Innovative trends and solutions for EHV XLPE insulated cable systems

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ABSTRACT

Modern underground cable system should provide optimized solutions regarding sustainability. This very general requirement touches various aspects: From cable and product design, selection of materials and suppliers over cable production and site conditions, towards logistics and operational aspects. This paper gives an overview of various detail solutions from a land cable system supplier located in the centre of Europe.

KEYWORDS

Cable systems, environment and sustainable development, HVDC, large conductors, reduced AC losses (Skin Effect), regional production, optimized logistics, CO2 optimized footprint

INTRODUCTION

In the coming years huge grid extension activities will be executed in many countries, as the demand for electrical power will increase. With megatrends like e-mobility and reduction of CO2 during power generation, the existing power grids will be extended and must be reinforced by various reasons (Remote power generation, power exchange over large distances, etc.). Many grid extensions at highest voltage levels will be done by using underground cable, as the public acceptance for overhead transmission lines is not given in many cases.

New cable technologies using HVDC voltages allow transmission over long distances by underground cable, and higher voltage levels and large conductor cross section with both, copper and aluminium will lead to higher transmission power.

In parallel to these technical trends, the cable system business itself must be environmental friendly and must become sustainable with their products and solutions which is then in-line with a green energy approach.

This paper describes the situation from a typical European EHV land cable system supplier´s point of view.

Typical approaches are:

- Large conductor EHV cable systems with reduced operational losses at AC applications. This can be achieved by an optimized cable design with reduced skin effect.
- Material supplies, which are reflecting the CO2 footprint
- Optimized logistic process to reduce CO2 during shipment. Regional production sites with short distances have advantages to optimize the CO2 footprint significantly.
- Production site with reduced CO2 footprints, and environmental friendly energy sources.
- Environment friendly accessory designs avoiding any insulation oils and SF6 gas. This can be achieved by dry-type accessory designs

SUSTAINABILITY OPTIMIZED PROJECT DISCUSSION

In the following sections a typical 380kV cable project for the German “Energy Transition” is discussed regarding sustainability optimist solutions regarding

- Reduced losses, skin effect optimization
- CO2 optimized material supplies
- Optimization of logistic footprint
- Environmentally energy supply of the factory

SKIN EFFEKT OPTIMIZED CONDUCTORS

The largest losses of underground cables system are related to the resistive conductor losses. For AC cables those losses are enlarged even more because of the additional skin effect losses. Typical conductor designs show an increased conductor resistance by more than 20% caused by this effect. The individual conductor designs show significant differences for the value of the so called Skin Effect factor Ks, which is describing the enlargement by the Skin Effect [1].

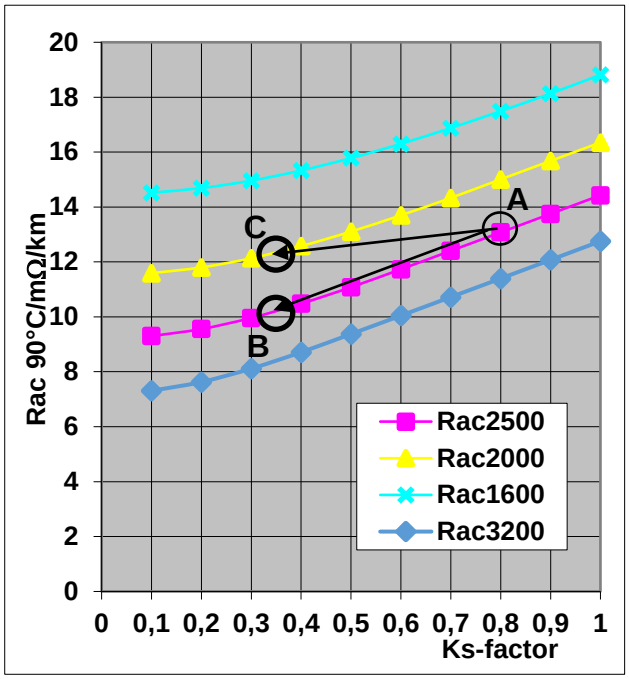

Fig. 1: Enlargement of the AC conductor resistance at different copper conductor cross sections as function of the Ks-factor

Typical values for the Ks factor are [1, 2]:

- Stranded copper conductors: 1.0
- Milliken (segmented) copper: 0.8
- Milliken design copper conductor with oxidized or enamelled wires: 0.35

With Skin effect optimized Milliken type conductors showing a Ks-factor of 0.35 instead of 0.8 the losses of the