360-24-bas

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

P. Pas-Calopa, J.-R. Riba and M. Moreno-Eguilaz
HV Test & Research Center AMBER
Universitat Politècnica de Catalunya UPC BarcelonaTech

INTRODUCTION

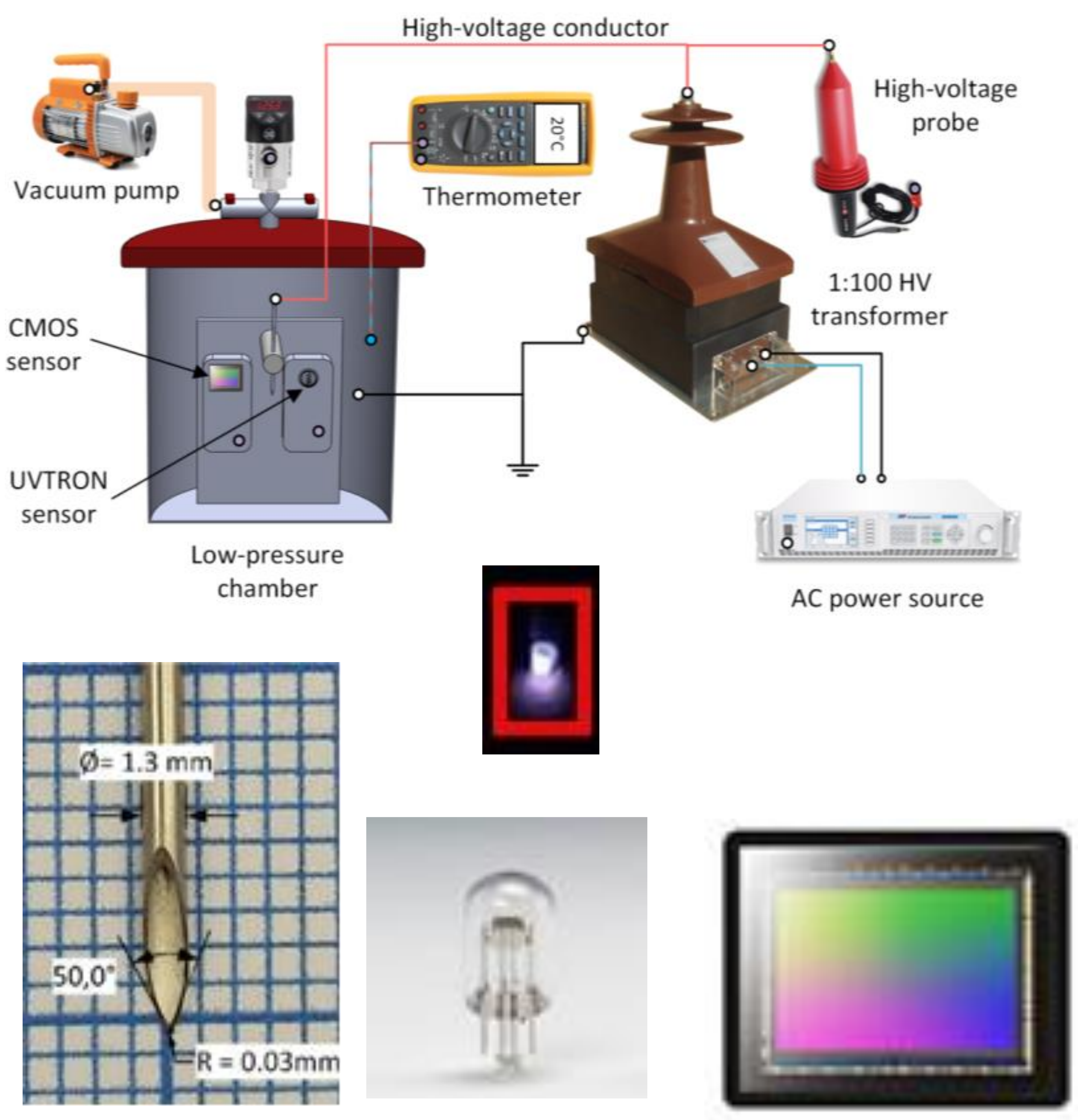
- Due to the enormous power requirements, modern aircrafts must operate at high voltages. However, the combined effect of higher voltage levels and low pressure environments is conducive to the occurrence of electrical discharges in electrical systems. Therefore, there is an urgent need to develop cost-effective systems to detect the discharges in the early stages before major failures can occur.

OBJECTIVES

- This paper compares two optical sensors for early discharge detection in a simulated aircraft environment. The experimental study is performed in a low pressure chamber. The pressure is changed from that corresponding to ground level to that corresponding to flight altitude, i.e., from 100 kPa to 20 kPa. The effect of the supply frequency is also studied, since modern aircraft operate up to 800 Hz.

DESCRIPTION

- Through experiments performed in a low-pressure chamber, the sensitivity is compared by determining and comparing the **corona inception voltage (CIV)** detected by a back-illuminated CMOS and a solar blind UV-C sensor.



- Experimental Setup:
  - The corona discharges were generated using a needle-plane geometry. It consists of a stainless steel needle 13 cm long, 1.3 mm in diameter with a hollow tip of 0.03 mm radius and 50° angle placed 20 cm above the ground plane.
  - The magnitude of the voltage and frequency applied to the needle-plane electrode were controlled by a programmable AC power source (SP300VAC600W).
  - The low voltage terminals of a single-phase high voltage transformer (VKPE-36) were connected to the AC source, while the high voltage terminals were connected to the needle-plane electrode..
  - The high voltage was measured with a high voltage probe (CT4028) connected to a computer through a data acquisition system (USB-6000 DAQ).

- The obtained results clearly show that as predicted by Peek and Paschen's laws, the CIV values obviously decrease with decreasing values of atmospheric pressure.
- They also show that the CIV value tends to decrease with increasing power frequency, although this dependence is less pronounced and in some cases within the experimental inaccuracies and variability inherent in the complex corona behaviour. The results also show that the effect of frequency decreases as the atmospheric pressure reduces.
- It should be noted that the UV-C sensor provides a frequency signal proportional to the intensity of the detected UV-C light, but it is not an imaging sensor. This means it is able to detect the corona activity and the approximate direction of the UV-C light, but not the exact location of corona. In contrast, the BI-CMOS imaging sensor can do both (the intensity of the corona activity and the exact localization of the corona source).

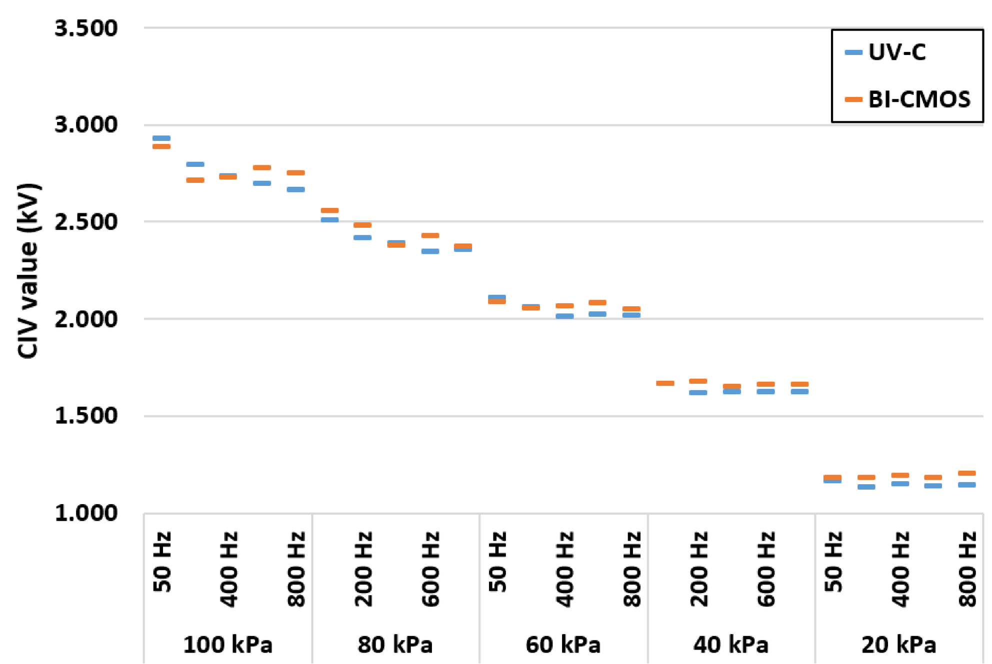


Table II. Percentage difference in the CIV values measured by both sensors for each frequency-pressure level using the needle-plane geometry.

	Air pressure					
	100 kPa	**80 kPa**	**60 kPa**	**40 kPa**	**20 kPa**	**Row average**
50 Hz	1.53%	-1.95%	1.02%	0.02%	-1.49%	**-0.17%**
200 Hz	2.95%	-2.44%	0.18%	-3.37%	-3.83%	**-1.30%**
400 Hz	0.15%	0.45%	-2.54%	-1.79%	-3.43%	**-1.43%**
600 Hz	-2.82%	-3.27%	-2.84%	-2.10%	-3.9%	**-2.99%**
800 Hz	-3.15%	-0.67%	-1.65%	-2.30%	-4.88%	**-2.53%**
Column average	**-0.27%**	**-1.58%**	**-1.17%**	**-1.91%**	**-3.51%**	

CONCLUSIONS

- This experimental study investigated the influence of pressure and frequency on visual corona detection using a solar blind UV-C sensor and a BI-CMOS imaging sensor.
- The results obtained have shown a similar sensitivity of both sensors for all the experimental conditions analysed, allowing a fast and sensitive detection and localization of incipient electrical discharges.