Qualification of 400 and 525 kV HVDC XLPE cable systems including a multitude of accessory configurations

Nils-Bertil **FRISK**, Roberto **GASPARI**, Espen **DOEDENS**, Nexans Norway AS, Norway
nils-bertil.frisk@nexans.com, roberto.gaspari@nexans.com, espen.doedens@nexans.com
Quentin **EYSSAUTIER,** Nexans SA, France
quentin.eyssautier@nexans.com,
Christian **FROHNE**, Nexans Germany GmbH, Germany
christian.frohne@nexans,com,

ABSTRACT

Nexans has developed and qualified 400 and 525 kV HVDC Extruded cable systems for combined submarine and underground applications. The cable design is based on a commercially available cross-linked polyethylene (XLPE) DC insulation material. The systems have been subjected to several pre-qualification and type tests at 400 and 525 kV level. The accessories in these tests cover installations for combined land and submarine application including; Anti-explosion termination, land joint, flexible factory joint rigid submarine field/repair joint and asymmetric field joint.

KEYWORDS

HVDC, XLPE, extruded, cable system, cable, cable accessories, testing, qualification.

INTRODUCTION

The growing need for electrical power and the focus on renewable energy sources boost the need for new technology and ways of transmitting energy. For transmission over longer distances the HVDC technology is superior to the AC technology due to reduction of losses. Beyond a certain break-even distance, installing a HVDC link becomes increasingly beneficial as illustrated in Fig.1. Since losses in HVDC cables mostly consist of ohmic losses, the range has no theoretical limit [1]. With an ever-growing global power demand, meeting such growth with renewable energy sources is a major challenge, additionally complexed by the production remoteness and power fluctuations of renewables. Overcoming such challenges, can be done by utilizing long distance interconnectors and connecting offshore renewable energy sources using long cables. HVDC cross-linked polyethylene (XLPE) cables are therefore a large potential contributor to fill the gap between the increased demand and increasingly fluctuating production.

For HVDC XLPE cables the maximum ampacity of the system is qualified and limited with regards to the maximum allowed conductor temperature and the temperature drop across the insulation [2]. Long distance links may contain large thermal variations in laying condition along the cable route, e.g.; submarine or land, deep water or HDD-pipe, direct burial or tunnels. The current rating of a cable system could therefore be limited by only a few bottlenecks along the route. The impact of the different ambient conditions can be reduced/avoided by using different conductor cross sections in the link.

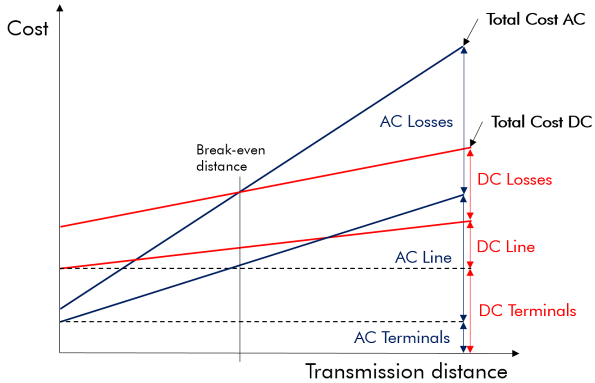

Fig. 1: Illustration of the relation in between cost and transmission distance for HVDC and HVAC.

As an example of this, a schematic drawing of a cable route to an offshore converter station is illustrated in Fig. 2. The figure indicates some examples of where transitions of conductor cross sections could occur along such cable route.

To verify the robustness and capability of a new technology testing are done according to international standards and recommendations. Nexans have therefore completed tests on HVDC extruded cable systems with different conductor material for land and submarine application, with the possibility to transition, reflecting the demand of the market.

CABLE SYSTEM DEVELOPMENT

A submarine 320 kV HVDC XPLE cable system was qualified by Nexans in 2016 and focus has since been on reproducibility and reliability [3]. The most likely next step for submarine was the 400kV voltage level. This is now realized with the newly developed 400 kV submarine cable system aimed to transmit 1,6 GW at a maximum laying depth of 500 m. For onshore cable systems, a potential market demand for even higher voltage step was detected. The aim was therefore going directly for the 525 kV voltage level with a 2 GW transmission capacity.

Land and submarine cables

A 400 kV cable with 1600 mm^2 copper conductor was designed for submarine application, shown in Fig. 3. designed for 500 m laying depth. A water blocking compound is used to prevent penetration of seawater into the conductor in case of damage to the cable. For land application a 525 kV cable with 2500 mm^2 aluminum conductor was produced and is shown in Fig. 4. The cables have been made using the same XLPE material in the insulation system.