

利用 TM 波频谱特性实现 XLPE 同轴电缆绝缘在线监测的模拟研究

摘 要

随着经济和社会的发展,生产和生活中对电能的需求不断增加,电力电缆越来越多地用于电网建设。但是,XLPE 电力同轴电缆由于设计及制造工艺的不良,以及随着铺设时间的延长会受到各种因素的不利影响,诸如长期过负荷运行、机械损伤、电化学腐蚀、绝缘皮老化等,如果不及时注意电力电缆的绝缘状况,对存在绝缘问题的电缆进行及时的更换,非常容易造成绝缘击穿,从而引起严重的安全事故,甚至电网的崩溃。为防止电缆事故的发生,在线监测技术势在必行,在线监测技术也将成为未来电缆监测的主流发展方向。在线监测技术可以减少大量的人力资源,可以保证在连续供电的情况下连续生产,也可以避免离线耐压试验造成的附带损害。尽管现在有很多方法可以对 XLPE 电力电缆绝缘性能实现监测,但是都存在一定的缺陷或者不足之处。作为电磁波的一种,横波(TM 波)就是指在传播方向上仅具有电场分量而没有磁场分量。可应用于 XLPE 同轴电缆,观察电场分布,判断 XLPE 同轴电缆的绝缘性能。通过 COMSOL 软件的模拟与仿真,可以发现利用 TM 波频谱特性实现 XLPE 同轴电缆绝缘在线监测的方法具有很强的可行性。

关键词: XLPE 同轴电缆, TM 波, 在线监测, COMSOL 软件

ABSTRACT

With the development of economy and society, the demand for electric energy in production and life is increasing, and power cables are more and more used in the construction of power grid. However, XLPE power cable will be adversely affected by various factors, such as mechanical damage, electrochemical corrosion, long-term overload operation, due to poor design and manufacturing process, and with the extension of laying time. If we do not pay attention to the insulation condition of power cable in time, it is easy to cause insulation breakdown and cause serious safety accidents. In order to prevent cable accidents, on-line monitoring technology is imperative, and on-line monitoring technology will become the mainstream development direction of cable monitoring in the future. On-line monitoring technology can reduce a large number of human resources, ensure the continuation of production without power failure, and avoid the collateral damage caused by off-line withstand voltage test to the cable. Although there are many ways to monitor the insulation performance of XLPE power cable, there are some defects or inadequacies. As a kind of electromagnetic wave, TM wave has only electric field component but no magnetic field component in the direction of propagation, which is called transverse magnetic wave. It can be used to XLPE coaxial cable. The insulation performance of XLPE coaxial cable can be judged by observing the electric field distribution. Through the simulation and analysis of COMSOL software, it can be found that it is feasible to realize on-line monitoring of XLPE coaxial cable insulation by using TM spectrum characteristics.

Keywords: XLPE coaxial cable, TM wave, on-line monitoring, COMSOL software

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