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Comprehensive Experimental Database and Model Fitting for Electric Arc Behavior in Aircraft Environments

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INTRODUCTION

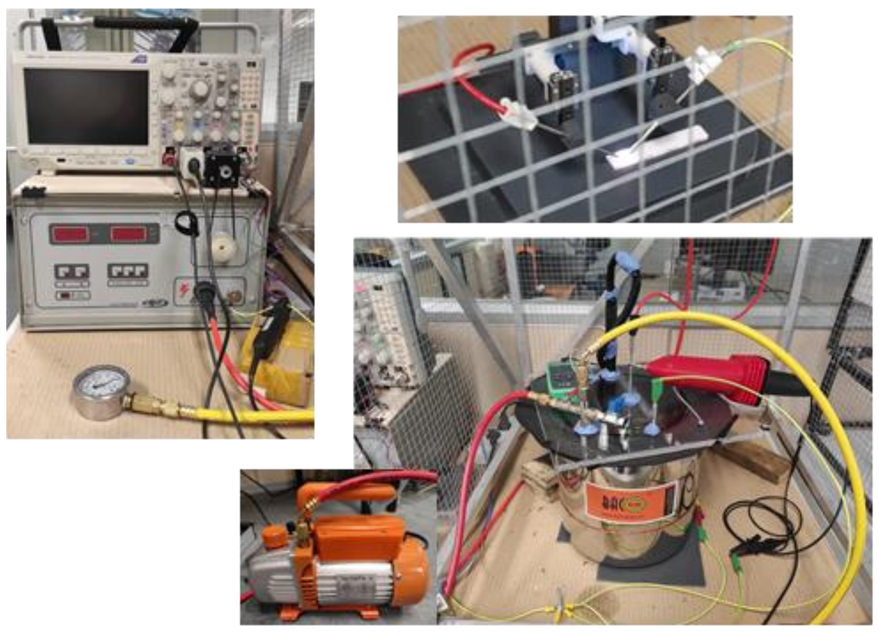
- This paper presents a methodology for building a database of approximately 1,000 tests that replicate parallel arc faults in More Electric Aircraft (MEA) systems to meet UL 746A standards. It ensures accurate representation of arc behavior through the use of Andrea's arc model, with fault analysis showing both model consistency and sensitivity to factors such as electrode spacing and pressure.

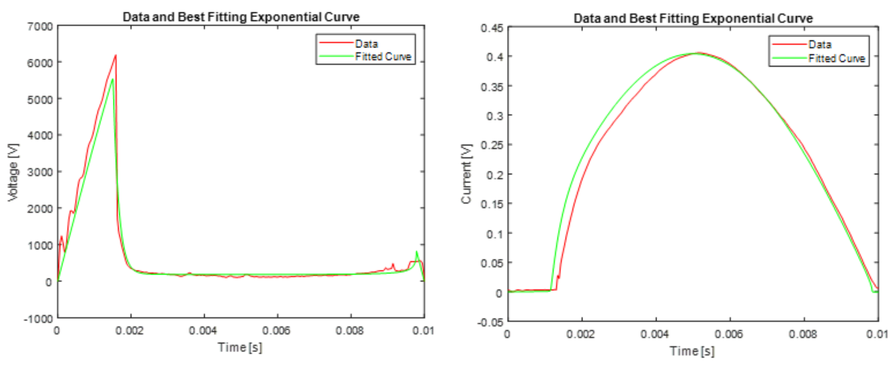
OBJECTIVES

- The work has two main objectives: firstly, to build up a comprehensive database through hundreds of tests under a variety of pressure and electrode spacing conditions; secondly, to validate the accuracy of a simplified model by fitting a significant number of cases of the collected data. These efforts are intended to deepen the understanding of arc behaviour, particularly in MEA systems.

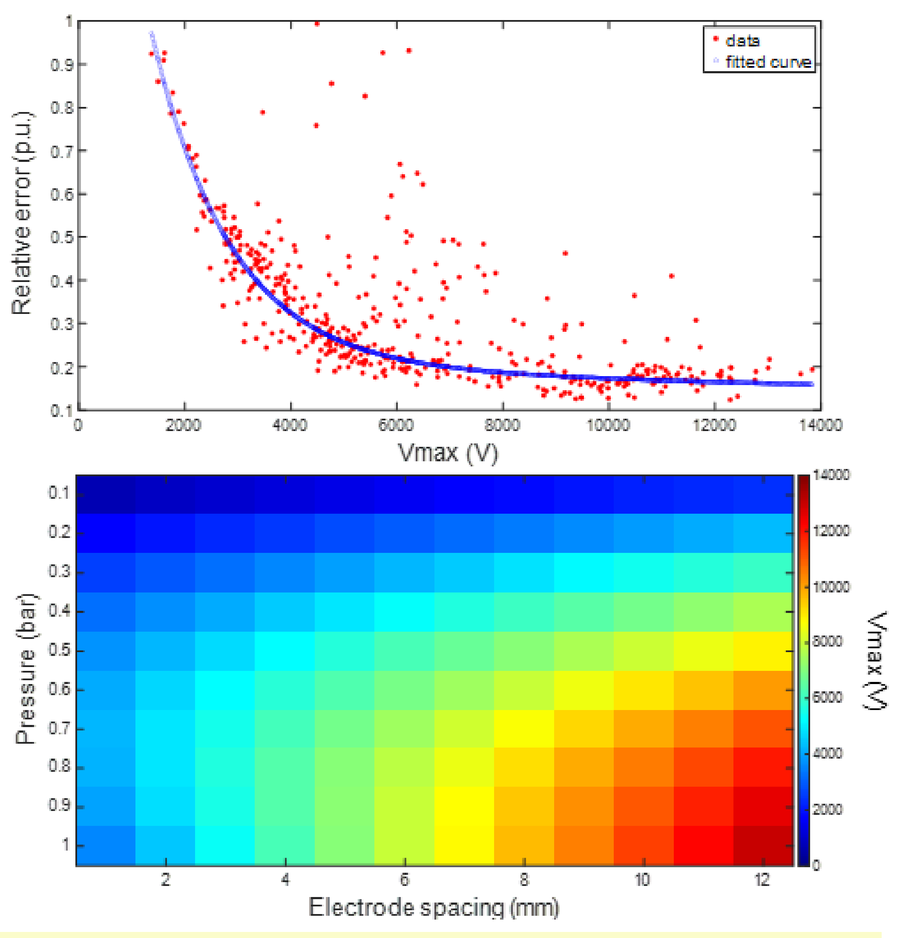
DESCRIPTION

- Close to a thousand tests were conducted to analyze arc voltages and currents between two electrodes under conditions simulating sea level and high altitude, ensuring relevance to aircraft environments.





- Experimental Setup:
  - Stainless steel rod electrodes are utilized with adjustable spacing (from 1 to 12 mm) above PVC and PTFE specimens.
  - Test conditions are controlled using a vacuum pump (pressures ranging from 0.1 to 1 bar) and adjustable voltage source.
  - Measurements are recorded using high-frequency probes and an oscilloscope.
  - Tests comply with UL 746A standards, assessing materials' resistance to ignition or carbonized path formation during low current, high-voltage arcs.
- Electric Arc Modelling:
  - Andrea's arc model is employed to align with scenarios outlined in the UL 746A standard, providing a more accurate depiction of arc behavior compared to classical models.
- Database: The study introduces a comprehensive database to study electric arc characteristics under diverse conditions.
- Data files include voltage, current, and environmental parameters, with photographic documentation capturing arc changes in specimens.
- Model Fitting: The model's accuracy and consistency across diverse scenarios are demonstrated.
  - The modeling error plotted against the source voltage Vmax, illustrates a decreasing error trend as Vmax increases.
  - The heat map illustrates the correlation among Vmax, electrode distance, and pressure, demonstrating that greater electrode spacing and higher pressures correlate with reduced modeling errors.



CONCLUSIONS

- The experimental database developed provides a valuable resource for the study of arcing behaviour, enabling in-depth analysis and a deeper understanding of arcing phenomena.
- Adjustment of Andrea's model parameters ensures accurate representation, thereby enhancing understanding of its applicability and reliability.