Pre-qualification of HVDC 525 kV Extruded Submarine and Land Cable Systems

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ABSTRACT

In this paper, the pre-qualification test on the HVDC 525 kV extruded cable systems for land and submarine transmission lines with more than 2 GW capacity are reported. This paper also introduces the design of HVDC cables and accessories that were implemented for the pre-qualification test.

KEYWORDS

HVDC, PQ Test, Extruded, Submarine Cable System, Land Cable System, Space Charge

INTRODUCTION

With the increasing demands for the long distance transmission that connects between countries and continents, the market for the HVDC cable systems are continuously growing. In this paper, the pre-qualification test on the HVDC 525 kV extruded cable systems for land and submarine transmission lines with more than 2 GW capacity are reported. This paper also introduces the design of HVDC cables and accessories that were implemented for the pre-qualification test.

The pre-qualification test layout was specially designed in such a way that two separate loops were formed for submarine and land cable systems. The submarine cable systems consisted of submarine cable, offshore field rigid repair joint, flexible factory joint and outdoor end terminations, while the land cable systems included directly buried underground cables in soil and in a duct, directly buried land joint, and outdoor end terminations. Both submarine and land cable systems underwent the mechanical pre-conditioning prior to the electrical tests. The pre-conditioning for submarine cable included coiling test, tensile bending test and straight tensile test, whereas bending test was performed for the land cable system. After the mechanical pre-conditioning, the cable systems were put into the electrical tests. During the electrical tests, the temperatures of the various locations on the cable systems were monitored using real time DTS. In conclusion, all the tests required for the pre-qualification based on CIGRE recommendation TB 496 were successfully completed[1].

DEVELOPMENT OF CABLE AND JOINT

In the early stage of development, we have completed the designs of cable and joints, and the development testing of ±525 kV cable system for VSC types has completed. The long-term demonstration test was conducted for ±525 kV XLPE cable and joints to verify their practical performance. The PQ test items proposed in the CIGRE TB 496 were applied for the long-term demonstration test, and DC test voltage was set to ±850 kV (1.62U_0) higher than the existing test voltage (1.45U_0=762 kV) in order to shorten the development period[2].

Specific environmental and installation conditions led to design a copper conductor size of 2500 mm^2, conducted from annealed profiled copper and filled with water blocking compound to limit water propagation in case of cable severance. Figure 1 shows the construction of HVDC submarine power cable.

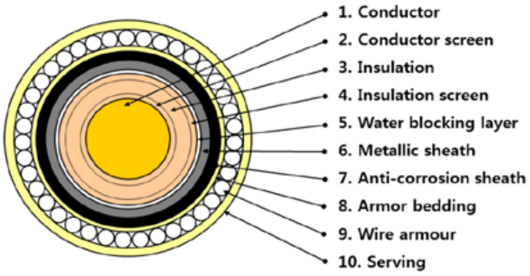

Fig. 1: Construction of HVDC Submarine Power Cable

Factory joint is a tape moulded type that has advantage of controlling the cable diameter and the same structure. Figure 2 shows design of factory joint. The conductor in the XLPE factory joint is welded and abraded to flush the cable conductor. The insulation system is made up of cross bonded PE (XLPE). Conductor, insulation and insulation screens are cured each curing processes. Over the insulation system a lead tube is swaged down on the insulation system and soldered to the lead sheath of the cable. The lead plumbs are reinforcement before a heath shrink sleeve is applied over the joint area.

Fig. 2: Design of Factory Joint

Repair joint is a pre-molded type that has advantage of jointing convenience. Figure 3 shows design of repair joint. The conductor joint on the repair joins is made with compression ferrules. Pre-molded joint body is used to form the electrical insulation system.

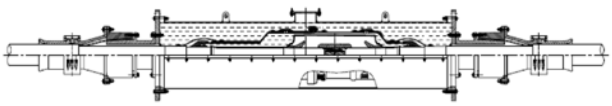

Fig. 3: Design of Repair Joint

A stainless steel joint box is used for mechanical protection of the joints and as an axial tension member during installation. Stainless steel is chosen in order to prevent corrosion problems. The armor wires are connected to each other with the brass joint lug to ensure continuity of the wires. Bend Restrictors are used on the ends of the joint