Time Domain Reflectometry of a Water Tree Inside an Underground Cable

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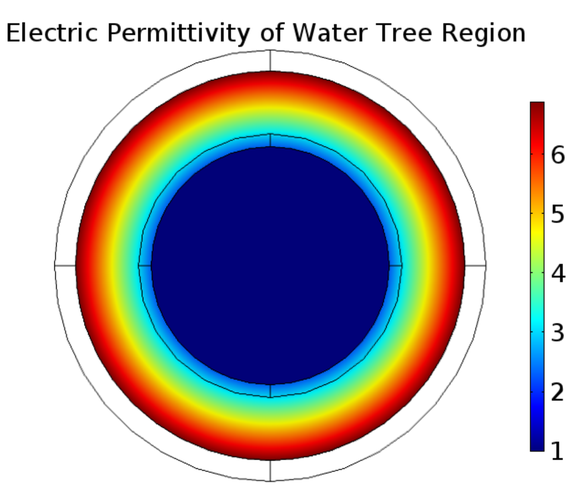
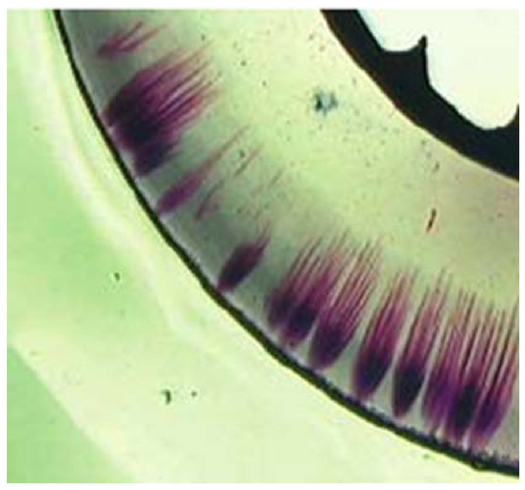
Introduction: Time domain reflectometry is used to detect the location of defects in underground cables. A common defect inside underground cables is a water tree; which can grow across the insulation without causing a fault. Therefore, to better understand the reflections produced during time domain reflectometry from water trees COMSOL was used to simulate this occurrence using the RF Module.

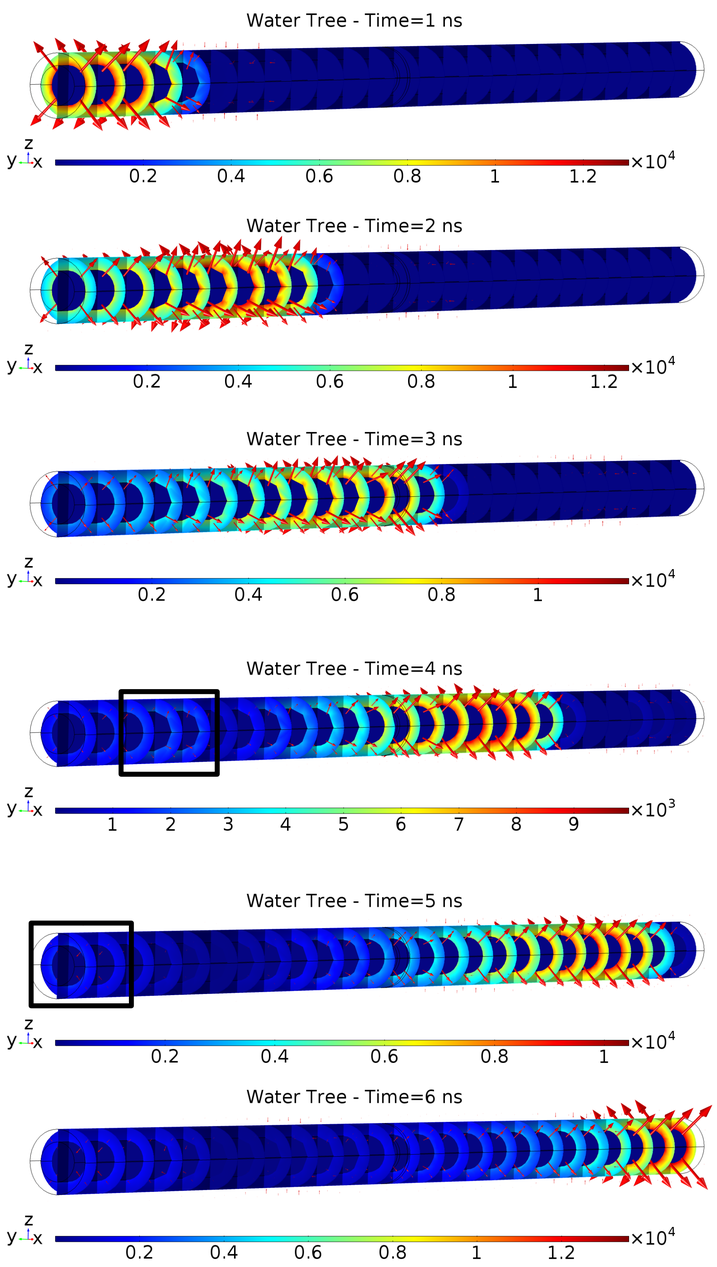


Electric Permittivity of Water Tree



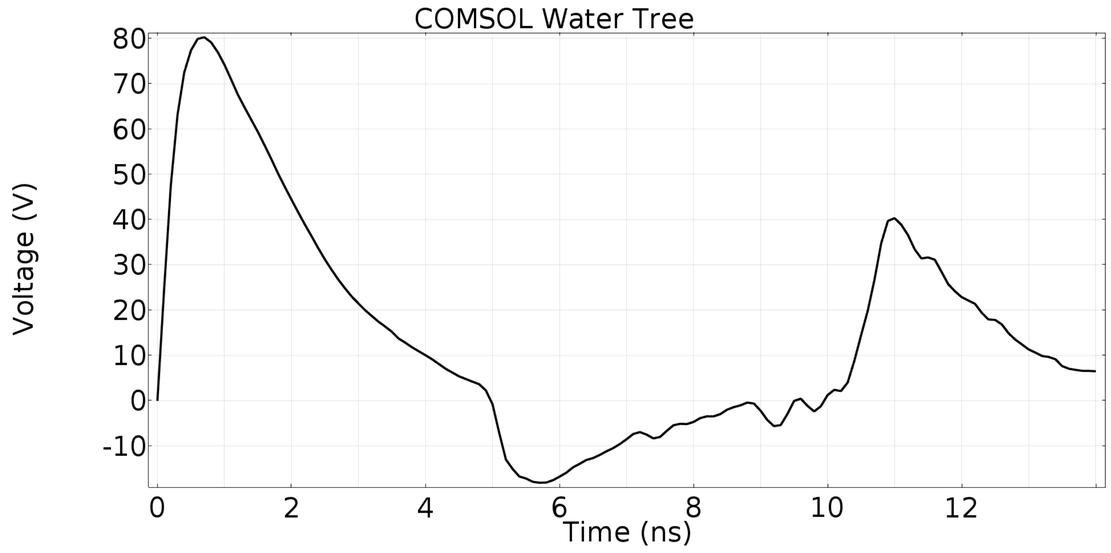
Water Trees in Underground Cable

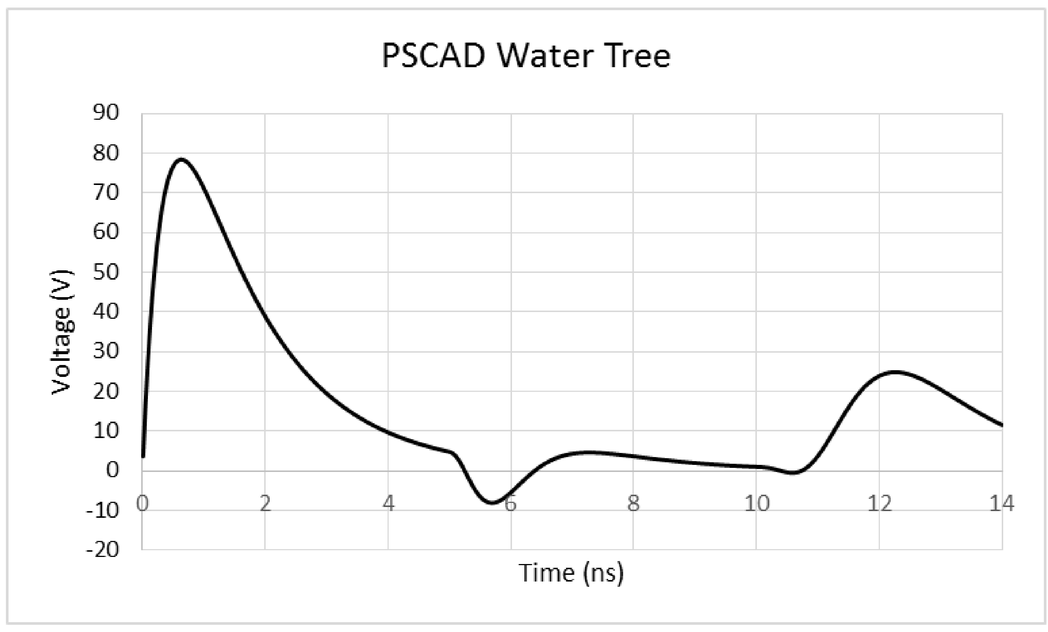
Results: The progression of the pulse through the cable is shown below, and the electric field is represented by both the arrow and surface plots. The return pulse from the water tree can be seen at 4 & 5 ns and the effect from the water tree on the electric field vectors can be seen at 3 ns.

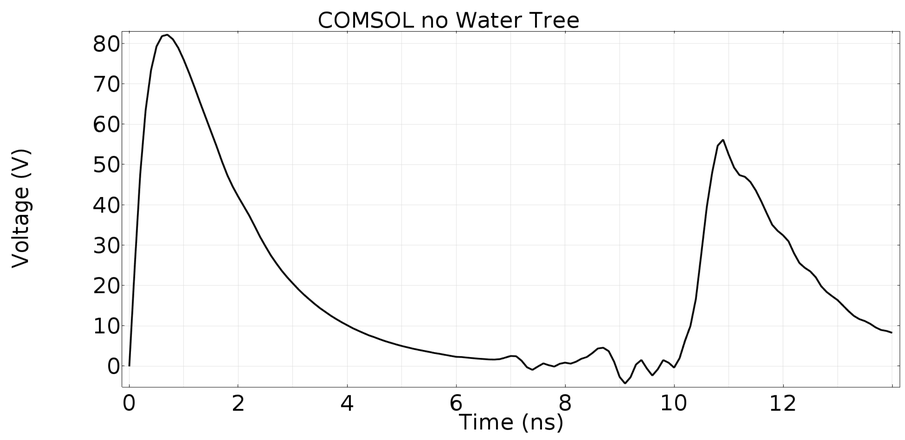


Electric field pulse traveling though cable

Computational Methods: The electromagnetic wave, transient study is used to propagate a high frequency voltage pulse through an underground cable containing a water tree. The permittivity and conductance of the water tree was developed in previous research.







Conclusions: The COMSOL and PSCAD simulations represented the same negative voltage reflection from the water tree with a similar magnitude and pulse width. This validates that the traditional model for a water tree is accurate for simulation. This research will help further future research by allowing for development of future equipment to better detect and monitor the growth of water trees in underground cables.