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Unit Operations in Fish Canning



Major operations

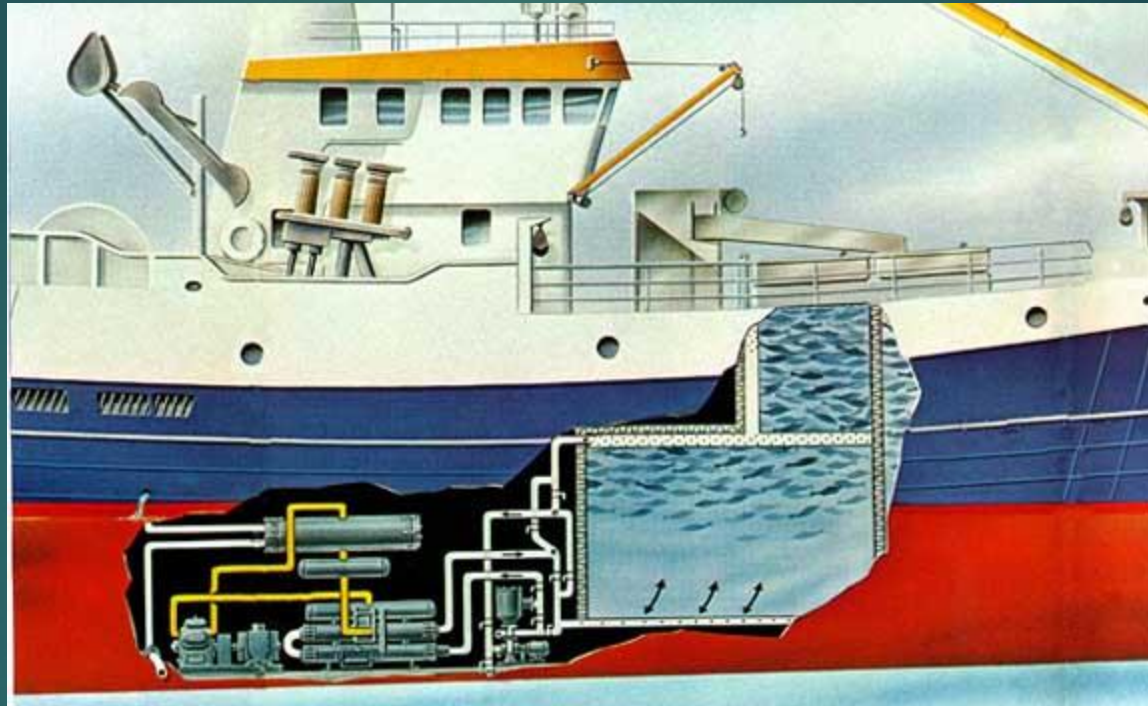
- ▶ Raw material handling
- ▶ Precooking
- ▶ Filling
- ▶ Exhausting
- ▶ Seaming
- ▶ Retorting
- ▶ Post-process handling

Raw material handling

- ▶ Eliminate fish with high bacterial load
- ▶ Do not expose fish to high temperature
- ▶ Choose fish from same lot
- ▶ Temporary storage of fish
 - ▶ Sprinkle salt (not for sardines)
 - ▶ RSW or CSW (4-6h)
 - ▶ Ice (8-10h)
 - ▶ Freeze in bulk/cold storage



RSW



Grading

Based on

- ▶ Quality
- ▶ Size – Sardines and shrimps
- ▶ Species
- ▶ Colour – Salmon (pink), tuna (white)
- ▶ Automatic grading machine - thickness

Fish Grading Machine



Pre-treatment

▶ Dressing includes

Scaling, heading, evisceration, filleting, skinning, butchering, bleeding

▶ Dressing yield

▶ Finfish 70-75%, Shrimps 40-50%, Oysters 10%

▶ Beheading


▶ Straight cut (reduced yield), 'V' cut (more yield)

▶ Machines available

▶ Filleting

▶ Removal of complete musculature from each side

▶ Machine or manual

- 
- ▶ Skinning
 - ▶ Machine
 - ▶ Descaling
 - ▶ Machine or manual
 - ▶ Washing
 - ▶ Soaking
 - ▶ Agitation
 - ▶ Drum wash
 - ▶ Spray wash (Economical)
 - ▶ Size cutting

Blanching

- ▶ Soaking in conditioning or flavouring agents
 - ▶ Removes blood and slime
 - ▶ Improves texture and taste
 - ▶ Give shiny appearance
 - ▶ Condition fish for processing

- ▶ **Cold blanching**

Soaking in sat. NaCl (15-25%) to improve texture and flavour. **eg. sardines**

- ▶ **Hot blanching**

Heating in low strength NaCl. It inactivates enzymes and prevent discoloration **eg. prawns and vegetables**

Blanching...

- ▶ **Acidification** with citric acid
 - ▶ Prevent natural compound formation
 - ▶ Prevent discoloration and off flavour

Precooking

- ▶ Steam, water, oil, hot air or smoke
 - ▶ Partially dehydrates flesh – shrinkage (easy filling)
 - ▶ Removes natural oils having strong odours
 - ▶ Reduce oil-water emulsion
 - ▶ Clean raw material and reduce bacterial load
 - ▶ Coagulates fish protein and loosen meat from frame
 - ▶ Expel respiratory gases from tissues
 - ▶ Give desirable texture and flavour
 - ▶ Inactivates enzymes that cause discoloration

Precooking...



- ▶ **Precooking loss** - water release from protein
Fish (15-30%); Tuna (17-18%)
Sardines (19-34%)
- ▶ **Moisture 60%** - ideal for canning
- ▶ **Lobster and Crab**
 - ▶ To coagulate protein
 - ▶ To break tissue
- ▶ **Oysters and Clams**
 - ▶ To kill the animal
 - ▶ To help to open the shell

Precooking...

- ▶ Flesh loss 10% - due to leaching of soluble proteins and nutrients
- ▶ **Prevention**
 - ▶ CMC and tripolyphosphate (1%) reduce 20-40%
 - ▶ Steam cooking
- ▶ **If under blanching?**
 - ▶ Water dissolves protein
 - ▶ Cloudiness of brine due to oil-water emulsion
- ▶ **If over cooking?**
 - ▶ Affect colour, flavour, texture

Precooking...

▶ Two types

1. Before – Steam cook and pack (Tuna)
2. After – Pack and precook (Sardines)

▶ Precooking after packing is good. Why?

- ▶ Minimize handling
- ▶ While draining avoid spilling

▶ Precooking before packing

- ▶ Arrange fish in griller and cook
- ▶ Cool and air dry (vacuum drying preferable)
- ▶ Aids oil absorption

Precooking...

▶ Shrimps

Hot blanched/ precooked after packing

▶ Sardines and mackerel

Cold blanched/ precooked in steam

▶ Tuna

Precooked in steam under pressure and salt added while filling

▶ Sardines/ shellfish

Cold blanched/ Smoke before canning

Filling

- ▶ Before filling

Clean can to remove dust, dirt, salt ZnCl_2 used as flux

- ▶ Filling

- ▶ Fill correct weight

- ▶ Leave uniform headspace (4-6 mm)

- ▶ Maintain correct solids to liquid ratio

Types of Filling

▶ Hand filling

- ▶ Labour consuming (In sardine cannery, 53% filling; 37% dressing; 2% precooking; 7% finishing)
- ▶ Give neat product
- ▶ Suitable for high value fish

▶ Machine filling

- ▶ Deliver certain volume rather than weight
- ▶ Suitable for sardines, tuna and salmon

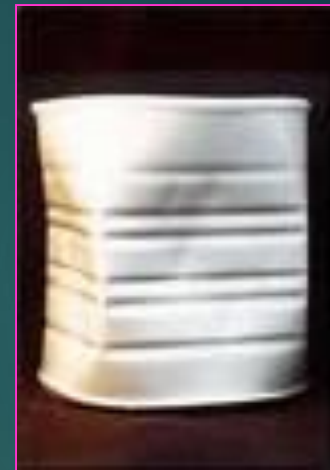
Machine Filling of Cans



Effects of Filling

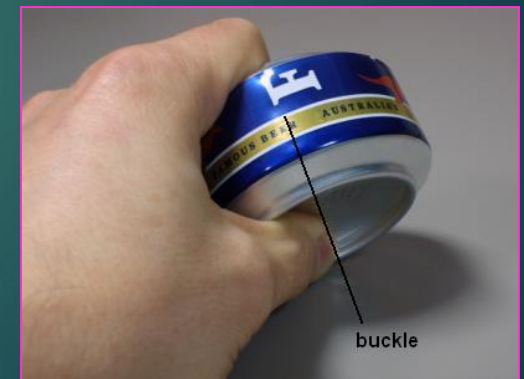
▶ Under filling (PANELLING)

- ▶ Container will force inward due to low pressure ie. high vacuum
- ▶ Create problem in labeling
- ▶ Excess air accelerate container corrosion



▶ Over filling (BUCKLING)

- ▶ Container bulge due to low vacuum
- ▶ Difficult to add additives
- ▶ Cause deformities
- ▶ Create microbial spoilage appearance



Additives

▶ Brine

- ▶ Common additive
- ▶ 3% salt solution or salt pellets
- ▶ Uniform penetration takes 3 days
- ▶ Enhance flavour
- ▶ Reduce curd formation (salmon/mackerel)



▶ Oil

- ▶ Principle additive
- ▶ Vegetable oil – olive, cottonseed, sunflower
- ▶ Penetration takes 18-20 days
- ▶ Mechanical oil dispenser
- ▶ Suitable for sardines, herring, tuna



Additives

▶ Tomato sauce

- ▶ Suitable for oil sardine and mackerel
- ▶ 28-30% of solid content
- ▶ Should not lose color



▶ Others

- ▶ Carboxy methyl cellulose (CMC)
- ▶ Mono sodium glutamate (1.6g/kg) with sugar and salt
- ▶ Sugar vegetable
- ▶ Spices



Exhausting

- ▶ Create partial vacuum before sealing
- ▶ Remove air from content and head space
- ▶ Avoid excessive strain on the seam
- ▶ Removes oxygen - prevent internal corrosion and rancidity
- ▶ Provide concave appearance due to vacuum

Methods of Exhausting

- ▶ Three methods – Heat, Mechanical, Steam
- ▶ Heat exhausting
 - ▶ Heat the can contents before sealing
 - ▶ Air expels, contents expand and water vapour replace air in headspace, seal and cool
 - ▶ Amount of vacuum depends on sealing temperature

EXHAUST BOX

- ▶ Cold fill the can, pass through steam exhaust with clinched ends before sealing
- ▶ **Clinching** – Can ends partially secured to the can body by single seam on opposite side, keeping the end sufficient to allow escape of air
- ▶ Heat exhausting good for **vacuum pouches**





▶ Mechanical exhausting

- ▶ Fill cold material
- ▶ Seal using vacuum sealing
- ▶ Suitable for cans
- ▶ Not suitable for flexible pouches

because partial vacuum collapse the pouch and prevent further escape of air

- ▶ Two stage sealing for flexible pouches
- ▶ First seal small area, draw vacuum and seal finally



▶ Steam exhausting

- ▶ Blast of air injected into headspace through ports around seaming head of double seamer
- ▶ Steam blows air away and create vacuum
- ▶ Effective for products packed in liquids
- ▶ Reliable exhausting temp 60-70°C

Sealing

CANS

- ▶ To restrict microorganism entry
- ▶ Done by double seamer
- ▶ Delay leads to loss of vacuum

POUCHES

- ▶ Fuse two thermoplastic materials by heat
- ▶ Using heated pressure plates or jaws (Hot bar sealing or Impulse sealing)



Double seaming

- ▶ Hermetic seal between can body and can end
- ▶ Done by two seaming rolls and chuck
- ▶ **Cover hook** - First edges folded, outer ridge curl around lid
- ▶ **Body hook** - Cover hook compress and flatten to 5 thickness metal towards body wall

Can washing

- ▶ Wash the spilled oil, brine or sauce from can
- ▶ Use mild soap or detergent (trisodium polyphosphate 1% at 80°C)
- ▶ **Washing schedule**
 - Prewash – Spray FW at pressure
 - Wash – Spray mild detergent
 - Rinse – Spray with FW
- ▶ **If no can washing**
 - ▶ Contaminants clog the retort
 - ▶ Problem in labeling
 - ▶ Rusting or corrosion due to loss of lacquer

Thermal processing

- ▶ Heat sealed can for a predetermined period at a predetermined temperature in

Saturated steam

Mixture of steam and air

- ▶ Heating medium depends on type of package
- ▶ **Glass/pouch** – Superheated water with air over pressure
- ▶ **Metal container** – Saturated steam

Aim of thermal processing

- ▶ Cook the food
- ▶ Destroy chemical enzyme
- ▶ Destroy microorganisms causing spoilage
- ▶ Achieve commercial sterility
- ▶ Elimination of spores of *Clostridium botulinum*, capable of producing toxin at anaerobic condition



- ▶ **Statistical sterility**

- ▶ Complete destruction of microorganisms – sterilization

- ▶ **Commercial sterility**

- ▶ Destruction of the growth of viable microorganism of public health significance and reproduction of microorganism of no public health significance

Thermal processing



- ▶ Time–temperature combinations influenced by
 - ▶ Acidity of foods
 - ▶ No. and type of microorganism and their heat sensitivity
 - ▶ Consistency of food

Classification of foods

Bigelow and Cameron (1932)

- ▶ Non-acid foods > pH 6.0
- ▶ Semi-acid foods pH 4.5 – 6.0
- ▶ Acid foods < pH 4.5

Esty and Cameron (1940)

- ▶ Low-acid foods > pH 5.0
- ▶ Medium acid foods pH 4.5 – 5.0
- ▶ Acid foods pH 3.7 – 4.5
- ▶ High acid foods < pH 3.7

Stumbo (1954)

- ▶ Low -acid foods > pH 4.5
- ▶ Acid foods pH 4.0 – 4.5
- ▶ High -acid foods < pH 4.0

Vertical Still Retort



Horizontal Still Retort



Cooling

- ▶ Kills thermophilic bacteria
- ▶ Prevents overcooking
- ▶ Prevents loss of flavour
- ▶ Use 5 ppm chlorinated water

$$Q = \frac{100 \times X}{Y}$$

X – Required ppm

Y – Available chlorine (%) in stock sodium hypochlorite

Q – Quantity of sodium hypochlorite to be added to 1000 L of water

Types of cooling

▶ Air cooling

- ▶ Floor, simple, cheap
- ▶ Disadv: More floor space, overcooking, discoloration

▶ Water cooling

1. Spray water at pressure
2. Pass through long water tank
3. Immerse in long tank with water flow
4. Keep in tank, rotate at 120 rpm speed (FAST)



▶ Pressure cooling (BEST METHOD)

- ▶ Sudden release of pressure cause excess strain
- ▶ To reduce pressure, introduce water along with compressed air from top of the retort
- ▶ Safety valve release the pressure raise
- ▶ Slowly reduce to internal pressure of can

Drying

- ▶ Liberation of heat from cans dry the surface
- ▶ Pass cans through blast air

Coding

- ▶ Label carry a code
- ▶ Avoid damage to lacquer
- ▶ Cause pin hole formation or corrosion
- ▶ Code contains
 1. Nature of content
 2. Name of Canner
 3. Date of Production

Labeling

- ▶ Attractive
- ▶ Aids identification
- ▶ Provide composition, preservatives, brand, manufacturers address, specific instruction
- ▶ Adhesive – not hygroscopic (not alkali or acid)

Casing

- ▶ Dry and suitable size
- ▶ Strong to withstand storage and transport
- ▶ Code in case/sampling/stock verification

Stacking of cans



Storage

- ▶ Cool and dry
- ▶ Not in extreme temperature
- ▶ Not in humid conditions
- ▶ Allow to mature
- ▶ Good sanitary condition
- ▶ Proper cooling prevent STACK BURN
 - ▶ Retention of heat in the stack
 - ▶ Spoilage or deterioration in quality
 - ▶ Accelerated corrosion
 - ▶ Texture/flavour/odour change