

# METHODS OF DRYING

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# METHOD OF DRYING

- Two methods mainly.
- Utilizing atmospheric conditions like temp, humidity, airflow etc. – natural drying
- Using artificial means like mechanical dryer for drying under controlled condition – dehydration
- **Sun drying :**
- Traditionally fish dried under sun.
- Carried out in open air using solar energy to evaporate water.

- Water is carried away by natural air current.
- depends on weather condition.
- **Disadvantages :**
  - Operation carried out only under bright sun
  - Long duration of drying.
  - No control over operating parameters.
  - More time required
  - Possibility of contamination with dust, sand etc.
  - Infestation with insects, their larvae & egg a problem
  - Poor quality product
  - Short shelf life

- **NATURAL DRYING :**

- Sun drying is also called natural drying.
- Solar & wind energies are utilized.
- requirements are:
  - Sufficiently high temp 35–40° C
  - Sufficiently low RH. RH above 75% is not desirable.
  - Use of raised platform (about 1 m) as air movement at ground level is slow.
  - Use of drying racks – facilitate air movement both under & over fish. Contamination of fish by dust/sand is minimized.
  - Racks with sloping top – easy draining of water



- **i) Drying on ground :**
- Fish dried on sand under sun.
- Product contaminated with sand, filth & other foreign matter.
- To prevent this, fish can be dried on coir mats, cement platforms, bamboo mat & jute sac.
- Fish must be turned over at intervals to ensure uniform drying.



- **ii) Rack drying:**
- Hygienic method of sun drying.
- Fish dried on raised racks above ground.
- Ensure air circulation from both over & under fish.
- Contamination of sand, dust etc can be avoided.
- Rack can be sloping type to drain water.

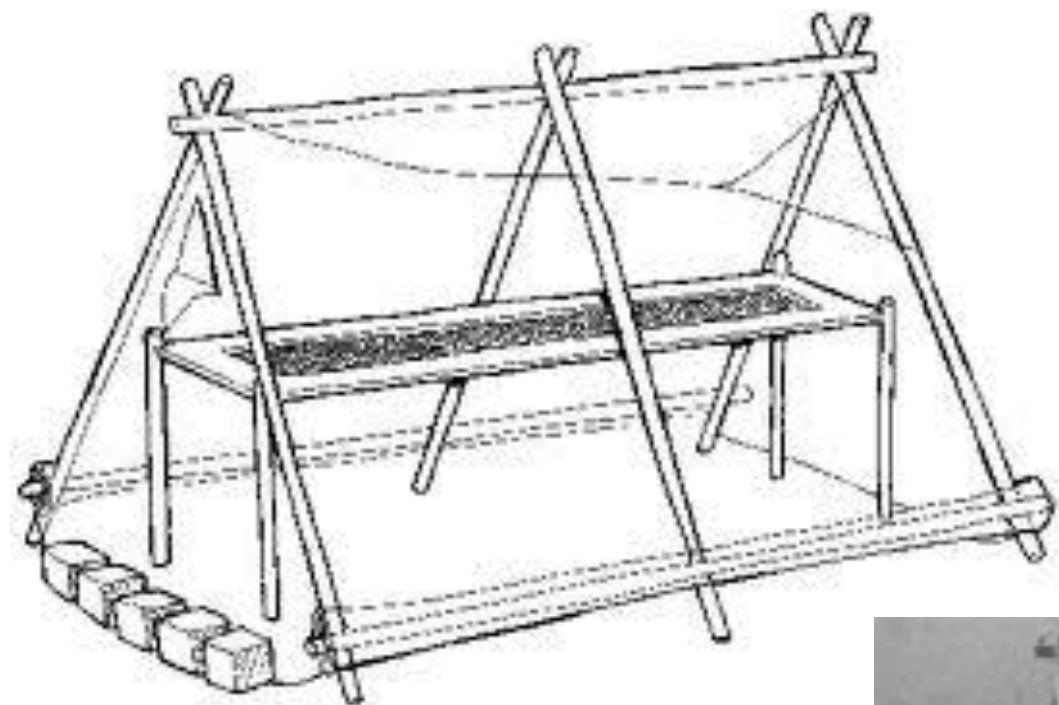




- **iii) Solar tent drying :**
- Use solar radiation for drying.
- One of the simplest form solar tent drier.
- Principle is a black surface absorb sun's energy effectively than any light coloured surface.
- Air heated is passed through the fish & escape via a vent at top.
- Fresh air enters inside through vent at the bottom.
- Air temp rises to 60° C or more in tropical climate.
- This may affect physical/nutritional quality of fish.



- advantages of solar tent drier over sun drying is :
  - ❖ No energy cost
  - ❖ Very low equipment cost
  - ❖ Shorter drying period
  - ❖ No contamination from dust, sand, flies, birds etc.
  - ❖ Produces hygienic product with low moisture.
- **iv) Solar collector drier :**
  - Solar energy is first collected in the solar collector chamber.
  - Heated air then passed through the drying chamber.





- Fishes kept for drying inside chamber in mesh/ trays.
- Hot humid air will escape through chimney.
- Clear polythene sheet at upper side, black PVC sheet at the bottom.
- Rack for fish spreading & drying is made up of black plastic mesh.
- **V)Solar cabinet dryer :**
- Rectangular shaped dryer made up of plywood.
- Front side – double walled.
- Inlet & outlet for entry & escape of air
- loading & unloading of fish through two doors.





स्वीट स्प्रिंग्स इन्फान्टरी  
यह संकेत गीत १९८६ में संकलित है  
भारतीय सेना के द्वारा है।  
दस्तावेज, फोटो, अन्य दस्तावेज  
संरक्षित हैं। दस्तावेज संख्या १९८६  
१९८६

# ARTIFICIAL OR MECHANICAL DRYING

- Removal of water from fish is by external input of thermal energy.
- Expensive method as need of fuel for heating & temp maintenance.
- Classified into 2 classes.
- i) Heat transferred to product through hot gas.
- Heat exchange takes place at the contact point.
- Outgoing air carry water vapour away.
- Eg. Kiln drier, tunnel drier.

- ii) Heat transferred to product through a solid surface.
- Cabinet holding the product may also be used.
- Eg. Drum drier, vacuum drier.

- **HOT AIR DRYERS :**

- Air heated by steam/electricity.
- Hot air blown over fish through fan/blower.
- Temp, air velocity, humidity are controlled.

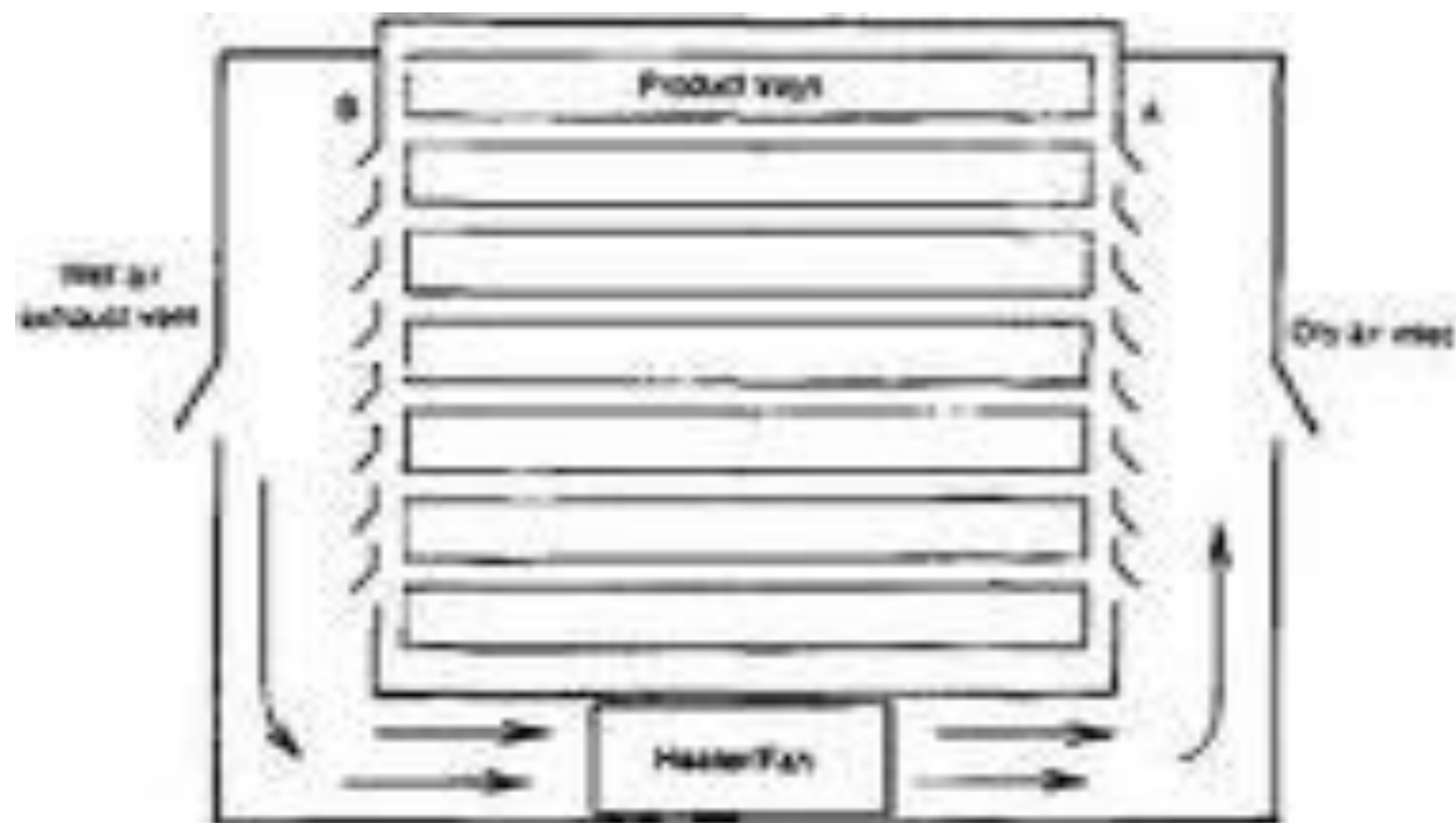


- **i) Cabinet Dryer :**

- Batch operated model for small scale operation.
- Consists of insulated/non-insulated framed str.
- Materials placed uniformly on trays inside .
- Fan inside blow air through a heat source.
- Hot air pass over the fish loaded in trays.

- **ii) Kiln Dryer :**

- Batch dryer of 2 story building.
- Floor of upper story having narrow slats where material is spread.



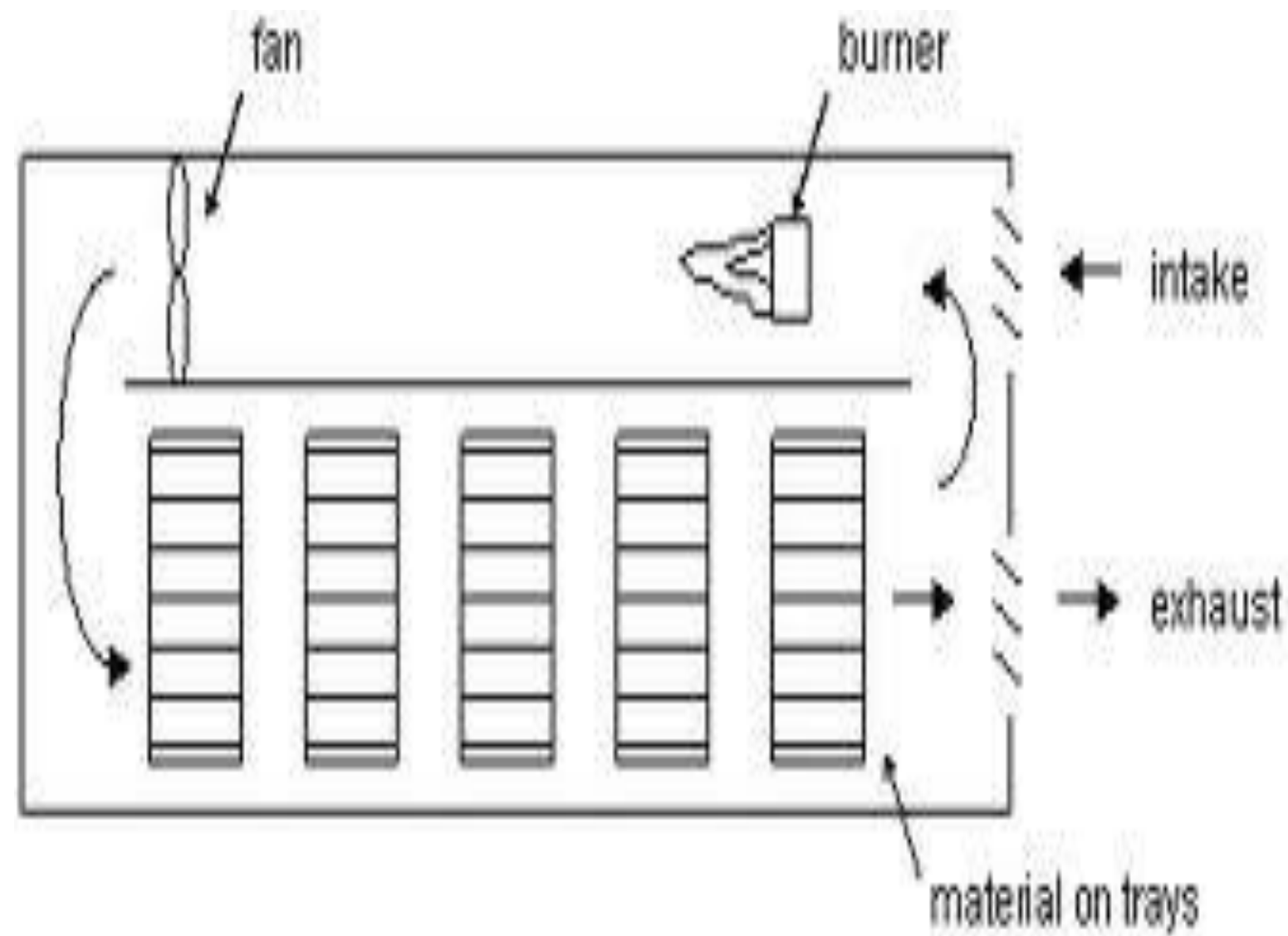
A - Inlet Vents

B - Exhaust vents

Opening/Closing controlled by humidistat

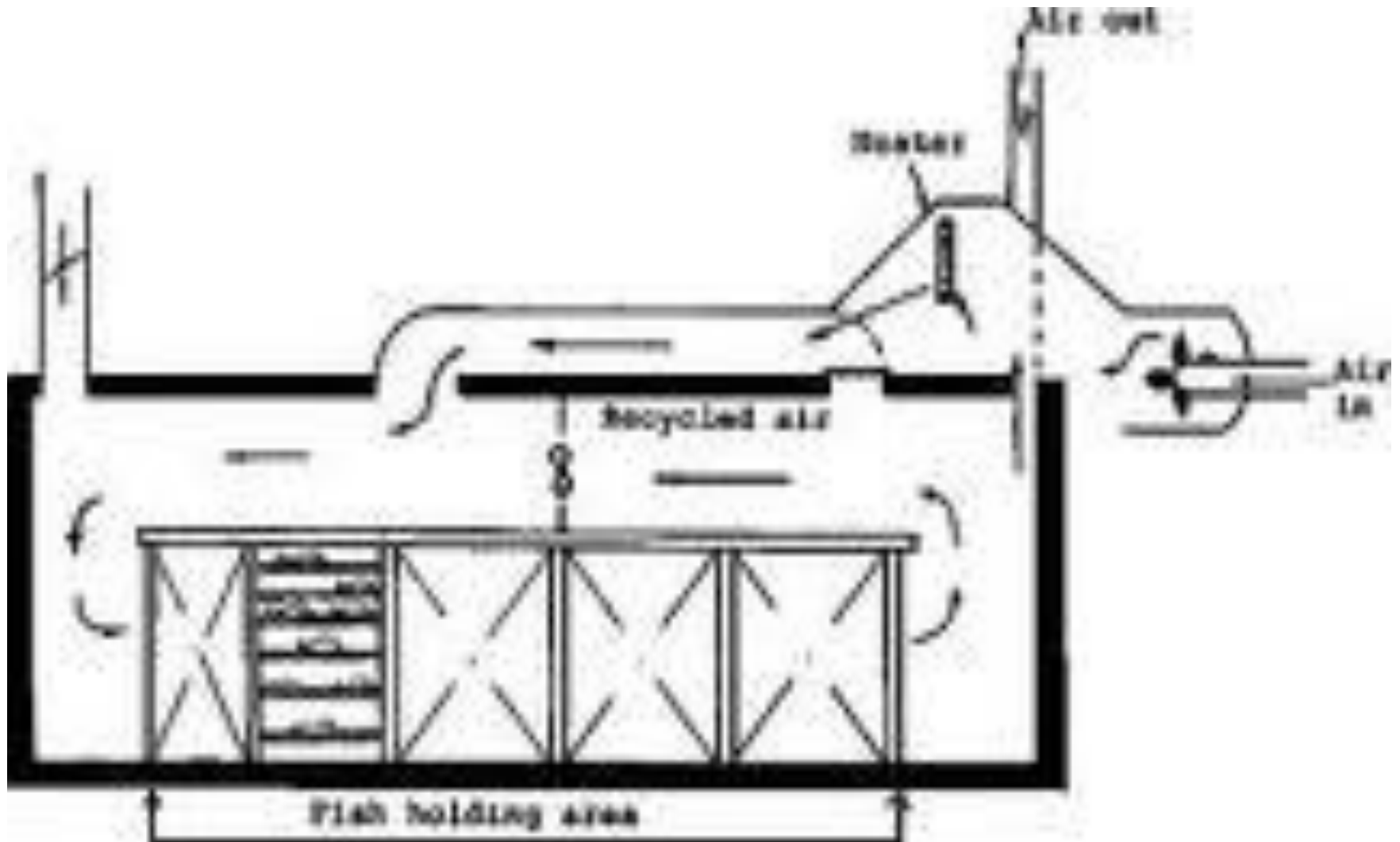
- Serves as drying room.
- Lower floor – burner /furnace producing hot gas.
- Hot gas pass through product by natural conduction
- Fan to blow hot gas.
- Material turned frequently for uniform drying.
- **iii) Tunnel Dryer :**
- Most commonly used for fish drying.
- 10–15 cm long tunnels.
- Trolleys loaded with fish move through the tunnel at a pre-determined schedule.
- Temp & air velocity controls are provided

- Hot air is blown over the fish across trays.
- when trolley of fresh fish leaves drier at one end, a fresh trolley of fish is introduced at the other end.
- **Parallel flow drying tunnel :**
- Here, movement of air is in the same direction as that of material.
- Hottest air in contact with wettest fish.
- Relatively higher temp.
- Air towards outlet may be cool & highly humid.



- **Counter flow drying tunnel :**
- Air movement is opposite to movement of product.
- Hot air comes in contact with driest material & finished product is very dry.
- If left long inside drier product may dry too much with poor organoleptic characteristics.
- Tunnel driers designed based on concept of hot air re-circulation/allowing hot air passing over fish to escape to atm.
- Re-circulating air becomes humid & slow down drying significantly.

- So, provisions for re-circulating hot air, facility for dehumidification & control of air temp is required.





- **iv) Multi deck tunnel dryer :**

- Several tunnels are placed one above the other.
- Air is blown in zigzag manner thrice then exhausted
- Heater, air blower & exhaust are placed in one side.

- **v) Fluidized bed dryer :**

- Product passed on a perforated conveyor bed.
- Air is passed below.
- So, product is partially lifted & dried.
- Used mainly for fish meal & fish powder.

- **CONTACT DRYERS :**

- **i) Vacuum dryer :**

- Hollow shelves fitted in chamber through which heating medium is circulated.
- Material is placed inside chamber in metal trays.
- Vacuum is drawn & drying proceeds under vacuum.
- Expensive method.
- Suitable for fatty fishes as oxidation & rancidity of fish can be minimized.

- **ii) Rotary dryer :**

- Air circulated through the shell or supplied from steam heat jacket.
- Rotary drum dryer, direct rotary dryer, indirect rotary dryer & steam dryer are some types.
- Used mainly for fish meal.

- **iii) Spray dryer :**

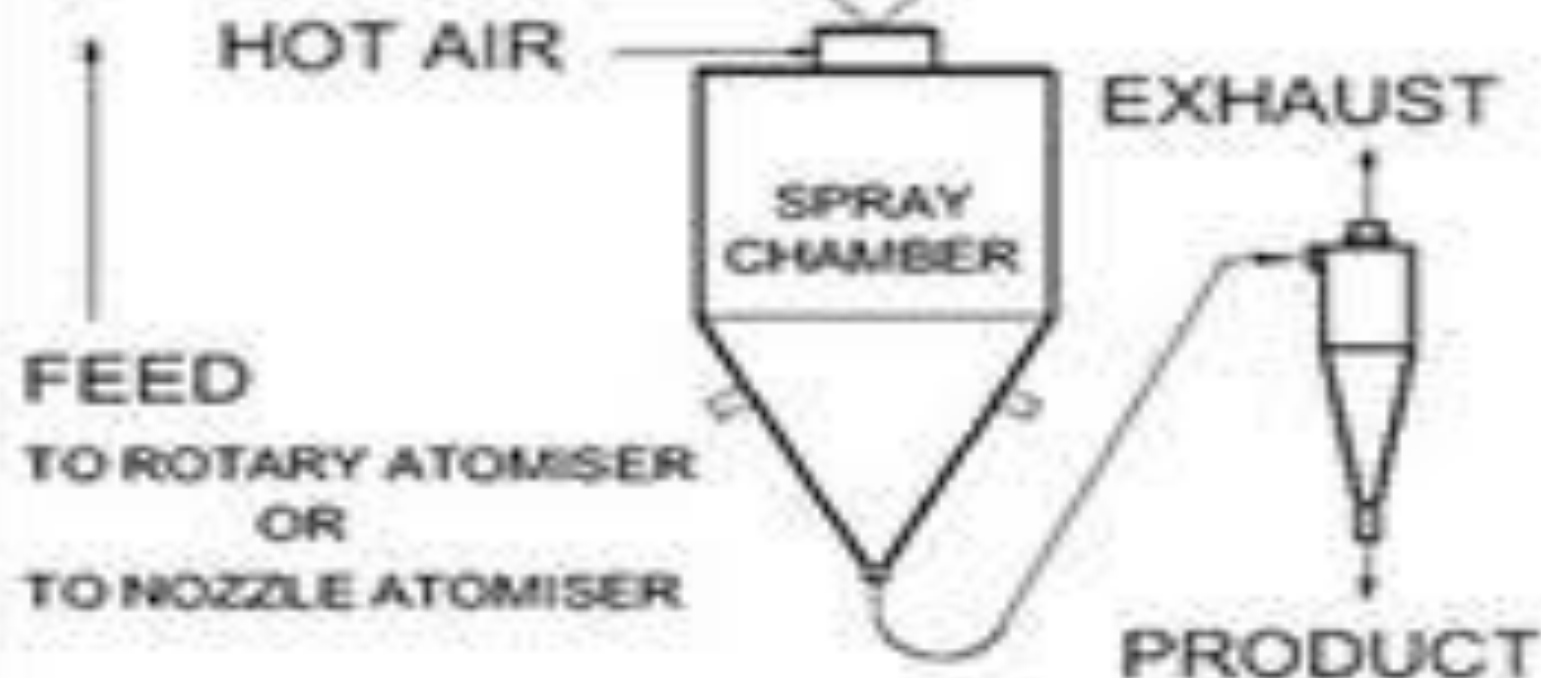
- For drying foods in liquid form or in suspension.
- liquid food which is in solubilised form, is atomized & dispersed as minute droplets
- Then suspended in stream of hot air in a Chamber.



ROTARY ATOMISER



NOZZLE ATOMISER



- it gets rapidly dried
- Application on fish products is limited to FPH & fish powder.
- Better retention of color, flavor & nutritive value are advantages.
- **iv) Drum Dryer :**
- Heat transfer through solid surface.
- Used for drying fluid materials.
- Food product in the form of slurry is deposited as thin film on the drum.
- Drum is heated by steam, while being rotated.

- Drying by keeping drum open to atm or under vacuum chamber.
- Product when dry is removed from surface of the drum using a scraper blade.
- Drums are classified as :
  - Single drum
  - Double drum
  - Twin drum



## v) Vacuum shelf dryer :

- A vacuum tight chamber with access door & outlet for gas & vapours.
- Hollow shelves fitted inside to circulate the heating medium.
- Materials to be dried is spread in thin layers in metal trays which rest on these shelves.
- Heating by circulating hot oil, steam or other heating medium.
- Vacuum drawn in chamber through outlet.
- Drying proceeds under vacuum.
- Initial drying rate is high, material shrinks later as



- Drying proceeds & tend to curve away from trays.
- This reduces effectiveness of contact of material with heating surface.
- Expensive process.
- Suitable for fatty fishes.



# EFFECT OF DRYING ON QUALITY OF FISH

- **1. Shrinkage :**
  - Major physical change observed in dried fish.
  - Shrinkage in volume as a result of structural change in fish muscle during drying.
- **2. Case hardening :**
  - Water in fish – dissolved salts, proteins, org matters
  - Water moves to surface of fish carries these.
  - Evaporating from fish surface is pure water .
  - Dissolved substances deposit on surface
  - If drying is above ambient temp, & RH low constant,

- Faster rate of drying.
- Surface of fishes dry but interior moist.
- Diffusion slows down
- product will be dry on surface but transfer of moisture from interior will not take place.
- This is **Case hardening**.
- In such condition temp of fish muscle is high results in its cooking.
- Final product is brittle, rehydration property is affected.
- Controlled by maintaining high RH & also temp of drying.

- **3. Denaturation of protein & toughening of texture :**

- As drying progresses, conc. of dissolved solids in water increases.
- Reduced evaporation due to case hardening results increase in temp of fish muscle.
- This causes denaturation of protein & tough texture with loss of juiciness.

- **4. Rehydration :**

- Air dried fish is hard in texture.
- Proteins denatured, water holding capacity is lost.
- Penetration of water retarded resulting poor rehydration.

- **5. Effects on color, flavor :**
- Pigments, fat in fish susceptible to oxidation.
- Prolonged drying of fish exposing to hot air accelerate the process.
- Air dried fish often suffers from discoloration & rancid flavor & odour.
- Non-enzymatic browning develops.

# SPOILAGE OF FISH DURING DRYING

- **1. Moulds :**

- Mould grow on salted & un-salted dried fish at high moisture content & RH (above 75%)
- If storage temp is 30–35° C moulds grow.
- Moulds on surface of fish increase moisture & product becomes susceptible to other spoilage.

- **2. Insect infestation :**

- Unsalted dried fish infested with blow flies, *Chrysomya sp*, *Lucilia sp.*, etc.
- Adult flies attracted & their larvae feed on wet fish

- Small fish dry quickly & larvae may perish before causing damage.
- Large fishes remain wet for longer time.
- **Controlled by :**
- Maintaining hygienic condition in fish handling & processing premises.
- Eliminating areas where adult flies may lay eggs, salt- drying.
- Control of Insect attack during storage like Beetle, Dermestes sp.



- They grow on 15 % moisture level, larvae feed on fish leaving the bones only.
- Drying with salting can reduce their activity.
- **3. Rancidity :**
- Fatty fish prone to oxidation & development of rancid flavor.
- To some degree rancid flavor is acceptable in dried fish.
- Rancidity can be controlled by airtight packaging of dried fish.

# PACKAGING & STORAGE

- Most important concerns regarding packaging
- to prevent moisture pick-up
- recontamination by insects & micro-organisms.
- Traditional packaging materials include :
- cane baskets, leaves, and jute bags.
- Alternatives include flexible packaging such as polythene bags, or wooden and cardboard packs.

- **Dry fish possess some problems during packaging :**
  - Irregular shape, Sharp protrusion, which may puncture packaging material & occupy space.
  - Often brittle & will break up when packed in regular shape packet.
  - Individual fish packaging shoot up the cost.
  - If not packed appropriately, absorb moisture & spoil quickly.
  - Necessitates water proof/vapour proof packaging

- **An ideal packaging material for dry fish should have properties like :**
  - Resistance towards mechanical abrasion & puncture
  - Sufficiently robust to prevent breakage during handling & distribution.
  - Eg. Corrugated fibreboard containers provide adequate mechanical protection
  - Be impermeable to moisture, oxygen & insects. Eg. Boxes of poly propylene can meet the requirement.

# Quality standard for cured fish products

- **Quality issues & safety aspect :**
- Main problem affecting cured fish are histamine, mycotoxins, 3,4 benzopyrene, oxidation of fat, halophilic bacteria & mould.
- Histamine – a biogenic amine index of bacterial spoilage & a risk factor to consumer's health.
- Max conc. of 20 mg/ 100g in fish is fixed as rejection level.
- Mainly seen in Scombroid fishes.
- Cured fish prone to mould & fungal attack.
- Product must be fully dried & not left in damp areas

- Lightly infected fish – cleaned by brine solution & re-dried.
- Main fungi isolated from dry fish is *aspergillus*, *mucor* & *penecillium sp.*
- Quality requirements of cured fish products :