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Studies on the Optimum Shape of Buffer for Reducing the Longitudinal Vibration of a Pipe String for Mining Manganese Nodules

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ABSTRACT

In order to reduce the longitudinal vibration of the pipe string in mining manganese nodules from deep-sea bottoms, the investigation of the shape effects of various buffers attached to the string reported that the resonance amplitude of the buffer whose shape caused a larger drag force reduced the vibration further, and that the buffers with disks normal to their axes were more effective for that purpose than the buffers without disks. In this study, the effects of the diameter-ratio of the disk-to-buffer and of the number of disks on the buffer, namely the interval between disks, on the vibration of the pipe string were studied to find the optimum buffer shape from the viewpoint of reducing the vibration. The result indicates that a buffer with larger diameter ratio is more effective in reducing the vibration as long as the ratio is less than the aspect ratio, which is the ratio of the length of the buffer to its diameter. Furthermore, it is found that the optimum value exists for the number of disks, namely the interval between disks, if the diameter-ratio and K_C number (Keulegan-Carpenter number) are given.

KEY WORDS: Longitudinal vibration of pipe string, vibration control, experiment, shape of buffer, diameter ratio, number of disks, optimum shape of buffer

INTRODUCTION

For mining manganese nodules from the deep-sea floor, a pipe string is needed to connect the mining ship on the sea surface with the collector on the sea floor. Furthermore, in the pump-lift system as shown in Fig. 1, the string must be equipped with the pump modules and buffer. The pipe string in this system is apt to vibrate longitudinally, laterally and torsionally due to the ship motions. Hence, these vibrations of the string must be controlled for the safe operation of the above-mentioned mining system. Among the vibrations, the longitudinal vibration itself has been found to be more destructive as far as the strength of the pipe string is concerned (Chung et al.,1981, Aso et al.,1991a) and further, according to the recent studies by Chung et al. (1994a, 1994b), the longitudinal vibration of the pipe string is amplified by the coupled bending and torsional vibrations. Therefore, it must be controlled as much as possible by various means.

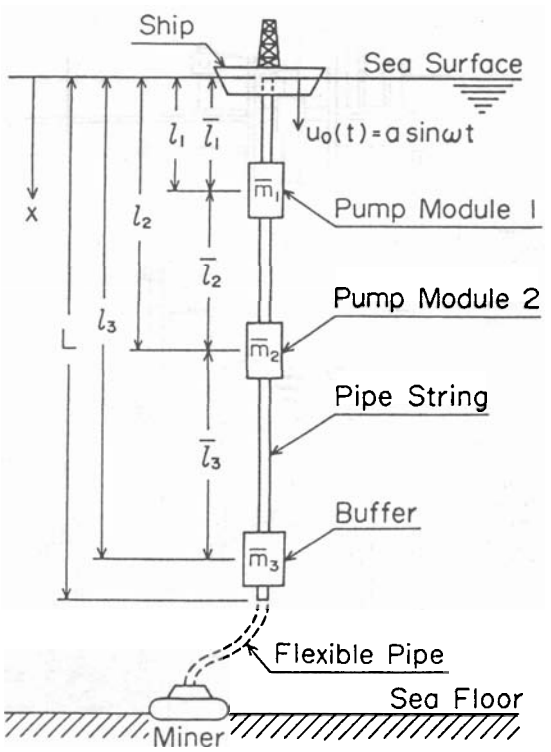

Fig.1 Mining system in the deep sea