Fig.3. Conference eminent speakers

Fig.4. Indigenous Australian dance performance

The Welcome Reception was held at the Hyatt hotel on Sunday 6-8 pm and was attended by over 100 delegates. Conference registration was also open during the event. The Gala Dinner on Tuesday evening was attended by about 180 delegates. Curtin University’s acting Pro-Vice Chancellor, Prof. Moses Tade, and the Conference Advisory Chair, Prof. Syed Islam, delivered a welcome speech to delegates. Prof. Shengtao Li, Chairman of CMD 2016 and chair of the CMD Steering committee delivered a talk about the history of CMD conference. Prof. Norasage Pattandech gave a presentation about the beautiful venue of CMD 2020 in Phuket, Thailand. The evening included a wonderful cultural performance by Wadumbah, a group of indigenous Australians performed traditional aboriginal dancing with didjeridoo playing.

During the conference, the Steering Advisory Committee meeting was convened to review the CMD state of affairs. The meeting was attended by Prof. Shengtao Li, China (Chair); Prof. Suwarno, Indonesia (steering committee member); Dr. Wojciech Koltunowicz, Germany (advisory committee member); Prof. Norasage Pattandech, Thailand (Chairman of CMD 2020); A/Prof. Ahmed Abu-Siada, Australia (Chairman of CMD 2018); Prof. Syed Islam, Australia (invited by committee); A/Prof. Toan Phung, Australia (invited); Prof. Hulya Kirkici, USA (invited); Dr. Robert Fleming, Australia (invited); Mr. Joe Tusek, Australia (invited); Dr. N. Hirai (representing Prof. Y. Ohki, Japan); Dr. Toshihiro Takahashi, Japan (biding for CMD 2022); and Dr. Nor Asiah Binti Muhamad, Malaysia (bidding for CMD 2022). Apart from other matters discussed, two biddings to host the CMD 2022 were presented. While the committee found that both proposals are strong and deserved endorsement, a decision was taken to select Japan to host CMD 2022.

Fig. 6. Group photo of CMD 2018 participants.

The Closing Ceremony along with paper awards announcement was held on Wednesday 4-5 pm. The six winning papers are: P106 by T. Maier, D. Lick and T. Leibfried; P40 by T. Münster, T. Kinkeldey, P. Werle, K. Hämel and J. Preusel; P166 by L. Liu, X. Li, Q. Zhang, J. Zhao, C. Liang and Z. Li; P119 by S. Nielsen; P238 by T. Takahashi; P120 by G. Behrmann, W. Koltunowicz and U. Schichler. With the Closing Ceremony, the CMD 2018 was successfully completed.

A/Prof. Toan Phung
University of New South Wales, Sydney, Australia
E-mail: toan.phung@unsw.edu.au

International Conference to be held in Asia

CATCON 2019 (4th International Conference on Condition Assessment Techniques in Electrical Systems)

Dates: November 18-21, 2019
Venue: Indian Institute of Technology Madras, Chennai 600 036
Organized by: Indian Institute of Technology Madras along with IEEE DEIS chapter, Calcutta and IEEE Madras Section

URL: http://www.ee.iitm.ac.in/CATCON2019

The purpose of this conference is to provide a broad coverage and dissemination of fundamental research in condition monitoring and assessment among researchers, academics, industry and practitioners. The technical program of CATCON 2019 will consist of tutorials, invited talks, posters, and oral presentations. Research papers describing original work on theories, methodologies, abstractions, algorithms, industry applications and case studies are invited. The topics include but are not limited to:

Track 1: Condition Assessment of Electrical Equipment
Track 2: Condition Assessment of Intricate Electrical Systems
Track 3: Advanced Signal Processing Tools and Computational Algorithms in Condition Assessment

Accepted full papers will be published in the proceedings. The Organizers are planning to publish all accepted papers in IEEE Xplore. The conference is participatory and at least one author of each accepted paper has to register and attend. "IEEE reserves the right to exclude a submission from distribution after the conference, including exclusion from IEEE Xplore, if the submission does not meet IEEE standards for scope and/or quality."

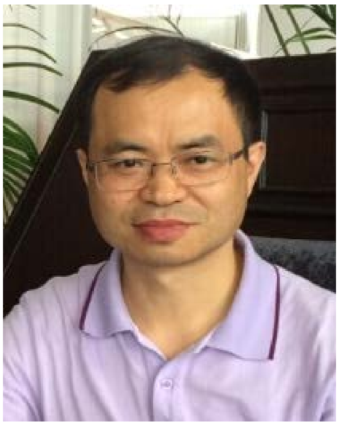
Important Dates:
Full Paper Submission portal opens: 1st Feb. 2019
Full paper Submission portal closes: 30th May 2019
Notification of Acceptance of the manuscript: 15th Jul. 2019
Camera Ready Submission portal opens: 30th Jul. 2019
Final submission of Full Manuscript: 30th Oct. 2019

Contact:
Prof. R. Sarathi, Indian Institute of Technology Madras
email : catcon2019@ee.iitm.ac.in
Tel : 044 2257 4436 / 5424

China Corner

Progress in UHVDC and UHVAC transformer oil in China

Shengtao Li, Huijuan Wang, Shujie Ma



Prof. Shengtao Li
Xi'an Jiaotong Univ.
Xi'an China

1. Overall

For further optimizing energy distribution in China, ultrahigh voltage (UHV) transmission technologies have been rapidly developed in recent years, including 1000 kV UHVAC with 9 GW capacity, ±1100kV UHVDC with 12GW capacity, and so on. Up to now, the Chang-Gu ±1100 kV UHVDC transmission line with the highest voltage level, the largest capacity, the longest transmission distance is the most advanced in the world.

As one of main electrical insulating materials in UHV transformers, transformer oil plays an important role in cooling, insulation and information carrier. In 1963, national key project "transformer oil R&D" was launched in China. In the 1960s, transformer oil meeting the requirements of ГОСТ10121 standard was produced by acid-base refining process. And furfural refining process was developed in the 1980s. Because of the great improvement in electrical insulation properties and oxidation stability, furfural treated oil meets the requirements of IEC296-82. It was applied to 500kV transformers to replace imported transformer oil. In 2000, a new special medium-pressure hydrotreating process was adopted to manufacture oil (named TGB20) with gassing tendency lower than -40μL/min. A series of transformer oils, which meet IEC60296-2003 and OEM standards, were developed by blending TGB20 with different base oils. However, the oxidation stability of this kind of oil without metal deactivator addition was poor. In order to improve the sensitivity of base oil to antioxidant, medium-pressure hydrogenation refining process with furfural treatment was developed. UHVAC oil meeting IEC60296-2012 was produced in 2012. At the same time, UHVDC oil was produced by self-developed precise fractionation process, so as to ensure the naphthenic oil with both lower viscosity and higher flash point, and with higher oxidation stability. From 2019, all of the UHV transformer oil in China will be produced from unique Xinjiang heavy oil by high pressure hydrogenation. And the naphthenic oil contains moderate aromatics while the sulfur and nitride impurity is further removed. It meets both IEC60296-2012 and ASTM D3487-16. More details are shown in Figure 1.

Since 1980s, the power transformer faults caused by transformer oil have been basically eliminated in China. The transformer oils in EHV/UHV transformers at home or abroad have been running well since then.

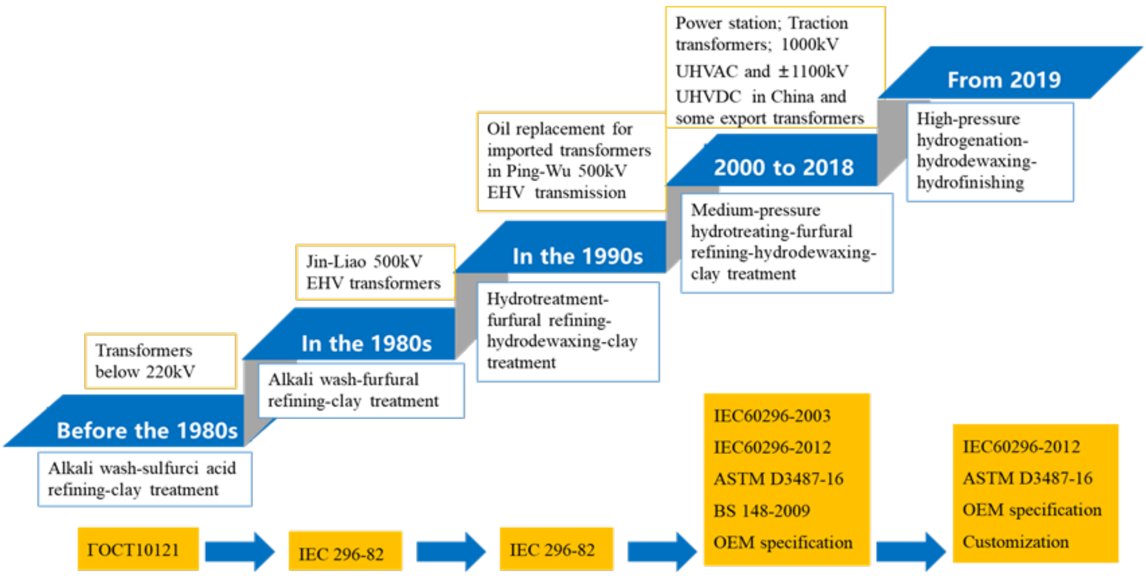


Figure 1. History of transformer oil development in China

2. Progress in the UHVDC and UHVAC transformer oil in China

2.1 Application of the UHV transformer oil in China

About 0.4million tons transformer oil per year is used, of which 0.3million tons is naphthenic, 0.1million tons is paraffinic. Paraffinic transformer oil is only used in transformers below 220kV, while high grade naphthenic oil can be used in EHV/UHV transformers. Besides, only inhibited transformer oils are accepted in China. All of the uninhibited oils are produced to export.

Up to now, there are three main companies producing transformer oil in China, that is, PetroChina, SINOPEC and CNOOC. 100% HVDC/UHVDC/UHVAC and nuclear power transformers, 90% EHV transformers in China are filled with PetroChina mineral insulating oil. Table 1 shows typical UHV transformer oils used in China.

Due to “Belt and Road” initiative and China’s UHV technology improvement, transformers are enormously exported to abroad. At the same time, transformer oil made in China is accepted by more and more customers from abroad, such as Philippines, Vietnam, Pakistan, and so on. It is worth mentioning that State Grid Corporation of China has contracted to build Brazil ±800kV UHVDC project with installed capacity of 11GW since 2015, and all the transformers are filled with PetroChina specialized naphthenic transformer oil named KI50X.

Table 1 Typical UHV transformer oil used in China

Project	Transmission distance	Voltage	Capacity	Transformer oil
Jin -Jing	640km	1000kV	9GW	KI25X
Jing-Jin	654km	1000kV	6GW	KI25X/KI45X
Xiang-Shang	1907km	±800kV	6GW	KI50X
Jin-Su	2059km	±800kV	7 GW	KI50X
Ha-Zheng	2192km	±800kV	8GW	KI50X
Chang-Gu	3320km	±1100kV	12GW	KI50X

2.2 Requirements for UHV transformer oil

In the past, the requirements for oil were different among UHVDC transformers introduced from Siemens and ABB, including electrical conductivity, gassing tendency, and so on. As a result, two types of UHVDC transformer oil were developed. As the transformer technology and oil treatment process were greatly improved, the key requirements for all the UHVDC transformer oils have been basically unified. With regard to UHVAC transformer oil, there is no difference among transformers manufactured in China.

Generally, there are two main requirements for UHVAC transformer oil because of high voltage, high capacity and high operating temperature of UHVAC transformers. Firstly, the oil must exhibit high insulation performance under UHVAC voltage. Secondly, the oil must have excellent oxidation stability and high flash point to ensure safety operation.

Compared to UHVAC transformer oil, there are many other special requirements for UHVDC transformer oil. UHVDC transformer in operation withstands not only AC voltage, lightning impulse voltage, but also DC voltage, DC superimposed AC voltage and DC bias polarity reversing voltage. Besides, the operating temperature is higher owing to DC bias and the harmonic wave. Therefore, there are basically three requirements for UHVDC transformer oil as follows:

(1) High insulation performance under DC, AC, DC superimposed AC voltage.
(2) Excellent cooling property and oxidation stability.
(3) Low viscosity and impurity to ensure high cleanliness of UHVDC transformers.

2.3 Key techniques of UHV transformer oil

The benefits of naphthenic oil together with the increasing UHV power transmission system needs predict a boom in related UHV R&D activities.

Compared to EHV transformers, UHV transformers have higher requirements to insulating oil. The oil not only meet IEC60296-2012 and ASTM D3487-16, but also possesses higher electric insulating performance, more excellent cooling property and oxidation stability. So the UHV transformer oils are produced from highly refined naphthenic oil with 0.3% antioxidant, via the international advanced Simultaneous Metered Blender and Automatic Batch Blender production technology. The typical properties of UHV transformer oils are briefly showed in Table 2. And UHV transformer oils exhibit excellent performances as follows:

(1) Excellent low-temperature performance: The hydrodewaxing process is conducted after furfural treatment, the pour point can reach up to -50°C～-70°C without any pour depressant addition.

Table 2. The key specifications and typical data of UHV transformer oil

Property	UHVAC transformer oil		UHVDC transformer oil		Test Method
	Limits	Typical data	Limits	Typical data	
Viscosity at 40°C/(mm²/s)	≤ 12	9.2	≤ 8.0	7.4	ISO 3104
Viscosity at -30°C/(mm²/s)	≤ 1800	1230	≤ 800	720	
Pour point/°C	≤ -40	-60	≤ -50	-63	ISO 3016
Aniline point/°C	≥ 63	80	≥ 63	74	D611
Density at 20°C/(kg/m³)	≤ 895	876	≤ 895	880	ISO 12185
DDF at 90°C	≤ 0.005	0.00004	≤ 0.005	0.00003	IEC 60247
Resistivity($\times 10^{12}$)/(Ω·m)	-	9.6	-	8.9	
Gassing tendency/(μL/min)	≤ +30	+21	≤ +30	+26	D 2300
Impulse breakdown voltage/kV	≥ 145	420	≥ 145	420	D 3300
Corrosive sulphur	Not corrosive	Non corrosive	Not corrosive	Non corrosive	D1275B
Antioxidant/%	0.08~0.40	0.29	0.08~0.40	0.29	IEC 60666
Metalpassivator additive	Not detectable		Not detectable		IEC 60666
Oxidation stability, 500h					IEC 61125C
Total acidity/(mgKOH/g)	≤ 0.3	0.05	≤ 0.3	0.02	
Sludge/%	≤ 0.05	< 0.01	≤ 0.05	<0.01	
DDF at 90°C	≤ 0.050	0.01	≤ 0.05	0.01	IEC 60247
Flash point/°C	≥ 135	152	≥ 135	149	ISO 2719
Carbon type (C_P)/%	≤ 50	42	≤ 50	38	D2140
Gas (N_2 sparged)/(μL/L): H_2	≤ 250	3.6	≤ 250	2.4	D7150
CO	≤ 115	24	≤ 115	32	
CO_2	≤ 385	115	≤ 385	106	
Total Hydrocarbon	≤ 122	3.2	≤ 122	2.5	

(2) Excellent oxidation stability: in order to improve impressibility of the base oil for antioxidant, a medium-pressure hydrogenation refining process is adapted instead of low-pressure hydrotreating. As a result, the UHV inhibited oil containing no metal deactivator shows excellent oxidation stability, and can be the same duration with transformers. Figure 2 shows various insulating oils after oxidation test by IEC61125 method.

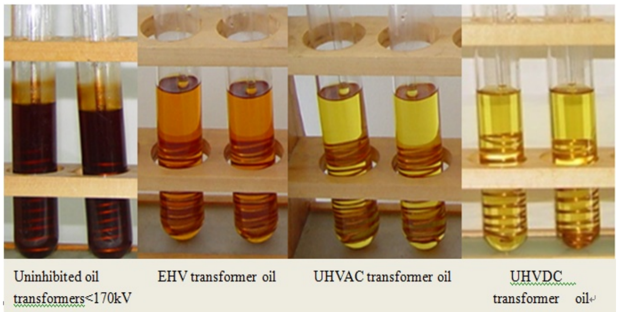


Figure 2. Various oils after oxidation test

(3) Excellent balance between sludge solubility and insulation property: the oil contains moderate aromatics and naphthenic hydrocarbons ensuring good solubility, while maintaining high negative impulse breakdown voltage and volume resistivity.

(4) Excellent balance between gassing tendency and oxidation stability: Gassing tendency and oxidation stability are conflicting properties. The higher the aromatic content, the better the gassing tendency, the worse the oxidation stability. However, since gassing tendency of di-aromatics is much lower than that of other aromatics, a new refining process was developed to get more di-aromatics while total aromatics content keeps constant. Finally, the gassing tendency can be lower than +30μl/min on the premise of super oxidation stability.

(5) Excellent stray gassing property: many studies have demonstrated that benzotriazole derivatives metal deactivator and oxidation are the main factors that cause stray gassing. Figure 3 shows stray gassing of UHV transformer oil before and after metal deactivator addition. Figure 4 indicates the gassing characteristics of series oils with various oxidation induction temperatures. UHV oil with excellent oxidation stability contains no metal deactivator, showing excellent stray gassing property. This is very beneficial to diagnosis of transformer actual failures.

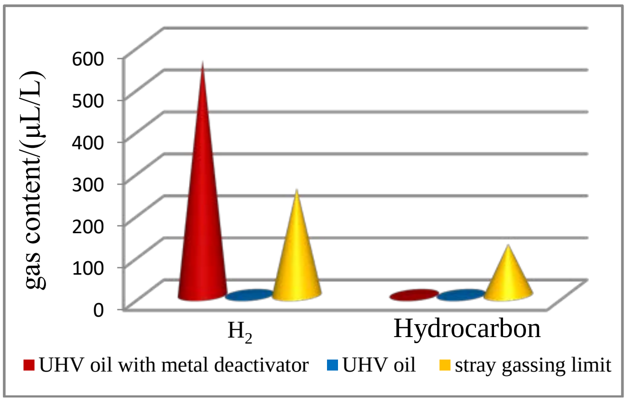


Figure 3. Influences of metal deactivator on gassing

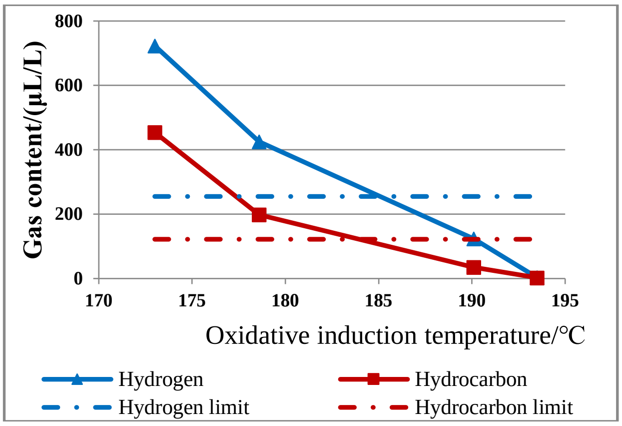


Figure 4. Effect of oxidation on stay gassing

(6) Besides the above-mentioned properties, there are some other special requirements for UHVDC transformer oil. For instance, the naphthenic oil viscosity at 40 °C is lower than 8mm^2/s, while the flash point is above 145 °C by self-developed precise fractionation process, the purity is higher than that of UHVAC oil.

Besides, all the international transformer oil standard specifications are based on AC test conditions, which is very different from UHVDC transformers. To satisfy the need of UHVDC transformer development, Chinese oil research institutes have collaborated with universities to develop transformer oil evaluation system. Lots of oil test methods have been established in China, including breakdown voltage test under DC voltage or polarity reverse electric field, oil oxidation test under DC voltage, partial discharge test under DC, AC and DC superimposed AC electric field, space charge test method of oil-paper insulation under DC field, stray gassing testing under condition of coincident DC electric field and temperature. The studies show that the effect of hydrocarbon composition on oil properties under DC voltage is very different from that under AC voltage. With the help of the self-developed transformer oil evaluation system, UHVDC transformer oil has been successfully developed in China.

3. Future Vision of UHV transformer oil

With the globally high concern about environment and safety, the UHVDC/UHVAC faces various challenges, such as fireproofing, good bio-degradability, more uniform electric field distribution in oil-paper insulation system. Consequently, the following issues should be carefully considered and properly solved:

(a) Improve the oil fire point while ensuring good heat transfer.

(b) Improve the biodegradability while maintaining good oxidation stability.

(c) Adjust hydrocarbon composition to improve performance of the oil-paper insulation in UHVDC transformer.

The above mentioned issues are rather challenging, so that the experts over the world should actively cooperate to overcome practical obstacles and develop cutting-edge techniques. As one of the main energy consumption countries in the world, China has the great determination as well as real actions to invest more on "Large Power Grid and its Flexible Interconnection". On 3rd September, 2018, National Energy Administration of China declared that 8 UHV transmission lines will be constructed during 2018 to 2019. It can be expected that more safety and more environmental UHV transmission systems will put into operation. China will provide a promising solution to today's energy problem. Furthermore, our experience could be of help to other countries with similar problems as well.

4. Summary

In recent years, fast progress has been made in UHVDC/UHVAC transformer oil in China. All of the oils have passed the certifications of Siemens, ABB and USA Doble Engineering Company. And lots of oil-paper insulation test equipment and test methods in DC fields have been developed.

With the new breakthroughs in the field, we believe that the insulating oil industry in China will thrive to fully meet the increasing demands for efficient, sustainable and clean energy, which definitely benefits both China and the world.

Authors:

Prof. Shengtao Li

Senior member of IEEE, Xi'an Jiaotong Univ. Xi'an, China, sli@mail.xjtu.edu.cn

(His photo is on the first page of this article.)

Huijuan Wang

IEC TC10 expert

PetroChina Lubricant Company, China

wanghuijuan_rhy@petrochina .com.cn

Prof. Shujie Ma

IEC TC10 expert

PetroChina Lubricant Company, China,

mashujie_rhy@petrochina.com.cn

Indonesia Corner

Geothermal Power Plants for Electrification of Indonesia


Prof. Suwarno Jati Pharmadita M.Sc.

1. Introduction

Geothermal energy is simply power derived from the Earth's internal heat. The geothermal energy is contained in the rock and fluids beneath Earth's crust. It can be found from shallow ground to several kilo meters below earth surface. The geothermal energy resources are usually found along major tectonic plate boundaries where many active volcanoes are located. There is a very active volcanoes with abundant geothermal areas in the world which is called the Ring of Fire. The Ring of Fire encircles the Pacific Ocean through several countries like Indonesia and The Philippine. In principles, trapped water in the rock beneath ground is heated up by the magma. Hot steam can be explored for a geothermal power plant. To find a geothermal reservoir one needs to drilling a well and testing the temperature of the steam .

2. Geothermal power plant.

There are three basic types of geothermal power plants. Firstly, a thermal turbine is directly operated using steam explored from a geothermal reservoir and to turn generator to produce electricity. Secondly, flash steam plants take high-pressure hot water from deep inside the earth and convert it to steam to drive generator turbines. The steam out from the turbine then is cooled down and the resulting water is injected back into the ground to be reheated to produce steam again. This type is the most popular geothermal power plants. The last type is the so called binary cycle power plants. This geothermal uses the heat from geothermal hot water to heat up another liquid to produce steam to rotate turbine and generator.

Geothermal energy can be extracted without burning a fossil fuel such as coal, gas, or oil. Binary plants release essentially no emissions. Unlike solar and wind energy, geothermal energy is always available, 365 days a year with almost constant capacity. It is relatively inexpensive, savings from direct use can be as much as 80 per cent over fossil fuels. However, there is a concern about the release of hydrogen sulphide. This gas release a strong smell. Another concern is the disposal of some geothermal fluids, which may contain a certain level of toxic materials.

The world's first Geothermal power station was built in 1911 in Larderello, in Southern Tuscany, Italy. By 1913 a 250kW power station had been built which provided power for the Italian electric railway system[1]. The largest group of geothermal power plants in the world is located at The Geysers (900 MW), a geothermal field in California to contributes to 14.3 GW geothermal power plants in the US [2].

In 2017, Geothermal capacity grew by 4.3% (600 MW) in 2017, to reach 14.3 GW. The largest additions to capacity were in Turkey (243 MW) and Indonesia (220 MW)[3]. Currently, The US has the largest geothermal capacity with 3.7 GW (26% of the world total), followed by Indonesia (2 GW), the Philippines (1.9 GW) and New Zealand (1 GW).

In overall, the geothermal share of global power generation remains very small (0.3%), but in certain countries it plays a significant role, e.g. Kenya (over 40% of power), Iceland (over 25%), and New Zealand (18%)[3]

The top 10 countries with installed geothermal power generation capacity is shown in figure 1.

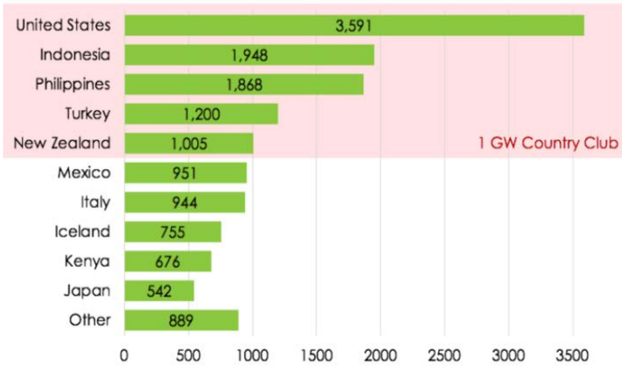


Fig. 1 Top 10 list of countries with installed geothermal power generation capacity as October 2018[4]

3. Indonesia Geothermal Power Plants

In January 1983, Kamojang power plant was inaugurated as the first Geothermal Production Field in Indonesia. And then is followed by other geothermal fields that start to produce electricity, such as Mt. Darajat (1994), Mt. Salak (1994), Mt. Sibayak (1997), Mt. Dieng (1998), Mt. Wayang Windu (2000), Lahendong (2001), Ulubelu (2011), Ulumbu (2012) followed by several power plants in the following years as shown in table 1. Examples of geothermal fields are shown in figures 2 and 3.

Table 1 Geothermal Power Plants in Indonesia

No	Power Plant	Developer/Operator	Capacity (MW)	Location
1	Sibayak	PT Pertamina	12	North Sumatera
2	Sarulla	Sarulla Operation, Ltd	330	North Sumatera
3	Ulubelu	PT Pertamina	220	Lampung
4	Salak	PT Star Energy Geothermal, Ltd	377	West Java
5	Wayang Windu	Star Energy Geothermal Wayang Windu	227	West Java
6	Patuha	PT Geo Dipa Energy	55	West Java
7	Kamojang	PT Pertamina Geo−thermal Energy	230	West Java
8	Darajat	Star Energy Geothermal Drajat	270	West Java
9	Dieng	PT Geo Dipa Energy	60	Central Java
10	Karaha	PT Pertamina	20	West Java
11	Matalopo	PT PLN	35	NTT
12	Ulumbu	PT PLN	10	NTT
13	Lahendong	PT Pertamina	120	North Sulawesi

Indonesia has now overtaken the Philippines in terms of geothermal power capacity. Moreover, by the end of 2018, Indonesia is expected to see its geothermal power capacity rise to 2,058 MW.

Additional geothermal capacity stems from the start of operations of the Plarah Karaha Unit 1 (30 MW) and the Sarulla Unit 3 (110 MW). In the remainder of 2018 the Sorik Marapi Modullar Unit 1 (20 MW), Sorik Marapi Marapi Modular Unit 2 (30 MW), Lumut Balai Unit 1 (55 MW) and Sokoria Unit 1 (5 MW) are expected to commence operations, thus adding more capacity to Indonesia's installed geothermal power generation capacity.

Fig. 2 Kamojang Geothermal Power Plant

Fig. 3 Wayang Windu Geothermal Power Plant

Geothermal reserves in Indonesia are located in Java and Sumatra Islands. The locations are highly populated and high electricity demand. Thus searching and exploiting geothermal resources in the areas are very important and need a large amount of investment.

Currently, the Indonesian geothermal energy resources have been confirmed from Sumatra, Java, Bali and Nusa tenggara. The exploration of the geothermal may produce electricity up to 29,000 MWe.

Indonesia is expected to be the world leader in geothermal energy harvesting. The country is determining to drive the progress toward its target under the Paris Agreement: the Nationally Determined Contribution (NDC) to establish 23 percent renewable energy by 2025 and to reduce carbon emissions by 29 percent by 2030[5]. To simplify the utilization of geothermal energy, the Government continues to simplify the geothermal exploration process to make attractive for various geothermal investors. Furthermore, the government has also issued a special regulation on geothermal, namely Law no. 21 of 2014 on Geothermal, Government Regulation no. 7 of 2017 on Geothermal for Indirect Use and other technical regulations [6]. The government is planning to establish 5.8 GW of new geothermal capacity to reach 9 % of total capacity by 2026and improve its energy source mix as shown in figure 4[7].

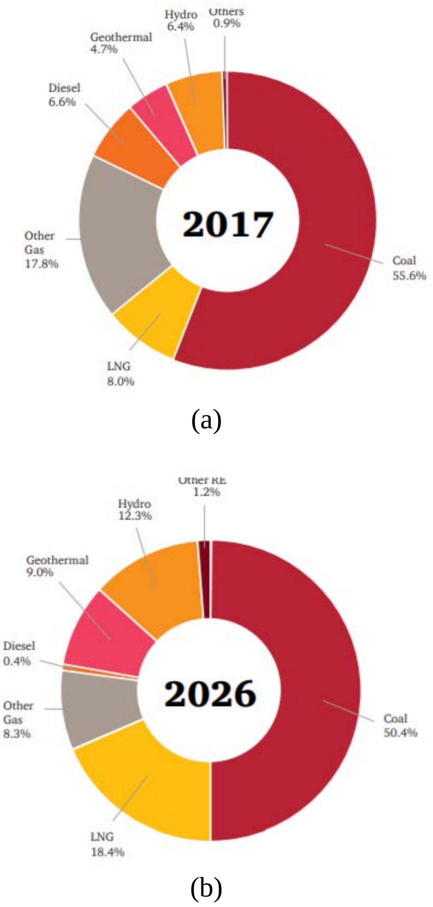


Fig. 4 Energy source mix for generating electricity in Indonesia

Indonesia has the largest geothermal potential in the world. It has potential resources of 11,073 MW and it reserves of 17,506 MW. Indonesia has abundant geothermal potential with 331 potential points spread from Sabang in the west to Merauke in the east. After shifting the Philippines position as the second largest geothermal power producer in the world, the Government projects Indonesia to become the world's largest geothermal power producer by 2023, beating America with geothermal power capacity of 3,729.5 MW.

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Professor Suwarno
School of Electrical Engineering
Institut Teknologi Bandung, Indonesia
suwarno@ieee.org

Jati Pharmadita, MSc
PLN Persero
-PT PLN (Persero), Strategic Procurement Planning Division
-InstitutTeknologi Bandung, Indonesia
jati.pharmadita@gmail.com

Establishment of MyHVnet -A Platform to Strengthen The Research and Development of High Voltage Engineering in Malaysia

Mohamad Kamarol Mohd Jamil

1. Introduction

High voltage (HV) study in higher institution in Malaysia was initially started in early 1970s at Universiti Teknologi Malaysia (UTM), Johor. At that time, the HV educational laboratory in UTM is the only higher institution party that could provide facilities for carrying out experiments, research and consultancy services. Since that, due to the rapid urbanization and higher demand on the development of HV infrastructure across the country, the HV research and development activities continue to sprout in Malaysia, both at the university and industry level. Started from 2008, the number of players involve in research and development at university and industry level is kept increasing. Although this denotes a good impact to the field of HV engineering, sometimes it gives a difficulty to identify the specialties of those players in specific high voltage related area, e.g., lightning protection, condition monitoring and diagnosis and insulation coordination. To overcome this issue, the idea of setting up the networking related to high voltage engineering among the industries and universities in Malaysia has been proposed in 2014. With regards to this idea eventually, the Malaysian High Voltage Network (MyHVnet) was officially established in 2015.

2. Establishment of MyHVnet

The first MyHVnet meeting was successfully held at UTM on 26th January 2015. The UTM has been chosen for the meeting since the university is a pioneer in HV engineering field. The meeting was attended by almost 40 candidates in HV related research and development from various universities in Malaysia and industries. The representative of Malaysian universities were from Universiti Sains Malaysia, Universiti Malaya, Universiti Putra Malaysia, Universiti Tek-nologi Malaysia, Universiti Malaysia Pahang, Universiti Malaysia Perlis, Universiti Malaysia Sabah, Universiti Teknikal Malaysia, Universiti Tun Hussein Onn, Universiti Tenaga Nasional, Universiti Teknologi Mara, Multimedia University and Universiti Kuala Lumpur. Whilst, the representative of Malaysian Industries were from Tenaga Nasional Research Sdn. Bhd., Malaysia Transformer Manufacturing Sdn. Bhd. and AM SGB Sdn. Bhd. In the meeting we have set three main objectives of the establishment of MyHVnet as follows;

Dr. M. K. M. Jamil
Universiti Sains Malaysia

i. To serve as a platform for the discussion of HV related research and development among member organizations
ii. To raise the awareness of research and development capabilities of member organizations to HV related industries.
iii. To lobby for HV related research funding

The MyHVnet hope to serve as a "one stop" platform for members from various organizations across Malaysia for the effective relationship and communication of HV related research and development. From the first meeting the committee member has been selected for the term 2015-2016, where the member comprises of chairman, co-chairman, secretariats 1 and 2, treasure and seven executive committee members. The first chairman and co-chair of MyHVnet was Prof. Dr. Zulkurnain Abdul Malek from UTM and Prof. Ir. Dr. Mohd Zainal

Fig.1: Photo session during 1st MyHVnet meeting in 2015

Abidin Ab Kadir from UPM. Figure 1 shows the photograph of the MyHVnet member whose attended the first meeting in 2015.

Fig. 2: Group photo during Dielectric Tutorial on May 2017

Fig. 3: Group photo during Distinguished Lecturer Workshop on Nov 2017

With the establishment of the MyHVnet many activities have been conducted. One of the main activity is the MyHVnet Colloquium. The first MyHVnet Colloquium was held in 2016 at UTM which covers various areas of HV engineering, i.e., lightning, insulation and electrical discharges, conditioning monitoring, and transformers. In this colloquium 71 papers from various universities and industries in Malaysia have been submitted and published in MyHVnet Newsletter.

Now the MyHVnet is continuously active with numerous number of activities that have been conducted together with the IEEE DEIS Malaysia Chapter. The new member for 2017-2018 terms was selected in the second meeting where MyHVnet has been chaired and co-chaired by Prof. Ir. Dr. Mohd Zainal Abidin Ab Kadir from UPM and Assoc. Prof. Ir. Dr. Mohamad Kamarol Mohd Jamil from USM, respectively. The activities with IEEE DEIS Malaysia Chapter that have been carried out throughout the year were Dielectric Tutorial (see Fig. 2), promoting the IEEE DEIS Malaysia Chapter, DEIS Distinguished Lecturer Programme by Porf. Tanaka (see Fig. 3), technical visit at HVDC, Gurun Malaysia (see Fig. 4), laboratory visit at HV Laboratory USM and HV workshop. Furthermore, since the MyHVnet colloquium become a key activity of MyHVnet, for the second time the 2nd MyHVnet colloquium was successfully held at UPM on 8th Feb. 2018 with 61 papers submission from universities and industries in Malaysia.

Fig. 4: Technical visit at HVDC Gurun, Malaysia on Oct 2017

3. Summary

The session for the member in MyHVnet for 2017-2018 is nearly completed by the end of December this year. The new member of MyHVnet will be appointed in the third meeting next year. The third meeting will be expected to be held at USM located at the north region of Malaysia. We are very much hopefulness that MyHVnet will be consistently active and could play their important role in order to ensure that the objectives of MyHVnet is attainable.

4. References

[1] MyHVnet Newsletter, no.1, 2016

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Assoc. Prof. Ir. Dr. Mohamad Kamarol Mohd Jamil ,

School of Electrical Electronic Engineering, Universiti Sains Malaysia, Malaysia

TECHNOLOGY REVIEW

IEC standards on insulation qualification of converter-fed motors

Dr. Ken Kimura

Thanks to the increasing global environment protection, conventional automobile engine which has to exhaust carbon dioxide have been replaced with electrical power-drive-system (PDS) gradually and would be perfectly in the near future. The PDS consists of a control unit with sensors, a power module and a three-phase motor. The power module consists of six or more power switching devices such as insulation-gate bipolar transistor (IGBT) at present or Silicon Carbide (SiC) device in future. According to the development of the power devices, maximum output voltage has already exceeded 3 kV and minimum switching time is shortened to sub micro-second region. Typical voltage waveform from the power module is “Pulse Width Modulation” (PWM) waveform, which consists of successive rectangular voltages with short rise and/or fall time. The fundamental Fourier frequency of the PWM waveform can control motor speeds. However, it has been pointed out that the higher frequency components can cause serious side-effects to the PDS: electro-magnetic disturbance and stator insulation [1]. As for winding insulation of motor stator, two factors can damage the insulation system. The first effect is the over-shoot voltage at motor terminals which can be explained by reflection theory. The other is uneven voltage distribution along winding in motors. Both phenomena may cause unexpected local high field especially on turn-turn insulation which leads to partial discharge (PD) occurrence. Many researchers have been investigating the phenomena with a lot of publications.

International Electrotechnical Commission (IEC) has been active to issue new documents against the new phenomena on emerging PDS technology. IEC started activities within Technical Committees (TC) 98 (insulation system) and TC 2 (rotating machine) independently by the end of twentieth century.

TC 98 has firstly published IEC 62068-1 in 2003 on general method of evaluation of electrical endurance by repetitive impulses. Then, IEC 61934 Technical Specification (TS) Ed.1.0 was published in 2006 on how to measure PD pulses under repetitive impulse voltages. After that, TC 112 born from TC 98 and SC 15E issued the second edition of IEC 61934 in 2011 [2]. On the other hand, TC 2 started a Working Group 27 (WG 27) to create an IEC document for qualification procedures on winding insulation of converter-fed motor. After intensive discussion the document was decided to be divided into IEC 60034-18-41 and -42 for Type-I and Type-II insulation. Type I and II mean that winding insulation endure without and with PD during service life. In other words, Type-I means so-called PD-free motors of relatively lower voltage rating, while Type-II corresponds to so-called PD-resistant high-voltage insulation system. And IEC 60034-18-41TS and -42 TS were prepared by WG 27 and issued in 2006 and 2010, respectively. After further discussion in Maintenance Team 10 (MT 10) of TC 2, the International Standards (IS) of IEC 60034-18-41 and -42 were published in 2014 and 2017, respectively [3,4].

Dr. K. Kimura

One of the most important proposals of IEC 60034-18-41 and -42 is the definition of Impulse Voltage Insulation Class (IVIC). The latest IEC 60034-1 Ed.13 authorizes the usage of IVIC according to test procedures mentioned in -41 and -42 as a new rating of converter-fed motor [5]. Since concrete PD test procedure is required for practical qualification, a new machine-specific IEC document is thought necessary instead of general description of PD measurements in IEC 61934TS cited by IEC 60034-18-41 at present. For this reasons New Work Item Proposal (NWIP) of IEC 60034-27-5 was proposed in 2015 by Japan National Committee of TC 2 and the project for 27-5 has been active in MT10 for a new TS. Author had an opportunity to be nominated as the project leader. The first committee draft (CD) was circulated in 2017 after long discussions in MT 10 meetings. In July 2018 the second CD was circulated and discussed in the last meeting in Sao Paulo. The role and key issues are reviewed here

IEC 60034-18-41:2014

As for qualification of the design of Type-I insulation systems, thermal ageing sub-cycles specified in IEC60034-18-21 or -31, including mechanical vibration, moisture and voltage test, should be applied on test samples and, after that, PD test should be performed. Turn/turn PD test should be done by means of repetitive impulse voltage. As for type test also, turn/turn insulation test should be performed by applying impulse voltage between each phase terminal and ground. It defined stress categories as shown in Table 1 using the overshoot factor (OF) U_p/U_a as shown in Figure 1. The insulations which pass the qualification tests mentioned above are classified to the severity categories A, B, C and D which was replaced with Impulse Voltage Insulation Class (IVIC).

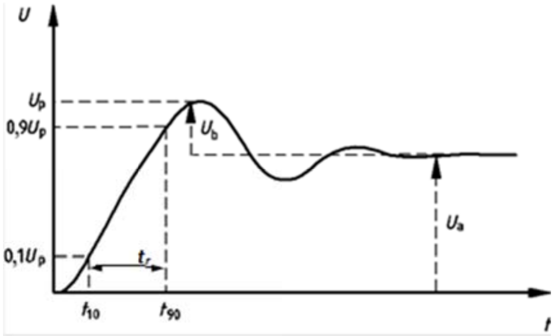

Figure 1. Voltage impulse waveshape parameters

Table 1 Stress categories for Type-I insulation system based on a 2-level converter (Table 4 of IEC 60034-18-41)

Stress categories	Overshoot factor OF (U_p/U_a)
A. Benign	OF < 1,1
B. Moderate	1,1 < OF < 1,5
C. Severe	1,5 < OF < 2,0
D. Extreme	2,0 < OF < 2,5

The role of IEC 60034-27-5 and key issues

MT10 has been updating IEC/TC2 documents published on winding insulation of rotating machines. As for insulation measurements, IEC 60034-27 series have been created. So far, offline PD, online PD, tangent-delta and insulation resistance have been standardized as IEC 60034-27-1, -2, -3 and -4, respectively. The measurements of these insulation properties have very long experiences among both utilities and manufacturers at acceptance and/or for the diagnosis of winding insulation, while online PD test has relatively shorter history.

On the other hand, PD test of motors under repetitive impulses is one of emerging technologies so that the latest experience and knowledge in laboratories or on sites should contribute to the project for 27-5. In 2017 the outline of IEC activities and the comprehensive research review have been presented and discussed in ISEIM [6,7].

In the followings, four technical items are discussed as key issues at present.

Impulse waveforms inside motor windings

Figure 1 shows the rising edge of simplified impulse voltage only and whole waveform of impulse voltage is not clear (rectangular or triangular, unipolar or bipolar distortion etc). Figure 2 explains the comparison of impulse waveforms in different portion of motor winding. When one unipolar rectangular voltage is applied between motor terminals (phase/phase), two cycles of bipolar sharp triangular voltage occurs in turn/turn insulation. Although the impulse voltage changes inside the winding, only unipolar triangular impulses are mentioned as test impulse voltage in Annex B of IEC 60034-18-41.

Another practical problem is the selection of test impulse generator available. For relatively small-

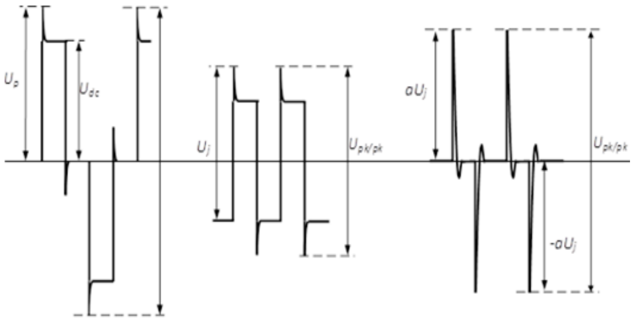

Figure 2. Comparison of phase/phase, phase/ground and turn/turn voltage for a 2-level converter (from left to right hands (Figure B.3 of IEC 60034-18-41))

capacity low-voltage rotating machines, conventional repetitive impulse (surge) tester for layer shortage detection may be used for PD tests. On the other hand, PD test of medium and/or large size machines need high-voltage impulse generators with sufficient current capacity which are not easy to find out. In order to obtain ideal waveform high capacity convertors may be necessary with controllable functions of high-voltage repetitive impulse outputs. A motor manufacturer has developed its own test generator with one-phase H bridge convertor with high-voltage power device and variable DC ling voltages.

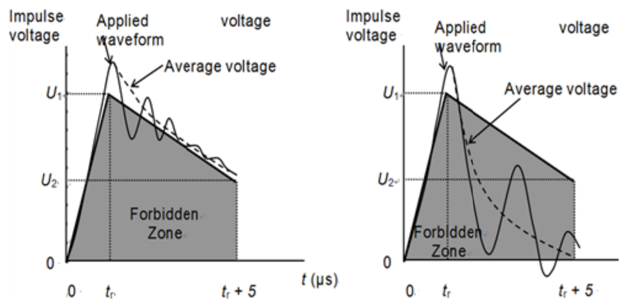

Figure 3. Example of test waveforms (left: acceptable and right-hand: unacceptable) (Figure B.2 of IEC 60034-18-41)

Tolerance of distorted impulse waveforms

The waveform of impulse voltage may be distorted with the impedance of test object and impulse generator in principle. Overshoot with ringing at impulse peak or slow oscillation after peak as shown in Figure 3 have been observed often in practical test sites. IEC 60034-18-41 describes that the left one in Figure 3 is acceptable and the right unacceptable. Generally, the distortion is difficult to suppress in practice and visual judgements of the acceptable/unacceptable of Figure 3 seem unclear. Accordingly, the second CD of 27-5 allows the distortion of impulse waveform in principle, and test voltage $U_{pk/pk}$ should be measured between maximum peak to minimum peak values for any waveforms.

The allowable change of rise time of impulse due to sample capacitance is mentioned as 0,3 +- 0,2 µs in IEC 60034-18-41. Since the rise time has large influence of voltage distribution as shown in Figure 2, the range should be kept in relative limited value range.

Selection of PD threshold voltages against thermal noise and electromagnetic disturbances

Threshold voltage for PD detection should be higher than noise and/or disturbance level. In the case of conventional PD measurement under sinusoidal voltage, calibration with pC before test has been done to show the sensitivity level of PD test. But the pC calibration is impossible for impulse PD measurement and sensitivity check should be reported as IEC 61934TS Clause 7 recommends sensitivity check method using low voltage pulse generator (LVPG). The arbitrariness of threshold value could lead to over-estimation of RPDIV, which might bring overqualification of IVIC. Author has proposed an extrapolation method to solve the arbitrary selection of threshold, but few researchers agree because of poor physical basis. So far, we have very few experiences on the sensitivity problems by now.

PDIV or RPDIV for PD criteria judgement

In third paragraph of Clause 11.1 of IEC 60034-18-41, PDIV with impulse is defined as the test repetitive impulse voltage with the first PD pulse against the number of repetitive impulses during sinusoidal one cycle. The description corresponds to the definition of conventional PDIV during sinusoidal voltage. On the other hand, Clause 11.3 of the same document mentions the usage of RPDIV on turn/turn insulation that If the RPDIV is below the pass criterion, the winding has failed. According to our experience, the PDIV with ramp sinusoidal voltage may be lower than RPDIV value. These contradiction within IEC 60034-18-41 would be resolved in the future edition. So far, however, new IEC 60034-27-5 may describe the test procedures in detail as possible to be complimentary to the present IEC 60034 -18-41.

Relevant published IEC standards on convertor-fed motor insulation were reviewed in terms of PD measurement with repetitive impulse voltage. Some technical issues on offline PD test methods were reviewed for a new document of IEC 60034-27-5. It is emphasized that the latest result of research and practical experiences should be involved in the 27-5 and that it should be complimentary to the present IEC 60034-18-41.

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Ken Kimura was received the B.S. and M.S. degrees from Waseda University, Japan in 1971 and 1973, respectively. He joined Mitsubishi Electric Corporation as research engineer in 1973. He received Dr. degree from Waseda University in 1985. He was a visiting professor of Kyushu Institute of Technology, Japan from 2001 to 2006. He was a professor of Nara National College of Technology, Japan from 2008 to 2011. Since 2015 he has been IEC TC2MT10 Project Leader for 27-5.

MISCELLANEOUS

Photos on Front and Rear Covers

Front Cover

High-speed Rolling Stock for UK Intercity Express Programme

The Intercity Express Programme (IEP) is the largest project in the history of British railways, and is intended to replace the aging rolling stock on the UK's East Coast Main Line and Great Western Main Line, which run between London and other major cities in the UK.

Hitachi was formally awarded a rolling stock manufacturing and maintenance contract for the UK IEP project in 2012. Including additional orders, the contract covers the manufacture of a total of 866 cars and the provision of maintenance services for a period of 27.5 years.

On October 2017, first Intercity Express Trains entered passenger service in the UK.

Intercity Express Trains will contribute to the provision of high-quality and reliable railway services.

Fujihiko Yokose
Hitachi, Ltd.
Railway Systems Business Unit
1-18-13 Soto-Kanda, Chiyoda-ku, Tokyo, Japan

Rear Cover

3D printed solid insulator

A Higher-performance solid insulator can be achieved not only by employing a new material but also by improving a manufacturing process. Recently, a “3D printer” attracts a renewed attention. A 3D printer is a device for additive manufacturing, which is the process of joining materials to make an object from 3D model data, usually layer upon layer. It has a potential to provide various solid insulators with functionally graded materials (FGM) such as permittivity graded materials.

We have clarified the technical feasibility of the stereolithographic 3D printing of an insulating component by using UV-cured-acrylic composite with micorometric alumina filler.

The upper figure is a conical insulating spacer with height of 10 mm using the alumina composite with micrometric alumina fillers with average diameter of 15 µm. The lower figure is a 2 layered FGM insulator.

Dr. Muneaki KURIMOTO
Nagoya University
Institute of Materials and Systems for Sustainability
Furo-cho, Chikusa-ku, Nagoya, 464-0039, Japan

Journals of IEEJ

A Journal which is edited by the headquarters of the Institute and five transactions which are edited by five technical societies* A to E are monthly published.

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IEEJ Technical Reports

Technical reports listed below were prepared by investigation committees in technical societies A to E in IEEJ and published from November 2017 to November 2018. Their extended summaries can be browsed in English on the web site below but the texts of technical reports are described in Japanese

No.	Title	Issue date (y/m/d)
1367	Advanced Measurements for Space Charge Distribution using Pulsed Electroacoustic Method	2018/8/10
1397	Magnetic Material and Its Evaluation Technology for Electromagnetic Actuator	2017/11/20
1402	Technical report for evaluation and utilization technology of the power magnetic material	2017/12/20
1411	Data-based Performance-directive Control System Design	2017/11/30
1412	Power capacitors and the voltage and reactive power control technologies of electric power system interconnected with distributed power source	2017/12/25
1413	Utilization of ICT in Traffic Control System of Expressway	2017/11/30
1414	Technical Issues for Application of Polymer Long-rod and Hollow Core Insulators	2017/12/15
1418	Research on Next Generation Lithography Technologies	2018/4/5
1419	Asset Management for electrical facilities in water and sewage utilities	2018/1/30
1420	Recent Progress of Si and WBG power semiconductor devices and ICs	2018/4/25
1421	Recent Progress in Motion Control for High-Functionality	2018/5/15
1422	Recent Trends and Suggestions on Lightning Risk Management for Wind Power Systems	2018/2/20
1423	Recent progress in Motion Control for Advanced Applications	2018/4/5
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(Standards Development and Planning Div.)	E-mail: iec@iee.or.jp
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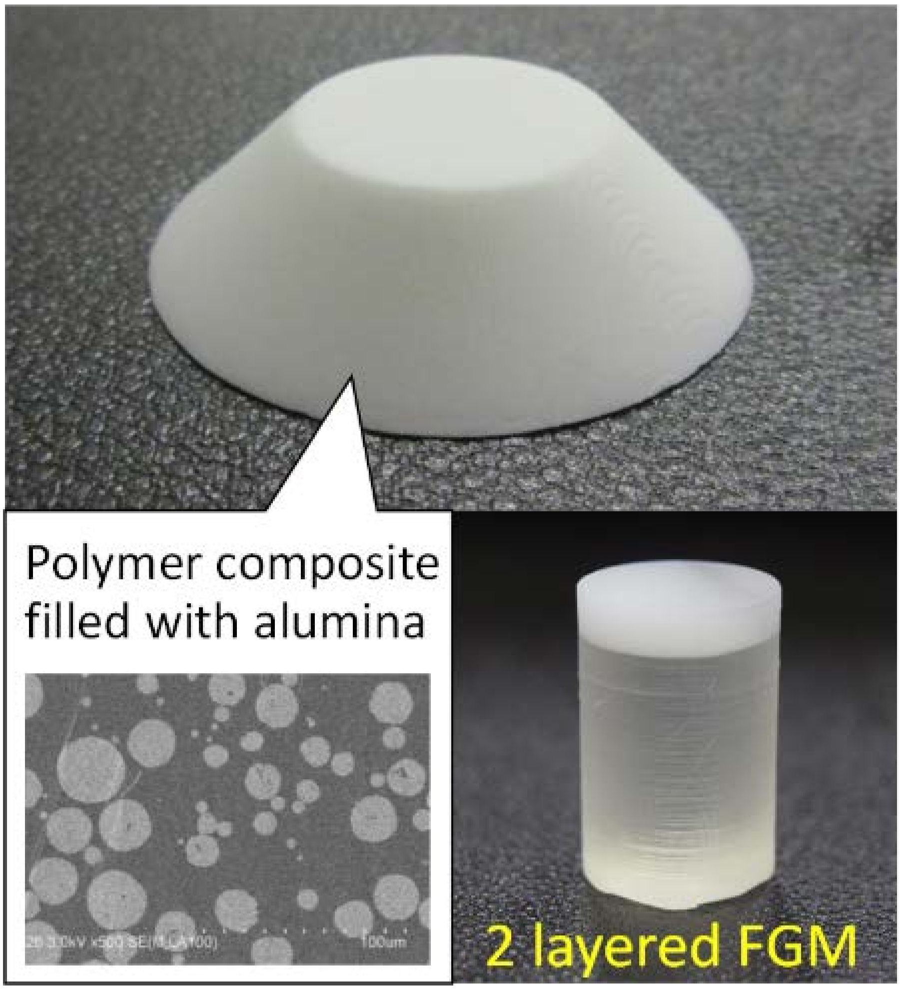

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The Institute of Electrical Engineers of Japan
8th Floor Homat Horizon Bldg., 6-2, Gobancho,
Chiyoda-ku, Tokyo 102-0076, JAPAN
Tel:+81-3-3221-7201, Fax:+81-3-3221-3704
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