Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 141 (2017) 460–464

Energy Procedia

www.elsevier.com/locate/procedia

4th International Conference on Power and Energy Systems Engineering, CPESE 2017, 25-29 September 2017, Berlin, Germany

A Wide-Range Model for Surge Arresters: Verification Analysis

Sadra Mousavi*, Behnam Feizifar, Emel Onal

Department of Electrical Engineering, Istanbul Technical University, Istanbul, Turkey

Abstract

This paper verifies and analyzes the proposed wide range (WR) model for surge arresters. The verification analysis of various surge arrester models is performed; 1) on the model itself independent of power systems, and 2) by considering that surge arrester models are connected to a simple power transmission system. In order to accurately verify the performance of the WR model, some of the well-known surge arrester models are utilized. Simulation results reveal the advantages of the new model compared to traditional models already available in the literature.

Keywords: EMTP-RV simulation; power transmission system; surge arrester; wide range model;

1. Introduction

Surge arrester is a protective equipment used for reducing over voltages caused by lightning and switching surges on equipment by diverting the content of surge current and restoring the equipment to its original condition. It is also able to repeat these tasks whenever required [1]. As is known, there are various types of surge arresters in the market based on various technologies and operating mechanisms. Among them, the metal-oxide surge arrester (MOSA) is so popular. It operates based on non-linear resistances built from metal oxide materials. Over the years, several models have been proposed to represent the electrical characteristics of surge arresters. These models generally include one or two non-linear resistors along with lumped elements such as resistances, inductances and capacitances. The oldest model which is based on two non-linear resistances has been proposed by the IEEE Working Group 3.4.11 [2].

* Corresponding author. Tel.: 90-5533247345
E-mail address: sadramousavi@itu.edu.tr

10.1016/j.egypro.2017.11.059

The IEEE surge arrester model is especially useful for surge currents with rising times between 0.5 μs and 45 μs. Another model has been proposed by Pinceti et al. which simplifies the parameters identification criteria of the IEEE recommended model [3]. A straightforward method has been proposed by Fernandez et al. in which the parameters of the IEEE model can be calculated from the manufacturer data related to surge arrester [4]. Recently, an electric model of MOSA has been proposed which covers a wide range of frequencies and amplitudes in various current regions. The simulation results have been validated through laboratory measurements [5]. A brief review of this wide range (WR) model along with its mathematical calculations will be presented in section 2. A comparison between various models will be presented and discussed in section 3. In section 4, the performance of each MOSA model will be analyzed within a test power transmission network in the electro-magnetic transient program-restructured version (EMTP-RV). Finally, the paper will be concluded in section 5.

2. Wide-range (WR) MOSA model

The WR model is newly proposed for a wide range of frequencies and amplitudes. In order to reach this goal, twelve ZnO varistors with different characteristics from five different manufacturers have been tested [5]. The topology of this model is shown in Fig. 1.

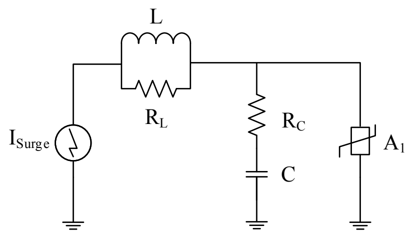

Fig. 1. Topology of the WR model.

In this model, calculations of the parameters are considerably easier than the other available models. The following equations are used to determine the values of these parameters,

$$L = \frac{h}{n} \quad (\mu H) \tag{1}$$

$$R_L = \frac{8 \times L}{\Delta t} \quad (\Omega) \tag{2}$$

where, h is the overall height of MOSA in meters; n is the number of ZnO parallel columns; and Δt is the time step of simulation.

In the next step, according to tables which are demonstrated in [5], a proper value of the parameter C will be chosen. Therefore, utilizing the below formula, the value of R_C can be easily obtained.

$$R_C = \frac{0.15 \times \Delta t}{2C} \quad (\Omega) \tag{3}$$

3. Comparative analysis of different models

By applying different types of surges to the available surge arrester models and considering residual voltages which are given by the manufacturer, the accuracy of each model is evaluated and also the comparisons are provided. Table.1 represents residual voltages of the MEH443-390 arrester for a 420 kV transmission system which is manufactured by TE connectivity Ltd [6].