ELECTRICAL AND THERMAL DESIGN OF UMBILICAL CABLE

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ABSTRACT

The main purpose of this technical paper is to analyze the various designs available for a Submarine Electro Hydraulic Umbilical, composed of power conductors, signal/control cables, steel tubes, thermoplastic hoses and/or optical cables, in order to reduce the options to the final project definition, considering the magnetic and thermal limitations of the components.
The circulating current at the power cores may cause a heating, higher than the operational temperature limit of the others components (thermoplastic hoses) and an induced voltage at the signal cables. The thermal and electrical analyses are performed to ensure that the cable design comply with the specification and is suitable for its operation conditions.
Finite element software for electromagnetic and thermal simulation is used and the analysis is based on the two-dimensional geometry of the object under evaluation and its materials physical properties.
The umbilical cable is suitable for static and dynamic application up to 3000 meters water depths and a service life of 25 years. The cable may be connected between platforms, wells and landfall
Real data for the induced voltage at signal cables under investigation are presented, discussed and also compared with theoretical value.
This paper also describes the methodology applied in the magnetic and thermal analysis.

KEYWORDS

Submarine Electro Hydraulic Umbilical,Electrical Analysis, Thermal Analysis.

INTRODUCTION

A subsea umbilical cable can be composed of steel tubes, hydraulic hoses, optical, power and signal cables.
It may be used to power submerged pumps to overcome ultra-deep water pressures, low reservoir pressure, long offsets connections from a central platform, high produced fluid viscosities, extend the life of mature fields or accelerate production on new fields.
Adding power cables to an umbilical can create some difficulties: temperature increase, electrical interference, limits to the length of the cable (splices).
Power cables can generate interference in signal cables due to its circulating current. Different cables are designed in order to minimize the effect of the induced voltages and guarantee the applicability of the product during its operational service life from an electromagnetic and thermal point of view.

Figure 1 – Electro Hydraulic Umbilical

Each conductor is a heat source and different components have different temperature limitation, therefore, to reduce the operating temperature, the conductor size may have to increase impacting in weight per meter of the umbilical.
Computer modeling offers a cost effective solution for designing different cables. Modeling and simulation has proven its ability to predict cable behavior with high accuracy at different design levels.
After the theoretical evaluation the umbilical cable is submitted to rigorous tests to ensure the umbilical systems reliability during installation phase and during throughout service life.

ELECTROMAGNETIC ANALYSIS

A material brings in technological interest in an electromagnetic type application, if it can acquire sufficient magnetization.
When metallic conductors are inserted in a variable magnetic field or when they are in motion in a constant field, there is as a consequence the generation of electrical currents called induced currents or eddy currents, which means that the conductor is supplied indirectly by induction.
The available physical applications with finite element software are: transient magnetic (variable currents and systems with different frequencies) and Steady State AC magnetic (circuits with the same frequency). These applications allow the considerations of induced currents and skin effect.

Transient Magnetic

The transient magnetic application allows the study of the phenomena created by the time variable magnetic field. The magnetic field is related to the presence of variable current. The main results that can be obtained with transient magnetic application are the induced currents and dissipated power by Joule effect.