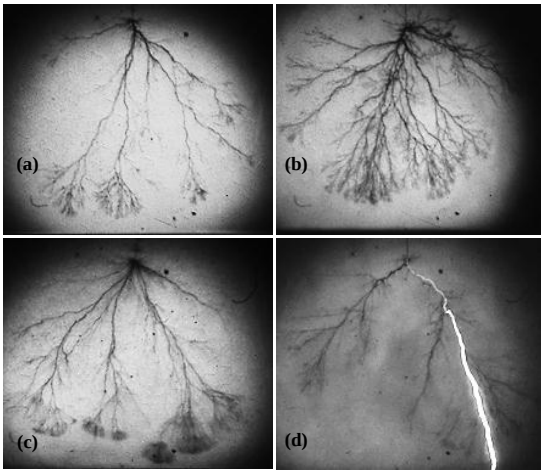
Student project / Master's thesis at SINTEF Energy Research, Department of Electric Power Technology

SINTEF Energy Research is a research institute located in Trondheim, Norway. It collaborates closely with the Norwegian University of Science and Technology (NTNU), educating candidates on MSc and PhD level. The Department of Electric Power Technology has advanced electric and materials technology laboratory and is engaged in contract research within electric power technology, analyses, testing and development of equipment.

Background

Dielectric liquids are important insulation materials used in transformers, switch gears etc. When the insulation is stressed by sufficiently high electric fields electrical breakdown of the insulation will follow resulting in permanent damage of the equipment. The phenomena responsible for this breakdown have been extensively studied over the last decades, and a large amount of experimental data on the process has been gathered. When sufficient voltages are applied a plasma channel originating from regions of high electrical fields propagates in the liquid. Typically this channel evolves into a bush/tree like structures with many plasma channels. Such structures are called streamers. Above the breakdown voltage of the insulation system the streamer will bridge the entire insulation causing breakdown between high voltage and ground. The processes responsible for this are not clearly understood, although electron avalanches occurring at the interface between the streamer and the liquid are believed to govern the propagation of the structure.

SINTEF Energy and NTNU has together with ABB established advanced experimental studies and molecular modelling of electronic properties of breakdown in dielectric liquids used e.g for transformer insulation. The project and diploma work will be a part of these studies



Images shows a positive breakdown developing in different liquids

Tasks

The project has both experimental and experimental tasks and the work can include elements of both these depending on the interests of the student.

Experimental studies of breakdown in a small gap

A small experimental set-up is established where various parameters may be studied. The set-up can be controlled using Lab-view. The set-up will be improved by installing optical observations of the breakdowns. The idea is to study various descriptors of a breakdown when varying liquids with different electronic properties. Results may be studies by statistical tools like e.g. chemometrical methods.

Simplified direct streamer simulation in Matlab

The breakdown process described above is too evolved to make a detailed computer simulation possible. Still a quantitative simplified model of the phenomena is created based on what we believe to be the most likely mechanism for inception and propagation of streamers. The next step will be to compare the results obtained by experiments with the computer model. This will be the main part of the proposed student work. The student will work in close collaboration with scientist at SINTEF Energy Research.

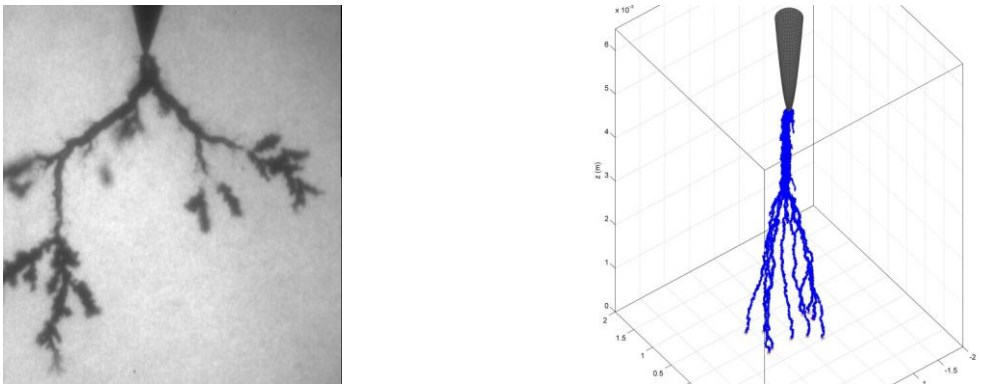


Figure 1 Picture of streamer (right), simulated streamer (left)

Key elements of the student project:

- Literature survey of streamer inception and propagation in dielectric liquids.
- Experimental studies of breakdown in liquids
- Compare simulation results with experiments. Trends in
    - speed and voltage
    - Shape, branches.
- Sensitivity analyses of input parameters

Contact persons:

Øystein Hestad, Tlf 971 12 257
Lars Lundgaard, Tlf: 930 07 018