

Time Domain Reflectometry of a Water Tree Inside an Underground Cable

K. Burkes¹

¹Savannah River National Laboratory, Jackson, SC, USA

Abstract

Time domain reflectometry is widely used to detect defects throughout underground cables. It can be used to determine the specific location of the defect due to the wave reflection produced [1]. One such common defect contained inside underground cables is a water tree. These water trees can grow across the insulation and not cause the cable to faults [2]. Also, they do not produce partial discharge [3], a common cable diagnostic tool. Therefore, to better understand the reflections produced during time domain reflectometry from water trees, the COMSOL Multiphysics® software was used to simulate this occurrence using the RF Module. The electromagnetic wave, transient study is used to propagate high frequency pulses through an underground cable containing a water tree. The permittivity and conductance of the material of the water tree was developed in [4]. The water tree produces a reflection when the high frequency pulse reaches its location in the cable as shown in Figure 1 and 2 and a portion of the pulse continues down the cable. The results are compared with research in [5]. These results can be used to help understand how water trees' size and shape help determine the magnitude and frequency of the reflection waveform produced. These results can better help understand field measurements of time domain reflectometry.

Reference

- [1] V. Dubickas, "On-Line time domain reflectometry diagnostic of medium voltage XLPE power cables," Licentiate thesis, Royal Institute of Technology, Stockholm, Sweden, 2006.
- [2] W. A. Thue, Ed., "Treeing," in *Electric Power Cable Engineering*, 3rd ed. Boca Raton, FL, USA: Taylor & Francis, 2012, pp. 367–384.
- [3] J. Densley, "Ageing mechanisms and diagnostics for power cables— An overview," *IEEE Elect. Insul. Mag.*, vol. 17, no. 1, pp. 14–22, Jan./Feb. 2001.
- [4] K. Burkes, E. Makram, and R. Hadidi, "Modeling the effect of a water tree inside tape shield and concentric neutral cables," in *Proc. COMSOL Conf.*, Oct. 2014.
- [5] K. Burkes, E. Makram, and R. Hadidi, "Water Tree Detection in Underground Cables Using Time Domain Reflectometry" in *IEEE Power and Energy Technology Systems Journal*, vol. 2, no. 2, pp.53-62, June 2015.

Figures used in the abstract

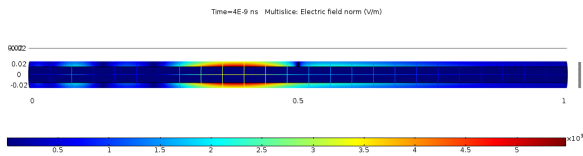


Figure 1: High frequency electric field pulse traveling toward water tree at the center of the cable.

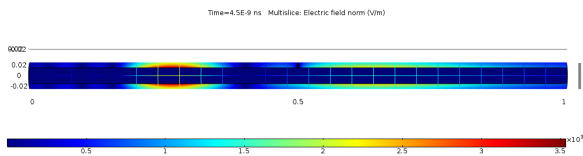


Figure 2: Reflection produced by water tree at the center of the cable with portion continuing down the cable.