MI cables for high depth application

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ABSTRACT

Mass Impregnated (MI) insulation cable technology have a proven operational experience in HVDC submarine high depth application. Thanks to recent evolution of the submarine cable laying vessels, cables with traditional MI insulation is going to reach new limit of 1800m water depth and beyond. The series of desk studies and laboratory tests that has been performed to extend safely the new technology limit are presented.

KEYWORDS

HVDC MI cables, high depth, new water depth limit

INTRODUCTION

Market evolution of high voltage (HV) cable industry, especially in the Mediterranean area [1], is pushing cable manufacturers to investigate technologies and cable designs for increasingly higher water depth installations. For these specific applications, mass impregnated (MI) technology can be as cost-effective as cross-linked polyethylene (XLPE) insulation, as reported in [2]. Effectively, high depth application cable design is mechanically driven and thermal rating may not represent a real limitation for MI cable design, also thanks to favourable environmental conditions at high depth like low ambient temperature and very limited burial depth: the economical gap between XLPE and MI is therefore narrowed.

Furthermore, HVDC MI cable systems like ITALY-GREECE [3], MON.ITA [4] and SA.PE.I [5] establish a solid reference for operational high depth cables, already at the record voltage of 500kV.

The maximum water depth limit was set at 1650m by SA.PE.I project, which is operational since 2012. Thanks to this previous experience, new development works and the recent evolution of the cable laying vessels, submarine cables for HVDC application with traditional MI insulation reached a new limit exceeding 1800m water depth, with the target to go beyond 2000m soon after.

This article presents a series of desk and laboratory studies performed to develop the cable and cable joints for the 1800m water depth MI cable design. Finally, a short description of the sea-trial run for the qualification of the deep-water cable design for Tyrrhenian Link is described.

CABLE DESIGN

The submarine cable design here presented is the one developed for the 500kV HVDC Tyrrhenian Link cable system, intended for installation in deep waters (defined as greater than 1800m).

Cable construction

A short description of the power cable layers is presented in (Fig. 1):

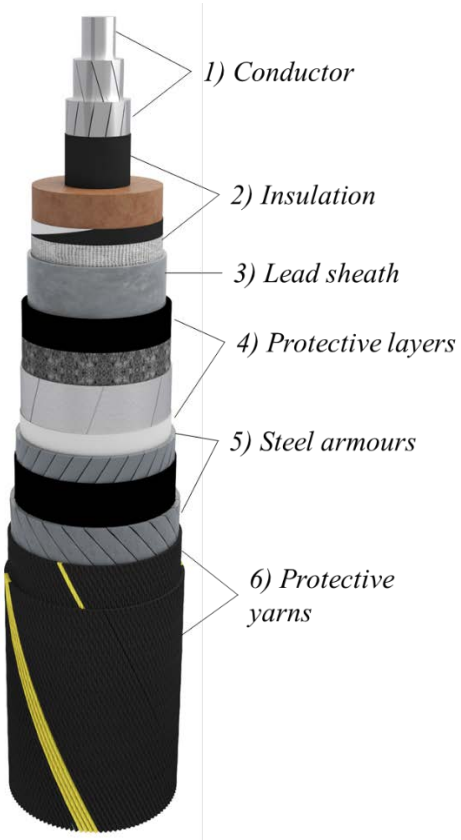

Fig. 1: submarine deep water cable construction

1) Conductor

It consists of a central aluminum rod surrounded by shaped segments to give the required nominal cross section area (keystone conductor).

2) Insulation

It is made of special high density paper tapes impregnated with viscous compound. Carbon loaded papers are used as conductor screen. Insulation screen consists of carbon loaded papers and metallised paper, followed by a fabric tape including copper threads for protection of the core. The nominal insulation thickness is selected in order to have the electrical stress at nominal voltage within the values already successfully experienced.

3) Lead sheath

Lead alloy "E" is chosen due to its good mechanical characteristics.