

# **2025 IEEE International Conference on Dielectric Liquids (ICDL 2025)**

**Lodz, Poland  
18-22 May 2025**



**IEEE Catalog Number: CFP25CDL-POD  
ISBN: 978-1-6654-7759-8**

**Copyright © 2025 by the Institute of Electrical and Electronics Engineers, Inc.  
All Rights Reserved**

*Copyright and Reprint Permissions:* Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

***\*\*\* This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.***

IEEE Catalog Number:	CFP25CDL-POD
ISBN (Print-On-Demand):	978-1-6654-7759-8
ISBN (Online):	978-1-6654-7758-1
ISSN:	2153-3725

**Additional Copies of This Publication Are Available From:**

Curran Associates, Inc  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: (845) 758-0400  
Fax: (845) 758-2633  
E-mail: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

CURRAN ASSOCIATES INC.  
**proceedings**  
.com

## TABLE OF CONTENTS

Application of Ester Liquids in Power Transformers ..... 1 <i>I. Fofana</i>	1
The Impact of Construction Materials of Power Transformers on Aging of Different Natural Ester Liquids..... 5 <i>Valentina Vasovic, Ahmed Gamil, Draginja Mihajlovic, Jelena Lukic</i>	5
Studies on the Partitioning of Furfural Between Liquid and Paper Insulation ..... 9 <i>Saurabh Saurabh, Shanika Yasantha Matharage, Zhongdong Wang, Gordon Wilson</i>	9
View of Atmospheric DGA Gases in Sealed Wind Turbine Transformers Filled with Synthetic Ester - Early Leak Detection Indicators..... 13 <i>Muhammad Daghrah, Mahdi Rahmbeksch</i>	13
Gas Generation Characteristics by Partial Discharge in Rapeseed-Oil and Soybean-Oil Based Natural Ester Liquids..... 17 <i>Taisei Homma, Yoshinobu Mizutani, Satoru Miyazaki</i>	17
Investigating Adsorbent-Based Partial Reclamation of Natural Ester Fluids for Transformer Applications..... 20 <i>Leena Gautam, R. Sarathi, I. Fofana, U. Mohan Rao</i>	20
Understanding the Performance of Natural Ester Insulating Liquids During Energization Transformer at Subzero Temperature ..... 24 <i>Ahmed Gamil, Ali Al-Abadi, Niklas Knuts, Esa Virtanen, Mika Norolampi, Mikko Hautamaki</i>	24
Investigating Thermal Performance of Oil-Immersed Power Transformers at Low Ambient Temperatures ..... 28 <i>Mohamed H. A. Hassan, Camilla Espedal, Athanasios C. Mermigkas, Inge Madshaven, Florian Bachinger, Nebojša Gavrilov, Uroš Plaznik, Hugo Campelo, Kaveh Niayesh</i>	28
An Experimental Study on Oil Impregnation Physics in Transformer Insulation ..... 32 <i>Erik Hagström, Hans Edin, G. D. P. Mahidhar, Jan Hajek</i>	32
Investigation on the Pyrolysis of Mineral Oil and Decane Stressed by Thermal Transformer Faults ..... 36 <i>Kristin Homeier, Laureen Stahl, Peter Werle</i>	36
Is There Evidence of Transesterification of Cellulose in Ester Insulating Liquids..... 41 <i>Edward Casserly, Griffin Burk, Brooke Carpenter</i>	41
Impact of Nanoparticles' Size on the Dielectric Properties of Synthetic Ester Oil..... 45 <i>Michail Pitsikalis, Konstantinos Koutras, Ioannis Triantafyllopoulos, Eleftheria Pyrgioti, Ioannis Gonos, Thomas Tsovilis, Georgios Peppas</i>	45
Transient Heterocharge Layers Development in EHD Conduction Pumping ..... 49 <i>Alexander J. Castaneda, Jamal S. Yagoobi</i>	49
Pressure-Flowrate Characteristics of Electrohydrodynamic Conduction Pump with Rod-Ring Electrodes Including Reverse Flow Range..... 53 <i>Masahito Nishikawara, Genki Seshimo, Takeshi Miyakita, Hiroshi Yokoyama</i>	53
A Novel Ion-Drag Pump System for Thermal Management ..... 56 <i>Alberto Navarro-Calvo, Mathieu Legrand, Patricia Vega-Martínez, Marta Platón-álvarez</i>	56

Optical Measurement of Electrically Induced Resonance in Sessile Liquid Metal Drops: A Method for Mechanical Characterization .....	60
<i>Laurent Davoust, Rémi Simon</i>	
Dynamics of Droplets in Water Vapor Condensation Process Under Non-Uniform Electric Field.....	64
<i>Dian Li, Guangze Liu, Zirui Xu, Yuhang Zhang, Jian Wu</i>	
Multipole Expansion for the Calculation of Field-Dependent Molecular Ionization Potentials.....	68
<i>Ingrid Dybdal, Inge Madshaven, Per-Olof Åstrand</i>	
A Method to Estimate Minimum Partial Discharge Inception Electric Field of Metallic Particles with Various Shapes in Mineral Oil.....	72
<i>Hirotaka Muto, Shigeyoshi Yoshida, Yoshinobu Kitagawa, Kenichi Mino, Yoichi Nakashima, Mitsugu Ueda, Tadao Minagawa</i>	
Electron Transport in Low Temperature Hydrogen .....	76
<i>A. F. Borghesani, G. Carugno, G. Messineo, J. Pazzini, M. M. Masood</i>	
Analysis of Electric-Field-Dependent Polarization of Triglyceride Ester Oil Molecules Using DFTB-MD Simulations .....	80
<i>Maja Kobus</i>	
Evaluation of Physicochemical and Dielectric Properties of Mineral Oil – Natural Ester Mixtures Under Various Ageing Conditions: Implications for Retrofilled Transformers .....	84
<i>Andrés Montero, Belén García, Shanika Matharage</i>	
Lightning Impulse Breakdown and Acceleration Voltages of a Synthetic Ester Liquid at Large Gaps.....	88
<i>Arif Adam Bin Mohd Nor, Qiang Liu, Zhongdong Wang, Attila Gyore, James Reid</i>	
Positive Backstrokes from a Propagating Negative Streamer in Transformer Oil in an 80-Mm Gap .....	92
<i>Torstein Grav Aakre, Lars E. Lundgaard</i>	
Analysis of Dielectric Properties of Selected Ester Based Dielectric Liquids at Negative Lightning Impulse Voltage .....	96
<i>Filip Stuchala, Pawel Rozga, Daniel Kolankiewicz, Fabio Scatiggio, Giorgio Campi</i>	
Underwater Wire-Guided Discharges: Energy Characteristics and Pressure Impulses .....	100
<i>Y. Chai, I. V. Timoshkin, M. J. Given, S. J. Macgregor</i>	
Space-Charge Effects on Streamer Propagation and Acceleration Voltage in Transformer Insulating Liquids.....	104
<i>Lars E. Lundgaard, Torstein G. Aakre, Inge Madshaven, Dag Linhjell</i>	
Discharge Inception and Breakdown of the Oil-Wedge Type Electrode Model Insulated with GTL Based Dielectric Liquids .....	108
<i>Pawel Rozga, Filip Stuchala, Marco Milone, Ed Van Schaik, Konrad Strzelecki, Dominik Gonda</i>	
The Moisture Absorption Characteristics and Its Influence on AC Breakdown Voltage of Silicone Oil and Mineral Oil .....	112
<i>Hangyue Mei, Shengyuan Cui, Zhou Zuo, Chao Wu, Xidong Liang</i>	
Dynamic Behavior of Fillers in Liquid Dielectrics: Dielectrophoretic Orientation Under Square Wave Voltage for Enhancing Charge Transport in Composites.....	116
<i>Huanmin Yao, Andrea Cavallini, Maoqun Shen, Wenrui Tian, Haoxiang Zhao, Haibao Mu, Guanjun Zhang</i>	

Local Field Factors in Dielectric Liquids: Cyclohexane and Ethyl Laurate .....	120
<i>Ingrid Dybdal, Inge Madshaven, Per-Olof Åstrand</i>	
Effect of Metal Organic Frameworks on Dielectric Characteristics of Mineral Oil .....	124
<i>Manas Chakraborty, Ambuj Kumar, Sisir Kumar Nayak</i>	
Electrostatic Charging Tendency (ECT) of Natural Ester-Based ZnO, TiO <sub>2</sub> and CuO Nanofluids .....	128
<i>Pawel Skotnicki, Abderrahmane Beroual, Maciej Jaroszewski</i>	
Analysis of the Influence of the Degree of Mixing of Insulating Oil with Synthetic Ester on the Dielectric Loss Factor of Impregnated Electrotechnical Papers in a Wide Frequency Spectrum.....	132
<i>Stefan Wolny</i>	
Testing of Some Performance of Insulating System with Biodegradable Ester .....	136
<i>Pavel Trnka, Jaroslav Hornak, Ondrej Michal, Zdislava Mokra, Stefan Hardon, Jozef Kudelcik, Zdenek Frana, Jan Leffler, Tetjana Tomaskova</i>	
Evaluation of Dielectric and Insulation Properties of Various Fluorinated Liquids and Analysis Using Molecular Descriptors.....	140
<i>Shota Suenaga, Ryuto Tomaiwa, Takahiro Okamoto, Motoo Tsuchie, Shoya Kawano, Masayuki Hikita, Masahiro Kozako</i>	
Assessing the Stability of Dielectric Properties and Viscosity of Natural Ester Oil Under Aging and Temperature Changes .....	144
<i>Alai Muniozgueren, Itsaso Artetxe, Juan F. Sevillano, Gorka Onederra, Ian Gilbert, Maite Mujika</i>	
Inspection of Factory Transformers.....	148
<i>Michal Koch, Ewa Kaluzna, Pawel Albrechtowicz</i>	
Surface Discharge Over Rock in Transformer Oil.....	152
<i>Jozef Kudelcik, Stefan Hardon, Samuel Mužila</i>	
Precautionary Analysis of the Design Aspects of a Preventive Autotransformer to Eliminate Its Potential Impact on the Results of DGA of Transformer Oil.....	156
<i>Kacper Blus, Michal Kaczmarek, Grzegorz Drygala</i>	
Effect of Dissolved Water in Ester Insulating Oils on the Discharge Characteristics Under AC and Lightning Impulse Voltages.....	160
<i>Katsunori Miyagi, Takuma Kinoshita, Satoshi Nambu, Syu Miyashita, Ryoichi Hanaoka</i>	
Application of Convolutional Neural Networks for Classification of Oil-Insulated OLTC Defects Using Acoustic Emission.....	165
<i>Michal Wlodarz, Andrzej Cichon</i>	
Comparative Analysis of Optical Emission Spectra Emitted by Electrical Discharges in Insulating Liquids Under Direct and Alternating Voltage .....	169
<i>Michal Koziol, Tomasz Boczar, Michal Kunicki, Dariusz Zmarzly, Lukasz Nagi</i>	
Application of Artificial Intelligence Tools for Partial Discharge Classification .....	173
<i>Tomasz Boczar, Oskar Zmarzly, Michal Koziol</i>	
Electron Thermalization in Para-H <sub>2</sub> at Very Low Temperature .....	177
<i>M. M. Makhdoom, G. Carugno, G. Messineo, J. Pazzini, A. F. Borghesani</i>	
Green Insulation System for Transformers in MVDC and HVDC Energy Networks .....	181
<i>Joyce Jacob, Ayyoub Zouaghi, Anatoli Serghei</i>	

Investigating the Effect of Nanofillers on the Electrical Conductivity of Dielectric Liquids and Their Impregnated Pressboard.....	185
<i>Joyce Jacob, Ayyoub Zouaghi, Anatoli Serghei</i>	
DC Creepage Flashover Properties on Overlapping Structures of Pressboards in Transformer Oil.....	189
<i>Yoshitaka Miyaji, Shigeyoshi Yoshida, Hirotaka Muto</i>	
Simulation of Streamer Propagation in Ester-Based Insulating Oils Considering Electron Saturation Velocity.....	193
<i>Bojun Li, Feipeng Wang, Shi Li, Sichen Yan, Wang Zhi, Ying Zhang, Jian Zhou, Jian Li</i>	
AC Dielectric Strength in Natural Ester and Natural Ester-Based ZnO, TiO <sub>2</sub> and CuO Nanofluids .....	197
<i>Pawel Skotnicki, Maciej Jaroszewski, Abderrahmane Beroual</i>	
PDIV Characteristics of Natural Ester-Based Nanofluids and the Impact of Varying Moisture Content Under Oxidative Aging .....	201
<i>Satyajeet Anand, Ambuj Kumar, Deepak Kanumuri, Sisir Kumar Nayak</i>	
Physiochemical and Thermal Assessment of Mineral Oil Aged Silicone Rubber Nano/Micro Composites .....	205
<i>Dhanunjaya Naidu Vangapandu, Palash Mishra, Jatoth Varun, Soumya Chatterjee, Chillu Naresh, Neelmani, Pawel Rozga, Luigi Calcara</i>	
Surface Morphological and Infrared Thermographic Assessment of Natural Ester Oil Aged Silicone Rubber Microcomposites.....	209
<i>Jatoth Varun, Palash Mishra, V. Dhanunjaya Naidu, R. Sarathi, Soumya Chatterjee, Ashish Paramane, Pawel Rozga, Filip Stuchala</i>	
Enhancing Dielectric Properties of Aged Mineral and Natural Ester Oils with Nanofillers.....	213
<i>Manal M. Emara, Diah-Eldin A. Mansour, Georgios D. Peppas, Ioannis F. Gonos</i>	
Effect of Fullerene Nanoparticles on Creeping Discharges Propagating Over Solid-Liquid Interfaces Under Impulse Voltage .....	217
<i>Hocine Khelifa, Eric Vagnon, Abderrahmane Beroual</i>	
Modeling of Space Charge Accumulation in Oil-Paper Insulation of Converter Transformer Under Polarity Reversed Voltage.....	221
<i>Wu Lu, Ge Sun, Kexian Li, Zheming Wang, Wenqiang Zhou, Hua Yang</i>	
Design Insulation Level Factor for New Biodegradable Liquids .....	225
<i>Bartlomiej Pasternak, Maciej Lalik, Grzegorz Drygala, Pawel Rozga</i>	
Experimental Investigation of Nanoparticle Sedimentation in Nano-Enhanced Natural Ester Insulating Fluids Using Acoustic Spectroscopy .....	229
<i>Štefan Hardon, Jozef Kúdelčík, Pavel Trnka</i>	
Dielectric Liquids for Insulation and Cooling: An Electric Vehicle Perspective by the IEEE DEIS Technical Committee on Liquid Dielectrics .....	233
<i>I. Fofana, U. Mohan Rao, P. Rozga, A. Beroual, M. Lashbrook, J. Acosta</i>	
Thermo-Electrical Performance Evaluation of a Bio-Based Synthetic Ester Dielectric Immersion Coolant by Functional Lab Scale Testing .....	237
<i>Beau Van Vaerenbergh, Marion Kerbrat, Pieter Struelens</i>	
Aging and Air Infusion Effects on the Performance and Longevity of Polyol Ester-Based Immersion Cooling Fluids for Data Centers.....	241
<i>Amir Farrokh Farzaneh, Martin Olofsson, Eva Gustavsson</i>	

Breakdown Characteristics of Streaming Lubricating Oil Toward Higher Power Density Motors for Electric Powered Aircraft .....	245
<i>Naoki Hayakawa, Naoki Nakazawa, Shimpei Noguchi, Hiroki Kojima, Nobuo Aruga, Kiyoshi Utatsu, Shunya Watanabe</i>	
Effects of Thermal Aging on the Electrical, Dielectric and Thermophysical Properties of Cooling and Insulation Liquids in Electric Aircraft .....	249
<i>Laureen Stahl, Kristin Homeier, Büsra Özdemir, Peter Werle</i>	
Compatibility of Ester-Based Cooling Lubricants with Solid Materials in Motors.....	253
<i>Zhi Wang, Feipeng Wang, Zhengyong Huang, Jiacheng Zhang, Bojun Li, Yihua Qian, Qing Wang, Jian Li</i>	
Enhanced Transformers Thermal and Moisture Distribution Modelling for On-Line Assessment of Insulations Condition.....	257
<i>Ali Al-Abadi, Jakub Bobrowski, Ahmed Gamil</i>	
The Influence of Natural Ester Aging Conditions on Its Neutralization Value in Terms of the Limits Given in the IEC 62975 .....	261
<i>Dominika Szczesniak, Piotr Przybylek</i>	
The Effect of Selected Experimental Conditions on DGA Key Gas Ratios During Simulated Thermal Faults in a Bench-Top Test Rig .....	265
<i>Pär Wedin, Elena Minchak, Jessica Singh, Robert Fairholm, Hugo Campelo</i>	
Experimental Study of the Effect of Moisture and Temperature on the Dielectric Properties of Kraft Paper Impregnated in Biodegradable Transformer Liquid .....	269
<i>Ismael Antolin, Inmaculada Fernandez, Cristian Olmo, Fernando Delgado, Cristina Mendez</i>	
Assessment of Natural Ester Retrofilling Effects on Transformer Lightning Impulse Behaviour Regarding to Safety Margins of Transformer Insulation: A Case Study on a 180 MVA, 400/36 kV Power Transformer .....	273
<i>Ozan Ali Mutlu, Belén García, Andrés Montero</i>	
Electrical Discharges in Dielectric Fluids, Correlation Between Amount of Energy Delivered and Dissolved Gases Produced .....	277
<i>L. Calcara, C. A. Serafino, G. Maffei, E. Breda, G. Tontoli, D. Rocconi, D. Gasparini, A. Santoro, D. Gamba, M. Mezzano Cont, C. Favata, M. Pompili</i>	
Dielectric Response Analysis of Nano-Impregnated Pressboard in Natural Ester Oil Incorporating TiO <sub>2</sub> and Fe <sub>3</sub> O <sub>4</sub> Nanoparticles .....	281
<i>Ambuj Kumar, Deepak Kanumuri, Niharika Baruah, Sisir Kumar Nayak</i>	
Comprehensive Regression Modeling for Evaluating Chemical Properties of Transformer Oil Under Thermal Aging Conditions .....	285
<i>Sifeddine Abdi, Boubakar Achraf Besseri, Noureddine Harid, Abderrahmane Haddad, Ahmed Boubakeur</i>	
A New Approach Toward Assessing Transformer Insulating Paper Condition Via Online Optical Detection of 2-FAL.....	289
<i>Letizia De Maria, Francesco Arcadio, Daniele Bartalesi, Carlo Roggero, Diego Chialvi, Vincenzo Gazzillo, Nunzio Cennamo</i>	
New Sensor Technology for Level Measurement of Dielectric Liquids Such as Cryogenic Liquids.....	293
<i>Niousha Dashpeima, Nelly Bonifaci, Philippe Benech, Jean-Marc Duchamp</i>	

Partial Discharge Analysis of Natural Ester Oil Based Nanofluid Impregnated Pressboard Insulation .....	297
<i>Subhendu Sekhar Sahu, Deepak Kanumuri, Thirumurugan Chandrasekaran, Sisir Kumar Nayak</i>	
Comparison of Polarization Phenomena and Changes in Relative Permittivity in Mineral- And Ester-Based Nanofluids .....	301
<i>Zdislava Mokra, Pavel Trnka, Ondrej Michal, Jaroslav Hornak, Pavel Slama</i>	
Energy Characterisation of Spark Discharges in Water .....	305
<i>Ruairidh W. Macpherson, Igor V. Timoshkin, Martin J. Given, Scott J. Macgregor</i>	
Investigation of Liquid Insulating Material for Power Module Encapsulation: Effects on Partial Discharge and Electric Field Characteristics .....	309
<i>Ryuto Tomaiwa, Shota Suenaga, Takahiro Okamoto, Motoo Tsuchie, Masayuki Hikita, Masahiro Kozako</i>	
Influence of Fe <sub>3</sub> O <sub>4</sub> , TiO <sub>2</sub> , and Al <sub>2</sub> O <sub>3</sub> Nanoparticles on Dielectric Strength of Natural Ester Oils .....	313
<i>Deepak Kanumuri, Subhendu Sekhar Sahu, Thirumurugan Chandrasekaran, Niharika Baruah, Sisir Kumar Nayak</i>	
Study on Physicochemical Properties of Liquid Crystal Based Natural Ester Insulation Oil.....	317
<i>Yizhou Jiang, Zhengyong Huang, Jian Li, Feipeng Wang, Chen Zhao, Haoyu Guo</i>	
Post-Mortem Study of Two 100 MW GSU Power Transformers .....	321
<i>Inmaculada Fernandez, Alfredo Ortiz</i>	

## **Author Index**