Escuela Superior Politécnica del Litoral

PARES & NONES
Un break científico

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Corona Discharge Impact Suppression in Ultra High Voltage Using a Novel Mechanism with Dielectric Oil

PROBLEM IDENTIFICATION

Ultra-high voltage at transmission systems enables to reduce the electrical power losses due to the Joule effect. However, if the environment is not the proper (i.e., polluted, high humidity, high temperatures, etc.) this fact may lead to an air ionization causing a Corona discharge (see **Figure 1**). As a result, electromagnetic parameters in the transmission line may be affected causing reduction in power transfer capacity on the line, or in critical situations, it may cause interruption of the electrical service.

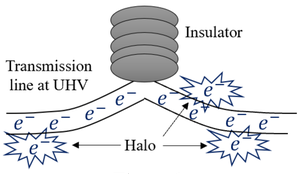

Figure 1
Corona discharge phenomenon

GENERAL OBJECTIVE

To develop a mathematical model that captures the impact of an innovative mechanism that can be attached to the transmission lines and suppress the effect due to the Corona discharge.

PROPOSED APPROACH

- A transmission line of longitude ℓ can be represented by its resistance R, inductance L, and capacitance C per unit length. If a Corona discharge takes place at some section Δx on the line, then by using two-port network theory, the system can be represented as shown in **Figure 2**.

- It is proposed an innovative mechanism (presented in **Figure 3**) that contains dielectric oil that is released when the Corona discharge takes place, producing an isolated layer that protects the line from the high electrical fields.

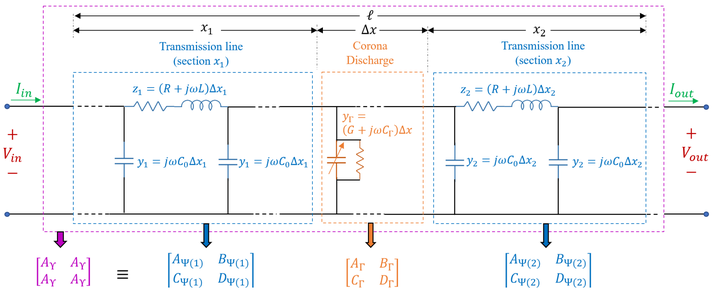

Figure 2
Two-port network representation of a transmission line with Corona discharge

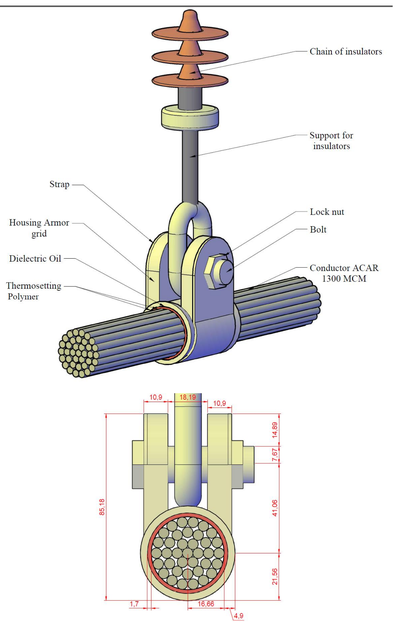

Figure 3
Innovative mechanism

RESULTS

To quantify the electromagnetic parameters A, B, C, D (i.e., **Figure 4**) of the transmission line, a finite element assessment using COMSOL Multiphysics 5.6 is conducted. Consequently, line and the Corona discharge are modelled using the Two-port network representation.

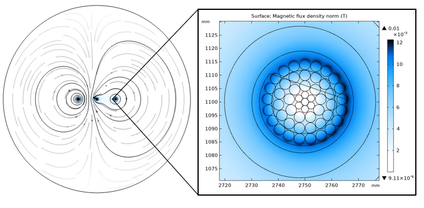

Figure 4 Magnetic flux density of the line in UHV

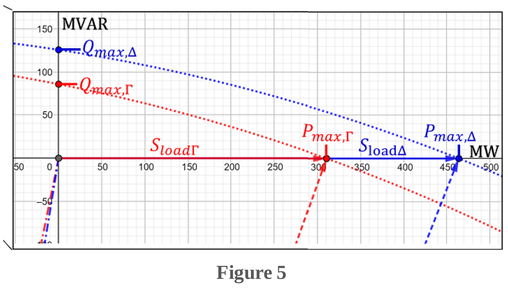

Figure 5
Transmission line transfer capacity for a load purely resistive

Figure 5 reveals that the Corona discharge limited the active power transfer capability of the line by an approximate amount of 34% compared to the scenario in which the released oil suppresses the Corona discharge. This is attributed to the impact of the Corona discharge on the transmission line that affects the A, B, C, D parameters. The influence of the Corona discharge is extended to the reactive power since the reactive power transfer capability of the line is reduced by an approximate amount of 34% in comparison with the scenario in which the Corona discharge is suppressed by the released oil.

CONCLUSIONS

- The operation principle of the mechanism is simple, it contains dielectric oil in a resin that is broken at temperatures that may propitiate the Corona effect. As a result, the dielectric oil is released and it isolates, cleans, and cools down the conductor, leading to an unfavourable environment for Corona discharge. Consequently, the transfer power capability can be restored up to 34%, resulting beneficial for the useful life of the line.

ACKNOWLEDGEMENT

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- In memory of Karina Marisabel Marín Morocho for being an invaluable inspiration and motivation in the development of this research. With all my love, rest in peace my lovely wife.