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# ABSTRACT

In recent years, the importance of HVDC (High Voltage Direct Current) lines and composite insulators has increased. The insulator surface is an area vulnerable to the occurrences of flashover. The flashover occurs when the electric field strength exceeds certain critical value (called the dielectric strength of an insulating system) in the insulator surroundings. The critical field value depends on the properties of the gas surrounding the insulator and electrode configuration (geometry). The total electric field can be generated by many sources. One of the sources can be also the charges on the surface of the insulator as well as in its bulk. For these reasons, it is necessary to investigate the phenomena that occur on the insulating elements of HVDC lines. Expanding knowledge of composite insulators and the phenomena occurring during the usage of the HVDC lines can lead to the improvement and increased efficiency of electric power distribution.

This dissertation contains a summary of research on the influence of electric charge accumulated on the insulator surface on the value of flashover voltage $U_f$ in the case of insulators working on HVDC lines. The tests were performed for DC and impulse voltages. The research for both types of voltage exposures was due to the fact that insulators working on HVDC line may be exposed to impulse flashovers (e.g. due to lightning or switching events).

In comparison to other studies conducted so far this dissertation is distinguished by:

– the length of tested insulator – the insulating part (dielectric rod) of the tested insulator was 270 mm length, while in other studies samples did not exceed 114 mm in length;

–asymmetric (uneven) distribution of charge on the perimeter (the charge was applied "on one side" only which allowed for the uneven distribution of charge). Other studies have focused mainly on cases where the charge was uniformly distributed around the perimeter;

– real fittings. In the studies described in this dissertation standard fittings were used, while in other studies mainly very wide or specially profiled electrodes were used to ensure uniform distribution of the electric field.

The dissertation has been divided into 16 chapters. The first chapter discusses the growing role of HVDC line and composite insulators. The research problem and justification of research topic are also included in the section. The second section includes a review studies published so far on the topic of the effects of electric charge on flashover voltage. The fourth chapter presents theses of dissertation. Chapter 5 describes solid bodies electrification methods. Chapter 6 presents the theory of surface potential measurement. The seventh chapter contains a description of the insulator models on which the study was conducted. The eight chapter describes the constructed and used measuring systems. Chapter 9 presents the results of simulations performed using COMSOL Multiphysics®, including the influence of selected parameters on the distribution of potential around the insulator and the influence of electric charge on the electric field distribution around the insulator. The tenth chapter presents the

results of measurements of potential decay and distribution of surface potential after corona electrification. Chapter 11 presents the results of numerical calculations of the effective surface charge density. The twelfth chapter presents the results of surface potential measurements after the impulse flashover and the charge influence on the value of the impulse flashover voltage. The next section presents the results of surface potential measurements after the DC flashover and the charge influence on the value of the DC flashover voltage. In chapter 14 the analysis of photographs of flashovers and insulators after the flashover was presented. In chapter 15 the analysis of measurement uncertainty for a few selected cases was presented. Chapter 16 contains a summary of the research and final conclusions. This dissertation also includes 18 attachments containing detailed findings and schemes of used systems.

Studies have confirmed the impact of the insulating material and revealed the role of core-housing interphase on the processes of charge storage and on potential distribution parameters. The study showed the influence of charge on the DC flashover value and no effect of charge on the impulse flashover voltage. The effect of the charge on the flashover voltage does not dependent on the insulator material. The analysis showed that a much greater role than the insulator material may be played by the geometry of fittings and insulator position in relation to grounded objects in its closest vicinity.

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