

Baking and roasting

Baking and roasting are essentially the same unit operation: they both use heated air to alter the eating quality of foods. The terminology differs in common usage; baking is usually applied to flour-based foods or fruits, and roasting to meats, nuts and vegetables. In this chapter the term baking is used to include both operations. A secondary purpose of baking is preservation by destruction of micro-organisms and reduction of the water activity at the surface of the food. However, the shelf life of most baked foods is short unless it is extended by refrigeration or packaging.

Theory of baking:

Baking involves simultaneous heat and mass transfer; heat is transferred into the food from hot surfaces and air in the oven and moisture is transferred from the food to air that surrounds it and then removed from the oven. In an oven, heat is supplied to the surface of the food by a combination of infrared radiation from the oven walls, by convection from circulating air and by conduction through the pan or tray on which the food is placed. Infrared radiation is absorbed into the food and converted to heat. Air, other gases and moisture vapour in the oven transfer heat by convection. The heat is converted to conductive heat at the surface of the food. A boundary film of air acts as a resistance to heat transfer into the food and to movement of water vapour from the food. The thickness of the boundary layer is determined mostly by the velocity of the air and the surface properties of the food and in part controls the rates of heat and mass transfer. Convection currents promote uniform heat distribution throughout the oven, and many commercial designs are fitted with fans to supplement natural convection currents and to reduce the thickness of boundary films. This increases heat transfer coefficients and improves the efficiency of energy utilization.

Equipment of baking:

Direct heating ovens

In directly heated ovens, air and the products of combustion are recirculated by natural convection or by fans. The temperature in the oven is controlled automatically, by adjustment of air and fuel flow rates to the burners. Natural gas is commonly used, but propane, butane, fuel oil or solid fuels are also found. Gas is burned in ribbon burners located above and below conveyor

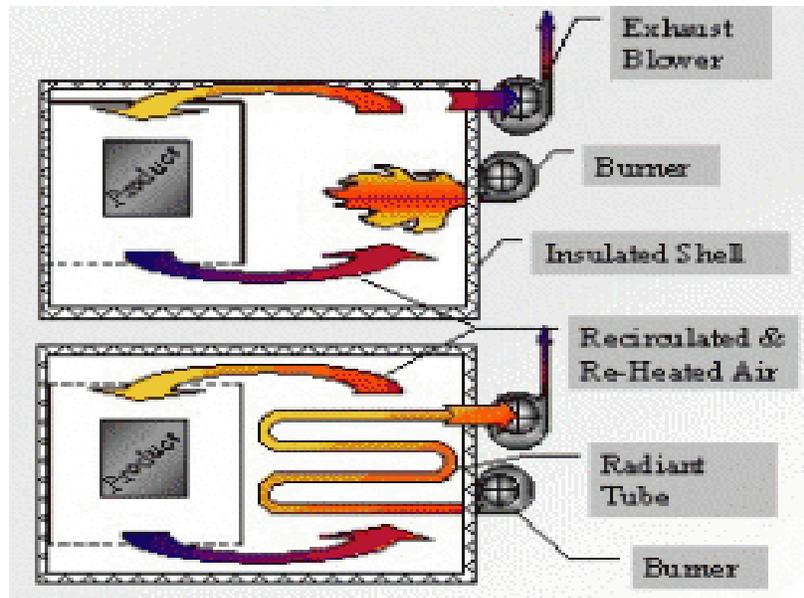
belts in continuous ovens, and at the base of the cabinet in batch ovens. Safety features are incorporated to extinguish the burners automatically if abnormal baking conditions arise, and pressure-relief panels are fitted to the top of the ovens to protect personnel should a gas explosion occur.

The advantages of direct heating ovens include:

- short baking times
- high thermal efficiencies
- good control over baking conditions (using the fan speed and the rate of fuel consumption)
- rapid start-up, as it is only necessary to heat the air in the oven.

Indirect heating ovens

Steam tubes are either heated directly by burning fuel or supplied with steam from a remote boiler. The steam tubes then heat air in the baking chamber. Heated air is commonly recirculated through the baking chamber and through a separate heat exchanger. Alternatively, combustion gases are passed through banks of radiator tubes in the baking chamber, or fuel is burned between a double wall and the combustion products are exhausted from the top of the oven. Electric ovens are heated by induction heating radiator plates or bars. In batch ovens, the walls and base are heated whereas in continuous ovens, heaters are located above, alongside and below a conveyor belt. Most ovens have 25mm thick ceramic tiles fitted to the hearth to promote even heat distribution.



Batch ovens

In the Peel oven, food is loaded into a baking chamber, either on trays or singly, by means of a long-handled shovel (a peel) which gives its name to the oven. More recent designs include the multi-deck oven which is widely used for baked goods, meats and confectionery products. Some designs have a 'modular' construction to allow expansion of production by duplication of modules, without having to replace the entire plant. The main disadvantages of batch ovens are higher labour costs and lack of uniformity in baking times, caused by the delay in loading and unloading.

Continuous and semi-continuous ovens

Rotary-hearth ovens, reel ovens and multi-cycle tray ovens all circulate the food through the oven on trays, and loading and unloading take place through the same door. The operation is semi-continuous when the oven must be stopped to remove the food. The movement of food through the oven, with or without fans to circulate the air, ensures more uniform heating.