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The effect of controlling stray and disc capacitance of ceramic string insulator in the case of clean and contaminated conditions

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Abstract

Due to their flexibility against the tension force and the easiness of maintenance characteristics of overhead transmission line, one of the biggest problems when using ceramic string insulator is the non-uniform voltage distribution on each insulator disc that connected on the string. This paper analyzes the effect of controlling stray capacitance (K_{csc}), disc capacitance (K_{cdc}) and contaminated pollution (K_{ccp}). In this paper research study considerations, the Electricity Generating Authority of Thailand (EGAT) 115kV overhead transmission line power towers are simulated in EMTP/ATP drawing and the results were analyzed. As it was found that in the clean condition, when the constant (K_{csc}) was conducted and adjustment when K_{csc} value has low value (decreases), the string efficiency would be high value (increases) for instances $K_{csc}=0.01$ string efficiency=99%, $K_{csc}=0.50$ string efficiency=64%. When the constant (K_{cdc}) was adjusted; if K_{cdc} is low, the string efficiency will also be low for instances at $K_{cdc}=0.01$ string efficiency=33%, $K_{cdc}=0.50$ string efficiency=40%. Nevertheless, K_{cdc} adjustment utilizes the appropriate value gained from factory that the $k=0$, so the value will be 90% higher. As for the contaminated condition, when the constant (K_{csc}) was adjusted as shown in Fig.11, if K_{csc} value is low, the string efficiency will be high for instances $K_{csc}=0.01$ string efficiency=99%, $K_{csc}=0.05$ string efficiency=65%. When the constant (K_{cdc}) was adjusted; if K_{cdc} is low, the string efficiency will also be low for instances at $K_{cdc}=0.01$ string efficiency=17%, $K_{cdc}=0.50$ string efficiency=40%. Considering on K_{ccp} , for example $K_{ccp}=0.01$ string efficiency=82% $K_{ccp}=0.50$ string efficiency=55%.

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Keywords: Contamination, Efficiency of string, Overhead lines, Pollution, String Insulator

1. Introduction

The Equivalence of Insulator String Circuit Parameter

As for the experimental investigation behavior of insulator, if it is not contaminated and clean, there is none practical leaking and the electrical insulating material acts looks like a capacitance.

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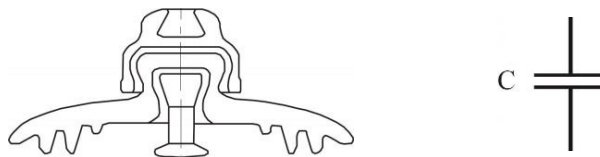


Fig. 1. Simplified illustration of clean insulator circuit³

Due to the analysis program, variation in the stray capacitance (K_{csc}) and disc capacitance (K_{cdc}) condition have been conducted. And primitive circuit parameters will be investigated. Calculation of the self-capacitance of each insulator, stray capacitances between cap and energized conductor, caps and ground, as well as each insulator cap and the other caps. The insulator string have been drawn utilizing EMTP for the analysis. The real transmission line consists of tower, insulator string and conductor. The primitive circuits have been illustrated where C_s is stray capacitance and C is disc capacitance.^{4,5,6}

2. The Research Procedures

Simulation procedures of seven disc suspension ceramic porcelain insulator (clean condition). In this case uses the data of three phases 115kV overhead transmission line system, the type of cemented cap insulator with disc diameter of 10 inches.^{4,5,6}

The primitive circuit of seven disc suspension ceramic insulator (clean condition) has been drawn as shown in Fig. 2. Normally, capacitance between steel cap, pin and disc ceramic porcelain insulator value is 10 to 40μF. Stray capacitance generally varies with the space and diameter of steel cap/pin of the insulator string and steel tower structure. The capacitance value can be measured by accuracy capacitance bridge. The stray capacitance value is 1-8μF.

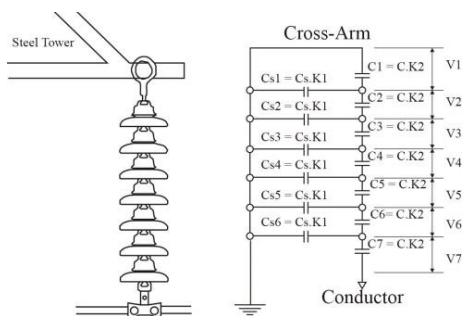


Fig. 2. Simplified primitive circuit of seven disc suspension ceramic insulator in clean condition

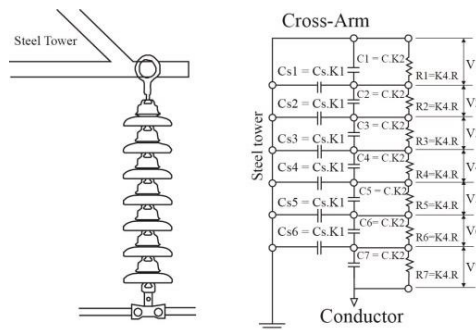


Fig. 3. Simplified primitive circuit of seven disc suspension ceramic insulator in contaminated condition

In case of seven disc suspension ceramic porcelain insulator (clean condition)/(contamination)

1) Using the value of cap, disc ceramic porcelain insulator and pin capacitor is $C_1 = C_2 = \dots = C_7 = 30\text{pF}$. /Using contaminated pollution resistance value is 4,400MΩ.

2) Using the value of the stray capacitance between steel cap/pin and steel tower (C_s) is 3pF. / Using the value of cap, disc ceramic porcelain insulator and pin capacitor is $C_1 = C_2 = \dots = C_7 = 30\text{pF}$. Using the stray capacitance value between steel cap/pin and steel tower (C_s) is 3pF.

3) Try to control stray capacitance by increasing the stray capacitance factor K_{csc} form 0.01, 0.03, 0.05, 0.07, 0.10, 0.20, 0.25, 0.30, 0.40, and 0.50 by using $K_{csc} = C_{s1}/C_s$ (clean condition)

Try to control stray capacitance by increasing the stray capacitance factor K_{csc} form 0.01, 0.03, 0.05, 0.07, 0.10, 0.20, 0.25, 0.30, 0.40, and 0.50 by using $K_{csc} = C_{s1}/C_s$ (contamination)

4) Run EMTP/ATP, collect data and plot graph. Same methodology for both clean & contamination.

5) After that using the value of cap, disc ceramic porcelain insulator and pin capacitor is $C_1 = C_2 = \dots = C_7 = 30\text{pF}$. Same methodology for both clean & contamination.

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