# EPR insulated cables for modern offshore systems

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## *ABSTRACT*

*In recent years the offshore industry is experiencing a marked technological development driven by challenging applications and need of overall system costs reduction. New concepts of offshore renewable energy generation systems require specific cable designs with adequate characteristics.*

*Medium voltage cables inside a wind turbine have to meet very demanding mechanical requirements in terms of bending radius, fatigue resistance and flexibility. New designs for 66 kV submarine array cables require high reliability and economical attractiveness. Floating offshore platforms require submarine and umbilical cables with superior fatigue resistance and thermo-mechanical performance.*

*Thanks to its outstanding electrical performance in the wet environment and superior thermo-mechanical characteristics, EPR insulated cables are particularly suited for modern offshore systems.*

## INTRODUCTION

In recent years the offshore industry is experiencing a marked technological development driven by challenging applications and need of overall system costs reduction.

Some of the following features are often involved in modern offshore systems:

- Longer distance to shore
- Deeper water areas
- Higher unit power

In order to design and operate those offshore systems economically and reliably it is sometimes necessary/beneficial to make use of:

- Floating platforms
- Higher system operating voltage
- Flexible cables
- Deeper power/umbilical cables

Several independent studies [1] [X] have shown that use of array cables operating at 66 kV instead of 33 kV would bring along considerable cost reduction on typical offshore wind farm systems. Although, the insulation material of 66 kV cables is operated at relatively higher electric stress than 33 kV cables which requires proper cable design and insulation material selection.

Currently EPR insulated cables are used for some of the heaviest duty applications including connection of wind turbines nacelles. The features and in particular the mechanical strain of these cables is unique and has no equal among any other equivalent insulation types.

The economical exploit of oil fields in deep water is generally achieved by means of floating platforms. Floating structures are not yet widespread in offshore windfarms but several concepts and some pilot projects have been deployed in recent years. These early applications are encouraging the study of larger full scale floating offshore wind turbines. The submarine cables intended for these applications, require superior fatigue resistance and better mechanical performances.

This paper analyses the feasibility and performances of EPR cables for modern off shore applications.

## BACKGROUND ON EPR INSULATED CABLES

EPR insulated cables are covered by the IEC standards and by many National Standards around the world and are currently used in several countries in power distribution and transmission networks at voltages up to 150 kV.

The origin of rubber dates from 1770, when Joseph Priestley conceived the word “rubber” for a gumlike substance used to erase pencil lines. Natural rubber-based insulators were the only polymeric materials used for cables and wires electrical insulation starting from the middle of the 1800 century and until 1930s, when the first suitable synthetics became available. During the following years, new technologies boosted the development of new rubber based insulations with better characteristics for the cable industry [2].

The early sixties represent a major step forward in the development of various polymers due to the discovery of dialkyl peroxides as cross-linking agents. The technology of this catalyst developed by Carl Ziegler and Giulio Natta (who awarded the Nobel Prize for this invention), lead to the copolymerization of propylene and ethylene which yielded ethylene propylene rubber [2]. A few years after this breakthrough, the first EPR insulated cables appeared in the market and, during the following 40 years, they have achieved an excellent track record in terms of reliability.

Use of EPR insulated cables reached its peak during the seventies and eighties following the failures in service caused by water treeing phenomenon in the first generation of polyethylene insulated cables [3]. Utilities have been using EPR insulated cables for submarine and land cables up to 170 kV for more than 40 years.

Nowadays use of EPR insulated cables is preferred for applications requiring superior mechanical and thermal