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Development of 500 kV DC XLPE cable system and its pre-qualification test

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This paper describes about the development work of XLPE cable system for HVDC link and their Pre-Qualification test results.

The DC transmission using cable system has been applied for long distance transmission line. Up to now, OF cable and MI cable have been mainly applied to the DC cable transmission. These situations are different from that of AC transmission.

In the AC transmission using underground cable, XLPE cable using polymeric insulating material has been widely used. The reason is why XLPE cable is excellent to the environment and is easy for maintenance because it doesn't use oil for insulation.

In addition to the above-mentioned characteristics, XLPE cable has the advantage of transmission distance compared with OF cable which needs oil- feeding, and has the advantage of transmission capacity compared with MI cable which is difficult to operate under high conductor temperature. Furthermore, if considering only a cable part, DC transmission is expected to become low loss and a compact system. Therefore, it is necessary to develop XLPE cable which can be applied to the HVDC transmission.

It is an important problem for DC XLPE cable that the space charge is accumulated in insulation under DC voltage. In case space charge is accumulated, electric field in some parts of insulation is enhanced and the electrical breakdown strength becomes low. Accordingly, we have developed the insulating material, which has few space charge accumulations, using for DC XLPE cables. The space charge in cable insulation can be measured by pulsed electro-acoustic method. By using this method, it was found that the distortion of electric field in DC XLPE cables was small, because of few space charge accumulations. Moreover, the accumulated space charge was constant under continuous DC voltage application in the long term.

From above, it was found that the developed insulating material has good electrical properties for DC cables.

As for DC 500 kV XLPE cable, the new insulation design method, which the distortion of electric field caused by space charge accumulation under DC voltage was considered, was applied. And DC 500 kV XLPE cables were manufactured and subjected to some electrical tests and mechanical tests. As the results, it was found that the developed DC XLPE cable was satisfied with required insulating properties.

In addition, the intermediate joint is needed for long length use. Then factory joint by using extruded molded construction method was developed. The factory joints also were subjected to some tests and it was confirmed that their properties were satisfied with requirements for DC 500 kV XLPE cable system.

At last, the pre-qualification tests were performed on the developed DC 500 kV XLPE cable system. The conditions of PQ tests include the recommendation of CIGRE WG21-01.

The test term was about 1 year and no breakdown occurred through test term. The remaining properties tests also passed.

From these results, the developed DC XLPE cable system was satisfied with required properties for application to HVDC transmission line.