Consideration of the unfaulted segment of HVDC line with cable and overhead parts during line fault location using spectrum algorithm

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The relevance of the discussing issue is caused by the need of accurate determination of the fault location in the HVDC transmission lines.

The main aim of this work was to develop an algorithm for accurate determination of the fault distance in the HVDC line, consisting of the both cable and overhead segments based on the spectrum method. Line voltage fluctuations, caused by the line discharge during short-circuit transient process with transient resistance and accompanied by a sharp voltage decrease can be simulated as an oscillation process in the short-circuit scheme composed of the lumped parameters of the short-circuit segment of the dc line. These parameters are depended on the main frequency f_0 with the highest amplitude, determined in the frequency spectrum of the transient line voltage. This main frequency f_0 is connected with the location of the short-circuit point and determines the value of the short-circuit segment parameters.

In this paper the formula of the unknown fault distance determination relying on the transient frequency, HVDC line parameters and the length of HVDC line faulted segment is determined. In this formula an unfaulted segment in the equivalent circuit of the HVDC system is considered.

The Line fault location (LFL) spectrum method solving the issue of fault distance determination in the HVDC line containing cable and overhead segments was proposed. This method considers the HVDC line containing also terminal devices of the line - smoothing reactors and high harmonic filters. These devices are used to provide low level interference in nearby communication lines and other communications that are sensitive to induced interference. In considered case of the dc line smoothing reactor is installed in the middle point of the double-frequency filter.

The equivalent circuit of the HVDC line unfaulted segment – equivalent line lumped model - was proposed. The formula to determine LFL distance in dependence of the main frequency in the transient voltage spectrum, line parameters and equivalent circuit parameters was obtained. The experiments of the dc line model, consisting the both overhead and cable segments, proved the relevance of proposed unfaulted segment equivalent scheme and expression for the fault distance were carried out.

Index Terms— Electrical power transmission line, HVDC transmission line, line fault location, short circuit, spectrum method, transient resistance, travelling wave method.