C.8.3.2.

Actual application of on-site diagnostic method for water treed XLPE cable by harmonics in AC loss current

Tanaka Atsushi, Tsujimoto Tomiyuki, Nakade Masahiko
Tokyo Electric Power Company, 1-1-3, Uchisaiwai-cho, Chiyoda-ku, Tokyo, Japan
Yagi Yukihiro, Adachi Kiyomi
The Furukawa Electric Co.,Ltd., 6, Yawata-kaigandori, Ichihara, Chiba, Japan
Tanaka Hideo
VISCAS Corporation, 4-13-14, Higashi-shinagawa, Shinagawa-ku, Tokyo, Japan

Water tree is one of the degradation aspects of XLPE cables used for under-ground distribution or transmission lines. Water trees are generated from voids or impurities in the insulation, or protrusions of the semi-conductive layer of XLPE cables. The growth of them lowers the performance of the insulation of XLPE cables, and that causes accidents of power operation by insulation breakdown at last. Therefore, there are many needs for diagnostic techniques to detect the water tree degradation. Some diagnostic methods have been developed, but the sensitivity of them is not sufficient for 22 kV/66 kV class XLPE cables. The reason is that the conventional methods are based on detecting signals from water trees bridged over insulation layer. In case of 22 kV/66 kV class cables, even unbridged water trees will be harmful because of their higher operating stress, so that there are demands on highly reliable new diagnostic methods for such class cables.

Water trees in XLPE insulation generate harmonics in the AC loss current. They are caused by the non-linear voltage – current characteristics of water trees and appear even in case of the unbridged water tree. We have carried out many experiments in the laboratory, and confirmed that the harmonics in AC loss current are closely correlated to water tree growth, breakdown strength, and the other aspects of degradation.

We made the on-site diagnostic system based on those results. The system consists of a signal generator which can generate a sinusoidal wave at any frequency or a composition wave of two frequencies, a power amplifier to amplify the power of output of the signal generator, a testing transformer, a riactor to reduce the reactive power, a standard capacitor and a current transformer to obtain the current through the cable insulation. The maximam output voltage of the system is composition voltage of 20 kV at 50Hz and 6 kV at 100 Hz. The acceptable load capacity is up to 1 F which is equal to the capacity of about from 3 to 4 km of 66 kV class XLPE cables. The system is less than 4,000 kg weight and can be carried by car in the condition that the equipment is complete. For measuring on-site cables, it is need to separate the measured cable from the power network, but it is not need to remove any earth lines which connect between the cable shield and the earth.

Many actual 66 kV XLPE cable lines have been measured by that system. After on-site measurement, some cables were removed and the performance of them was investigated in detail in the laboratory. As the result, we have established the suitable logic to diagnose the degradation of XLPE cables.