Unit II - Topic 5

Retort processing, Microwave heating of foods

Retort technology refers to the technology used in the thermal processing of food and food products. It is a rather unique method and is vastly different from simple packaging as the packages are packed using metal, some alloys or some flexible laminating materials. All of this is basically done to prevent the food from going bad due to a number of reasons, some of which are microbiological in nature. In this technology the food is generally processed and packed together.

There are two main ways in which this technology is used, one is through the use of steam and other is by using superheated water, which enables the cooking of food in individual packages itself. With the advancement in food technology, new innovations in the food industry are seen every day and since the application of retort processing in food technology, the hygiene levels of food packaging have immensely improved.

Steps involved in Retort Processing :

There are seven steps involved in the processing and packaging of food using retort technology,

- **Preparation of Retorts:** this first step requires the thorough cleaning and washing of the machinery that is to be used, like – thermometer, valves, gauges, etc.
- **Loading:** the second step is loading the packaging material, like – cans or retort pouches.
- **Venting:** Then venting takes place, this is the process which ensures that there is no pre-existing air in the packaging containers.
- **Cool off Time:** Subsequently, the retorts are given time to rise up to the temperature needed for processing.
- **Processing:** during this step it is ensured that no fluctuation in temperature happens throughout the process.
- **Blowing down:** Then the supply of steam is stopped, giving the product time to cool off.
- **Unloading:** finally, the retorts are packed and ready to be transported.

Historical Significance of Retort Technology -
Due to the high demand in ready to eat food a lot of manufacturers have turned to this mode of production and retort technology is massively used to process and prepare ready to eat meals. Even though the use of retort technology in food has increased only in the recent years, this is not a novel concept. Retorts, also known as Autoclaves have been a part of the food industry for over a century now. Even in the Napoleonic wars, heat was used to preserve food, during the battle of Waterloo the soldiers were provided rations in cans and even explorers carried canned foods with them as they

lasted long. That was back in the eighteen hundred. Hence, both the centuries before this one has seen use of a retort- like technology.

RETORT POUCH:

A **retort pouch** or **retortable pouch** is a type of food packaging made from a laminate of flexible plastic and metal foils. It allows the sterile packaging of a wide variety of food and drink handled by aseptic processing, and is used as an alternative to traditional industrial canning methods. Packaged foods range from water to fully cooked, thermo-stabilized (heat-treated) high-caloric (1,300 kcal on average) meals such as Meals, Ready-to-Eat (MREs), which can be eaten cold, warmed by submersing in hot water, or through the use of a flameless ration heater, a meal component introduced by the military in 1992.[1] Retort pouches are used in field rations, space food,[2] fish products,[3] camping food, instant noodles, and brands such as Capri Sun and Tasty Bite.

Some varieties have a bottom gusset and are known as stand-up pouches.

Origin

The retort pouch was invented by the United States Army Natick R&D Command, Reynolds Metals Company, and Continental Flexible Packaging, who jointly received the Food Technology Industrial Achievement Award for its invention in 1978.[4] Retortable pouches are extensively used by the U.S. military for field rations (called *Meals, Ready-to-Eat*, or *MREs*).

Construction

A retort pouch is constructed from a flexible metal-plastic laminate that is able to withstand the thermal processing used for sterilization. The food is first prepared, either raw or cooked, and then sealed into the retort pouch. The pouch is then heated to 240-250 °F (116-121 °C) for several minutes under high pressure inside a retort or autoclave machine. The food inside is cooked in a similar way to pressure cooking. This process reliably kills all commonly occurring microorganisms (particularly *Clostridium botulinum*), preventing it from spoiling. The packaging process is very similar to canning, except that the package itself is flexible. The lamination structure does not allow permeation of gases from outside into the pouch. The retort pouch construction varies from one application to another, as a liquid product needs different barrier properties than a dry product, and similarly an acidic product needs different chemical resistance than a basic product. Some different layers used in retort pouches include:

- polyester (PET) – provides a gloss and rigid layer, may be printed inside
- nylon (bi-oriented polyamide) – provides puncture resistance
- aluminum (Al) – provides a very thin but effective gas barrier
- food-grade cast polypropylene (CPP) – used as the sealing layer
- polyethylene (PE) – can be used instead of PP as a sealing and bonding layer

This multi-layer structure prevents the retort pouch from being recycled into other retort pouches or food packaging. However, the material can be recycled into an aluminized resin or up-cycled into textile materials.[5] The weight of a pouch is less than regular cans or bottles, and the energy required to produce each pouch is less than competing packaging from metals, paper, and glass.

MICROWAVE PROCESSING

45.1 Introduction

Microwaves are part of electromagnetic spectrum in the frequency range falling between radio and infrared region. Two frequencies have been set aside for exclusive use of microwave heating application namely 915 MHz and 2450 MHz.
Microwave heating is a method that offers technique of heating requiring neither conduction nor convection. Microwave generates heat within the food rapidly raising the temperature to the desired extent. Special oscillator tubes called magnetrons and keltron, which generate the microwaves are used. These devices convert low frequency electrical energy into hundreds and thousands of mega-cycles. The electromagnetic energy at microwave frequency is conducted through a coaxial tube or wave-guide at a point of usage. The microwaves are channeled along a wave guide, then a stirrer or paddle distributes them evenly into cavity. Once they are inside the cavity, three things can happen to the microwaves, i.e. reflection, transmission and absorption.

The microbial inactivation kinetics for microwaves are essentially the same as the inactivation kinetics of conventional thermal processing. Although as many as four separate effects have been proposed - selective heating of micro-organisms, electroporation, cell membrane rupture and cell lyses due to electromagnetic energy coupling are the significant ones. It has also been suggested that microorganism load can be reduced to a greater extent by microwave treatment.

45.2 Mechanism of Microwave Heating

Heating with microwave frequency involves primarily two mechanisms dielectric and ionic. Water in the food is often the primary component responsible for dielectric heating. Due to their dipolar nature, water molecules try to follow the electric field associated with electromagnetic radiation as it oscillates at the very high frequency. Such oscillation of trip molecules produces heat. The second major mechanism of heating with microwave frequency is through the oscillatory migration of ions in the food that generate heat under the influence of the oscillating electric field. Kinetic energy is actually imparted to the ions by the electric field so that the field is alternating rapidly heat.

Microwaves penetrate materials and release their energy in the form of heat as the polar molecules (ones with positively and negatively charged ends - such as water) vibrate at high frequency to align themselves with the frequency of the microwave field. The microwaves interact directly with the object being heated. The interaction is related to the chemical properties of the object and it is possible to apply heat in ways that can not be achieved by conventional means: convection heating, conductive heating or radiant heating .

45.2.1 Microwave Generation

The microwaves are generated by special oscillator tubes called "Magnetrons and Kystron". These are devices that convert low frequency electrical energy into hundreds and thousands of megacycles. The electromagnetic energy, at microwave frequency is conducted through a coaxial tube or wave guide at a point of usage. Both Magnetron and Kystron are electron tubes which generate microwaves.

1. **Magnetron:** It is a cylindrical diode with a ring of resonant cavities that acts as a anode structure. The cavity is the space in the tube which becomes excited in a way that makes at a source for the oscillation of microwave energy . The Magnetron is a vacuum valve in which the electron, emitted by the cathode, turn around under the action of a continuous electric field produced by the power supply and of a continuous magnetic field. The movement produces the electro-magnetic radiation.

2 **Keltron:** It is a vacuum tube in which the oscillation are generated by alternatively slowing down and speeding upon electron beam. This results in periodic bunching of electrons. Keltron uses the transit time between two given points to produce this modulated electron stream which then delivers pulsating energy to a cavity resonator and sustain oscillation within the cavity.

Advantages of Microwave Processing:

The main advantage of a microwave oven over the conventional oven (electric and gas oven) is its high thermal efficiency in converting the energy in electricity into heat in the food. Other advantages are:

1. Speedy: microwave cookers heat food more quickly than any other conventional oven (shortening of processing time often by 70-85% and more).
2. Clean: with microwave cooking there is no risk of the food burning onto the cooker walls or they do not become hot in the way that the surfaces of conventional oven do. In addition, most foods are cooked covered and so remain in their containers (higher quality of product).
3. Smell free: because food is contained within the cooker cavity (and usually also in a covered dish), smells are kept to a minimum.
4. Less washing up: it is often possible to microwave food in serving containers or on the plate from which it is to be eaten. This is reducing the kind of washing up required when saucepans and metal oven dishes are used.
5. Thawing: thawing can be done quickly in a microwave cooker, saving hours in the fridge or kitchen and removing, the need for too much forward planning.
6. Nutritionally sound: many foods retain more nutrients than when cooked conventionally, as cooking time is so short, and there is little or no added water, particular examples are fish, vegetable.
7. Easy to use: once controls and cooking techniques are mastered, microwave cookers are extremely easy to use.
8. Cool: unlike conventional ovens, microwave cookers do not produce external heat and so can be used anywhere that is convenient such as a dining room.
9. Higher capacity: due to shorter residence time
10. Less space requirement by up to 50-90% against other methods
11. Better hygiene of working environment
12. Easier and faster maintenance
13. Savings of electric energy in comparison with conventional methods are frequently within the range of 25-50%.
14. Waste elimination and lower consumption of fossil fuels, causing lowering of environmental stress.

Disadvantages of Microwave processing

1. Because of speed, and the way in which microwave energy cooks, food cooked in a microwave oven will not be brown, so no crust formation or browning in case of bread or meat (in such cases microwave with grilling can be used).
2. High initial cost.
3. Short cooking time does not allow flavors to develop and this makes food unacceptable.

Application of Microwave in dairy and Food Processing

1. Baking: for internal heating microwave, for external heating hot air (electric coil) or infrared for crust formation.
2. Concentrating: concentration of heat sensitive fluids and slurries at relatively low temperature in relatively short time.
3. Cooking: it cooks relatively larger pieces without high temperature gradients between surface and interior (for continuous cooking of meals).
4. Curing: effective for glue-line curing of laminates (as in package) without direct heating of the laminate themselves.
5. Drying: microwave selectively heats water with little direct heating of most solids. Drying is uniform throughout the product, drying at relatively low temperature.
6. Enzyme inactivation (blanching): rapid and uniform heating inactivates enzymes, so it is adapted for blanching of fruits and vegetables without leaching losses associated with hot water or steam and it does not overcook the outside before core enzymes are inactivated.
7. Finish drying: when most of the water has been removed by conventional drying, microwaves remove the last traces of moisture from the interior of the product quickly, and without overheating the already dried material.
8. Freeze drying: the ability of the microwave energy to selectively heat ice crystals in matter makes it attractive for accelerating the final stages of freeze drying.
9. Heating: almost any heat transfer problem can benefit from the use of microwaves because of their ability to heat in depth without high temperature gradient.
10. Pasteurizing: microwaves heat the product rapidly and uniformly without the overheating associated with conventional methods.
11. Precooking: it is well suited for precooking ‘heat and serve’ because there is no overcooking and no cooking losses.
12. Puffing and foaming: rapid internal heating by microwave causes puffing and foaming when the rate of heat transfer is made greater than the rate of vapor transfer out of the product interior. May be applied to puffing of snack foods and other materials.
13. Solvent removal: many solvents other than water are efficiently vaporized by microwave, permitting solvent removal at relatively low temperature.
14. Sterilizing: where adequate temperature may be reached (acid foods), quick, uniform come up time may permit HTST sterilization. Selective heating of moisture containing microorganisms makes possible the sterilization of such materials as glass, and plastic films, which are not themselves heated appreciably by microwaves (it will not destroy bacterial spores)

15. Tempering: microwave heating is roughly proportional to moisture content, so it can equalize the moisture in a product that came from the process of non uniform condition.
16. Thawing: controlled, rapid thawing of bulk items is possible due to substantial penetration f microwaves into frozen materials.

Microwave processing technique has attracted considerable attention in the dairy and food processing area. However, its application in the dairy industry has not aroused as much interest. Some of the applications of microwave in dairy industry include -inactivation of bacteriophage in cheese whey, production of anhydrous milk fat, heat treatment of whey protein concentrates, mass crystallization of lactose in sweetened condensed milk, sterilization of milk, pasteurization of milk (HTST method), in -packaging sterilization of yoghurt and tempering of frozen butter. The process can also be used for cooking of cut curd cubes during cheese making, and plasticizing of Provolone and Mozzarella cheese.

Microwave energy is unique energy sources that may allow shorten processing time, saving in energy, labor and space and often better quality products. Advances in technology concentrating, focusing and controlling microwave energy has increased the feasibility of developing microwave processing for the food and dairy industry. Microwave processing is expected to grow beyond our expectation due to increasing consumers demands for newer type of convenience foods having more nutritional value and better sensory quality in the recent years. There is a great potential for the combination ovens because they are more effective than either oven alone in the manufacture of shelf stable packed foods. Advances in microwave oven design and narrowing gap in cost between microwave and thermal processing will provide and incentive for the development of newer microwave processes.

Microwave food processing design development will require additional research on mechanisms of microwave heating of foods, particularly in the areas of energy coupling and propagation modes, and further development of quantitative electro physical and electrochemical models as an aid to microwave process design.