

Design and Manufacturing of $\pm 200\text{kV}$ HVDC Submarine Power Cable in Zhoushan Flexible DC Transmission Project

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ABSTRACT

Zhoushan multi-terminal flexible DC transmission project in Zhejiang province, China is the world's first five-terminal DC transmission project, in which 103km $\pm 200\text{kV}$ submarine fiber optic composite power cable linking Dinghai and Daishan is supplied by ZTT transmitting capacity of 400MVA with conductor cross section of 1000mm^2 . This paper demonstrates the simulation verification design of the insulation thickness and electric stress of the $\pm 200\text{kV}$ HVDC cables for this project and proves that the electric stress at any point of insulation complies with the performance of insulation material. Manufacturing process of cable and factory splice is also introduced together with the relevant tests carried on the submarine composite cable including DC voltage test according to CIGRE TB 496 and mechanical test that verifies the reliability of the power cable factory splice and optical fibers.

KEY WORD

Zhoushan flexible DC Project; $\pm 200\text{kV}$; DC Cable; Electrical stress;

0 PREFACE

Zhoushan multi-terminal flexible DC transmission project is the first five-terminal flexible DC transmission project in the world located in the north area of zhoushan isles of Zhejiang province, which adopts $\pm 200\text{kV}$ DC submarine power cable and land cable to connect up main land's converter station (Dinghai), Daishan land's converter station, Hengshan island's converter station, Yangshan island's converter station and Sijiao island's converter station. The project has come into operation since June, 2014. It reinforces the electric connection between isles, develops the technological level, builds solid foundations for wind energy and solar energy and improves the international competition in DC current transmission.

The cable between Dinghai island and Daishan island is main circuit. It contains conductors which cross section is 1000mm^2 , optic fiber cable of 24 cores. Load of the cable is 400MW. The length of DC submarine cable offered by ZTT is 103km. Each submarine cable has two sets of factory joints. The length is ground cables is 9.2km which has 12 sets of factory joints. It is the first application of $\pm 200\text{kV}$ XLPE DC cables in china which has the highest voltage, biggest cross section and longest length. Construction of the cable in main circuit is XLPE insulation, lead sheath, thick round galvanized steel armor, PP outer serving and optic fiber cable. The production model type: DC-HYJQ41-F-200kV 1x1000+2x10B1+2x2B4, the construction is shown in Fig.1.

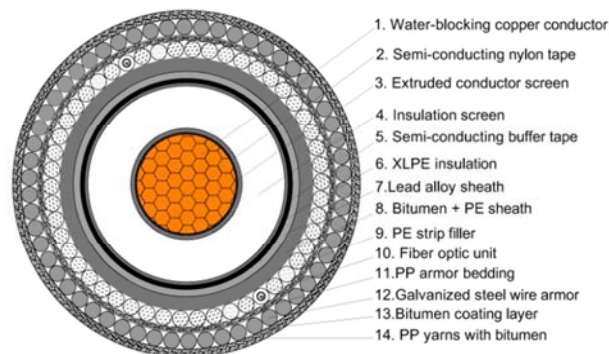


Fig.1 Construction of DC submarine cable

1 INSULATION THICKNESS DESIGN OF HVDC SUBMARINE CABLE

Design for insulation thickness uses finite elements doing iteration calculation. Electric field in insulation depends on the environment temperature, while temperature in insulation depends on the thickness. To make sure the long operation of cable, electric field in insulation during operation shall not higher than designed value. Construction of submarine cable is shown in Tab. 1

Tab. 1 Dimension of 1000mm^2 HVDC submarine cable

1. Conductor	Compacted round water blocking conductor	8. Bitumen+PE sheath	Nominal thickness: 0.5+4.0mm
	Nominal dia.: 38.2mm		Nominal dia.: 93.4mm
2. Semi-conducting nylon tape	Nominal thickness: 2x0.12mm	9. PE strip filler	Nominal thickness: 6.0mm
	Dia.: 38.6mm		Nominal dia.: 105.4mm
3. Extruded conductor screen	Nominal thickness: 1.2mm	10. Optic fiber cable	Numberxtype: 2x12B1
	Nominal dia.: 41.0mm		Nominal dia.: 5.0mm
4. XLPE insulation	Nominal thickness: 16.0mm	11. PP yarns bedding	Nominal thickness: 2.0mm
	Nominal dia.: 73.0mm		Nominal dia.: 109.4mm
5. Insulation shield	Nominal thickness: 1.0mm	12. Steel wire armor	Nominal thickness: 5.0mm