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The development of an extruded HVDC cable system and its first application in the Gotland HVDC light project

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Résumé

En 1997, ABB et GEAB ont approuvé d'installer le premier système au monde de câbles extrudés à haute tension continue. La transmission de puissance de 50 MW sous tension continue de 80 kV est assurée par une liaison bipolaire de 72 km réalisé avec des câbles extrudés. Le succès de l'introduction des câbles résulte d'un programme de recherches consacrées au développement des matériaux pour câbles. La charge d'espace, la résistivité électrique et le claquage électrique sont les principales propriétés étudiées pour la sélection de nouveaux matériaux. Le peroxyde de réticulation sélectionné permet de produire des câbles avec une grande résistance mécanique, haute flexibilité et faible poids. La configuration bipolaire de systèmes de câbles extrudés à HT continue possède des avantages techniques et environnementaux; En effet, les câbles sont petits mais robustes et peuvent être installés de façon rapide et économique en les enterrant, ce qui présente ainsi peu d'impacts.

Abstract

In 1997, ABB and GEAB agreed to install the world's first HVDC Light cable system. The transmission, rated 50 MW at 80 kV dc, includes a bipolar 72 km extruded HVDC cable link. The successful introduction of the extruded HVDC cables system is the outcome of a comprehensive development program. Space charge accumulation, resistivity and electrical breakdown strength were identified as the most important material properties when selecting the insulation system of the cable. The selected peroxide crosslinkable material gives cables with high mechanical strength, high flexibility and low weight. Extruded HVDC cable systems in bipolar configuration have both technical and environmental advantages. The cables are small yet robust and can be installed by ploughing, giving only minor impact and making the installation fast and economical.

1. Introduction

HVDC cables are today employed to provide high power transfer over long distances, mainly through waterways. The cable technology is based on oil impregnated paper insulation systems. These cables have many technical advantages, however the manufacturing process is time consuming and sensitive. It has therefore long been desired to make extruded HVDC cables similar to those used in ac systems.

The difficulties encountered in developing such an extruded HVDC cable have mainly been concerned with the space charge movements in the material. The high dc field forces space charges to move and accumulate, giving local increases of the stress distribution which can lead to breakdown. Apart from good space charge properties it is also important to have a material with high volume resistivity and high electric breakdown strength.

New types of dc accessories have also been developed. This research has mainly focused on understanding the high stress interface phenomena between the materials. Tape moulded joints as well as prefabricated EPDM joints have been developed, together with prefabricated polymeric terminations with resistive control of the dc electrical field.

The extruded cable system has been introduced on the market together with new transistor based converters in the HVDC Light concept. The first commercial installation was made on the Swedish island of Gotland during 1998 and 1999.

With the HVDC Light concept, dc links can now also be employed for smaller transmission demands such as the 50 MW Gotland link. The extruded cables can however be used for higher power demands. Today 150 kV cables are available, and the present target is set at 600 kV.