

RETORT POUCH PROCESSING

HAUZOUKIM
Assistant Professor
School of Fisheries



Retort Pouches/Flexible Cans

- Laminate structures
 - Thermally processed like cans
 - Shelf stable
 - Convenient – frozen boil-in-bag products
- Definition:
 - Flexible laminated pack – sufficient strength and heat resistance – used in place of cans – for heat processing and storage of food products
 - Container made of 2, 3 or 4-ply material which, when fully sealed acts as a hermetically sealed container that can be heat processed at similar temp. and pressure as metal containers.

- Material for retort pouches:
 - Superior barrier properties
 - Longer shelf life
 - Seal integrity
 - Toughness
 - Puncture resistance
 - Withstand thermal processing parameters

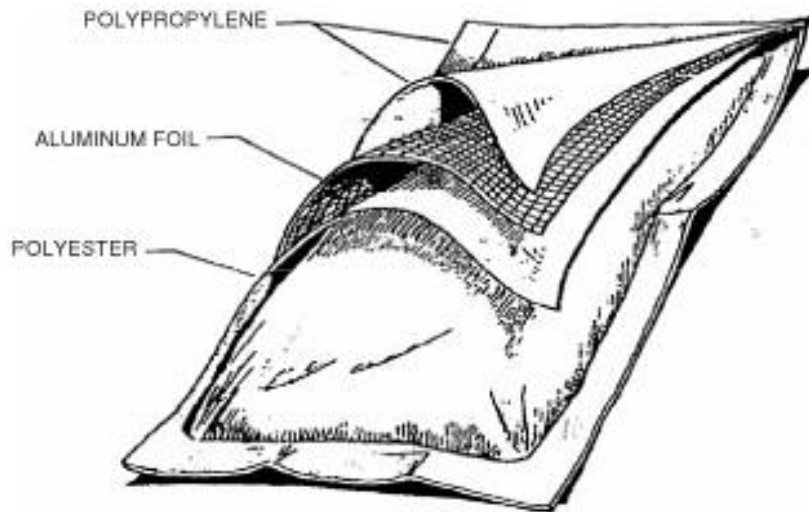
History

- Retort pouch as substitute to metal cans – 1948 – Continental Can Company, U.S.A
- Not successful – lack of suitable materials
- 1964 – Natick Laboratories & packaging companies in U.K, Europe and Japan
- Late approval by USFDA – polyurethane adhesive (tolylidene di-isocyanate) - carcinogenic

- Alternate bonding systems – cleared by USFDA
 - Polyurethane adhesive with alkyl isocyanate
 - Morprime process – dispersion of micronised polypropylene (without adhesive)
- Delay in clearance – loss – companies withdrew – set back
- Competition with well established canning and frozen food industries
- Expensive – cost (200 pouches/min vs 400 cans/min) and labour
- Japan – phenomenal growth in retort pouches
 - Less developed canning and freezing industries
 - Demand for products packed in curries and sauces
 - less metallic flavour

Composition of Retort pouches

- 3-ply laminated material
- Polyester/aluminium foil/polypropylene



- Outer polyester film:
 - 12 μ thick
 - Protects Al foil
 - Provide strength and abrasion resistance

◆ Disadvantages-

- High probability of having pin holes
- Shrinks during heat processing

- Core aluminium foil:
 - 12 μ thick (7,9.15 μ)
 - Water, light, gas and odour barrier properties

◆ Disadvantages-

- Presence of pin holes
- Opaque colour
- Poor heat sealing quality

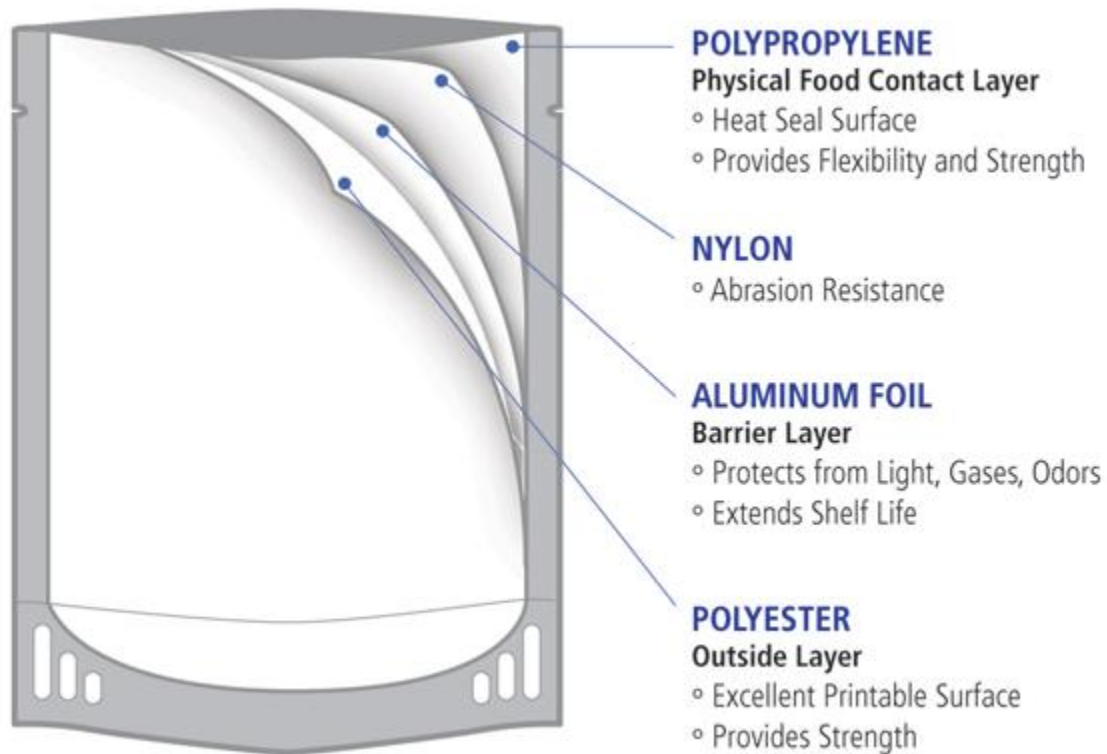
- Inner polypropylene:
 - Thickness – type of product
 - Soft/liquid products – 50 μ
 - Hard/fish products – 70 μ
 - Provide heat sealability (melting point 140°C) and product resistance
 - Protects Al foil
 - Overall pack strength/impact resistance

◆ Disadvantages-

- Translucent
- Low heat resistance

- 3 layers – combined by adhesive lamination
 - Polyurethane adhesive with alkyl isocyanate
 - Morprime process – dispersion of micronised polypropylene (without adhesive)
- 4 ply laminate
 - 12.5 μ PES – 25 μ Al foil – 12.5 μ PA/nylon – 75 μ PP
 - PA – high strength and impact resistance (prevents puncturing of laminate by fish bones)

4 ply laminate



- Sardine and Mackerel in sauce/curry and natural packs
- Shelf life – 3 years



- Vegetable and fruit products
- Mutton curry
- Chicken curry

Specifications

- UK standards:
 - Seal width – 8±2 mm
 - Lip size – 0.5 mm
 - Notch position – 25 mm from top
 - Notch size – 2.5±1 mm
 - Bursting strength – 40 psig
 - Sealing/tensile strength – 75N/25mm
 - Process resistance
 - outer ply – Grade 1 or 2
 - inner ply – No delamination

Requirements for retort pouch film

1. Low gas (O_2) permeability –
< $1\text{cc}/6.4 \times 10^{-2} \text{ m}^2/24\text{hrs}/\text{atmosphere}$
2. Low water vapour transmission rate –
< $0.05 \text{ gm}/6.4 \times 10^{-2} \text{ m}^2/24\text{h}/\text{atmosphere}$
3. Resistance to temperature – from $<0^\circ\text{C}$ to 121°C – possible storage condition exposures and minimum sterilization level

4. Inertness – resistance to penetration by food components and low migration of film components – food and drug regulations
5. Heat sealability and capability – handling on automatic fabricating and filling equipment
6. Good aging properties
7. Physical strength – resist handling abuse – manufacturing and distribution
8. Migration residue – max 60ppm

Processing of Retort pouches

- Steps:

1. Pouch making-

- Printing (gravure printing) PES film – good print quality, multiple colour registration, repeat length, long run economy
- Printed PES film – adhesive laminated to Al foil – PP base laminate
- Adhesive – applied to a substrate – passed through oven – sets – combining on heat roller by pressure
- Pouches – manufactured by hot bar sealing and impulse sealing

- Hot bar sealing – sealing directly with a hot bar
- Teflon coated bar – prevents over heating
- Horizontal form fill and sealing machine – automatic



- Corners of pouches – rounded reduce damage due to collision during handling and transport

Filling

- Manual/automatic
- Large sized food/solids – manual
- Automatic – flat pouches – held vertically – opened by blowing air
- Material transferred – automatic weigher/counter
- Liquids/liquid-solid mixes – dispensed using rotary valve piston dosers
- Solids – dispensed using dry fillers
- Fish pieces – hand filling

- Precautions to avoid microbial contamination:
 - Pouch closure seal – free from contamination with product – impair sterility – spoilage/leakage
 - Whole area – kept clean
 - Filling contents – same temperature
 - Equipments/surfaces – free of pathogens

De-aeration

- To remove bulk of air from pouches before sealing
- Residual air after processing - < 2%
- Too much air
 - inflate and burst pouches during retorting
 - impairs heat transfer – under sterilization
 - oxidative rancidity – flavour changes – fatty fish
- Air removal
 - ensures product stability
 - avoids pouch bursting during retorting
 - assists uniform heat transfer
 - allows detection of spoilage/swelling
 - facilitates cartoning

- Methods of exhausting:
 - Liquid products – squeezing the pack/spouting out head space – raises liquid level to just below line of seal
 - Solid products – vacuum chamber seals
 - Injecting saturated steam into packs – displace air and sealing immediately
 - Hot packing

Sealing

- Hot bar sealing – hot metallic teflon coated bar
- Double sealed – reduce seal defects
- First heat sealing – adjusted sealing temperature and pressure suited to pouch material and thickness
- Second heat sealing – optimum temperature and pressure – complete hermetic sealing – perfection
- Over seal – extend over mouth of pouch – prevent mould growth in product contamination above closure seal

Seal cooling

- Heat sealed part – mechanically cooled in water cooled press – perfect sealing

Traying

- Maximize heat transfer, minimize damage to seals and pouches
- Filled and sealed packs – laid flat on retort trays
- Specially designed crates
- Each pouch – accommodated in separate compartment/slot – ensures similar dimensions – uniform exposure to heating medium
- Trays – pocketed – prevent pouch movement and super imposition during retorting
- Mesh restraint over trays – prevent pouch inflation and distortion



Pouch loading



Pouch tray



Pouch rack

Retorting

- Heat sterilization – over pressure autoclave – steam (75%)-air(25%) mixture
- Process time – determined by heat penetration tests
- 121°C for 30-45 min
- Vertical retorts – more efficient than horizontal
 - Number of pouches per unit of retort volume
 - Floor space
- Automated retorts – computer controlled evaluation programme – monitor process conditions

Cooling

- Rapidly cooled after sterilization – prevent over cooking
- Cooling water – chlorinated – avoid microbial contamination

De-traying

- After retorting – no manual handling – avoid contamination
- Automatic de-traying equipments – pick up pouches from retort trays using vacuum suckers – transfer to rinsing and drying equipments

Rinsing

- Chlorinated water – 10ppm
- Scales/impurities attached to pouches from retort – removed by rinsing
- Prevent microbial contamination

Drying

- Wet pouches after rinsing – dried before cartoning
- Air knives – remove bulk of water
- Internal heat of pouch – removes last traces of adhering water film from surface

Outer packing/Over wrapping

- Prevent damage to pouches – handling during transit storage and retail sale in shops
- Additional safety for internal contents (fish) – prevent disintegration during handling
- Prevent rodent attack
- Outer packs – cartons, film overwraps, semi-rigid thermoformings
- Glue sealed cartons – widely used
- Automatic outer packaging machines

Bulk packing

- Transport and sale
- Packed in corrugated master cartons
- Size and number of pouches/carton – depend on type of contents
- Packed in horizontal configuration – extra stability

Quality Control

- Maintenance of good quality control – essential as canning
- GMP
- Ensuring microbial safety:
 - Environmental sanitation and hygiene
 - Adequate thermal process
 - Control of air inside pouch to minimum
 - Protection of seal area from contamination by food material
 - Maintenance of good seal integrity
 - Post-process hygiene

- Critical factors:
 - Product consistency
 - Maximum filling/drained weight
 - Sealing perfection
 - Processing time and pressure
 - Temperature distribution and control
 - Residual head space
 - Processing and racking systems
 - Pouch thickness

- Quality of pouch material and type of adhesive
- Pack sterility – tested before marketing – standard testing procedures

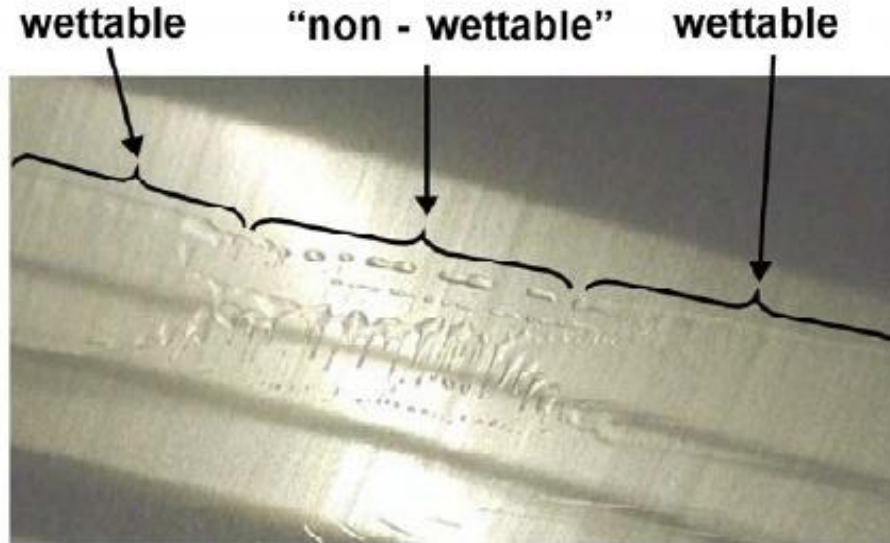
Reheating before consumption

- Parameters :
 - Economical form of reheating – bulk in bags, bulk out of bags, portions
 - Equipment for reheating – convection/ IR/ microwave ovens, compartment steamer, steam-jacketed kettle
 - Influence of storage time
- Microwave heating – suitable method

Standard testing methods for assessment of quality of retort pouches

1. Determination of Surface Wettability

- Wettability – adhesive property – food and adhesive
- Dewetting – formation of droplets on film surface



- Moderate wettability – proper bonding of adhesives
- Excess wettability – more adhesion of food particles
 - PVC, PVF, PES, PA > PE, PP

- Tested on fresh material
 - Apply Visking solution – cotton bud – whole width of pouch/film surface gently with light pressure
 - After 30 sec – check for dewetting by solution at any point of surface
 - Dewetting – indicates – wettability of surface < surface tension of solution
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- Quantitative testing - tensiometer

2. Determination of product resistance of laminate

- 2 sets of pouches – control and sample
- 6 pouches filled with product, 6 pouches with water (control)
- Seal all pouches at 230°C
- Retort samples and control in pressure retort – 30 min for control, 45 min for sample
- Cool to room temperature – empty contents – wash thoroughly with cold water

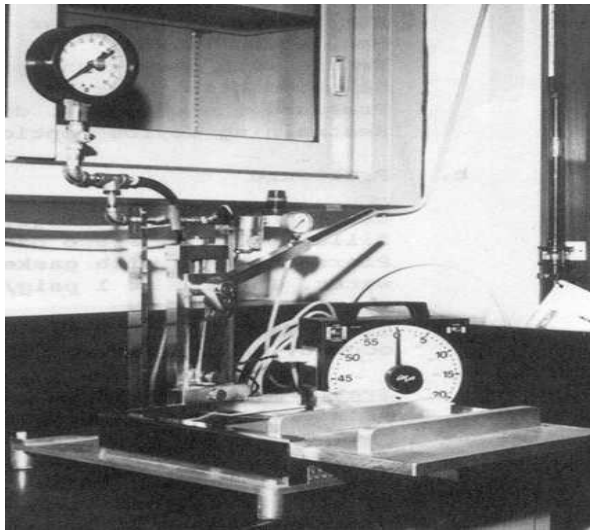
- Cut pouches into 1x25mm size strips in machine direction and transverse direction – cut across seam area
- Pull seam apart – delaminate (using UTM) – examine plies
- Determine bond/tensile strength

3. Determination of process resistance of pouches

- Place a crumbled and uncrumbled pouch in pressure cooker with water
- Heat to 121°C at 15 psi for 30 min
- Cool – take out pouch – examine for delamination – grade

4. Test for burst strength

- Bursting strength tester
- Clamp pouch lips in between rubber jaws – tighten well
- Release air gradually for 30 sec
- Pouch holds air for 30 sec without bursting – absence of pin holes – good quality



5. Determination of seal strength

- Heat sealability and seal integrity – important properties
- Seal strength – determined by measuring force required to pull apart pieces of film sealed together
- Determined using UTM
- Sample width - <25mm
- Record maximum stress at breakage
- Minimum recommended seal strength – 75 N/25mm width



UTM



Proper seal



Defective seal

Sealing Defects

- Pre-requisites for achieving a good seal:
 - properly formed and undamaged pouches
 - absence of foreign materials in the sealing area of the pouch (e.g., product, oil)
 - proper placement of the pouches within the jaws of the sealing machine
 - flat, smooth and parallel sealing surfaces

- Seal integrity depends on:
 - Sealing temperature
 - Temperature distribution on seal-bar
 - Seal speed
 - Pressure created by sealing tool holding pieces together
 - Dwell time/duration of sealing
 - Sealing material compatibility
 - Seal area contamination and the condition of sealing surface
- Scanning laser acoustic microscope (SLAM) – non-destructively image micrometer scale defects

Defects	Description/Reasons
1. Defective seals	Wrinkles on the width of seal and foldings of material on seal area
2. Leaks	Broken or loose seal or external damage Open pin holes
3. De-shaped pouches	De-lamination Use of wrong adhesives for bonding
4. Bulged packs after retorting	Over-filling Improper air removal
5. Soft and hard swell	Insufficient retorting Gas formation, defective de-aeration during filling and sealing
6. Punctures/cuts	External action while handling
7. Dirt	Smearred to surface during processing/from retort
8. Softening and disintegration of internal contents	Over processing/excessive handling













De-lamination



Deterioration of coating due to fat intake

CLOSURE SEAL-VISUAL INSPECTION CRITERIA

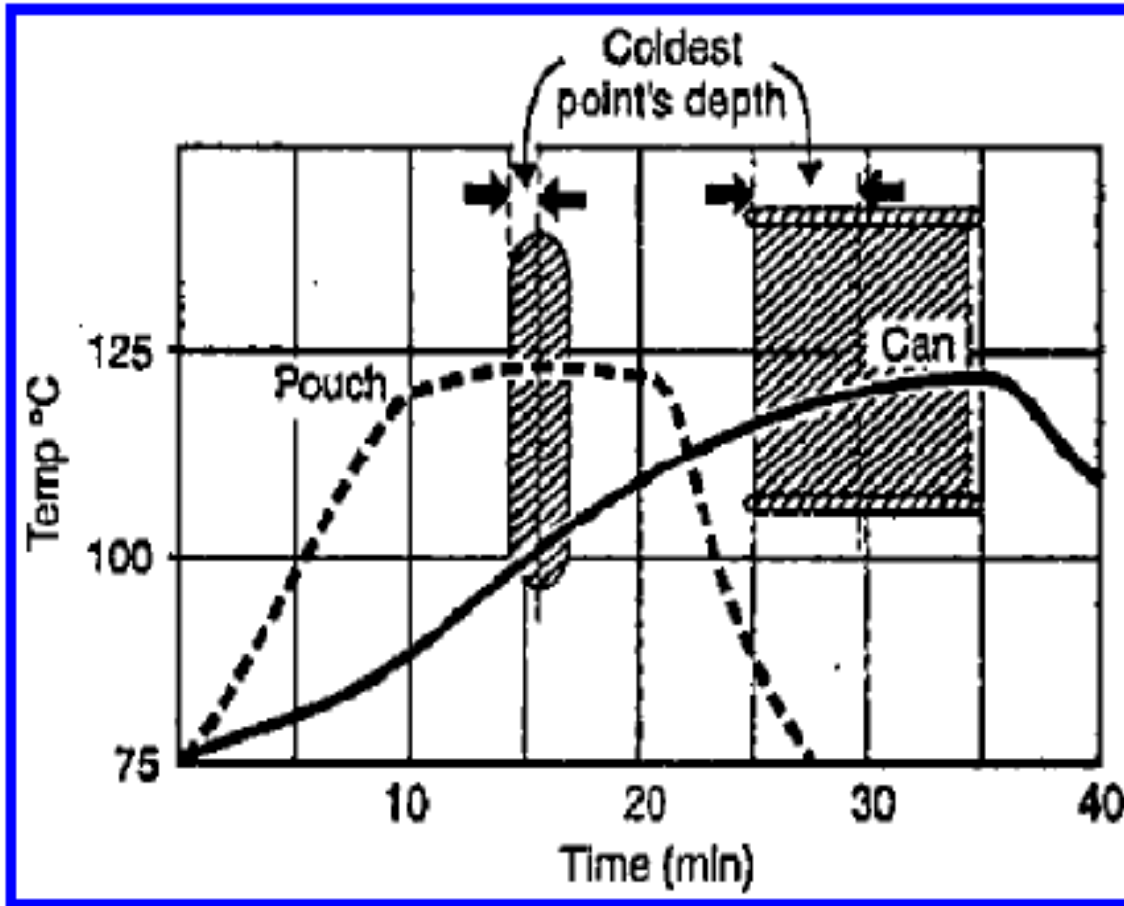
ACCEPTABLE	NON-ACCEPTABLE		
 <p>HOT-BAR NO DEFECTS</p>	<p>MAJOR WRINKLES</p>	<p>ENTRAPPED MATTER</p>	<p>EMBOSSSED SURFACE</p>
 <p>THERMAL IMPULSE NO DEFECTS</p>	 <p>FOLD-OVER WRINKLES</p>	 <p>FOOD, SOLID</p>	
 <p>MINOR WRINKLE</p>	 <p>SEVERE WRINKLE</p>	 <p>CONDENSATE OR GREASE FILM</p>	<p>DIRTY SEALING BAR</p>
 <p>MINOR WRINKLE</p>		 <p>FLUID DROPLET</p>	

Comparison of retort pouch technology with conventional metallic canning



Features	Retort pouch	Can
Feasibility	Highly suitable for delicate products such as seafood, sauces	Good for products having tough texture such as beef, pork, etc.
Product development	Slower filling, thermal processing more complex	Convenient production line including filling and thermal processing
Sterilization time	Less	More
Product quality	Superior product quality, with more natural color, flavor, and texture	Intense cooking results in loss of natural sensory attributes
Shelf life	Comparable with canned products	Comparable with retort pouch products
Convenience in handling	Less weight, needs less storage space	More weight, requires more space for storage
Convenience in consumption	Can be easily opened by tearing across the top at a notch in the side seal or by cutting with a scissors	Requires a can opener
Capital investment	Higher capital investment	Medium level of capital investment
Marketing	Trade and consumers need to be familiarized with handling the pouches	Established technology and hence, minimum consumer education needed

Thermal processing in pouches vs cans



Heat transfer rates in retort pouch and can of comparable volumes

- Processing time –30-40% less in pouches
 - High surface area to volume ratio, thin cross-section – rapid heat penetration – uniform heating
 - Cans – over heating at periphery – loss of sensory and nutritional attributes
 - Less thermal loss of quality in pouches – reduced exposure to heat – better taste, colour and flavour of product
- Greater control of retort pressure – flexible nature and limited seal strength
- Steam/air mixture – prevents expansion of gases inside – counteract internal vapour pressure – prevent bursting

Advantages of retort pouches over cans

- Variable shape and size
- 85% reduction in empty weight and space
- Less cost per pouch
- Easy, safe and cheaper transportation – packed closely and tightly in master cartons
- Shelf life – equal to or better than cans
- No refrigeration/freezing
- Easy opening facility
- Environmentally safe – destroyed by incineration
- Easy reheating prior to consumption
- Improved graphics capabilities

Disadvantages of retort pouches over cans

- Not robust like cans - strong protective outer pack – packing costs higher
- Less speed of processing line
- Higher investment cost
- Susceptible to rodent and insect attack
- Detection of leakage not easy

Consumer Attitude

- Increasing consumer demand:
 - ❖ Shelf stable ready-to-eat products – home meal replacement options
 - ❖ Change in lifestyles
 - ❖ Desire for diverse products
 - ❖ Better hygienic quality
 - ❖ Convenience in handling
 - ❖ Comparable quality and cost advantages over cans



Seafood in retort pouches

- Fish curry, fish paste
- Fish balls in curry
- Salmon flakes, tuna
- Crab, clams, shrimp, oyster
- Fish sausage
- Surimi



Advancements in pouch packaging

- Conventional pouches – pillow style – fin ends lying on sides
- Stand-up pouches with flat base - erect position on shelves – better display
 - Bottom – separate panel adhered to body wall
 - ‘W’ shaped side gussets – block-like shape
 - Good seal integrity
 - Tuna, salmon, smoked fish



- Boil-in-bag – elongated rectangular shape - convenient

