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A New Approach for Optimal Design of Corona Ring

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Polymeric insulators are largely used in electrical systems. However, these equipment still present serious problems, mainly related to their polymeric material layer. When the polymer is exposed to intense electric fields, insulation failure and loss of hydrophobicity may occur.
These problems are caused due to non-uniform electric field distribution along the insulator, which tends to intensify the electric field on the sheds near to the phase terminal. Non-uniform electric field distribution can be minimized using suitable corona rings.
Issues involving bad corona rings design were found out at 230 kV transmissions lines of a Brazilian energy company. Insulators have presented failures after only 5 years of use, such as core tracking and fiberglass mechanical rupture. The company's suspicion was that the corona ring provided by the manufacturer was ill-designed. After some study, Ferreira (2007) proposed a new corona ring design, although no optimization method was used by the author.
Therefore, in this paper several optimization methods were used to determine the optimal corona ring design. The following methods were utilized: Nelder-Mead, COBYLA and BOBYQA. In addition, a software based on the Finite Element Method was used to performer the simulations.
Results show that the optimized corona ring provides a reduction of 79.6% on the electric field when compared to the manufacturer's ring. When compared to the design proposed by Ferreira (2007), the reduction was 63.5%.
With respect to the performance of the optimization methods, the Nelder-Mead method was found as the most suitable for the problem solution, due to its smaller computational effort and great convergence speed.
The method presented in this paper, can be generalized to any insulators with different voltage levels. Moreover, the method has some advantages over other available methods, such as those presented by Sima et al. (2004) and Murawwi et al. (2013).

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