

Flow Analysis by CFD Model of Lifting System for Shallow Sea Test

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ABSTRACT

Numerical study on a lifting system developed for shallow sea test was performed by a CFD model. In this study, the flow behaviors in a lifting pump and flexible hoses is simulated by using FLUENT, a commercial CFD model. Two cases for avoiding the pump cavitation behavior were selected according to the hose length and the depth of lifting pump. From the numerical results, it is found that the calculated NPSH meet the minimum required by a lifting pump based on the shallow sea environments.

KEY WORDS: Manganese nodules; CFD; NPSH; numerical results

INTRODUCTION

The deep sea floor could be thought as the last treasury of mineral resources to be left for mankind. The advanced countries have already driven forward actively the development of deep sea mineral resources in preparation for the on-land mineral resource exhaustion since 1960's. Especially, the successful development of deep sea manganese nodules requires developing exploration, mining and transfer technologies simultaneously, among which mining technology includes collecting and lifting technologies of the manganese nodules (Chung, 1994). Lifting system is crucial to achieve the success of the deep-sea mining project, by which manganese nodules are conveyed from the seafloor to the mining ship. The conveying principle can be classified into the hydraulic pumping system and the air lift system according to the fluid dredging type, the continuous line buckets system of the mechanical type and the modular marine mining automation system (Yoon et al., 2003). Among the lifting methods, the hydraulic pump lifting system is situated between the buffer system and the lifting pipe that is connected to the mining ship. The lifting pump, one of the core parts in the hydraulic pump lifting system, need to be designed with multi-stages because it requires a high hydraulic head (Park et al, 2007). In Japan, an 8-stage lifting pump was developed for its offshore experiment (Chung, 1994).

In this study, the simulations of the lifting pump and the connecting flexible hoses for shallow sea test have been conducted to guarantee the performance of the developed lifting pump using FLUENT, a

commercial CFD model. The mining system consists of an underwater pump and flexible pipes in suction and discharge parts. From the results, the flow characteristic of the system was analyzed to be used as basic data.

MODELLING OF THE MINING SYSTEM

The schematics of the lifting system are shown in Fig. 1. The target of the study is the hydraulic pumping system which is the two-phase lifting technology of solid and liquid. The simulations were performed for two objectives: the prediction of pump efficiency and the total analysis of the lifting performance. The total mining system was divided to perform the research efficiently and computational fluid analysis for the deduction of characteristic flow values of each part. The analytic method was employed to analyze the total system.

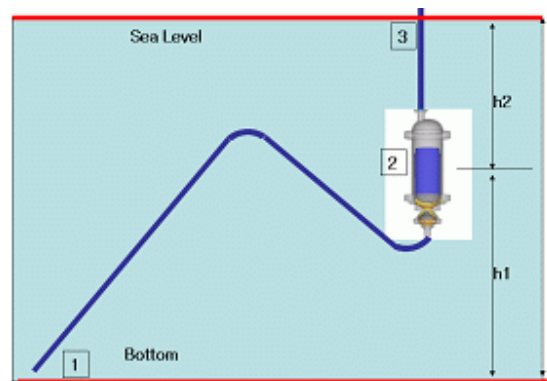


Fig.1 Flow-line of the lifting system

The pump was divided into two parts as in Fig. 2.