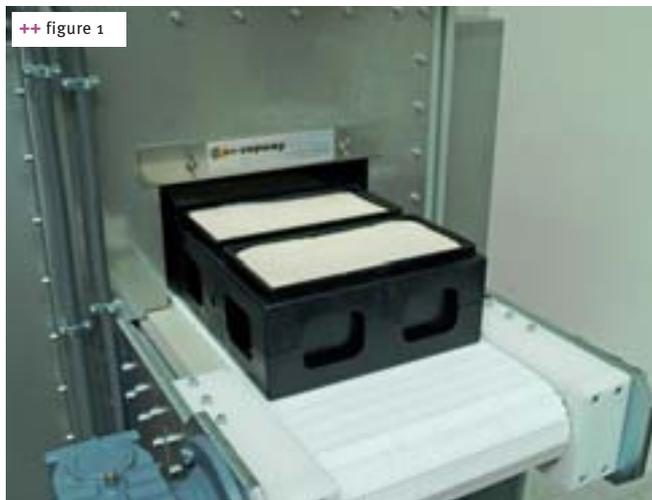


Baking with electromagnetic waves

THE DUTCH PRODUCER OF AUTOMATIC BAKERY LINES CAPWAY AND THE ITALIAN PRODUCER OF RADIO-FREQUENCY & MICROWAVE OVENS STALAM HAVE JOINED FORCES



++ figure 1
The products are baked in special strap pans made from plastic material



++ figure 2
Pizza bases can also be baked with radio frequency or microwaves

++ figures 3 + 4
Baguette and toast bread are removed from the pan after baking

Both companies are ready to supply industrial bakeries worldwide with production lines incorporating Capway & Stalam technology for various bread types, in particular crustless and white-crust bread as well as par-baked products.

Heating from the inside out – baking via electromagnetic waves has occupied the time of the developers of bakery technologies for quite some time now. Microwave and radio-frequency technologies have been used in other fields of the food industry for many years, for example, for the pasteurization of packaged bread and other food stuffs, for tempering and thawing of meat, fish and vegetables and also for drying after baking crackers and cookies. In particular the increasing market for crustless toast bread in the Mediterranean countries and Middle East has fired the developer's imagination.

Prior to getting acquainted with the Italian based Stalam S.p.A, Capway from the Netherlands was already experimenting with a microwave oven that it had developed together with the technical university in Eindhoven. Stalam, the family enterprise from Nove near Venice is one of the leading specialists in the application of electromagnetic waves (radio-frequency or microwave) for heating, drying, sterilizing, etc. The joint realization of a complete, automatic line for crustless bread, which is now in production, was the first time Stalam and Capway had co-operated together.

After witnessing the successful conclusion of this project, Capway and Stalam decided to pursue jointly the development of fully automated baking lines based on the dielectric heating technology and so marrying the core competencies of both companies. They will be presenting the full range of turn-key solutions



++ figure 3



++ figure 4

at iba; microwave, radio-frequency and infra-red baking technology.

The radio-frequency and microwave technologies are similar but also different in several aspects. One difference is the frequency range used for the process. Radio-frequency uses 27 MHz waves, where microwave technology uses 2450 MHz. The type of distribution of rays inside the oven is also different. With radio-frequency technology, the rays are emitted from two plates above and underneath the baking chamber. In a microwave oven, the rays are introduced through a dedicated opening in the baking chamber and are reflected at the walls of the baking chamber. For a baking capacity of 2,800 bread loaves per hour, six radio-frequency generators are needed for providing the energy required for baking while creating uniform energy distribution throughout the oven. A microwave oven needs several hundreds of individual microwave generators to supply sufficient energy and create the uniformity for the baking process. Both types of oven require a safety zone at the loading and the unloading end. However, the safety measures needed for a radio-frequency oven are much simpler and therefore cheaper.

In addition to this, a radio-frequency oven uses 65-70% of the total energy input energy for the baking process. The same figure for a microwave oven is 55-60%. Compared to that, the energy efficiency of a conventional oven is substantially lower because amongst others a large percentage of the energy input is lost through the chimney and through heating up the metal pan-straps.

Another big difference between radio-frequency and microwave ovens is the way they operate during production. A microwave oven works according to the on/off principle which means that, when there are no products in the oven (= no absorbing of energy) the microwave generators have to be switched off. If this is not done, the energy will ►

Plastic pan straps for bread

During the course of realizing an automatic line with a radio-frequency oven for toast bread with Stalam, Capway has developed a pan-strap completely made out of plastic materials which is suitable for industrial bread production lines using both RF and/or MW oven technology. The pan-strap is heat resistant to approximately 225 °C, so it can also be used in conventional ovens. The pan-strap consists of a frame and a number of pans inside the frame. The number of pans, their dimensions and the dimensions of the frame can be adjusted according to the capacity of the line. The frame is made out of a very durable and reinforced plastic material that provides the mechanical resistance required for automatic handling on an industrial line. The pans, holding the dough, are made of a food-grade plastic material and are placed individually into specially designed openings in the frame in such a way that they cannot be removed again. Therefore the pans and the frame act as one object, the pan-strap. By way of the specially designed openings for the pans in the frame and the connections between the pan and the frame, it is possible to create a convex shape in the pan in order to produce completely square toast bread. The lids are also designed so that the part of the lid in contact with the dough during the baking process is also food grade and a convex shape can be made in the lid. Furthermore, the material of the lid provides for sufficient weight to prevent the dough from pushing the lid up during baking. It also stays completely straight during baking while being exposed to the RF and/or MW waves. Based on the experience gained on the project, Capway is now developing plastic baking forms for baguettes and bread types that can be par-baked since RF/MW lines are particularly suitable for these types of products. +++



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damage the oven and also the generators themselves. The energy has to go somewhere! A radio-frequency oven works according to the principle: when there is no product in the oven (= no absorbing of energy), there is no energy delivered. A radio-frequency therefore has an automatic 'fail-safe' function because of the way the technology works. This makes a radio-frequency oven easier to control and to operate.

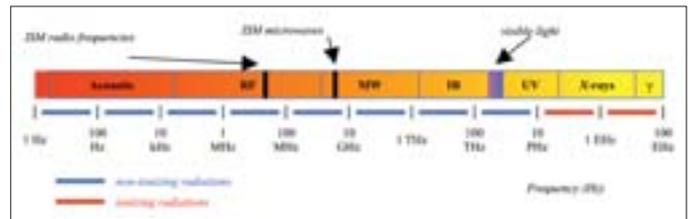
The Stalam and Capway combination can offer bakeries both radio-frequency and microwave operated production lines that are fully automated and turn-key. Hans van Dijk, CEO at Capway and Enrico Zanetti, Managing Director at Stalam agree that it makes sense to consider both technologies for baking bread products. There are products where a radio-frequency oven gives better results and there are products where a microwave oven is favourable. In these cases the choice of which technology to use is straight forward on product quality grounds. However, there are also products

where radio-frequency and microwave give a similar end product. In these cases, the choice of which technology to use is also straight forward but this time on economical grounds; it is more profitable to use a radio-frequency oven.

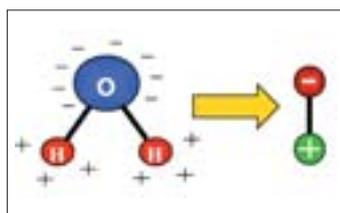
A baking curve can be created in both oven types by control of the energy introduced. Also, both oven types allow an immediate change of baking curve resulting in very short change-over times from the production of 1 product to the other. The experience gained by Capway and Stalam shows that an 850 gr. square crustless shaped bread needs a baking time of between 9-11 minutes in a radio-frequency oven and slightly shorter in a microwave oven. Extensive tests in using both microwave and radio-frequency ovens for products as diverse as pizza bases, par-baked and pre-baked baguettes and hard rolls have been carried out. The test facility where both oven types can be tried out with products is available for customers who want to see for themselves what impressive results can be achieved. +++

Radio frequency and microwaves

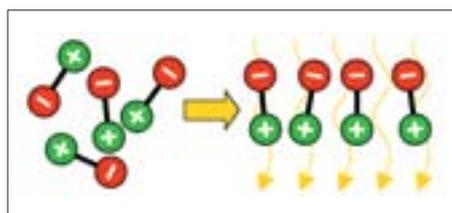
An electromagnetic field is a physical entity which is formed by the simultaneous action of phenomena of both electrical and magnetic nature, whose intensity varies cyclically with a certain oscillation frequency. Due to the electromagnetic fields and especially to their specific interaction effects with the matter, it is possible to generate heat inside several materials (dielectrics). Specifications for industrial, scientific and medical applications allocate specific frequency ranges to the use of electromagnetic fields within the radio frequencies range (allowed frequencies: 13.56, 27.12 or 40.68 MHz) and the microwaves range (2450 MHz and, in some Countries, 896 / 915 MHz).



++ figure 1
Frequency spectrum



++ figure 2
Water molecule is an electrical dipole

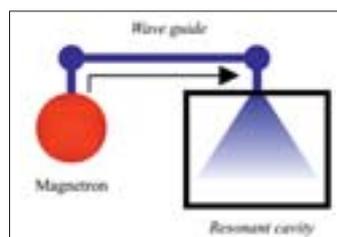


++ figure 3
Alignment of dipoles to follow force lines of a dipole

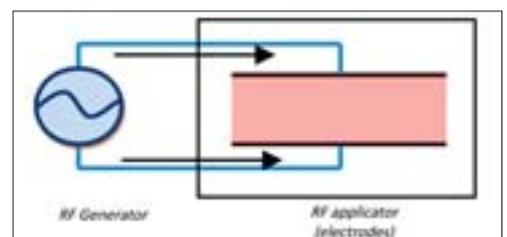
Dielectric loss

Dielectric loss is the physical phenomenon that allows radio frequencies and microwaves to transfer heat to a product. Many non-conductive materials and especially water are made of so-called polar molecules. In such molecules, the elementary positive and negative electrical charges, despite being globally balanced, are not uniformly distributed: There is a portion of the molecule where a positive charge prevails and another portion where a negative charge is in excess.

Polar molecules, when exposed to the action of an electromagnetic field, tend to follow the force lines of the electric component, rotating around their position to align themselves; if the electric component of the electromagnetic field inverts its polarity with a high enough frequency, the repeated re-alignment of the polar molecules originates the heating due to "friction" with neighbor molecules.



++ figure 4
Structure of typical microwave equipment



++ figure 5
Structure of typical radio frequency equipment

Source: Stalam S.p.A. +++

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