

[Title of Invention]

METHOD AND APPARATUS FOR MAKING ICE USING SUPERCOOLED WATER

[Technical Field]

[0001]

This invention relates to a method and apparatus for making and storing ice, such as accumulated ice for providing a cooling source of air conditioning, sprinkler ice for indoor and outdoor skiing ground, common cooling ice and unit cooling ice.

Especially, the invention relates to an apparatus of the type in which supercooled water (below 0-degree C) generated in a supercooling vessel is transformed into ice through a cancellation (release) of its supercooled condition without being laid open in an atmosphere.

[Background Art]

[0002]

The apparatus of the type in which supercooled water is led to be melt for cancelling its supercooled condition without being laid open in an atmosphere is widely utilized. This type can protect ice against melting by blocking heat exchange with the atmosphere. And also it can protect against corrosion of the tubes and apparatus due to oxision melting into circulating water. In this type, following prior arts are well known.

[0003]

[Patent Reference 1]

In JP7-4801A, entitled "Ice making apparatus" (Japanese Patent No. 2811271), a spouting flow is directed from an outlet of a small-diameter tube to an inside of a large-diameter tube, so that the supercooled condition is cancelled by a phase-changing trigger device. In this method, a part of the supercooled water flows into an outlet tube without being circulated within the ice making apparatus, whereby it causes a problem that the process time becomes too short to reduce "residual supercooling degree", which represents a temperature difference between a solidification temperature 0-degree C and a measured temperature at the outlet of the ice making apparatus.

[0004]

[Patent Reference 2]

In JP2004-85181A, entitled "Ice water-supply apparatus", JP6-74498A, entitled "Ice making apparatus", and JP2001-241705A, entitled "Method for cancelling supercooling of water and ice making apparatus", a circulaton-flow is utilized for cancelling a supercooling condition of water through the action of water keeping and agitating, by means of trigger

materials such as air or ice-water, a thermo module, a mechanical shock unit or a supersonic element.

In these apparatus, since generated ice pieces are introduced into the central portion as the results of the circulation-flow, they cannot give a trigger action upon the supercooled water remaining near the periphery.

[0005]

[Patent Reference 3]

In JP2002-13846A, entitled "Method and apparatus for making ice by cancelling supercooling under the water", a sub-line separate from a main-line is provided for causing a circulation-flow. The inside diameter is gradually reduced like as a cone, so that the ice generated by the cancellation of the supercooled condition of the water is used as a seed ice for causing continuous cancellation of the supercooling. In this apparatus, since additional sub-line is required, it becomes a complicated construction. Further, there is a problem that the density of the ice becomes small as the flow increases.

[Disclosure of Invention]

[Problems to be solved by the Invention]

[0006]

The first purpose of this invention is to prevent supercooled water from flowing out the outlet without being treated and also prevent the residual supercooled degree from remaining at high level so as to raise the rate of making ice from the supercooled water.

The second purpose of this invention is to ensure the cancellation of the supercooling of the water so as to prevent the residual supercooled water from forming an ice wall sticking to the inside of the tube. This ice wall tends to accumulate and block the passage of the tube.

[Means for solving the Problems]

[0007]

In order to solve the above problems, according to one aspect of the present invention, there is provided a method for making ice through a cancellation of supercooling of supercooled water made within a supercooling vessel (container) without letting the supercooled water to be laid open in an atmosphere. This method comprises the steps of;

introducing supercooled water from a horizontal and tangential direction at a lower portion of a vertically arranged cylindrical riser housing,

letting a circulation-flow to cancel the supercooling of the supercooled water thereby collecting generated ice near the axis of said cylindrical housing,

passing the supercooled water and the ice by force at a condition of a jet-flow through a nozzle which is arranged near the central axis of said cylindrical housing at an upper position of said lower portion, toward a central portion of said cylindrical housing, and

letting the residual supercooling of the supercooled water to be cancelled by a convection current streaming up and down formed of said jet-flow,

whereby the most part of the supercooling of the supercooled water are cancelled by the circulation-flow and the jet-flow.

[Effect of the Invention]

[0008]

According to the ice making method of the present invention, the combination of the circulation-flow and the jet-flow effectively cancel the most part of the supercooling of the supercooled water, so that it can ensure the cancellation of the supercooling more than a conventional cancellation method utilizing the circulation-flow only.

Thus, it becomes possible to prevent supercooled water from flowing out the outlet without being treated and also prevent the residual supercooled degree from remaining at high level. Then, it can raise the rate of making ice from the supercooled water.

Further, since the cancellation of the supercooling is safely done, it can prevent the residual supercooled water from forming an ice wall sticking to the inside of the tube. This ice wall tends to accumulate and block the passage of the tube.

[0009]

According to another aspect of the present invention, there is provided an apparatus for making ice through a cancellation of supercooling of supercooled water made within a supercooling vessel without letting the supercooled water to be laid open in an atmosphere. This apparatus comprises;

a supercooling vessel for making supercooled water,

an ice making area including a vertically arranged cylindrical riser housing,

an inlet pipe for introducing supercooled water from a horizontal and tangential direction to a lower portion of said cylindrical housing,

a circulation-flow portion arranged at the lower portion of said cylindrical housing for cancelling supercooling of the supercooled water,

an ice-core generating device arranged near said circulation-flow portion for generating an ice-core forming a trigger of cancellation of the supercooling,

a jet-flow nozzle arranged near the central axis of said cylindrical housing at an upper position of said lower portion, said nozzle feeding a centrally collected mixture of ice

and water after a treatment of said cancellation by the circulation-flow toward a central portion of said cylindrical housing while selecting the ice and water,

a jet-flow portion arranged in a central position of said cylindrical housing for cancelling the supercooling of the water with ice supplied from said circulation-flow portion, said water with ice having a residual supercooling degree under the cancellation of supercooling by the circulation-flow, and

an outlet pipe for discharging water with ice which is almost free from supercooling from an upper portion of said cylindrical housing,

wherein the most part of the supercooling of the supercooled water is cancelled by the circulation-flow and the jet-flow.

[0010]

According to this apparatus, the similar effects mentioned above relating to the method of the invention are accomplished.

[0011]

As a further preferable embodiment, a phase-change intercepting element is arranged between the supercooling vessel and the inlet pipe so as to prevent a phase-change between water and ice from extending to the upstream side. This kind of element are formed by a connection such as a plastic pipe or a rubber tube having a different thermal transmittance ratio from that of the inlet pipe, or a connection by a flexible steel tube.

[0012]

In this invention, an ice-core generator is arranged near the circulation-flow portion for generating an ice-core which forms a trigger of cancellation of the supercooling. This ice-core generator is formed by aforementioned trigger materials, such as a thermo module, a mechanical shock unit or a supersonic element. By energizing these devices, the supercooling condition is cancelled.

[Best mode of carrying out the Invention]

[0013]

Fig. 1 and Fig. 2 show a preferable embodiment of an ice making apparatus of the present invention. This apparatus is a type in which supercooled water (below 0-degree C) generated in a supercooling vessel is transformed into ice through cancellation of the supercooling without being laid open in an atmosphere.

This apparatus comprises a supercooling vessel 1 for making supercooled water, an ice making area 2 including a vertically arranged cylindrical riser housing 12, a transferring pipe 3 for directing the supercooled water from the vessel 1 toward the cylindrical housing

12, an inlet pipe 4 for introducing the supercooled water from a horizontal and tangential direction to a lower portion of the cylindrical housing 12, an ice-core generator 6, and an outlet pipe 10 for discharging water with ice which is almost free from supercooling toward a water-ice pipe 11.

[0014]

The supercooling vessel 1 is a well known heat exchanger (cooler) in which, while ice making water enters an inlet pipe 13 and flows out of the transferring pipe 3, cooling liquid enters through an inlet pipe 15 and flows out of an outlet pipe 16. Thus, the ice making water is cooled to a supercooled condition (below 0-degree C) by the heat exchanging operation.

[0015]

Interior space of the cylindrical housing 12 is divided into a lower circulation-flow portion 5 and a central jet-flow portion 8 by a nozzle plate 7. At the center of the nozzle plate 7, a circular nozzle 7a is disposed. In the circulation-flow portion 5 positioned lower of the cylindrical housing 12, supercooling water coming from the inlet pipe 4 forms a circulation-flow, in which an ice-core generated by the ice-core generator and supercooled water are mixed so that the supercooling condition is cancelled.

[0016]

Preferably, between the supercooled water transferring pipe 3 of the supercooling vessel 1 and the inlet pipe 4, a phase-change intercepting element 18 made from material having a different thermal transmittance ratio from those of the pipes 3 and 4 is disposed so that it can prevent a phase-change from water to ice from extending to the upstream side. This phase-change may block the pipes 3 and 4.

[0017]

In this apparatus, an ice-core generator 6 is disposed near the circulation-flow portion 5. This ice-core generator 6 comprises aforementioned trigger materials, such as a thermo module, a mechanical shock unit or a supersonic element.

[0018]

The residual supercooled water with ice after being treated by the circulation-flow (and the ice-core generator) in which a part of the supercooling is cancelled, are forced to the upper jet-flow portion 8 through the jet nozzle 7a disposed at the center of the nozzle plate 7. In this moment, the main mixture of water and ice after partial cancellation of the supercooling by the circulation-flow is collected near the central axis, where ice is

preferentially collected based on the difference of specific gravity between water and ice. Thus, supercooled water containing many ice is selectively collected.

[0019]

In succession, in the jet-flow portion 8 forming the vertical center of the cylindrical housing 12, jet-flows containing supercooled water and ice tend to flow like convection currents as shown in Fig. 1, so that almost full of the residual supercooling are forced to be cancelled. Consequently, most of the supercooling are cancelled by the circulation-flow and the jet-flow. The ice and water having a high rate of making ice are transferred through the ice-water outlet pipe 10 toward the ice-water pipe 11.

[0020]

Fig. 3 is a graph comparing three sets of residual supercooling degree [k], which represents a temperature difference between a solidification temperature 0-degree C and a measured temperature at the outlet of the ice making apparatus, under the condition of changing the water temperature of introduced supercooling water at three temperature levels of -0.5, -1.2, and -2.0 degree C. Each residual supercooling degree is measured at the outlet of the ice making apparatus.

The result A shows the residual supercooling degree according to the present invention. The result B shows the residual supercooling degree in which only agitation by a jet-flow is applied. The result C shows the residual supercooling degree in which only agitation by a circulation-flow is applied.

Especially, under the condition in which the water temperature of introduced supercooling water is at the level of -0.5 degree C, the residual supercooling degree at the outlet of the apparatus becomes the highest, where ice tends to stick to the inside of the ice-water tube thereby blocking the passage of the tube.

According to the present invention, the residual supercooling degree [k] becomes the smallest. The supercooling is satisfactorily cancelled such that the ice does not tend to stick to the inside of the ice-water tube. Therefore, it has been proved that the residual supercooling becomes considerably low under the present invention.

[Industrial Applicability]

[0021]

As described above, according to the method and apparatus of the present invention, the combination of the circulation-flow and the jet-flow effectively cancel the most part of the supercooling of the supercooled water. It can ensure that the cancellation of the supercooling is prosecuted well than a conventional cancellation method utilizing the

circulation-flow only. Thus, it becomes possible to prevent supercooled water from flowing out the outlet without being treated and also prevent the residual supercooled degree from remaining at high level, so that it can raise the rate of making ice from the supercooled water. Further, since the cancellation of the supercooling is surely done, it can prevent the residual supercooled water from forming an ice wall sticking to the inside of the ice-water tube, which ice wall tends to accumulate and block the passage of the tube. The technical advantages of the present invention are remarkable.

[Brief description of the drawings]

[0022]

FIG. 1 is a frontal view of the ice making apparatus according to the invention.

FIG. 2 is a plan view of the apparatus of the invention.

FIG. 3 is a graph showing the results of the present invention as compared with prior arts.

CLAIM

[Claim 1]

A method for making ice through a cancellation of supercooling of supercooled water made within a supercooling vessel without letting the supercooled water to be laid open in an atmosphere comprising the steps of;

introducing supercooled water from a horizontal and tangential direction at a lower portion of a vertically arranged cylindrical riser housing,

letting a circulation-flow to cancel the supercooling of the supercooled water thereby collecting generated ice near the axis of said cylindrical housing,

passing the supercooled water and the ice by force at a condition of a jet-flow through a nozzle which is arranged near the central axis of said cylindrical housing at an upper position of said lower portion, toward a central portion of said cylindrical housing, and

letting the residual supercooling of the supercooled water to be cancelled by a convection current streaming up and down formed of said jet-flow,

whereby the most part of the supercooling of the supercooled water are cancelled by the circulation-flow and the jet-flow.

[Claim 2]

An apparatus for making ice through a cancellation of supercooling of supercooled water made within a supercooling vessel without letting the supercooled water to be laid open in an atmosphere comprising

a supercooling vessel for making supercooled water,

an ice making area including a vertically arranged cylindrical riser housing,

an inlet pipe for introducing supercooled water from a horizontal and tangential direction to a lower portion of said cylindrical housing,

a circulation-flow portion arranged at the lower portion of said cylindrical housing for cancelling supercooling of the supercooled water,

an ice-core generating device arranged near said circulation-flow portion for generating an ice-core forming a trigger of cancellation of the supercooling,

a jet-flow nozzle arranged near the central axis of said cylindrical housing at an upper position of said lower portion, said nozzle feeding a centrally collected mixture of ice and water after a treatment of said cancellation by the circulation-flow toward a central portion of said cylindrical housing while selecting the ice and water,

a jet-flow portion arranged in a central position of said cylindrical housing for cancelling the supercooling of the water with ice supplied from said circulation-flow portion,

said water with ice having a residual supercooling degree under the cancellation of supercooling by the circulation-flow, and

an outlet pipe for discharging water with ice which is almost free from supercooling from an upper portion of said cylindrical housing,

wherein the most part of the supercooling of the supercooled water is cancelled by the circulation-flow and the jet-flow.

[Claim 3]

An ice making apparatus as claimed in claim 2, in which a phase-change intercepting element is disposed between said supercooling vessel and said inlet pipe so as to prevent a phase-change from extending to the upstream side.