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Back From the Abyss: A Case Study of the Condition of a Thermoplastic-Hose Umbilical After Extended Service in Deep Water

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Abstract

This paper attempts to shed some light on the deepwater performance capabilities of subsea umbilicals incorporating thermoplastic hoses as fluid conduits and for provision of hydraulic power, by reporting and discussing the significance of the empirical findings derived from a case study of a section of thermoplastic-hose (TPH) umbilical salvaged after deployment in the deepwater Zafiro field offshore Equatorial Guinea for more than a decade.

It is of utmost environmental and economic importance for an umbilical to perform safely and reliably throughout the productive life of a subsea oil and gas project. Offshore oil and gas producers have used TPH umbilicals beneficially for more than 30 years to link remote and/or subsea wells with operating facilities. As offshore E&P has moved into ever deeper water, the performance capabilities of TPH umbilicals increasingly have been challenged, both in the field and in the minds of deepwater operators, despite steady improvements in umbilical construction methods and materials of construction, alike.

Today, TPH umbilicals are manufactured to exacting technical design standards and quality is carefully monitored and verified throughout the manufacturing process. However, uncertainty about TPH umbilical capabilities persists in part because of a dearth of publicly available, scientific data evaluating their performance in the field. This case study contributes such hard-to-get credible scientific data to the public record by documenting the extent of physical and chemical degradation suffered by a TPH umbilical following extended deployment in deep water.

The author describes the physical design, dimensions, and technical characteristics of a salvaged TPH umbilical and the conditions under which it was utilized, including the water depth in which deployed, the role played in the Zafiro field, and operating conditions during deployment.

The author describes the testing methodology and the results of various tests performed upon the umbilical to determine its physical and chemical condition to establish a scientific basis for drawing conclusions about the safety and reliability of TPH umbilicals in deep water.

Introduction

TPH umbilicals and steel-tube (ST) umbilicals containing no thermoplastic hoses are engineered to design standards embodied in API 17E/ISO 13628-5 Specification (API, 2003) (ISO, 2002). Yet, the two basic types of umbilicals exhibit widely differing performance characteristics, so selecting the right subsea production umbilical system for a given deepwater application is not straightforward. Modeling umbilical performance is a complex task and offshore producers must take into account a wide range of demanding performance criteria--fluid-conduit bore size, anticipated working pressures, internal chemicals or fluids to be transported, and hose-end fitting requirements--as well as a host of site-specific logistical and installation factors. In most cases, the selection process favors the umbilical system that will perform reliably and efficiently under expected operating pressures and temperature extremes in the most cost-effective manner. The superior fatigue-resistance of TPH umbilicals enables them to claim the advantage in most dynamic applications. However, there are no clear cut rules that can dictate the optimal subsea umbilical design for all deepwater and ultra-deepwater applications.