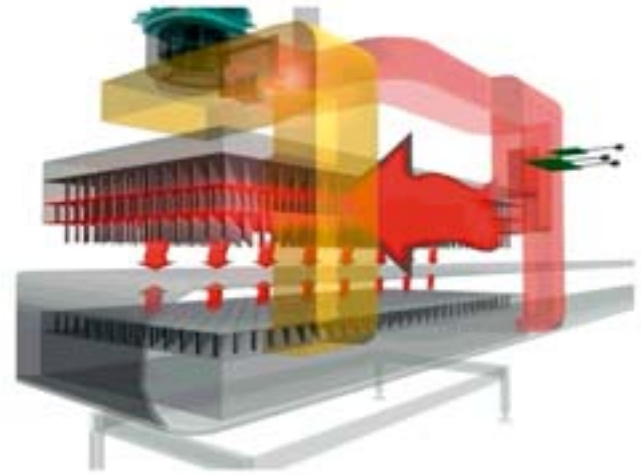
Biscuit giants

SOPHISTICATED OVENS FOR BISCUITS COME IN ALL SHAPES AND SIZES BUT TUNNEL OVENS ARE PREVALENT IN THE MARKET.



++ **figure 1**
Air flow in a Gouet oven

Biscuits are offered in numerous variations from simple butter cookies and scones to Spritz cookies and Danish pastry biscuits. All these products belong to the category of fine bakery wares and dry baked goods but the product specific requirements in terms of oven technology are often as various as the biscuit's names or their origin. Biscuits and cookies are different, therefore, the ovens must be different as well. Is that so or is there an oven system in which all biscuit products including Danish pastry can be baked with the same high quality?

The temperature must be right

In any case, one decisive criterion in industrial biscuit production is the uniformity of the baked good. The reason for that is simple and clear: biscuits and Danish pastry cookies are in general flat products, the baking time is rather short and the baking temperature is low compared to bread baking. Nevertheless, temperature deviations or uneven temperature zones in a tunnel oven will immediately affect the baking result. A number of manufacturers is now relying on a combination of different heating systems for biscuit ovens and they know why.

The systems

+ Ovens with direct heat: These are either heated by open gas flame via an arrangement of burner heads or electrically heated ovens. Ovens with direct gas heaters can sometimes be problematic because flue gases can contain pollutants which might migrate into the product. This risk is particularly high in the case of deviating or substandard gas quality.

+ Ovens with upstream electrical pre-baking or heating zone They are for heating the dough pieces prior to the initial baking. The resulting very uniform initial baking compensates possibly not quite uniform temperatures in the oven over the entire baking time. This system has proven as pre-bake unit upstream from direct gas heated ovens or flue gas circulation ovens with a suboptimum flue gas conduction in the feeding section. Furthermore, the electrically heated pre-baking zones act as heat buffers which can reduce the heat loss at the feeding section of the oven.

+ Classical flue gas circulation ovens: Mostly one burner chamber in each section or module in which the flue gas is heated through the direct burner flame. The flue gas flows through separate channels which are not connected with the baking chamber, either above or underneath the baking chamber.. The flow behavior of the flue gas can be controlled by either changing the cross-section of the flue gas channels, or by flaps controlled via fans.

+ Flue gas circulation ovens with additional convection: In addition to the system described above, air from the baking chamber is sucked in and fed back into the oven via additional air pipes and nozzles. This system has some advantages over the pure flue gas circulation oven in which the dough pieces are baked in a stationary atmosphere. Physically seen, an insulating layer forms around the dough piece in the oven thus slowing down the heat transfer rate. Simply speaking, direct circulation air blows off the insulating layer and ensures quicker heat transfer. In addition to that an agitated atmosphere can on the one hand improve the distribution of humidity inside the oven (improved steaming effect) but on the other the convection also supports steam removal. Some manufacturers force the steam removal by introducing fresh air via the convection pipe, thus creating a slight overpressure inside the oven. In this way water vapor is pushed out of the oven in the shortest possible time.

+ Pure convection ovens: Heating gas heated by a burner is not directly guided through the oven but through an arrangement of pipes or channels. The air inside is heated up and blown via fans and air feeding slots or air inlet sheets into the oven. Heat transfer in such ovens is in most models controlled via burner temperature and air speed or air volume. The advantage of this system is a higher uniformity in terms of heat distribution. Due to the low mass in the heat carrier, hot air circulation ovens are very flexible, and compared with all oven systems they have the best temperature ▶

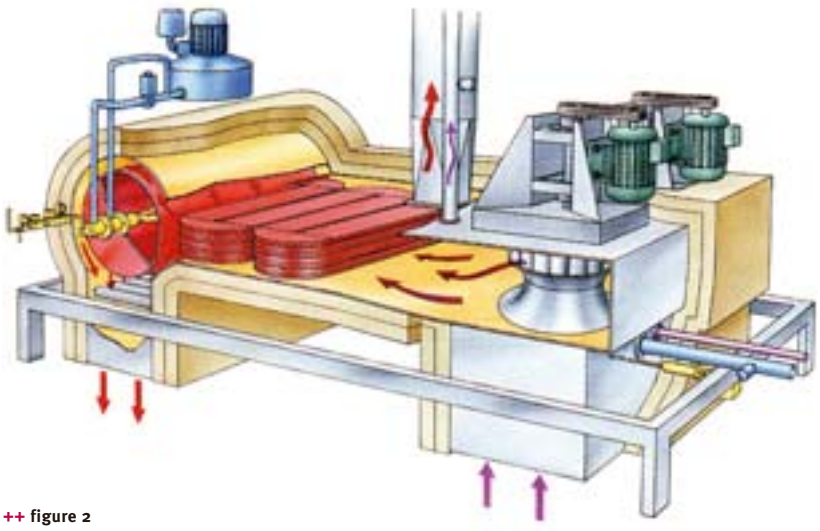
rise rate. However, one drawback is that the high air circulation speed dries out the baked goods more than is desirable.

+ Combination ovens with several heating systems: These are divided into two groups: The first group includes ovens which are equipped optionally with heat gas circulation and heated air circulation for each heating zone. This is achieved with two independent burner and air pipe systems. Either the oven operates as a heating gas circulation oven or as a heated air circulation oven or as a combination of both. The second group are the so-called hybrid ovens which follow the same approach but are of different design. Here the option of modular oven design is used to heat different modules separately. For example: Module one can be heated directly, module two can be a flue gas circulation element and in the third module the baking process utilises convection heat. This systematical approach achieves the optimum baking result in each baking phase. However, the problems of such ovens are their focus on optimum product properties. Such specialist ovens are very suitable for the products for which they were designed, but flexible use for other products is limited.

Superimposed convection in flue gas convection ovens

Werner & Pfleiderer Industrielle Backtechnik, Tamm, Germany, offers this system as an option. The combination of radiation and convection is adjustable for the entire oven as well as for individual baking zones or modules. Operation of the oven as a pure radiation oven without convection is also possible.

The HYM oven system of WP-I is quite new. Here the tunnel oven constructors went even further and equipped their oven with two heating systems (flue gas circulation and heated air circulation) which can be used separately or combined. It is also possible to operate the oven with radiation heat only, or exclusively with convection heat or with a combination of both. No other manufacturers offers such variants so far.



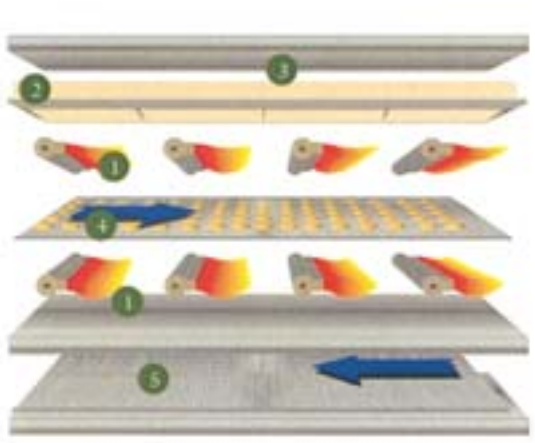
++ figure 2
Heat flow in a Rademaker oven

Convection as heating principle

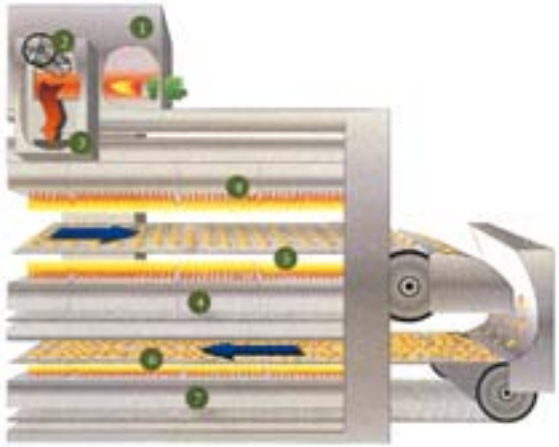
One of the best known hot air circulation ovens for biscuits is the Meincke Turbo oven. It can be used for cookies, small bakery items, cakes, crackers, sweet rolls, muffins, sheet cakes, Danish pastries, pizza, yeast-raised baked goods and many other items. It is operated following the principle of indirectly heated convection and there are over 1,000 machines in operation already. Due to the accelerated air speed, the heat transfer is also much quicker. The forced air movement around an object speeds up the heating process – alternatively, the same rise in temperature can be achieved at a lower temperature level to reduce energy consumption. Compared to ovens with stationary atmosphere, the baking times are shorter. Another advantage of the convection system is the even distribution of warm air around the baking belt so that no energy can accumulate inside the oven (no scarfing). The heat from the gas flame in the Meincke Turbo oven is guided through a high-quality tubular heat exchanger. The heating registers are integrated in every second oven module, the modules without burner and heat exchanger are connected via air ducts to the heat distribution system.
Baking temperature, the humidity inside the oven and the ratio top-to-bottom heat can be easily controlled individually for each zone in the Meincke Turbo oven. The working width is 0.6 to 4 meters. Each segment forms a heating zone with individual adjustment of temperature and heat distribution. The individual heat exchangers are available in different types based on the individual temperature requirements. The total heating effect of each zone can be varied and the amount of circulating air can also be adjusted depending on the baking processes.

A range of different systems

Rademaker/Den Boer, Culemborg, the Netherland, relied on their own experiences with modular concepts for make-up lines on oven construction. The individual modules are not only completely prefabricated in the factory, the dimensions of the individual modules correspond to common container sizes so that for the final assembly no elaborate and costly heavy load transportation is required. Due to the well considered prefabrication, even very large ovens can be erected at the customer's location in only one fourth of the usual assembly time. The Multibake ovens are designed as series of follow-up models. The new range is divided into four oven types, of which types R and I are of interest for biscuit baking. Besides the classical models type D (direct heat) and R for radiation (heating gas convection), the series I stand for impingement (hot air circulation). In these ovens, according to the manufacturer's information, the baking times for Danish pastry, puff pas-



++ figure 3
Direct gas fired section with firebricks underneath the ceiling



++ figure 4
Convection module with additional drying zone in a Reading Spectrum oven

try and short paste cookies could be reduced by up to 40 %. The air circulation speed is state-of-the-art, which means frequency-controlled and with an air speed up to 30 m/sec. However, the maximum performance will not be applied for light biscuits. Rademaker recommends an air speed of 8-12 m/sec for Danish pastry items. This shows the enormous capacity reserves of the system. Most other suppliers can only achieve 20 m/sec under full load. The modules are equipped with independent burner towers, so any kind of combination is possible. Rademaker Den Boer call this variant type H for hybrid.

The American way with interesting details

Flexible type of heat transfer is key to the Spectrum oven by Reading Bakery Systems, Robesonia, Pennsylvania, US. Each section of the oven can be heated to different temperatures and thus optimized to the respective product. Beside the heat carrier system, it is possible to choose different types of humidity control via flaps or active steaming systems. At the inlet section of many biscuit and cracker ovens there are preheating zones which in Reading's oven are equipped with electrical heat radiators in the top heat area of the ovens. Here only inherent moisture is used for baking. The manufacturer calls the second heating option "Smart Section". A combination of electrical radiators and directed hot air flow, which is heated up in an upstream heat exchanger connected to a burner, is used for baking. Air speed and humidity are adjusted via frequency transmitters which also allow a product-specific adjustment of the system. The highlight of the system is located at the discharge section of the oven. Here there is the option to transport the crackers or sticks via slip and turn device underneath the baking chamber back along the entire oven length. Residual moisture is removed without additional energy consumption just because of the waste heat from the baking oven above. This return transport also saves a lot of space. The ovens are also available in sections which are designed to fit into ship containers to keep the costs for transport over large distances manageable.

The second variant is the Prism oven. Different to many other suppliers, Reading offers the possibility to use stone plates as heat storage and an emitter of radiation heat. This increases the portion of radiation heat in the total heat flow. For the DGS oven (direct gas fired), the American company also offers a stone plate cover for the top of the oven. The heating is done directly via gas fire pipes. The stones at the oven ceiling are acting as an insulating layer, but they are also heat accumulators increasing the heat mass of the oven and ensuring a more uniform heat transfer. Stone also has an immediate effect on the humidity inside the oven. Stone stores and releases humidity which levels the climate inside the oven. According to latest research, this also effects the flavor of the baked goods in a measurable range. Besides the directly heated and stone-covered section there are also modules available for baking with convection or hot air. Due to the combination of direct heat and stone plates at the oven ceiling as well as guided hot air convection it is possible to adjust each oven individually to the product's requirements. According to the manufactures, the Prism oven is clearly best suited for the production of biscuits. +++