Influence of sea currents on the strategy of riser re-entry

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Abstract. The paper is concerned with dynamics of a riser in re-entry. The model is formulated by means of the segment method taking into account large displacements, bending, torsional and longitudinal flexibilities but also hydrodynamic forces, internal fluid flow, sea currents and ship motion. Validation of the model is carried out by comparing our own results with ones available in the literature obtained by different methods and from experimental measurements. The optimisation problem of moving a riser in re-entry subject to sea current is formulated and solved. The task is to choose such a trajectory of a surface vessel, that regardless of the sea current, the bottom end of the riser is placed as close as possible to the defined position, within a given period of time and with minimising the energy of the system after the manoeuvre.

Introduction

Flexible risers used for transporting oil and gas from the seabed to platforms or ships become longer and longer as the water depths in exploration of hydrocarbons increases. The risers are subject to loading from ocean environment which includes surrounding water, sea currents as well as internal fluid. One of important manoeuvres performed during exploitation of risers is its relocation, called re-entry, and it usually requires positioning of the bottom end of the riser above a wellhead. A riser is a highly flexible structure and it is difficult to control its movement due to the sea environment and the motion of the base (vessel or platform). In such situations an appropriate choice of a trajectory of a base is essential. The riser, after disconnection with a wellhead, undergo large change in curvature due to its length, weight, hydrodynamic forces and sea currents and those have an essential influence on the displacements of the bottom end of the riser. Extensive research on modelling risers [3] includes models based on the finite element methods. In this paper, we apply the segment method which is a generalisation of the model presented in [4]. The model is validated against the results presented by other researchers obtained by numerical simulations and experimental measurements.

Results and discussion

The segment method developed for this study introduces longitudinal flexibility in the model. The equations of motion are formulated using the Lagrange equations. The model enables us to analyse large displacements of the riser and all hydrodynamic loading. Numerical effectiveness of the model made it possible to apply it to solve an optimisation problem of selection of the trajectory of the surface vessel transporting the riser. The task if formulated as a nonlinear optimisation problem in which the trajectory of the vessel is chosen in such a way that the bottom end of the riser is placed in the proximity of the wellhead.

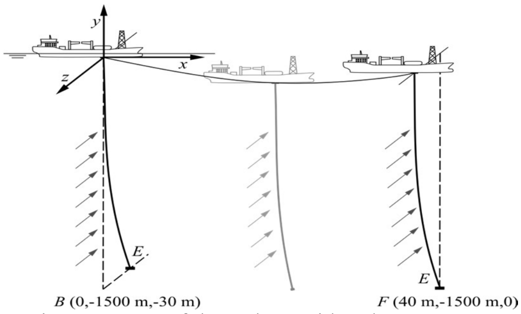

Figure 1: One of the task considered.

The vessel movement has to account for the change in curvature of the riser not only due to the hydrodynamic loading but also different types of sea currents. One of such cases is presented in Figure 1. The effectives of the method is very important since the solution of the optimisation task requires integration of the equations of motion at each optimisation step for different parameters defining the motion of the base. The results of simulations for different directions and intensiveness of sea currents will be presented and discussed.

References

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