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Deploying vertical wires with drones to study wind turbine electrification under fair weather

Pol Fontanes Molina[1], Marcelo Arcanjo[1], Joan Montanyà Puig[1], and Carmen Guerra-Garcia[2]
[1]Universitat Politècnica de Catalunya, ESEIAAT, Electrical Engineering, Spain (pol.fontanes@upc.edu)
[2]Massachusetts Institute of Technology (MIT), Cambridge, MA, 02139, USA (guerra@mit.edu)

The response of tall structures such as towers to the electrical atmosphere is well known, but much has to be learned about how the rotation of wind turbine blades affects the electrical response of wind turbines. To better understand current induction and the appearance of point/corona discharge from wind turbine blades, a series of experiments lifting vertical wires with drones under fair weather conditions have been conducted. During the experiments, the length of the wire (vertical) and its vertical velocity were recorded using the drone's telemetry. Additionally, the wire was grounded through a pico-ammeter to measure current induction and a corona discharge detector, based on a wideband current measurement coil, was placed close to the tip of the lifting wire to detect possible point/corona discharge appearance at the wire tip.

Preliminary tests included testing the sensor in the laboratory by measuring artificially generated corona pulses, to verify that pulses from this sensor registered on the field could be attributed to point/corona discharge phenomena. Measured amplitude for this induced current was on the order of hundreds of nano-amps.

For these experiments, an insulated copper wire with 0.14Ω/m resistance and with the top tip exposed to the environment was deployed using two different tips, a rounded tip of 1mm radius and a sharp needle tip of 0.1mm radius. The electric field at the ground level was measured using an electric field mill. All flights were performed during the morning and the ground electric field amplitude ranged from 50V/m to 200V/m.

When using rounded tips, corona discharge was not detected by the coil, but an induced current proportional to the vertical speed of the wire was measured. This component of the current is interpreted as a change of potential in time, and the amplitude of these induced currents is on the order of tens of nano-amps.

Results when using the sharp tip showed two clear sources of induced currents on the wire, vertical speed (as in the rounded case) and corona discharge. When using the sharp tip, corona discharge was detected when the wire reached around 50 m and induced current amplitude increased with altitude. A pulsating current was measured by the coil sensor indicating the existence of corona discharge on the wire.

The rate of decrease of the measured currents after reaching steady positions of the wires might be attributed to the screening effect of the released charge.

These experiments proved that key factors for the current induction on wind turbine blades include the change in height at a certain speed, along with the occurrence of point/corona discharges with the radius of curvature of the blade tips. Under the effects of electrified thunderclouds, the magnitudes of the currents could reach several orders of magnitude.