Mechanical Protection Design of Submarine Pipeline

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ABSTRACT

The risk faced by the part of the submarine pipeline crossing the channel or waterway mainly comes from the active or passive anchoring of ships passing through the channel. Once the pipeline is damaged or leaked, it will cause incalculable losses to the economy and even unimaginable damage to the environment. In order to ensure the safety of the pipeline, the analysis of anchor resistance has become an important issue that needs to be solved urgently. This paper will analyze and study the problem of anchor resistance of submarine pipeline crossing the channel or waterway.

KEYWORDS: Mechanical protection; Submarine pipeline; Anchor

INTRODUCTION

Submarine pipeline is the main means of offshore oil and gas transportation. With the development of the marine transportation industry, the number of coastal ports is increasing, and the number and tonnage of navigation ships are also increasing. The anchoring operations of ships in the offshore are more frequent, and the risk of damage to the submarine pipelines caused by ships is increasing. Once the submarine pipeline is broken or even pulled, it will not only affect the normal oil and gas exploitation, but also cause huge economic losses and incalculable damage to the marine environment. Therefore, in order to prevent accidents before they happen, and try to avoid the occurrence of submarine pipeline safety accidents, the research on submarine pipeline protection methods becomes particularly important.

METHOD OF PROTECTION

It was also noted (Ma et al., 2012) that the commonly used mechanical protection method is rock berm cover (either with rocks, gravels, sands or other mechanical means) over the pipeline to protect them from the accidental dropping and/or dragging of the anticipated anchors from vessels. Rock berm option, as shown in Figure 1, is proposed for its ease in construction, robustness, cost and good track records of providing excellent protection against dropped objects and anchor drag.

Figure 1 Typical Rock Berm Protection Option

The consequences of a direct hit by a large holding capacity anchor onto an unprotected pipeline during operation are severe. The provision of armour rock cover is one of the protection methods to mitigate the risk of pipeline damage subjected to direct anchor impact.

ROCK COVER PROTECTION DESIGN

General

The pipelines will be mechanically protected by rock berm cover against the following possible critical accidental scenarios:
- Anchor dropping directly above the pipeline;
- Dragging of anchor across the pipeline.

The mechanical protection design of submarine pipeline mainly includes the following parts:
- Anchor drop into rockfill layer or soil
- Anchor drag trajectory
- Trench slope stability
- Rock grading design.

The mechanical protection design shall meet the requirement that there is sufficient safety distance between the anchor and the pipeline in case of anchor dropping and anchor dragging.

Anchor Drop into rockfill layer

Accidentally dropped objects pose serious and costly hazard to subsea installations. High fidelity nonlinear simulations can accurately predict object's fall trajectories and better manage risks (Majed et al., 2015). A