

Diagnosis and Lifetime Evaluation of Power Apparatus



Background

We carry on research on various advanced diagnosis technique and lifetime evaluation methods based on electrical and thermal degradation for power equipments such as transformers, gas-insulated switchgear, hydro-power generator, and XLPE cables (cross linked polyethylene insulated power cable) to reduce the maintenance cost of those equipment.

Principal results

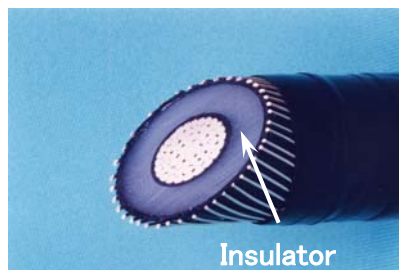
- (1) We verified the deterioration mechanism of aged XLPE cables, and evaluated the remaining lifetime of XLPE cables.
- (2) We proposed the easy-installing on-line partial discharge monitoring system for the stator windings to establish the deterioration diagnosis technique of hydro-power generators.
- (3) We proposed an estimation method of lifetime of a distribution transformer based on the thermal deterioration of insulating paper due to the load current of the transformer.

Future Developments

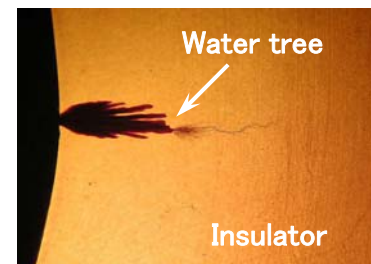
Our future plan is the development of more accurate advanced degradation diagnosis and remaining lifetime evaluation technique for power apparatus and XLPE cables.



Pre-breakdown phenomena detection system for XPLE power cable

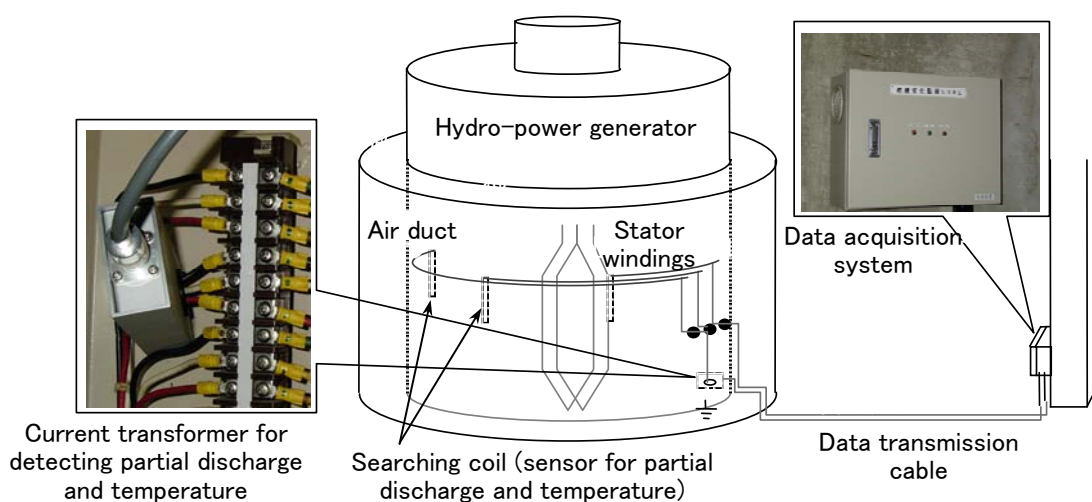


Cross section of XPLE cable (20kV-class)



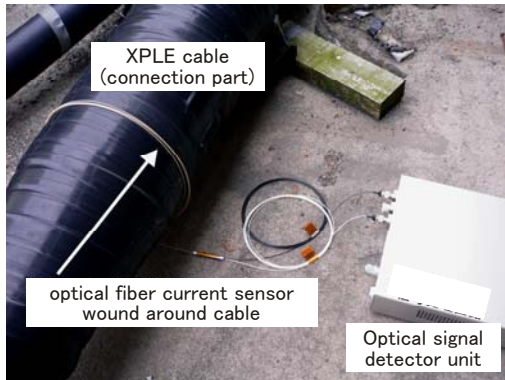
Example of "water tree"

We re-verified that the predominant degradation process of aged XPLE cables is attributed to the "water tree" and its extension in insulators.



Online partial discharge monitoring system for hydro-power generator stator windings

XLPE cable

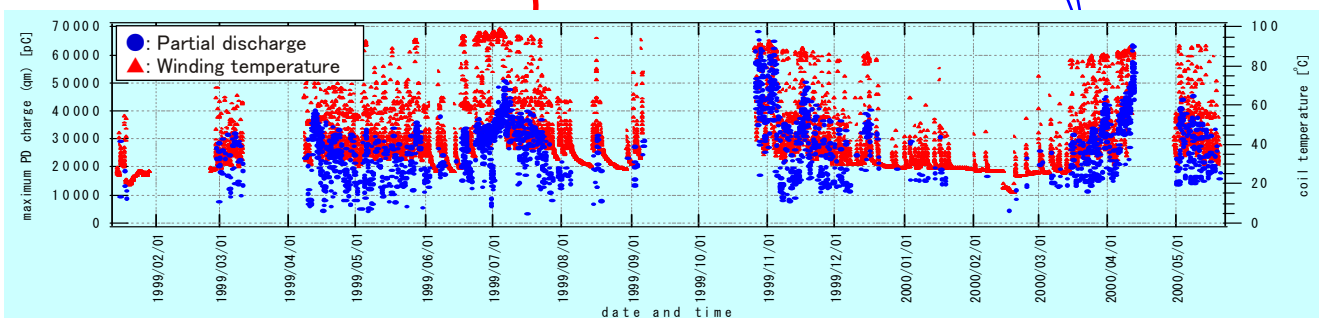
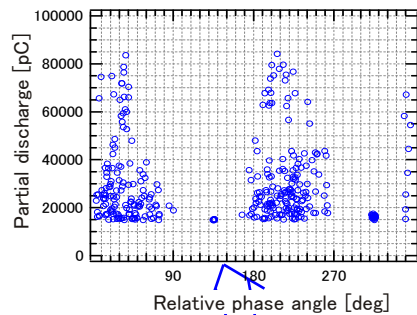


Water-tree deterioration in XLPE cable may cause the third harmonic current which flows on the conductor superimposed over the load current of power frequency. Based on this principle, we proposed an optical fiber current sensor wound around the cable. This sensor can be applied to online diagnosis system for XLPE deterioration.

Deterioration signal sensing system for XLPE cable using optical fiber current sensor

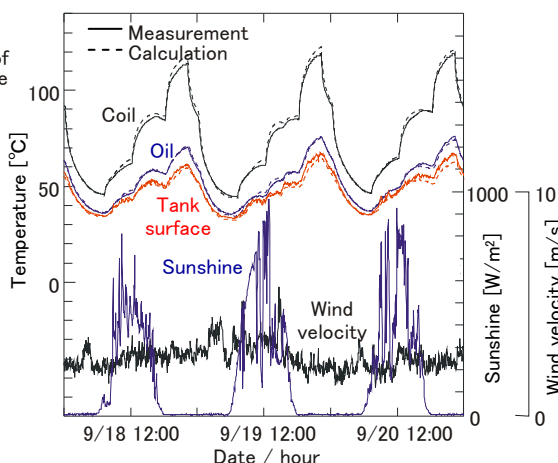
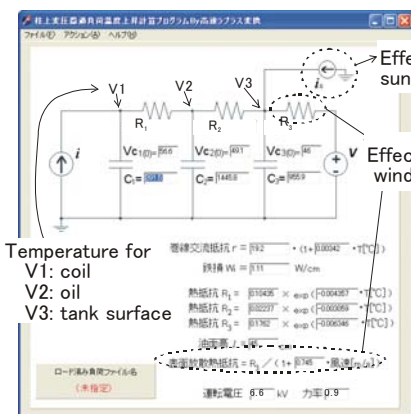
Hydro-power generator

We proposed a diagnostic method based on the continuous measurement of partial discharge and temperature for hydro-power generator to evaluate deterioration of the stator windings.



Example of on-site partial discharge and temperature records during 1.5 year for hydro-power generator

Distribution Transformer



Using this method, it is possible to estimate the lifetime of distribution transformer taking the overloaded condition into account.

Transient temperature rise calculation program for distribution transformers

Comparison between calculated and measured daily temperature change