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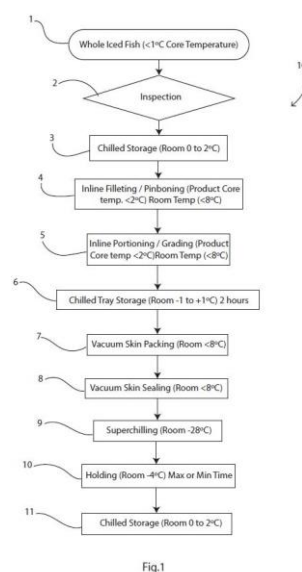
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### (54) PROCESS FOR SHELF-LIFE EXTENSION OF FISH

(57) A process for treating and packaging fish comprising the steps of receiving (1) and inspecting fish at a point of intake; chilling (2) the fish; and filleting and portioning (4) the fish. The process includes holding (6) the fileted and portioned fish in bulk production trays in an environment of -1°C to +1°C; followed by packing (7) the portions to provide a package which is vacuum skin sealed (8, 101), wherein the fish is vacuum skin packed by placing the portions in a retail individual-product tray and covered with a skin film, and sealing with a vacuum pressure of less than 5mBar. The packages are super-chilled in a super-chill stage (9, 200), to a temperature in the range of -4°C to -2°C during a time duration in the range of 45mins to 180mins. The super chilling is implemented by delivering air with a temperature in the range of -25°C to -30°C to the packages. The method finally includes storing (10) the packages in a chill hold environment at a temperature of -6°C to -1°C; and despatching the packaged fish portions for transport to retailers. The packages have a shelf life up to 12 days arising from the combination of steps in the process. <Figure 1>



“Process for shelf-life extension of fish”

INTRODUCTION

5     Field of the Invention

The invention relates to a process for treating and packaging fresh fish, with the aim to increase the shelf life of the product.

10    Currently, fish which has been vacuum packed and conventionally chilled can have a shelf life of up to several days, whilst retaining its freshness.

US2002012724 describes a process for filleting and treating fish.

15    JPH0838035 describes a method for carrying out dehydration, packing, chilled refrigeration, processing and transportation of fresh fish.

20    CA998973 describes a method of chilling fish, in which there is super-chilling, to provide a product in which chilled fish portions are stored in an insulated carton that can be formed from polystyrene, and the top section of the carton is snowed with dry ice over a membrane which prevents the fish portions from freezer-burn.

GB1029550 describes a method of preserving chicken products by deep chilling.

25    The invention is directed towards extending the shelf life of fish, whilst retaining the freshness of the produce. Particularly, the invention is directed towards providing an improved process of preparing a fish product with a long shelf life, preferably up to about 12 days, with the ability to ship the product in a consumer-friendly package in which the product is presented in a manner which is visible and ready for sale.

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SUMMARY OF THE INVENTION

The invention is as set out in the attached claims.

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We describe process for treating and packaging fish comprising the steps of:

- (a) receiving and inspecting fish at a point of intake;
- (b) chilling the fish;
- (c) fileting and portioning the fish to provide fish portions;
- 5 (d) holding the portions in bulk production trays in an environment of  $-1^{\circ}\text{C}$  to  $+1^{\circ}\text{C}$ ;
- (e) packing one or more of the portions to provide a package which is vacuum skin sealed, wherein the portions are vacuum skin packed by placing the portions in a retail individual-product tray and covered with a skin film, and sealing with a vacuum pressure of less than 5mBar, and repeating said packing steps for a plurality
- 10 of packages;
- (f) in a super-chill stage, chilling said packages to a temperature in the range of  $-5^{\circ}\text{C}$  to  $0^{\circ}\text{C}$  during a time duration in the range of 45mins to 180mins, the super-chilling being implemented by delivering air with a temperature in the range of  $-25^{\circ}\text{C}$  to  $-30^{\circ}\text{C}$  to the packages for said duration;
- 15 (g) storing the packages in a chill hold environment at a temperature of  $-6^{\circ}\text{C}$  to  $-1^{\circ}\text{C}$ ; and
- (h) despatching the packages as fish products for transport to retailers.

Preferably, the fish is transferred to a chill room, from the point of intake, for the chilling step

20 (b). Preferably, said chill room environment temperature is in the range of  $0^{\circ}\text{C}$  to  $2^{\circ}\text{C}$ .

Preferably, for step (c) the fish is transferred to a fileting stage from the chill room, wherein the fish is fileted in said fileting stage in a room environment temperature of less than or equal to  $8^{\circ}\text{C}$ . Preferably, for step (c) the fish is transferred to a portioning stage from the fileting stage,

25 wherein the fish is portioned in a portioning stage room environment temperature of less than or equal to  $8^{\circ}\text{C}$ .

Preferably, for step (e) the portions are vacuum skin packed within 10 minutes of leaving the chill environment of step (d) by placing the portions in a thermoformed retail product tray which

30 is covered immediately with the skin film, and sealed with a vacuum pressure of less than 5mBar.

Preferably, the super-chilling of step (f) is implemented by delivering air in the range of  $-25^{\circ}\text{C}$  to  $-30^{\circ}\text{C}$  to the fish for a cycle time of approximately 60 minutes. Preferably, the super-chill air is

35 delivered at approximately  $-28^{\circ}\text{C}$ .

Preferably, the super-chill stage is implemented in a spiral chilling chamber, having a closed environment within which air is circulated vertically through a spiral-mesh open conveyor holding the packages and is cooled by a heat exchanger which draws air in and delivers it between heat exchanger or evaporator plates. Preferably, the coolant for the heat exchanger or evaporator coolant is ammonia, and the coolant temperature is in the range of -30°C to -38°C. Preferably, the packages are super-chilled in order to reach a fish core temperature in the range of -4°C to -2°C.

Preferably, for step (f) the cooling air flow rate is in the range of 2.5m/s to 4.0 m/s. Preferably, the chill hold environment temperature of step (g) is approximately -4°C.

Preferably, for step (g) the packages are held in the holding room for approximately 20 to 30 hours. Preferably, the super-chilled fish packages are transported, after step (h), in a chilled environment with a temperature in the range of approximately 0°C to 2°C.

We also describe a fish package product whenever produced by a process of any preceding claim.

We also describe a process for treating and packaging fish comprising the steps of:

- (a) receiving and inspecting fish at a point of intake;
- (b) chilling the fish;
- (c) fileting and portioning the fish, and packing the portions in a package which is vacuum skin sealed;
- (d) in a super-chill stage chilling the packaged fish to a temperature in the range of -6°C to 0°C during a time duration in the range of 45 mins to 180 mins; and
- (e) storing the chilled vacuumed skin packages in a chilled hold environment.

In one embodiment, the fish is transferred to a chill room, from the point of intake, for the chilling step (b). In one embodiment, the chill room environment temperature is in the range of 0°C to 2°C. In one embodiment, the fish is transferred to a fileting stage from the chill room, wherein the fish is fileted in a room environment temperature of less than or equal to 8°C. In one embodiment, the fish is transferred to a portioning stage from the fileting stage, wherein the fish is portioned in a room environment temperature of less than or equal to 8°C.

In one embodiment, the fish is transferred to a chilled tray storage area wherein the fish is chilled during a further chill stage, on trays in a chilled room temperature of -1 to +1°C. In one embodiment, the fish is vacuum skin packed by placing the portions in a thermoformed tray and covered immediately with a skin film, and sealing with a vacuum pressure of less than 5mBar, and the vacuum skin packed portions are transferred to the super-chill stage.

In one embodiment, the super-chilling is implemented by delivering air in the range of -25°C to -30°C to the fish for a cycle time of approximately 60 minutes. In one embodiment, the super-chill air is delivered at approximately -28°C.

In one embodiment, the super-chill stage is implemented in a spiral chilling chamber, having a closed environment within which air is circulated vertically through a spiral-mesh open conveyor holding the packages and is cooled by a heat exchanger which draws air in and delivers it vertically between heat exchanger or evaporator plates. In one embodiment, the coolant for the heat exchanger or evaporator is ammonia, and the coolant temperature is in the range of -30°C to -38°C.

In one embodiment, the fish is super-chilled in order to reach a fish core temperature in the range of -5 to 0°C. In one embodiment, the fish is super-chilled in order to reach a fish core temperature in the range of -4 to -2°C.

In one embodiment, the chill hold environment temperature of step (e) is in the range of -6 to -1°C. In one embodiment, the chill hold environment temperature of step (e) is approximately -4°C. In one embodiment, for step (e) the fish is held in the holding room for approximately 20 to 30 hours. In one embodiment, the packaged and super-chilled fish is transported, after step (e), in chilled storage with a temperature in the range of approximately 0 to 2°C.

## DETAILED DESCRIPTION OF THE DRAWINGS

### Brief Description of the Drawings

The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only with reference to the accompanying drawings in which:

Fig. 1 is a flow diagram of the process of the invention;

Fig. 2 is a side view of a vacuum skin packed fish portion;

Fig. 3 is a diagrammatic view showing the super-chilling process in more detail,

Fig. 4 is a plot showing core product temperature during super-chilling; and

Fig. 5 is a plot of Total Viable Colony Forming Units (TVC) for sample salmon products, illustrating shelf life arising from the described process.

### Detailed Description

Referring to Fig. 1, a flow chart of a process 100 of the invention is illustrated. The process 100 has an initial stage 1 whereby whole iced fish is received in the process factory; at this stage the fish has a core temperature of less than 1°C. The fish is then weighed and inspected in stage 2 of the process. The fish is quality checked for colour, size and freshness. Freshness is detected by an organoleptic meter, in this case of the type known as a "Torrymeter".

The fish which has passed the quality checks is subsequently transferred to chilled storage in stage 3 of the process. In this stage the room temperature is 0°C to 2°C and the produce is temporarily stored here.

Following this, the fish is transferred to a filleting area 4, where the fish is filleted, washed and trimmed to specification. This may include the fish being pin boned, inspected, washed and packed into blue food grade liners. The fish is then transferred to a portioning stage 5. During the portioning stage 5 the fish is cut into the relevant portions with sizes required for sale. Each of the portions are automatically weighed and graded for sale. The room temperature is less than or equal to 8°C and the core temperature of the fish is less than 2°C for both the filleting and portioning stages.

The portions are then placed on production handling trays and transferred to a chilled storage room 6 which is at a temperature of approximately -1°C to +1°C for a minimum of 2 hours. This is a wait zone before the fish is vacuum skin packed in stages 7 and 8.

In stage 7, the one or more of portions are placed in a thermoformed tray, and covered immediately with a layer of skin film to provide a fish package. The thermoformed tray may consist of an EVOH layer and/or A-PET PE material. The skin film comprises a base web and a top layer web of EVOH top layer A-PET material; the base web is approximately 300  $\mu\text{m}$  to 500  $\mu\text{m}$  in thickness and the top web is approximately 80  $\mu\text{m}$  to 120 $\mu\text{m}$  in thickness. Air is substantially removed between the thermoform tray and the skin seal so as to create a vacuum, to an extent of less than 5mBar pressure. This is carried out within 10 minutes of leaving the chill room.

10 In stage 8, the thermoformed tray and skin film are subsequently sealed to complete the vacuum skin packaging of the fish portions to provide the packages.

This results in a vacuum skin-sealed package containing the individual fish product, as it would be viewed by the end customer, to be sold as an individual product. The process as described below achieves treatment of this fish package product in a manner allowing it to leave the factory and be shipped to a retail destination, which may be overseas, with a shelf life of up to 12 days. This is achieved without need to contain the product in an insulating container in the retail environment. Moreover, it is achieved in a manner which does not require additional handling insulation and chilling procedures for shipment in addition to what is conventional.

20 The environment or room temperature for stages 7 and 8 is less than or equal to 8°C. This temperature level is important as it is a requirement for employees to have a level of comfort for working in, without affecting the core temperature of the fish.

25 Stage 8 is performed directly after stage 7 and both stages can be performed together in the one machine.

Referring to Fig. 2, an example package 101 is shown in side profile. The skin film 102 vacuum surrounds the fish portion F, flush to the edges of the fish portion and without any gaps, and is sealed to the tray 103.

The fish core temperature during the stages 7 and 8 is approximately 4°C. The fish core temperature is maintained substantially constant during the packaging stages 7 and 8.

Before the skin film is applied, marinades or sauces may be added to the fish if required.

Following the completion of the vacuum skin packing of the fish, each package is lead straight and transferred to a super-chilling stage in step 9. In the super-chilling stage 9, the packaged fish is chilled using forced air flow at an air temperature of approximately  $-28^{\circ}\text{C}$  for a cycle time of approximately 60 mins in total with the end point to achieve a fish core temperature of  $-2^{\circ}\text{C}$  to  $-4^{\circ}\text{C}$ . Preferably, the fish core temperature should not decrease below  $-4^{\circ}\text{C}$  as this would cause excessive crystals to form. The fish product can have up to approximately 30% crystals, having crystals in excess of this is not advantageous. The duration of super-chilling can be in the range of 45 mins to 180 mins, but the upper end of this range would only be required where the fish product is large, in excess of 1kg. Typically, and preferably, the time for super-chilling is in the range of 50 mins to 80 mins for most fish product sizes.

Referring to Fig. 3, the super-chilling of the packages is achieved by spiral chilling using an apparatus 200. An inlet wire conveyor 210 enters and moves through a spiral configuration or path 220 with approximately 40 levels, and the outlet conveyor 230 delivers the chilled fish packages to a delivery area, not shown. The packages are vacuum skin sealed as shown, and are placed on the conveyor at a spacing of about 50:50 with the gaps being approximately equal to the longitudinal dimension of the products. The chilling is implemented by a heat exchanger 250 having a fan inlet 260 which draws in air within the (sealed) room and forces it upwardly through plate heat exchanger elements 265 which carry ammonia ( $\text{NH}_3$ ) coolant. The coolant enters at about  $-35^{\circ}\text{C}$  and exits at the air outlet temperature of about  $-28^{\circ}\text{C}$ . The flow rate of the fan inlet 260 and the flow rates and the temperature of the ammonia ( $\text{NH}_3$ ) coolant are calibrated so as to deliver air at a temperature of  $-28^{\circ}\text{C}$  at 3.5 metres per second. The cooled air is directed upwardly and across within the confines of the room and downwardly through the spiral paths, being able to pass through the conveyor mesh turns due to the open wire configuration and the spaces around the products.

The cooling air flow rate is preferably in the range of 2.5m/s to 4.0 m/s, and as noted above a rate of about 3.5m/s has been found to be particularly effective.

While the super-chilling air temperature is in this case  $-28^{\circ}\text{C}$ , it is envisaged that it may be advantageously elsewhere in the range of  $-25^{\circ}\text{C}$  to  $-30^{\circ}\text{C}$ .

Fig. 4 illustrates an example temperature profile for a duration of approximately one hour, showing a reduction in product core temperature from about 2° C to about -2.7°C during this period. These measurements were made with measured by a temperature recorder of type having a needle probe inserted in the product and a lead to an external data logger which travels with the product. In this case the recorder used was a LogTag® TRED30-7 temperature recorder.

The heat exchanger 250 has a 355kW compressor and the fan has a 30kW rating with a speed of 2800 rpm to deliver air at a temperature of -28°C at 3.5 metres per second. By using a spiral chiller, each portion of fish has good contact with the super cold air being supplied to chill the fish.

The packaged fish is then transferred to a holding room where the room temperature is preferably approximately -4°C, but can be elsewhere in the range of -6°C to -1°C. This is to provide wait time before the product is required to be transported to retailers.

Finally, the product is transported to the retailers. It is in a chilled environment of approximately 0 to 2°C. The transport chilling and retail chilling arrangements are conventional for chilled products. However, due to the overall process described above an extended shelf life of up to 12 days is achieved, without need for any special transport, retail storage, or product container requirements.

It has been found by the inventors that by using this process, the shelf-life of the fish can increase to up to 12 days from the point of intake. This is a significant improvement on the current industry standard of approximately 9 days.

Further, the inventors have found that they are able to achieve this level of shelf-life and freshness with an environment temperature of less than or equal to 8°C for several of stages. This provides a better work environment for employees without compromising on the quality of the produce.

Referring again to Figs. 4, this illustrates the fish core temperature profile during super-chilling, showing the effectiveness of the super-chilling stage. This is at the core of the overall process. However, the other stages are particularly advantageous in combination, especially:

Initial QC, filleting, and chill room.

Production tray storage in range of  $-1^{\circ}\text{C}$  to  $+1^{\circ}\text{C}$ .

Sealing individual portions. This is particularly effective if the sealing is skin sealing as described, particularly with a pressure of less than 5mBar to provide the final end product configuration at this early stage in the process. However, it is envisaged that the sealing may not be skin sealing, rather the fish product is placed on a retail tray and a membrane is applied across the top of the container without any or without significant contact between the film and the product. In this case, the fish product will have the benefits of the process as described except the skin sealing aspect.

Super-chilling with air at about  $-28^{\circ}\text{C}$  to achieve a fish core temperature of  $-4^{\circ}\text{C}$  to  $-2^{\circ}\text{C}$ , while in the end-product packaging.

Chill hold environment of  $-6^{\circ}\text{C}$  to  $-1^{\circ}\text{C}$  before transport to the retailer.

Due to the above process, the transport and retailer handling chill requirements are conventional, and an extended shelf life of up to 12 days is achieved.

Referring to Fig. 5 this illustrates graphically the quality of the fish product over this shelf life. The vertical axis is Total Viable Colony Forming Units. From this it will be seen that the bacterial count is kept very low over this extended period. This plot of data was obtained based on results averaged from a cumulative total of 19 samples, using ISO4833-1:2013 (Microbiology of the food chain – Horizontal method for the enumeration of microorganisms – Part 1: Colony count at  $30^{\circ}\text{C}$  by the pour plate technique).

In practical terms, this means that the product may be processed at a location such as the west of Ireland, near the port of landing, and shipped abroad to retailers in Europe.

The invention is not limited to the embodiments described but may be varied in construction and detail. For example, as noted above the process may be as described except that the product sealing is not skin sealing, but is instead covered by a film across the top of retail tray or container. The product is in this case still retail-ready and individually packed, but the film is not in contact with a significant part of the surface of the product as it is in Fig. 2.

## Claims

1. A process for treating and packaging fish comprising the steps of:
  - (a) receiving (1) and inspecting fish at a point of intake;
  - (b) chilling (2) the fish;
  - (c) fileting and portioning (4) the fish, to provide fish portions;
  - (d) holding (6) the portions in bulk production trays in an environment of  $-1^{\circ}\text{C}$  to  $+1^{\circ}\text{C}$ ;
  - (e) packing (7) one or more of said portions to provide a package which is vacuum skin sealed (8, 101), wherein the portion or portions are vacuum skin packed by being placed in a retail individual-product tray and covered with a skin film, and sealing with a vacuum pressure of less than 5mBar to provide a package, and repeating said packing steps for a plurality of packages;
  - (f) in a super-chill stage (9, 200), chilling said packages to a temperature in the range of  $-5^{\circ}\text{C}$  to  $0^{\circ}\text{C}$  during a time duration in the range of 45mins to 180mins, the super-chilling being implemented by delivering air with a temperature in the range of  $-25^{\circ}\text{C}$  to  $-30^{\circ}\text{C}$  to the packages for said duration, wherein the super-chilling step (f) is performed by spiral chilling with an inlet wire conveyor (210) entering and moving the packages through a spiral path (220), in which the packages are placed on the conveyor at a spacing and the chilling is implemented by a heat exchanger (250) having a fan inlet (260) which draws in air within a room and forces it upwardly through plate heat exchanger elements (265) which carry coolant, and in which cooled air is directed upwardly and across within the confines of the room and downwardly through the spiral path;
  - (g) storing (10) the packages in a chill hold environment at a temperature of  $-6^{\circ}\text{C}$  to  $-1^{\circ}\text{C}$ ; and
  - (h) despatching the packages as fish products for transport to retailers.
2. A process as claimed in claim 1, wherein for step (c) the fish is transferred from the chill room to a fileting stage with a room environment temperature of less than or equal to  $8^{\circ}\text{C}$ ; and the fish is transferred from the fileting stage to a portioning stage at which the fish is portioned in a room environment temperature of less than or equal to  $8^{\circ}\text{C}$ .

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3. A process as claimed in claims 1 or 2, wherein for step (e) the fish portions are vacuum skin packed within 10 minutes of leaving the chill environment of step (d) by placing the portions in a thermoformed retail product tray which is covered immediately with the skin film, and sealed with a vacuum pressure of less than 5mBar; and wherein the super-chilling of step (f) is implemented by delivering air in the range of -25°C to -30°C to the packages for a cycle time of approximately 60 minutes.
4. A process as claimed in any preceding claim, wherein the packages are super-chilled in step (f) in order to reach a fish core temperature in the range of -4°C to -2°C; wherein the chill hold environment temperature of step (g) is approximately -4°C; and wherein the packages are transported, after step (h), in chilled environment with a temperature in the range of approximately 0°C to 2°C.
5. A fish package product whenever produced by a process of any preceding claim.

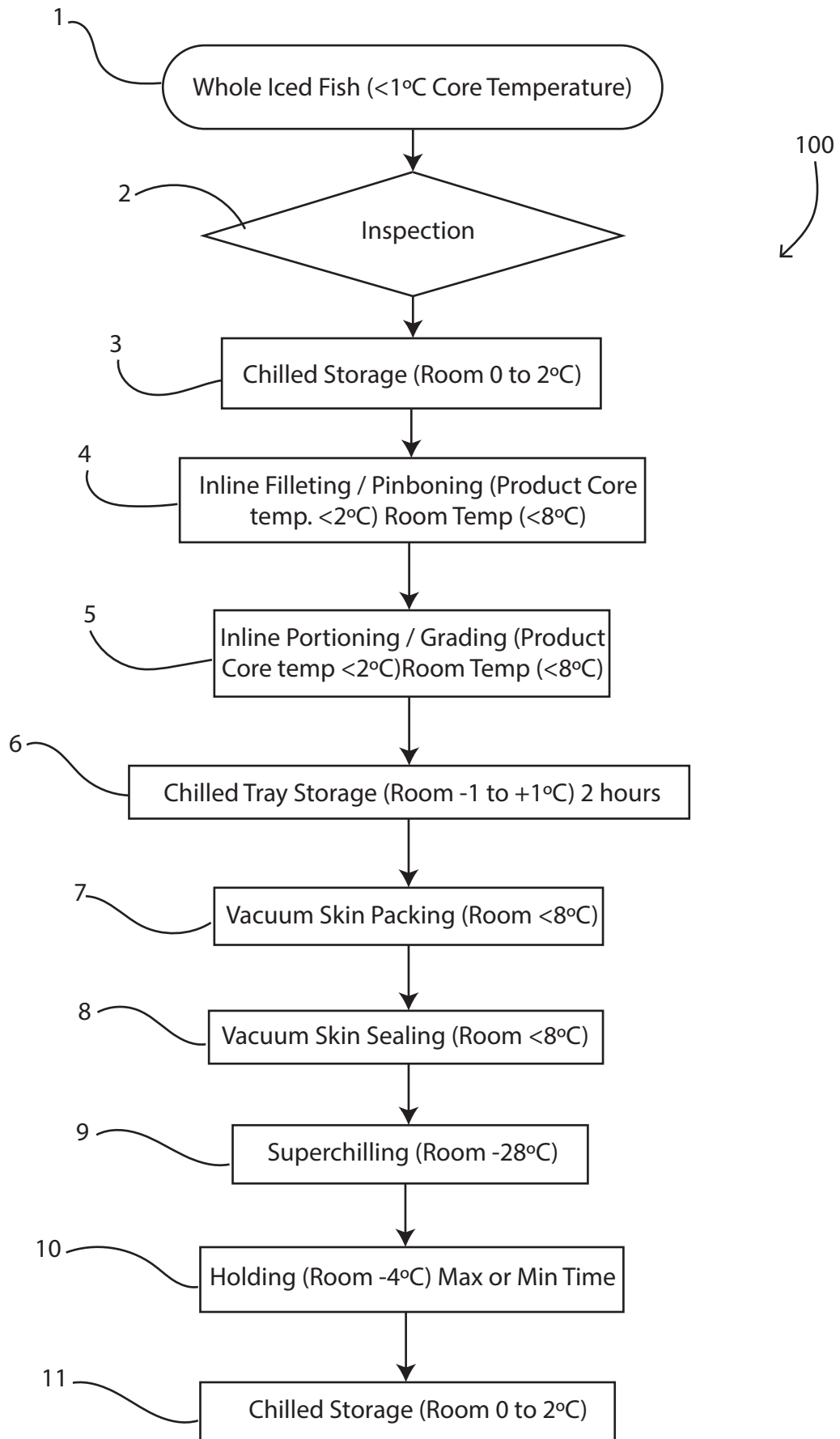


Fig.1

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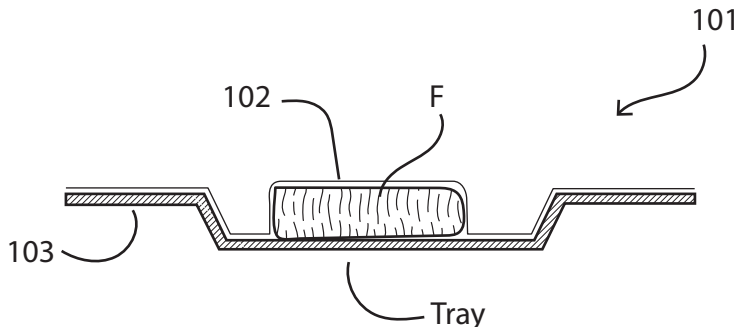


Fig.2

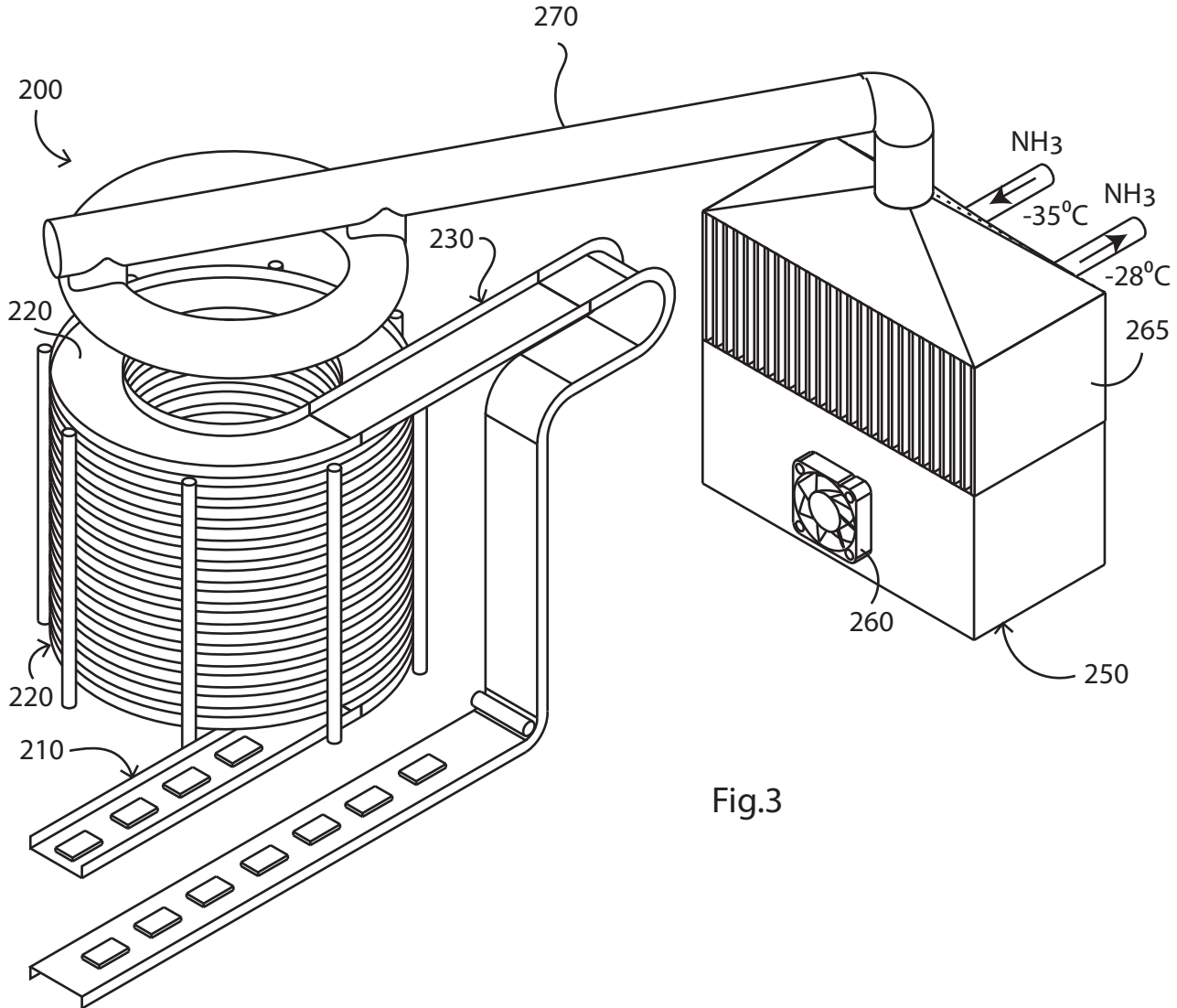
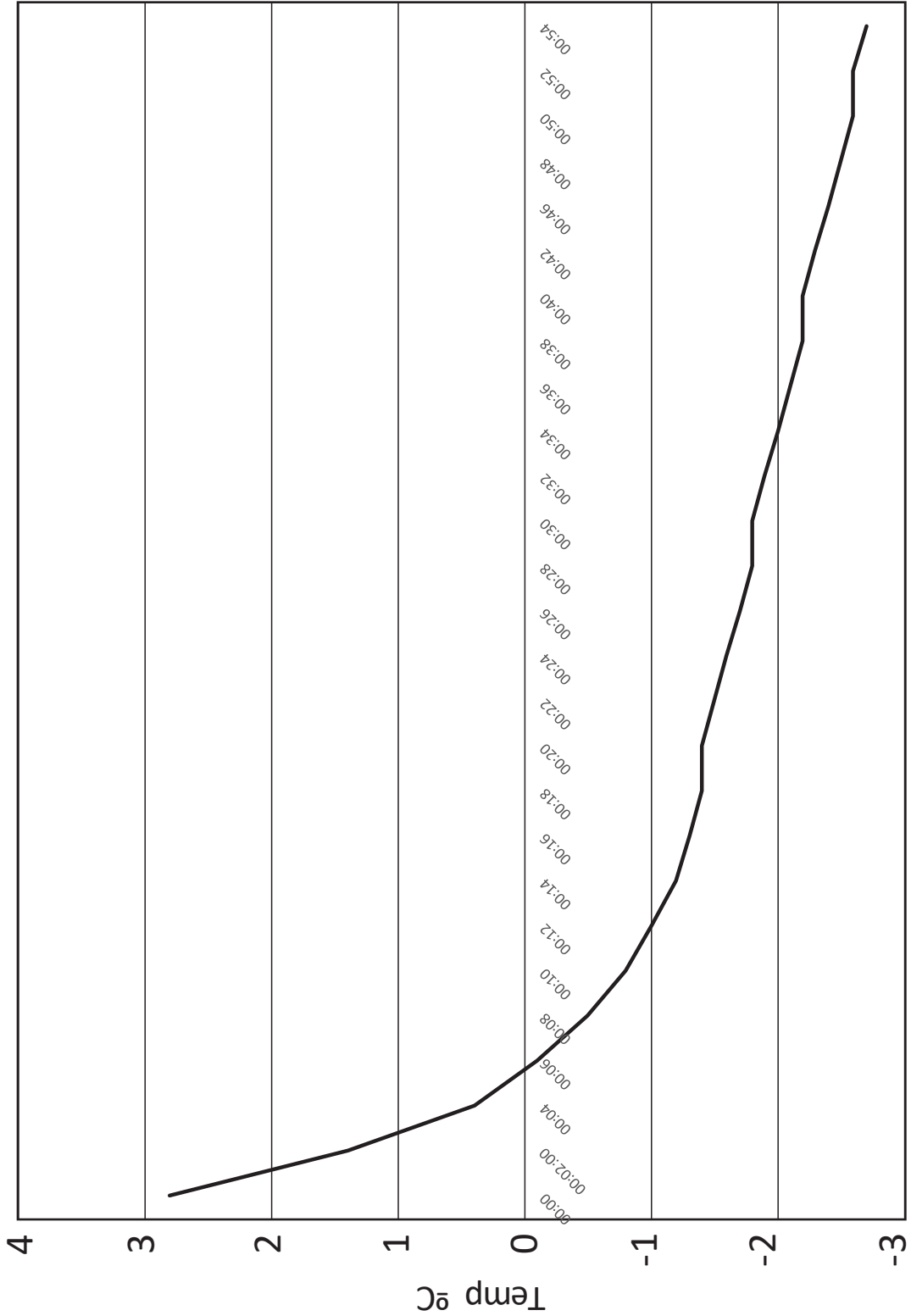


Fig.3

Suprachilling



Mins

Fig.4

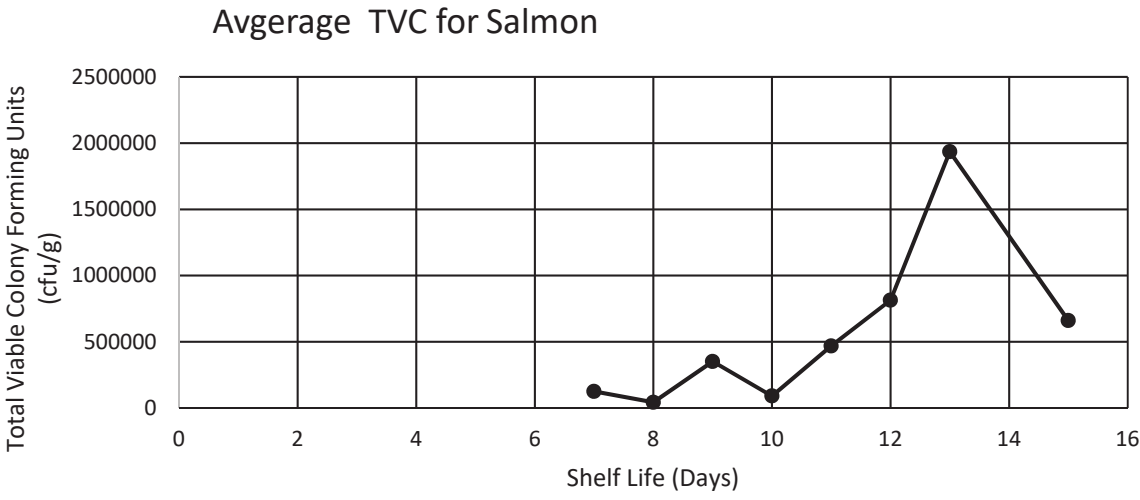


Fig.5