



OTC 18196

Deepwater Installation of Pipelines and Risers by Towing

I.C.P. da Cruz and J.D. Davidson, Subsea 7

Copyright 2006, Offshore Technology Conference

This paper was prepared for presentation at the 2006 Offshore Technology Conference held in Houston, Texas, U.S.A., 1-4 May 2006.

This paper was selected for presentation by an OTC Program Committee following review of information contained in an abstract submitted by the author(s). Contents of the paper, as presented, have not been reviewed by the Offshore Technology Conference and are subject to correction by the author(s). The material, as presented, does not necessarily reflect any position of the Offshore Technology Conference, its officers, or members. Papers presented at OTC are subject to publication review by Sponsor Society Committees of the Offshore Technology Conference. Electronic reproduction, distribution, or storage of any part of this paper for commercial purposes without the written consent of the Offshore Technology Conference is prohibited. Permission to reproduce in print is restricted to an abstract of not more than 300 words; illustrations may not be copied. The abstract must contain conspicuous acknowledgment of where and by whom the paper was presented. Write Librarian, OTC, P.O. Box 833836, Richardson, TX 75083-3836, U.S.A., fax 01-972-952-9435.

Abstract

Pipelines up to about 5km in length can be transported and installed in very deep water by towing in a catenary between two tugs. The catenary tow is performed without additional buoyancy. The initial, shallow water section of the tow, from an onshore fabrication site to the point where the catenary is established, requires the use of additional temporary buoyancy, rated to much less than the full installation depth. The buoyancy can be removed economically in long strings if the buoys are constructed in such a way that they can be flooded to a condition of near neutral buoyancy. Detailed analysis of the effect of wave action and vortex induced vibration (VIV) shows that installation can be performed without incurring significant fatigue damage. The depth at which buoys are removed and catenary towing is initiated is based on an economic assessment intended to minimize the combined cost of the buoyancy and of the towing tugs. This technique is applicable for infield pipelines and risers.

Introduction

Installation of pipeline systems by towing is a long established and proven technology. In the North Sea, nearly 60 pipeline bundles have been installed in water depths up to 450 metres using a technique called the "Controlled Depth Tow Method" or CDTM. However 450 metres is close to the limit for North Sea practice because of the way in which buoyancy is provided. For West Africa, the Gulf of Mexico and Brazil, where many field developments are in water up to 2000m deep, a new methodology is required.

The proposed new methodology has its roots in existing technology and it will be described following a brief outline of the existing methodology.

Current North Sea Practice

In North Sea pipeline bundles practice, one or more pipelines are contained inside a carrier pipe, which serves both as a

buoyancy element and as mechanical protection. The carrier pipe is pressurized with nitrogen, to approximately seabed ambient pressure at the installation depth, to enable it to resist external hydrostatic pressure. Pressurisation with nitrogen takes place onshore before the completed pipeline is launched, and the greater the installation water depth, the higher the nitrogen pressure must be. Higher pressures require thicker pipe, and eventually the carrier pipe becomes so heavy that it ceases to be an effective buoyancy element. The pipelines are contained within the carrier pipe and thus displace no water, so the carrier pipe must support the full dry weight of the pipelines rather than the submerged weight. The net result is that the practical limit for bundles, in which pipelines are contained within a carrier pipe, is about 500 metres.

In North Sea bundles practice, the carrier pipe is sized to overcome the weight of the contained pipelines and to provide a little (typically 5%) excess buoyancy. Ballast chains are attached to the bundles at intervals, their weight being sufficient to overcome the excess buoyancy of the carrier pipe and to leave a few chain links resting on the seabed. The on-bottom weight of the chain links is chosen so that there is enough frictional resistance to prevent the bundle being moved around by currents, while not being so large that the whole pipeline bundle is difficult to move with a towing tug. The on-bottom chain weights used are typically around 50 Newtons per metre of pipeline length. The ballast chains include short lengths of rope, dimensioned so that the bundle sits on its chains approximately 5 metres clear of the seabed. A pipeline bundle in this configuration is said to be in "off-bottom" mode.

A pipeline bundle in off-bottom mode can be moved easily by a towing tug, and manoeuvring speeds are typically up to two knots. If the speed is increased, the force of the water passing the chains deflects them significantly out-of-vertical and hydrodynamic lift is generated. Water passing the chains acquires a downward momentum, and the force required to generate that downward momentum is the lift force felt by the pipeline bundle. At speeds in the range 4 to 5 knots, the lift is large enough to overcome the chains' on-bottom weight, and the bundle "flies".

In the Controlled Depth Tow Method (CDTM), a pipeline bundle forms a shallow, stable catenary between a leading tug and a trailing tug. The minimum practical water depth for CDTM is about 60 metres, and in that water depth, there would be typically 20 metres clearance between the lowest point of the catenary and the seabed, while the ends of the pipeline catenary would be typically 20 metres below the sea surface. In 100 metres water depth, the lowest point of the