

Proposal for multidisciplinary Consortium

At

**Department of Chemical Engineering
Haldia Institute of Technology
Haldia, West Bengal**

Title: IOT enable Ionic-Gel Enhanced Early Streamer Emission Consortium (IIGEESE Consortium)

Project Title: Development of an ionized gel powered Early Steaming Emission machine for arresting lightning to protect civil and industrial assets.

Background:

Lightning is one of the most severe natural electrical phenomena and represents a significant threat to electrical infrastructure, electronic systems, industrial installations, communication networks, and human safety. A lightning discharge can involve extremely high currents, rapid current rise times, and substantial electromagnetic and thermal effects. Direct or nearby lightning strikes can therefore produce insulation flashover, equipment damage, power-system disturbances, fire hazards, and service interruptions. With the increasing deployment of sensitive electronic and electrical equipment, renewable-energy systems, communication infrastructure, and interconnected power networks, the need for reliable and high-performance lightning protection has become increasingly important.

Conventional lightning protection systems primarily rely on air terminals, down conductors, grounding systems, and surge protection devices to provide a preferential path for lightning current and limit the resulting electrical stress on protected equipment. Among these technologies, Early Streamer Emission (ESE) lightning arresters have been developed with the objective of initiating an upward connecting leader earlier than a conventional air terminal under suitable atmospheric electric-field conditions. The intended outcome is to provide an increased protected zone around the air terminal. However, the performance of an ESE system depends on several interacting factors, including electric-field enhancement, electrode geometry, corona discharge characteristics, environmental conditions, material properties, and the dynamics of streamer/leader development.

A major challenge in the development of advanced ESE lightning arresters is therefore the controlled generation and maintenance of corona and streamer activity under rapidly changing high-electric-field conditions. Conventional metallic electrodes are effective conductors but provide limited scope for dynamically modifying their electrical response. Furthermore, the long-term performance of an outdoor lightning arrester can be affected by humidity, temperature, contamination, ageing, ultraviolet exposure, mechanical degradation, and other environmental factors.

Recent developments in functional materials, ionic materials, polymeric gels, electroactive materials, and high-voltage plasma phenomena provide an opportunity to explore alternative approaches to lightning initiation and protection. In particular, an ionic gel can provide mobile ionic species within a mechanically stable matrix, potentially offering distinctive electrical, dielectric, and interfacial properties. Its combination of ionic conductivity, charge-storage capability, dielectric response, and adaptability could be investigated as a means of modifying the local electric-field and charge-distribution characteristics of an ESE electrode system.

The proposed project aims to investigate this concept through the development of a high-performance ionic-gel-assisted ESE lightning arrester. The research will integrate expertise from high-voltage engineering, materials science, polymer/gel chemistry, plasma physics, electrical insulation, computational modelling, and experimental diagnostics. Particular emphasis will be placed on understanding the relationship between ionic-gel composition, electrical properties, electrode configuration, corona characteristics, streamer development, and lightning interception behaviour.

The project will involve systematic material development and characterization, electric-field modelling, laboratory high-voltage testing, corona/streamer diagnostics, environmental and ageing studies, and prototype development. The resulting knowledge will help establish the scientific and engineering basis for determining whether ionic-gel technology can provide measurable advantages for high-performance lightning protection.

Ultimately, the project seeks to develop a reliable, environmentally robust, and scientifically validated next-generation lightning arrester, while establishing design methodologies that can support future applications in power transmission and distribution, industrial facilities, telecommunications, renewable-energy installations, and other critical infrastructure. The work will also contribute to a better fundamental understanding of the interaction between ionic materials, high electric fields, corona discharge, and streamer initiation, thereby creating opportunities for further innovation in advanced lightning protection technologies.

Objective:

A multidisciplinary consortium is a cooperative group of professionals, researchers, or organizations from different fields working together on a shared goal or complex project. It is short, technically descriptive, and broad enough to include researchers from the departments of **Chemical Engineering, Electrical Engineering, Mechanical Engineering, Electronics and Communication Engineering, Computer science and Engineering, Artificial Intelligence & Machine Learning and Applied Electronics and Instrumentation Engineering**

Expected outcome:

1. An working model for field trial
2. Institute patent application
3. Publication on the test result analysis
4. Sell in market after successful field trial.

Field trial analysis and necessary modification before market ready may require additional fund for development of few more models for reliability test across various installations.

PI of the project and Coordinator of the Consortium

Dr. Biswajit Mandal, Associate Professor, Chemical Engineering, HIT

Biswajit Mandal

CO-PIs of the project and members of Consortium

Prof. Sunil Baran Kuila, Professor & HOD, CHE

Mr. Banshidhari Samanta, Assistant Professor, EE

Dr. Tilak Mukherjee, Associate Professor, ECE

Mr. Asit Kumar Nayek, Assistant Professor, AIML

Dr. Somak Karan, Associate Professor, AEIE

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Banshidhari Samanta
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Asit Kumar Nayek
Somak Karan
Sutapa Roy

Soumen Roy
Sankar Narayan Pal
Tapasi Das
Amit Biswas

Approx. budget for execution of the project:

1. Fabrication of customized ESE with detachable downward spikes, active air conducting terminals, triggering electrodes/spikes, super capacitors: Rs 40,000
2. High grade copper strip: Rs 15,000
3. Digital lightning strike counters for IOT integration and analysis: Rs 15,000
4. Manufacture of ionic gel of variable conductivity: Rs. 15,000
5. Chemical Earthing Electrodes: Rs. 25,000
6. Lightning arrester testing kit :Rs. 35000
7. Ground fault detector: Rs.15,000
8. Multimeter. Tester, SPD etc: Rs. 15,000

Total estimated cost: Rs. 1,75,000

(Signature)
(HOD-CHE)