

Research and Application of XLPE Insulated AC and DC Submarine Cables in China

Hongliang ZHANG, Zhiyu YAN, Ming HU, Xinliang LU, Yan YAN, Zhe SUN, Hongmiao YU; Jiangsu Zhongtian Technology Co., Ltd. (ZTT), (China), zhanghongliang@chinaztt.com, yanzy@chinaztt.com, hlm@chinaztt.com

ABSTRACT

In view of the application of XLPE submarine cable in China, the difference between the manufacturing cost of three-core submarine cable and single-core submarine cable was firstly analyzed. The first three-core 110 kV and three-core 220 kV high-voltage submarine cable were developed in China. At the time, the equipment and process research work was carried out, and the corresponding actual project application situation was introduced. Subsequently, three high-voltage flexible DC transmission projects have been completed in China since 2013, respectively, using ± 160 kV DC submarine cable, ± 200 kV DC submarine cable and ± 320 kV DC cable, detailing the performance of the above products and Test and operation. Finally, combined with the needs of large-capacity and offshore transmission, the development and test of China's first 500 kV AC submarine cable and ± 525 kV DC cable were introduced.

KEYWORDS

XLPE Insulated; Submarine Cable; HVDC; HVAC

INTRODUCTION

With the development of basic materials, processing technology and overall system technology, XLPE insulated submarine cables have been widely used in the global energy Internet backbone network, marine new energy development and island grid interconnection construction, and have become the development of marine resources. Key technologies and product support. In recent years, China has also achieved remarkable results in the development and application of XLPE insulated submarine cables^[1-3]. With Zhongtian Technology as the representative, it has accumulated rich application experience in three-core 110 kV and 220 kV high-voltage AC submarine cables, and is in high-voltage flexible DC. Cable applications have achieved world-renowned results. Since 2016, Zhongtian Technology has made significant progress in developing 500 kV ultra-high voltage AC and DC submarine cables^[4]. This paper focuses on the research and development, testing and engineering application of the above typical products, and provides reference for similar product development and engineering applications in the future.

THREE-CORE HIGH-VOLTAGE AC SUBMARINE CABLE HAS BEEN THE FIRST CHOICE FOR OFFSHORE WIND POWER CONSTRUCTION IN CHINA

In 2008, China's first offshore wind power project "Donghai Bridge 100 MW Offshore Wind Farm" was applied for the first time in 35 kV three-core submarine cable. The 35 kV XLPE insulated submarine cable is selected to meet the needs of the fan interconnection and

access to the high voltage power grid. The 35 kV submarine cable integrates the fan power and transmits it to the onshore 110 kV booster station. The submarine cable structure contains power cable and communication optical cable, and realizes power transmission and communication temperature measurement.

With the development of China's marine wind power to large-capacity units and long-distance wind farms, medium-voltage transmission methods have been unable to meet the requirements of large-capacity power integration and post-land booster stations. Therefore, domestic high-voltage submarine cables have ushered in a good opportunity for development and application.

Economic comparison analysis of XLPE insulated AC three-core high-voltage submarine cable and single-core high-voltage submarine cable

Compared with XLPE insulated AC single-core high-voltage submarine cable, the manufacture of three-core high-voltage submarine cable is more difficult, but in the case of roughly the same transmission capacity, the three-core submarine cable has obvious economics in manufacturing cost and overall project investment. Advantages, taking a copper conductor 220 kV submarine cable with a cross section of 500mm² as an example. Table 1 lists the cost comparison of the main materials in the three-core fiber composite submarine cable and the three single-core fiber composite submarine cable products in the same cross section^[5].

The data in Table 1 is calculated by referring to the relevant provisions in GB/T 32346.2-2015. It can be seen from Table 1 that when the main material consumption of the 220 kV XLPE insulated three-core submarine cable is 1, the cable manufacturing cost is significantly increased if the single-core submarine cable is used to form the same circuit. Especially for the armor layer consumption, in order to avoid the excessive loss of the armor layer, the non-magnetic metal should be selected as the armor layer during the design. The results in Table 1 are based on the single-core cable using copper wire armor, and three The core cable is calculated using galvanized steel wire armor, so the cost difference is huge. In addition, the use of single-core AC submarine cable will also increase the investment in transportation, laying and maintenance of the project.

Tab. 1 Comparison on materials consumption of 220 kV 500 mm² HVAC submarine cable for three-core and one-core

Material type	Unit	three-core	single-core
Copper	kg/m	1	1