Characteristics of Freezing in Ports in Hokkaido, Japan

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ABSTRACT

Freezing mechanisms in ports are clarified by laboratory experiments, and the characteristics of ports in Hokkaido concerning the freezing conditions and freezing places are investigated based on the data of field surveys. The mechanisms of freezing in ports can be classified into three patterns, and the freezing occurs easily in ports with closed water areas that are very calm, shallow in water depth and restricted in seawater exchange. Furthermore, prediction models of starting day of freezing are proposed.

KEY WORDS: freezing mechanisms, freezing area, prediction models.

INTRODUCTION

Ports, harbors and fishing ports in cold regions in Hokkaido, Japan, freeze during winter. This freezing has a negative impact on the economic activities because ships cannot depart from or arrive at ports. The convenience would be strikingly improved by taking appropriate measures, to prevent ports from freezing, such as the heat supply method and the air-bubble method. To make effective use of these countermeasures, clarification of the freezing characteristics and factors that cause freezing in each port is important.

In this study, freezing mechanisms are investigated by laboratory experiments, and the characteristics of each port concerning the freezing conditions and freezing places are investigated based on the data of field surveys which have been conducted since 1987. Furthermore, prediction models of starting day of freezing are proposed.

FREEZING MECHANISMS

(1) Method of the laboratory experiments

The experiments were conducted in a laboratory where the room temperatures can be set. Figure 1 shows the water tank in the laboratory and positions to measure the water temperature. The salinity of the artificial sea water was 35‰, and the water tank was insulated with 5 cm thick Styrofoam.

The room temperature was kept constant (-5, -10, -15, -20 °C) and the water in the tank was stirred until its temperature fell to 7 °C. Then changes in the water temperature and the freezing state were observed every 12 hours until the water started to freeze. Furthermore, to investigate the influence of changes in the salinity due to freezing and thawing, artificial sea water in the water tank was frozen and thawed by changing the room temperature between +5 and -10 °C in a 24-hour cycle, and the salinity at the time of thawing was measured at five positions by salinometer: 0, 2.5, 5.0, 12.5 and 25.0 cm from the water surface.

Figure 1 Positions to measure the water temperatures