Corrosion, we just have to live with it

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ABSTRACT

Corrosion is a major concern for sub-sea cable reliability. These cables are normally watertight, however, CIGRE recently recommended to test wet sub-sea array cables for offshore wind-parks. Furthermore, it should be noted that several kilometres of wet medium voltage submarine cables were installed more than twenty years ago and have been operating without any reported problems.

This paper highlights the most significant parameters for corrosion of metal components inside a cable and proposes a means to effectively lower the influence of the polymer components. For example, stress introduced electrical degradation (SIED) of the inner semi-conductive screen is influenced by the polymer properties.

The influence on corrosion by different cable constructions will be highlighted especially component tapes. Many tapes contain additives such as super-absorbent polymers (SAP) that do not work in salt water and degrade very quickly without any saltwater absorption. A newly developed SAP has been tested for this application.

SUMMARY

Corrosion is a chemical degradation process that occurs in wet and in dry conditions. In this paper we try to highlight the different parameters that can influence this chemical process in wet conditions. We evaluated the influence of a change in the pH value on the degradation mainly on the metals that are used in a cable.

We show on practical examples the effect of corrosion on cables.

KEYWORDS

Corrosion, super-absorbent polymers, tapes, copper, aluminium, sub-sea

INTRODUCTION

Corrosion is a subject that many people do not want to talk about, since it is related to bad maintenance, premature ageing or bad design. However, corrosion can also occur with very well-designed cables or with regular maintenance. Ageing and corrosion are somehow connected since corrosion is a chemical phenomenon that only happens over time like ageing. The chemicals that are created during an ageing process can influence the corrosion process and vice versa.

DEFINITION

The definition of corrosion according to the electrochemical organisation is:

Corrosion is a dangerous and extremely costly problem. Buildings and bridges can collapse, oil pipelines break, chemical plants leak, and bathrooms flood. Corroded electrical contacts can cause fires, corroded medical implants may lead to blood poisoning, and air pollution has caused corrosion damage to works of art around the world. Corrosion threatens the safe disposal of radioactive waste that must be stored in containers for tens of thousands of years.

The most common kinds of corrosion result from electrochemical reactions. General corrosion occurs when most or all of the atoms on the same metal surface are oxidized, damaging the entire surface. Most metals are easily oxidized so they tend to lose electrons to oxygen (and other substances) in the air or in water. When oxygen is reduced (gains electrons), it forms an oxide with the metal.

When reduction and oxidation take place on different kinds of metal in contact with one another, the process is called galvanic corrosion. In electrolytic corrosion, which occurs most commonly in electronic equipment, water or other moisture becomes trapped between two electrical contacts that have an electrical voltage applied between them. The result is an unintended electrolytic cell.

Take a metal structure such as the Statue of Liberty. It looks strong and permanent. Like nearly all metal objects, however, it can become unstable as it reacts with substances in its environment and deteriorates. Sometimes this corrosion is harmless or even beneficial: the greenish patina that covers the statue's copper skin protected the metal beneath from weather damage. Inside the statue, however, corrosion caused serious harm over the years. Its iron frame and copper skin acted like the electrodes of a huge galvanic cell, so that nearly half of the frame had rusted away by 1986, the statue's one hundredth anniversary.

Furthermore, for a chemist, corrosion is not only the degradation of metal, but also the degradation of a polymer. However, initially we will focus on the classical corrosion process.

CABLE CONSTRUCTION

Cable construction from a chemical perspective is a very complicated issue. There is a metal conductor, with different layers of polymers plus a metallic screen that should be covered by a polymer. Additionally, cable makers are using tapes, which is another story by itself.

Thus, the electrochemical behaviour is a fine balance between many components inside the cable.

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