Name: Barun Kumar Yadav

Id no.: 14AG63R011

Native place: Darbhanga (Bihar)

Email:barunkumaryadav1990@gmail.com

Education: B.Tech Agricultural Engineering

University of graduation: U A S bangalore

Year of passing out: 2013

Job experience (if any): No

Training/projects undergone: VST power tiller,Southern region Farm machinery testing and traning institute, SWCRI bellary, In plant training Mahindra excellence centre Rural agriculture work experience programme hodhanhaali karnatka

Seminar on: Modified Atmospheric packaging

MODIFIED ATMOSPHERIC PACKAGING OF FOODS

DEPARTMENT OF AGRICULTURAL AND FOOD ENGINEERING IIT KHARAGPUR

By

Barun Kumar Yadav

14AG63R11

CONTENTS

MAP

- Modified atmosphere packaging (MAP) is defined as 'the packaging of a perishable product in an atmosphere which has been modified so that its composition is other than that of air' (Hintlian & Hotchkiss, 1986).
- Gas exchange between the pack headspace and the external environment may also occur as a result of permeation across the package material.
- The gas mixture used is dependent on the type of product.
- The atmosphere has been changed by altering the proportions of carbon dioxide, oxygen, nitrogen, water vapour and trace gases.
- The gaseous atmosphere changes continuously throughout the storage period due to factors such as

  Respiration of the packed product,

  biochemical changes and

  the slow permeation of gases through the container.

Purpose of MAP

- Reducing respiration rate
- Extending shelf life
- Maintenance of freshness

Principle of MAP

- Modification of gas composition
  - Reducing oxygen concentration
  - Increasing CO_2 concentration
  - Decrease ethylene level
  - Adding CO

Gases used in MAP

Oxygen

- The reduction of surrounding oxygen can control the oxidative and browning reactions.
- Oxidative reactions occur in meat and fish i.e. lipid rancidity.
- Browning reactions are presented on the surface of fruits and vegetables.
- Low level of O_2 is preferred to avoid both fermentation and growth of aerobic spoilage microorganisms.
- Some microorganisms such as *Cl. botulinum* can grow in complete absence of O_2. This microbial hazard could be eliminated, if completely O_2 absence is avoided.

Carbon dioxide (CO_2)

- It has important bacteriostatic and fungistatic properties.
- It is water solute and creates carbonic acid, causing pH reduction and increasing solution acidity, which has further preservative effect.
- When temperature is increased gas solubility also increases. Therefore, in low temperatures, the antimicrobial activity of CO_2 increases as a result of the increased concentration.
- The high solubility of CO_2 can result in pack collapse due to reduction of headspace volume.

Nitrogen

- It has low solubility in water (0.018 g/Kg at 20°C), and it aims to prevent pack collapse.
- Nitrogen indirectly affects the microorganism growth in foods, which is achieved with the avoidance of aerobic bacteria growth.

Carbon monoxide

- CO has been studied in MAP of meat.
- The MAP effect on myoglobin was indicated, which leads to the formation of carboxymyoglobin, a bright red pigment.
- The commercial use of CO is still under consideration because of its high toxicity and flammability.

Sulfur dioxide

- It is antimicrobial in its non-ionized molecular form. This is achieved in low pH environments(p<4).
- Its fungicidal and bacteriostatic properties affect Gram(+) rods (e.g., *E. coli*, *Pseudomonas)* and Gram (+) rods (e.g., *lactobacilli*).
- In many food packages, such as fruits, sausages, juices, wines and shrimps packages, sulfur dioxide is used.

Noble gases

- He, Ne, Ar and Xe are members of this group.
- Ar can replace nitrogen to fill in wine bottle neck before corking.
- Noble gases can extend the shelf life of fruits and vegetables.
- The main gas that is used in modified atmosphere packages is Ar.
- Ar has ability to prevent growth of m.o. in foodstuffs such as broccoli and lettuce.

- MAP of non-respiring foods, a high CO2 content (>20%) is used in most cases together with a low O_2 content (<0.5%) and a recommended storage temperature < 5°C for the most foodstuffs.

- MAP of respiring foods i.e. fresh fruits and vegetables, once the atmosphere has been changed to the desired level, the respiration rate of the produce should equal the diffusion of gases across the packaging material in order to achieve an equilibrium atmosphere in the package.

Method of atmosphere modification in package foods

- Vacuum packaging
- Gas flushing
- Gas packaging
- Mechanical air replacement (i) gas flushing; and (ii) compensated vacuum.
- Passive atmosphere modification.
- Active packaging that can be classified as oxygen absorbents, carbon dioxide absorbents/emitters, ethanol emitters and ethylene absorbents.

Passive atmosphere modification

- The produce is sealed within the pack with pack flushed with required gas mix or no modification to atmosphere.
- Subsequent respiration of produce and gas permeability of packaging allow an equilibrium modified atmosphere to be reached.
- So it is also called as Equilibrium modified atmospheric packaging .

Passive MAP

Lower O_2 concentration → To reduce respiration rate

Increase CO_2 concentration → To prevent microbial growth

Maintain high RH → To avoid dehydration

Active MAP

- When packaging performs an additional role, other than just exhibiting itself as an inert barrier to external influences.
- The concept of active packaging has been developed to correct deficiencies in passive MAP.

Active MAP

- Oxygen scavengers

- extends shelf life

- Reduce need for extremely low O_2 in MAP

Oxygen scavenger pouch

Oxygen scavenger in crown cap

Active MAP

CO_2 scavengers

- Reagents : $Ca(OH)_2$
- To avoid packaging destruction
- Applications: coffee
- $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

CO_2 emitters

- reagents: ascorbic acid
- To avoid food deterioration
- Applications: meat, poultry, fish, cheese

Active MAP

- Moisture absorber
  - Reagents – silica gel, activated carbon, zeolite, cellulose and derivatives
  - To control excess moisture in packaged food
  - To reduce water activity on surface of food in order to prevent growth of moulds, yeast and spoilage bacteria.
  - Applications – meat, fish, bakery products, fruits and vegetables.

Active MAP

Ethylene scavengers

- Reagents – potassium permanganate, activated carbon
- to prevent too fast ripening and softening.

$$(12KMnO_4 + 3CH_2{=}CH_2 \text{------} > 12MnO_2 + 12KOH + 6CO_2)$$

arrots

Active MAP

- Gas flux

- Reagents - N_2
- To reduce O_2 level
- Applications – cut salads
- This system is expensive and needs high ba

Packaging materials

- The material that wraps the product is crucial to the success of MAP.
- The correct atmosphere at the start will not serve for long if the barrier material allows it to change too rapidly.
- The properties required in the material are such that few single film materials are completely suitable.
- Not a multilayer material composed of two or more co-extruded or Laminated films is required.
- Several factors must be taken into account in determining the combination of properties required for each specific product and market.

The more important factors are the following:

1. The *type of package* to be used (rigid or semi-rigid, lidded tray or flexible film pouch.

2. The barrier properties needed.

- It is desirable to maintain the atmosphere initially introduced into the package for as long a period as possible and to keep the gas ratios unchanged. But it is not always so.
- Fresh vegetable produce and fruits continue to respire, as we have seen, even when placed in a modified atmosphere, and hence they will produce changes.

3. Mechanical strength :

- How resistant to puncture does the material need to be?
- For example are we packaging foods with sharp bones?

4. Will the product induce *fogging* and hence will an anti-fog coating be necessary?

5. Integrity of sealing :

- The better the seal, the more difficulty there will be in opening the pack.
- The right balance between tightness and security of the closure and the ability to peel back a lidding material must be determined.

MACHINERY USED IN MAP

MODIFIED ATMOSPHERE PACKAGING (MAP) EQUIPMENT IS DIVIDED INTO TWO MAIN CATEGORIES:

- PILLOW WRAP AND
- CHAMBER

PILLOW WRAP CAN BE DIVIDED INTO TWO FURTHER CATEGORIES:

- HORIZONTAL
- VERTICAL PROCESSING MACHINES.

CHAMBER MACHINES CAN USE TWO DIFFERENT TECHNIQUES.

- THERMOFORMING TECHNIQUE.
- IN SECOND TECHNIQUE, READY CONTAINERS CAN BE USED FOR THE PACKAGING OF PRODUCTS (**PREFORMED CONTAINER MACHINES**)

Figure 10.6 Examples of plastic pre-formed trays for MAP foods.

Thermo fill seal

- Gas replacement by evacuation within the vacuum chamber.
- Typical products- meat, fish, cooked meat, pizza
- Manufacturers- multivac, macaplastic etc

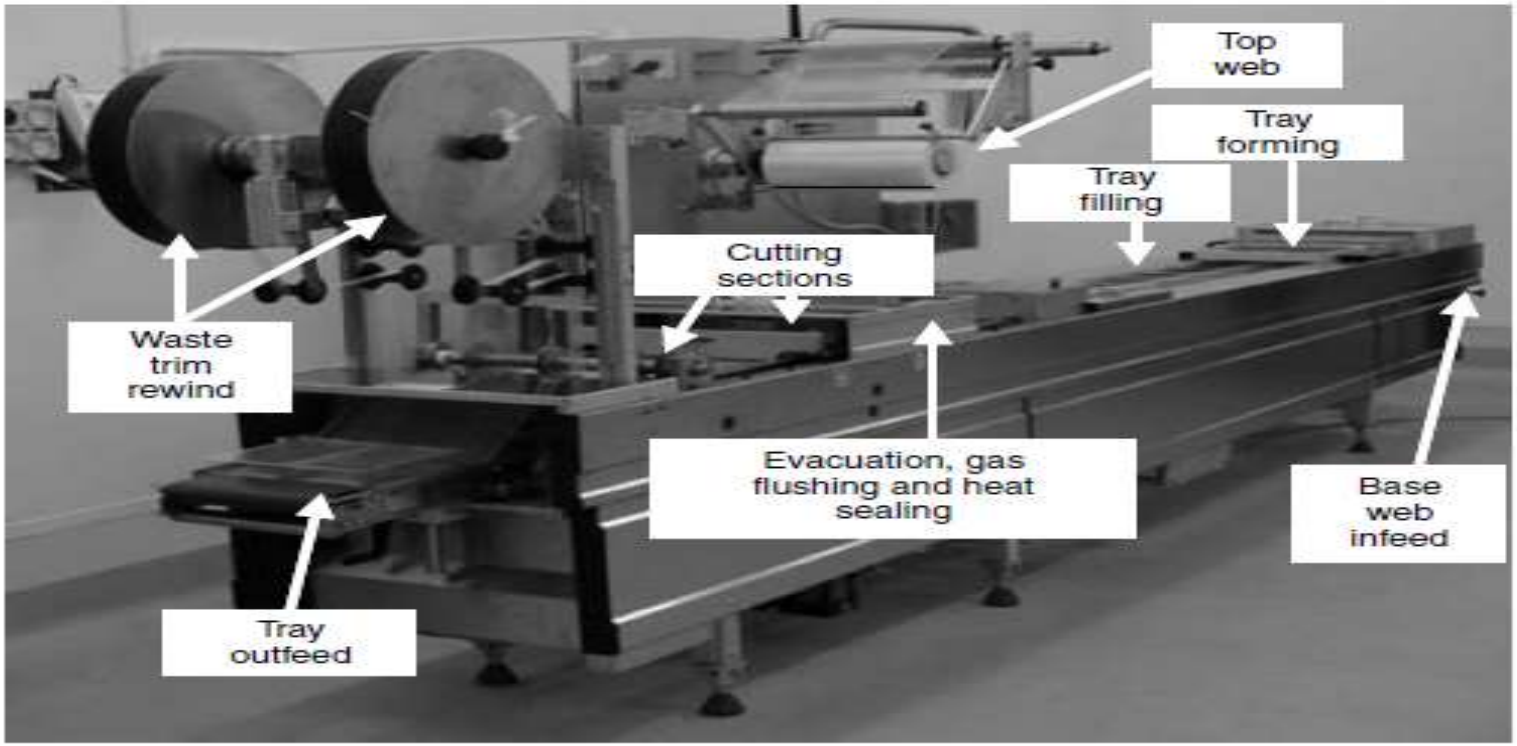


Figure 10.7 Multivac R230 thermoform fill seal machine.

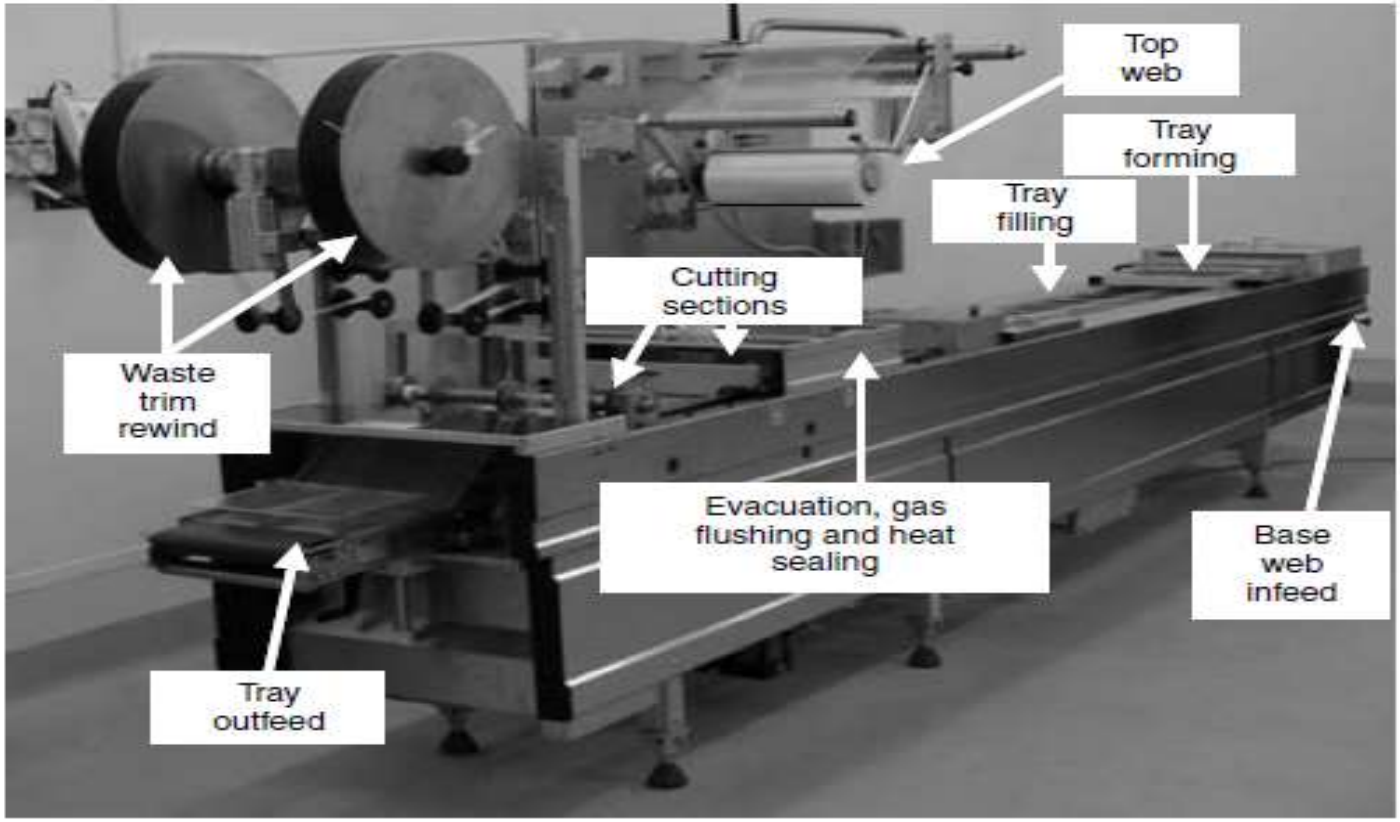


Figure 10.7 Multivac R230 thermoform fill seal machine.

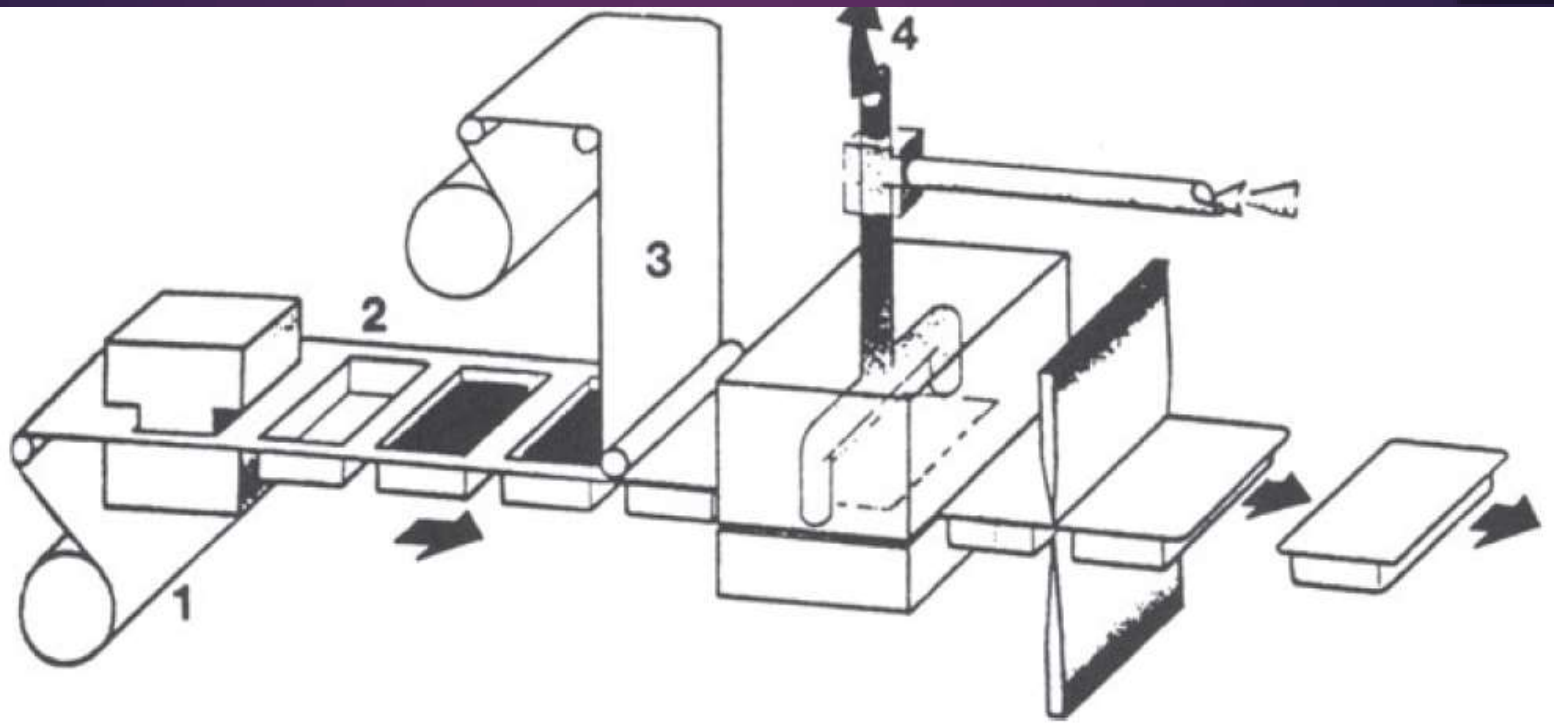


Figure 3.2 Thermoforming packaging machine fed from two film coils. One inner thermoformable film (1) is formed into a tray (2). The food product is placed in this tray covered by an upper film (3). A vacuum is created in the tray (4), and broken by the gas mixture just before the upper film is sealed.

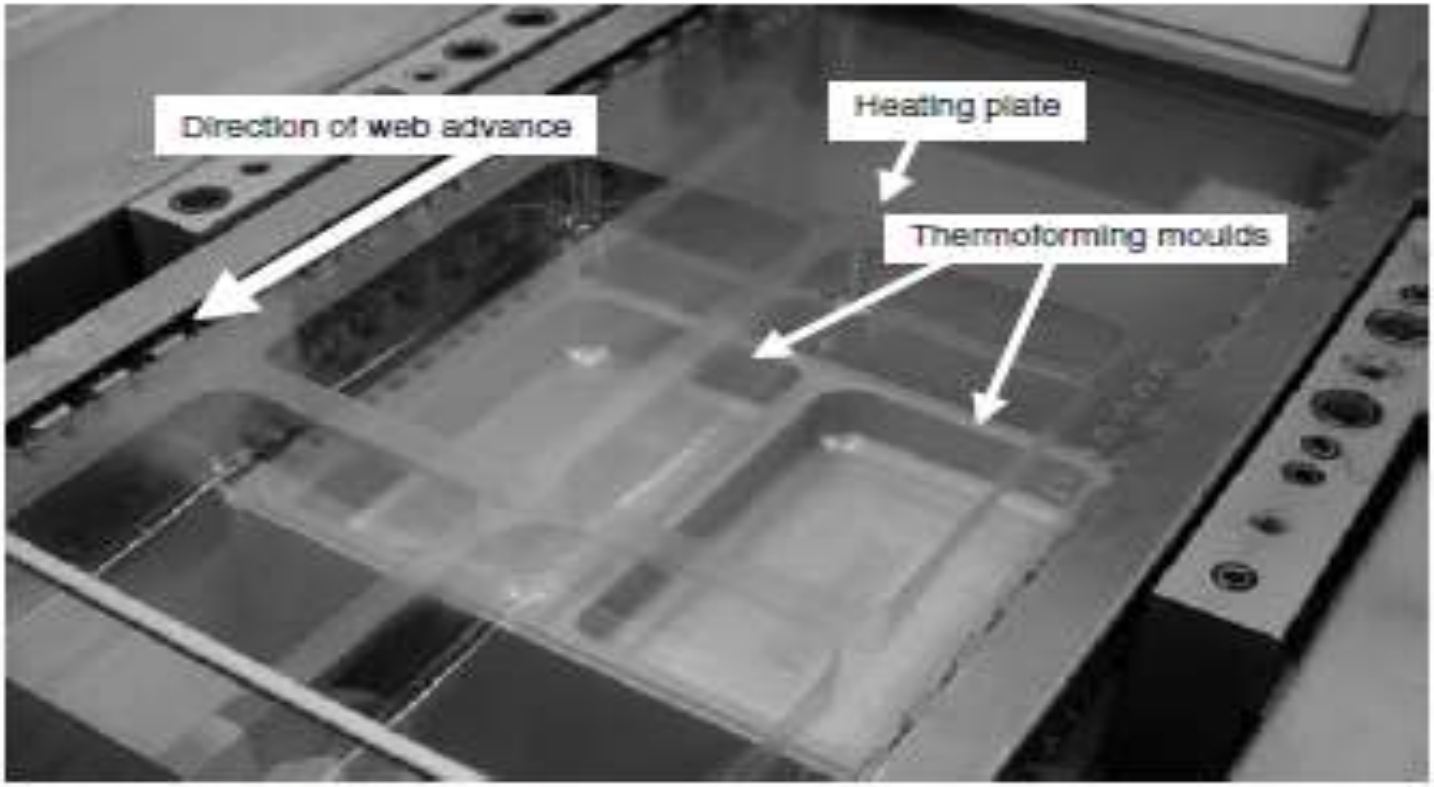


Figure 10.9 Base web thermoforming section on the Multivac R230.

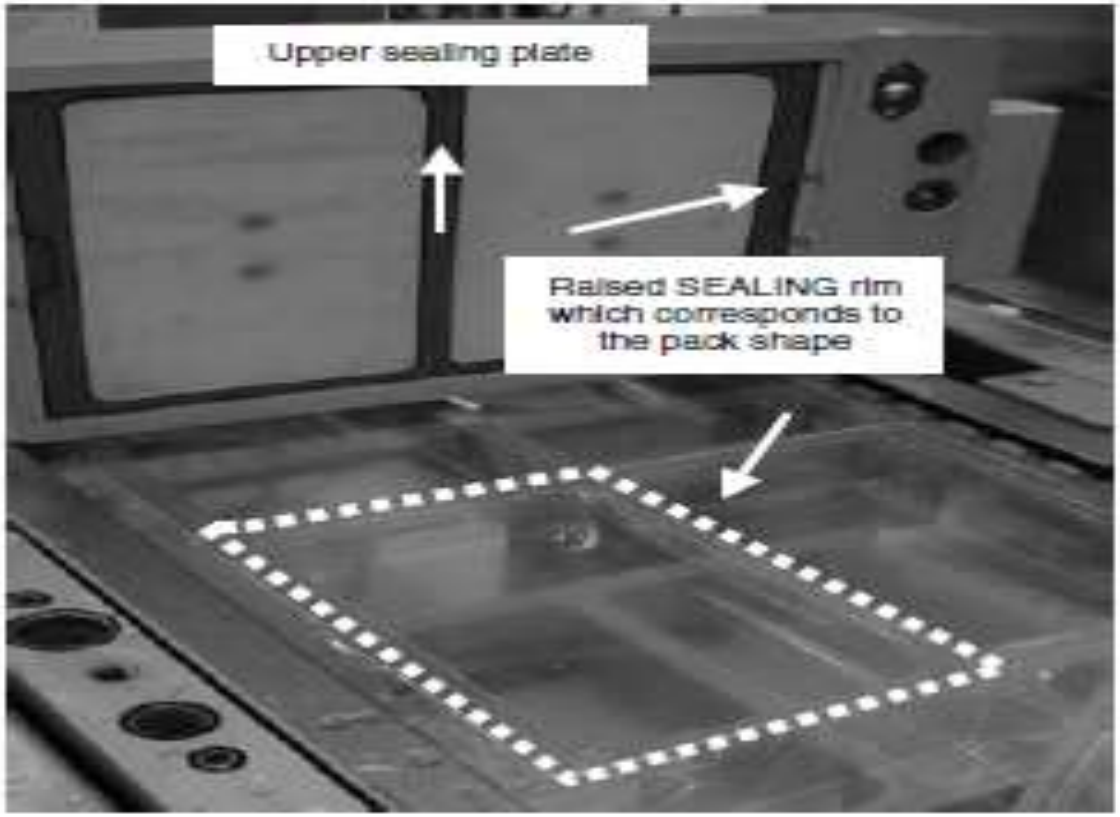


Figure 10.10 Top web heat sealing on the Multivac R230.

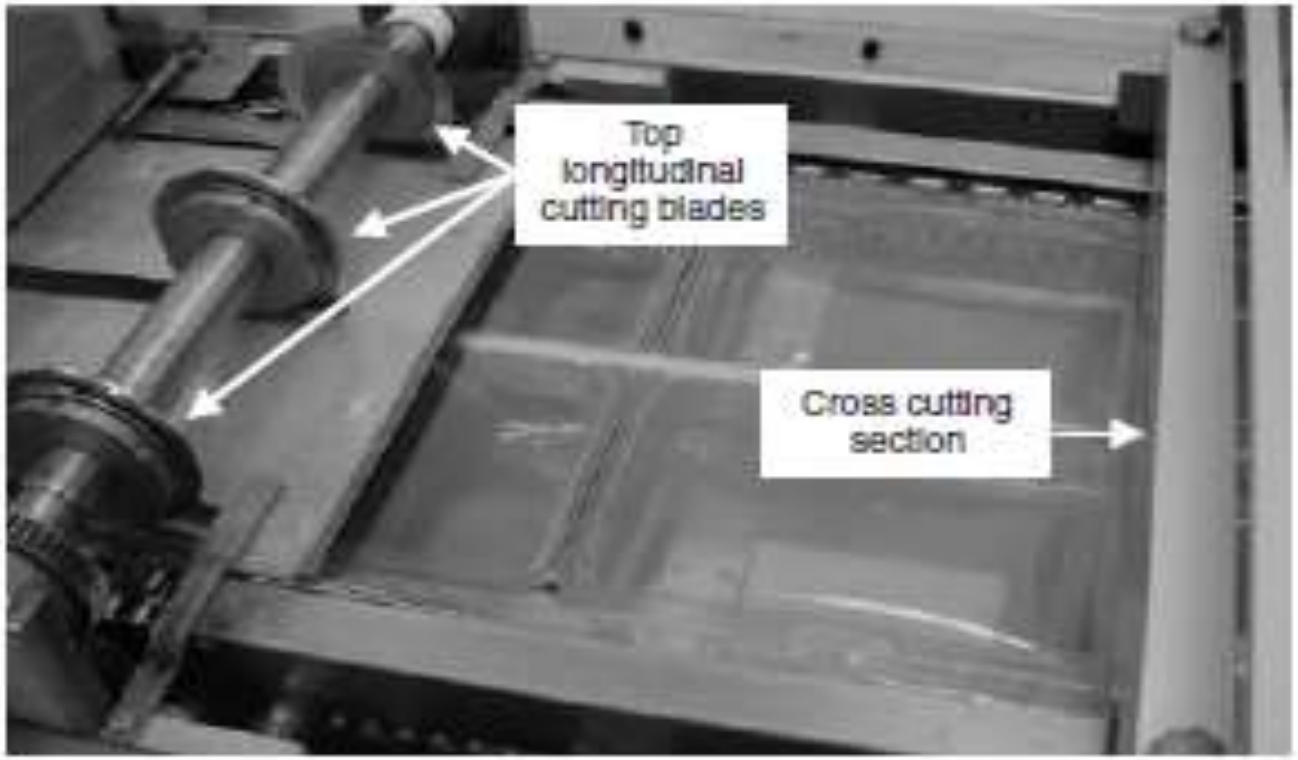


Figure 10.11 Cutting section on the Multivac R230.

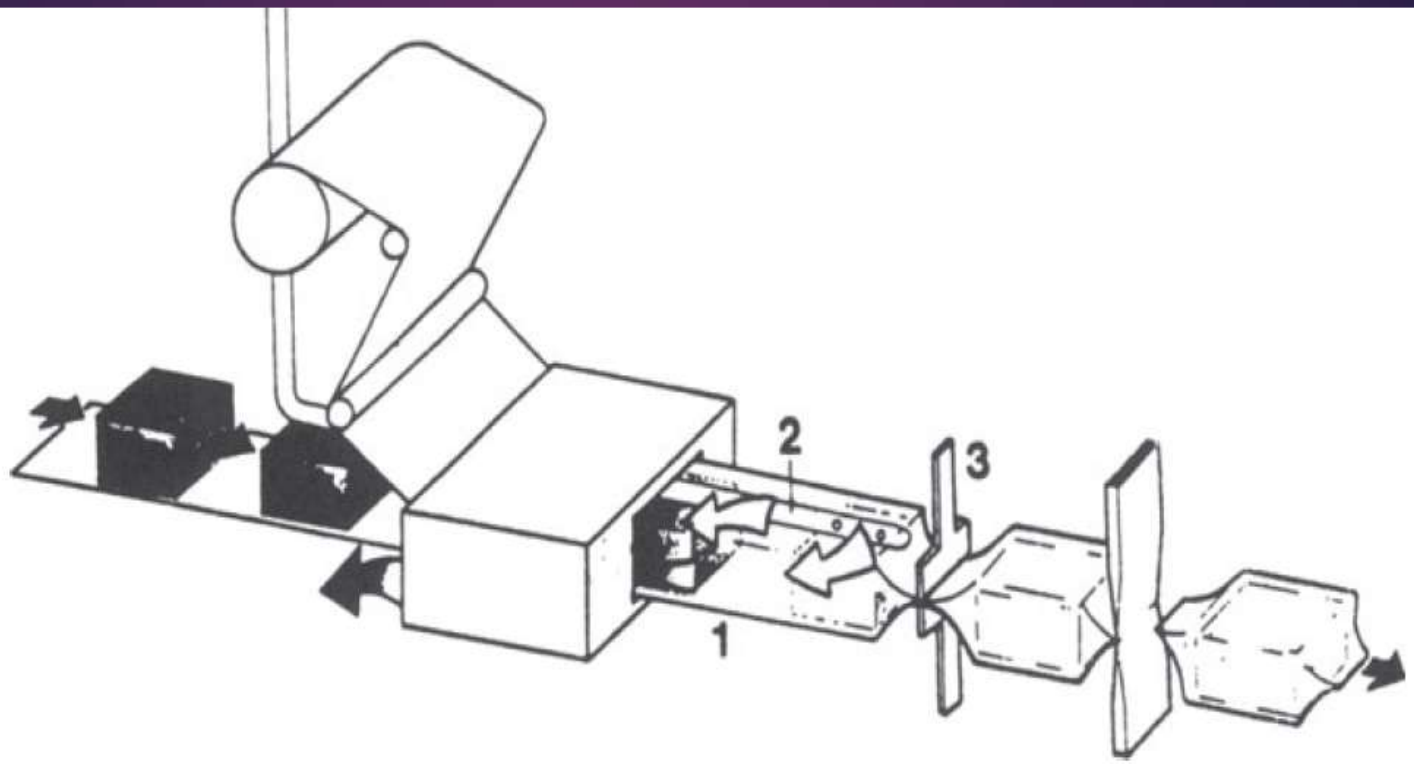


Figure 3.3 Gas flushing. Purging the air from the package is accompanied by continuous gas flushing. The packaging machine provides a film tube (1). Gas is injected into this tube through an injection pipe (2), which extends to a point just before the sealing jaw (3).

Examples

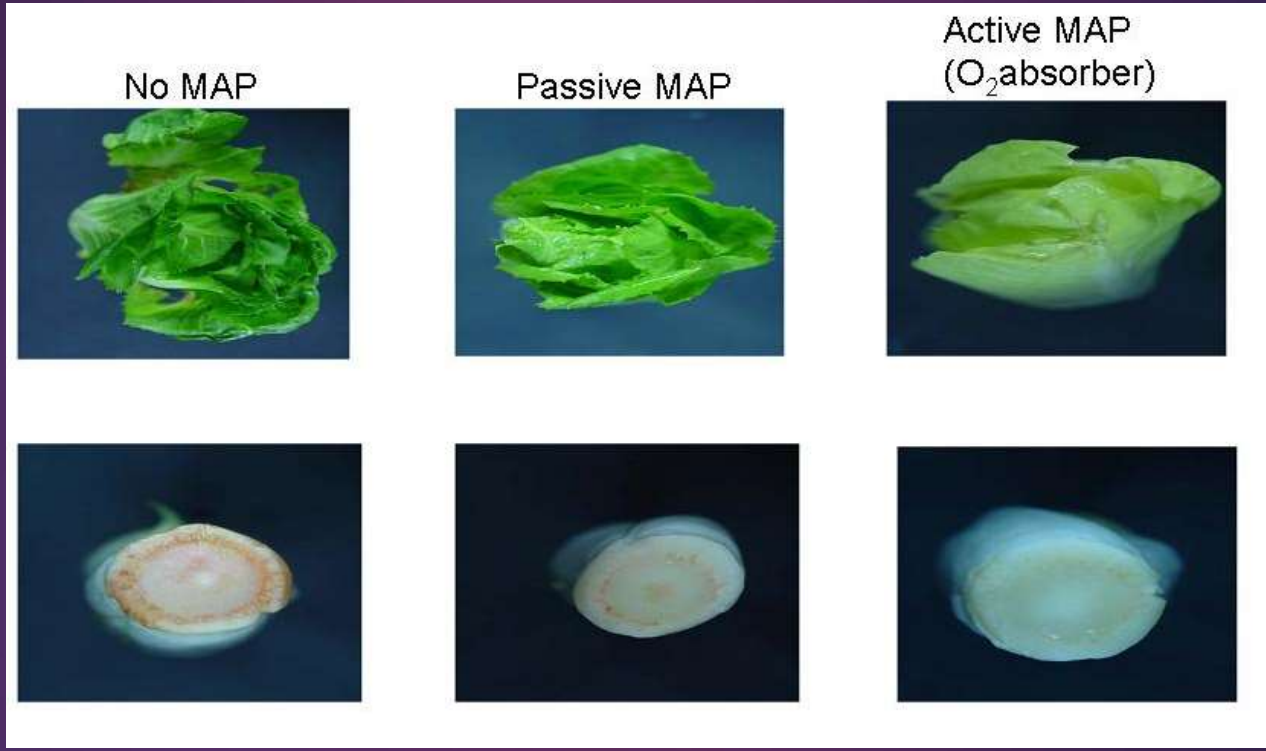
Low O_2 Delays Ripening of Plums

AIR 1% O_2 + 5% CO_2

5 weeks at 10°C

Six Months Storage of Bartlett Pears

Influence of packaging conditions on greening and browning on endive after 7 days of storage at 20°C



Lettuce in MAP

Source : http://www.packagingdigest.com/articles/200203/32.php accessed on 27/10/2014

- Fresh cut fruit in MAP

Source : http://foodservice.treetop.com/products/product/apple-slices-4-3-lbs accessed on 26/10/2014

Fruits

Pomegranate- 4 months at 6 deg C

Passion Fruit- 5 days at 20 deg C

Fig- 4 days at 20 deg C

Mango- 35 days at 20 deg C

Vegetables

Okra- 5 days at 18 deg C

Green Onion- 3 days at 10 deg

Cucumber- 3 days at 20 deg C

Dilli- 3 days at 10 deg C

Opportunities of MAP in India:

77 MT fruits and about 150 MT vegetables , losses 22 % worth Rs 2 lakh crore per year.

Seasonal Vegetables: (like okra, brinjal, carrot, green peas, bottle gourd, tomato etc.)

Perennial Vegetables: (like garlic, onion, potato etc.)

Seasonal and Perennial Fruits: (like mango, orange, cheeku, grapes etc.) and perennial fruits (like banana, papaya etc.).

Exports of Fresh Produce

The Solution

References:

1. Principles and Applications of Modified Atmosphere Packaging of Foods-Edited by R. T. PARRY , Springer-science+business media, b.V ISBN 978-1-4615-2137-2 (eBook)
2. Food preservation Techniques-Peter Zeuthen and Leif Bagh, Sarensen, CRC, Woodland Publ.Ltd.
3. Modified Atmosphere and Active Packaging Technologies, Ioannis Arvanitoyannis CRC Press 2012, Print ISBN: 978-1-4398-0044-7, eBook ISBN: 978-1-4398-0045-4.

- Food packaging technology edited by RICHARD COLES and MARK J. KIRWAN ,CRC, ISBN 1–84127–221–3 ,2003 by blackwell publishing ltd
- http://elearning.packagingconnections.com/ accessed on 20/10/2014