The air entrainment effect stability on the marine pipeline

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ABSTRACT

The purpose of the study is to discuss the influence of the air entrainment on the marine pipeline stability. It is important to prevent excessive air from entering the pipeline, which can affect the weight of the pipeline and lead to problems such as pipe instability, changes in pipe materials and pipeline structure, and alterations in fluid properties that can impact the environment at the discharge point. If the presence of air in the pipeline is too high, it can reduce the weight of the pipeline, causing it to float above the sea bed, particularly for HDPE pipes. To analyze the percentage of entrained air volume entering the pipeline at different locations, a three-dimensional computational fluid dynamics software called FLOW-3D was utilized, which solves Navier-Stokes equations with various turbulence closure models and uses mesh convergence. To avoid excessive air entering the lines, it is important to dissipate air by disturbing the flow with baffles and raising the bottom of the tank for simulation. By comparing different cases, the percentage of entrained air volume can be determined in the pipeline. The goal of this study is to establish a numerical model that can be used to analyze and discuss the results for further application in the engineering field.

KEY WORDS: air entrainment; marine pipe; FLOW-3D.

INTRODUCTION

Coastal regions are popular sites for power plants due to their accessibility to seawater, which is pumped in to reduce the temperature of the discharge point before being discharged back into the sea. However, this process can impact the marine environment, making the stability of the marine pipeline an important topic. When air entrainment is high, the weight of the pipeline reduces, causing the pipeline weight to become insufficient in resisting wave force, which may cause the HDPE pipe to float above the sea bed. To minimize air entrainment, a discharge chamber is typically set up beside the sea, where the difference in elevation between the bottom of the pool and the baffle that disturbs water flow can allow air to evaporate on the surface of the pool, enabling water to enter the pipeline without entrained air. According to HR Wallingford's manual (2005), air can be entrained at the inflow location, such as a drop chamber, which can affect pipeline stability. In this study, three cases for numerical simulation were set up and compared the results using the power plant located in Masinloc, a northern area of the Philippines situated about 150 km from Manila and near the China South Sea. The precise location of the power plant is shown in Fig. 1 from Google Maps.

Fig. 1 Location of power plant site