

## P1. Apparatus for Producing Unfrozen-temperature and Melt-resistance Ices for Maintaining Freshness of Fish

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### 1. Introduction

Transportation networks for fresh foods to overseas or remote places have been rapidly developed recently. The transportation and preservation of fresh foods using temperatures between their freezing temperatures and 0°C (unfrozen temperature: UT) have the following advantages:

- 1) Maintains the live state of the fish.
- 2) Inhibits the increase of microbes.
- 3) Inhibits the deterioration of taste, flavors and color tones from oxidation and enzymatic action.

However, the range of UTs are small; e.g., the freezing temperatures of the fresh fish are -2.25 to -0.75°C. Further, existing apparatus for producing ice for maintaining the UT have the following problems:

- 1) Produces ice-solution mixtures in a liquid state (sherbet state), and is easily soluble, therefore does not maintain UT for a long time.
- 2) Cannot respond quickly to various fresh fish with different freezing points.
- 3) Is large scale (high initial costs).

### 2. The Incentive of this Research

Okabe et al. (1956) reported an economic investigation of new freeze-concentration apparatus using a vacuum evaporator. From this report, it is possible to know the changes of specific gravities of ice chips which are ice-solution mixtures discharged from a cooled cylinder immersed in a seawater tank. In the case of seawater with an initial specific gravity of 1.0215 (salinity of about 3wt%), the changes in the specific gravity of the discharged ice chips are 1.021 to 1.024 in 4 hours. Therefore, the freezing point change due to the changes in the specific gravity of these ice chips is only 0.21°C from -1.49°C (specific gravity: 1.021) to -1.70°C (1.024) in 4 hours.

### 3. The Apparatus of this Research

The apparatus (Jpn Pat 6311191) of this research comprises the following process:

- 1) Obtains solutions with constant concentrations using a mother solution tank, a diluent tank and a mixing tank,
- 2) Produces ice chips which are ice-solution mixtures of constant melting points depending on

the cooling temperatures and rotating speeds of a cooled-rotating cylinder immersed in a solution tank.

This apparatus has the following properties:

- 1) Produces the ice chips of UT.
- 2) Produces the ice chips with the following melt properties. Therefore, the holding time of UT becomes several times longer than that of sherbet ices.
  - Are in a solid state. Therefore, the proportion of ice in ice-solution mixtures is several times larger than that of the sherbet ices.
  - Are a flat shape. Therefore, the ice chips layer forms a heat insulating layer.
- 3) Produces the ice chips in a soft solid state. Therefore, the ice chips do not injure fresh fish.
- 4) Quickly changes the melting points of the ice chips, and therefore responds quickly to the UT of various fish.
- 5) Is simple to operate, has a low cost and continuous production is possible.
- 6) Can be easily mounted on transportation such as trucks and ships, and therefore can easily be moved to necessary places.

The melting points of the ice chips produced by this apparatus can be -0.53°C and -1.04°C at the freezing rates (= (quantity of ice)/(quantity of ice-solution mixture)) of 0.8 and 0.9 at the salinity of 0.2wt% respectively.