

**Microwave combination ovens the route to profit**  
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Today we are commemorating the 40th anniversary of the British Society of Baking. What might be a surprise is that last week it was the 50th anniversary of the microwave oven. Following his discovery of the effect of microwaves on a chocolate bar in his pocket, the original patent was filed in America by a research scientist called Percy Spencer, one of the wartime pioneers of radar development.

Although most people attribute the invention of the microwave oven to America, what is not widely known is that the heart of the design, the cavity magnetron, was invented during the war by Professors Randall and Boot of Birmingham University.

Merrychef Ltd is now the largest manufacturer of commercial microwave ovens in the EC. In the UK the first commercial microwave oven was shown in 1958 by Merrychef's founder C E Tibbs. The Artica was developed by R C Constable in 1960.

This oven subsequently had recirculating hot air added, resulting in the first combination microwave oven, a design that was patented in 1968 and was the direct predecessor of the Mealstream combination microwave oven. The use of both gas and electric heating was covered in this and other patents that followed.

The use of combination ovens offers today's caterer fast cooking (typically one-fifth of the time of conventional methods), and the ability to cook high quality dishes to order from frozen.

## **Technology**

Microwaves are part of the electromagnetic spectrum, which also includes visible light, radio waves, TV and satellite transmissions. Microwaves used for cooking have a frequency of 2,450 million cycles per second, and come between those frequencies used for mobile phones and for satellite TV transmissions.

Now I feel it is time to expose one or two myths about microwave heating, as I explain how microwaves heat food.

### **Myth 1 - microwaves heat by friction**

When food products are exposed to microwave energy, the microwaves act directly on the water molecules within them.

Water molecules are polarised, that is they have a positive end and a negative end. As the applied microwave field changes polarity 2,450 million times per second, the water molecules try to line up with the applied field, and are vibrated rapidly.

This vibration is what we term 'heat', and so the microwave energy directly heats the food rather than relying on externally applied heat.

In contrast, when heat is applied by a grill or hot air to the outside of food, the only way it can heat the food is by causing the surface molecules to vibrate faster. These in turn rub on the molecules further in, and so conventional cooking heats by friction, not microwave cooking

## **Myth 2 - microwaves heat from the inside out**

Microwaves are applied to the outside of food. Just as sunlight penetrates water, microwaves penetrate the food, but less and less effectively.

In practice, microwaves heat best near the surface of the food, with less and less heating taking place as the depth increases. Effective penetration into food is typically limited to about 30mm, but this varies slightly depending on the dielectric properties of the food. After this distance, all heating is performed by conduction (that is, friction in the same way as conventional cooking).

In microwave cooking, providing that water is still present in the food item, the surface temperature will not exceed 100°C. Because the brown colour that we are accustomed to seeing on the surface of cooked foods is the result of a chemical change that occurs at much higher temperature, food cooked by microwaves alone will be pale and will look 'under-done'.

By combining microwave heating with a conventional heating method, the above weakness of unappetising food is eliminated.

In combination ovens, recirculating hot air is combined with microwave energy, which results in the fastest cooking method of all.

I am sure you are aware of the speed increase associated with fan assisted ovens compared to those that rely purely on convection. Air is forced across the heating element and then across the surface of the food product, thereby enabling a rapid transfer of heat to occur.

By recirculating the air maximum efficiency is achieved. There are now a number of combination ovens appearing on the domestic market due to the expiry of the original patents, but it is important to note the differences between these and commercial ovens.

Because of the 'heavy-duty' design, the performance of commercial ovens which must be capable of 24-hour use is much more consistent than domestic ovens, which are only designed for intermittent use.

Tests performed by the Ministry of Agriculture clearly show that power output in domestic ovens rapidly decreases with time of use due to heating of the main components, whereas commercial ovens with their better cooling give a very consistent power output.

This obviously has major implications for compliance with health and safety regulations on core temperature of food products, as a commercial oven will always heat the food to the same temperature; unfortunately one cannot say the same for a domestic oven used in a commercial situation.

## **How to increase profit**

## **Speed**

Typical cooking times are one-fifth of those associated with conventional cooking methods.

This speed makes combination microwave ovens ideal for use in any area where a sudden rush of orders is likely - the lunchtime rush at snack bars being a typical example. The ability to quickly produce a range of hot snacks, pies and pizzas on demand can only improve profitability.

## **Elimination of waste**

The speed advantage mentioned above allows 'cooking to order' from frozen. A trial is presently in progress with an Intercity organisation, where the old traditional cooking equipment has been replaced with combination ovens and freezers, and is now offering the customer freshly baked items - previously this operator was using fresh and chilled produce delivered daily.

What was not sold that day was scrapped. Now the freezer units are simply wheeled off the buffet carriage and restocked in preparation for the following day. It is worth noting that the ovens were specially modified to accommodate the varying supply and total loss of power every 20 miles.

The savings that can be realised using this new methodology will easily justify the purchase of capital equipment necessary.

## **Freshness**

Although bakeries have traditionally used either fresh or chilled products, and these products benefit greatly from combination microwave cooking, the developments in combination microwave oven technology mean that frozen products can now be used equally easily with no decrease in quality.

The phrase 'You can tell if it's fresh if it's frozen' appeared recently in the 1995/96 frozen food year book. The aroma and visual impact of seeing the products emerging from the oven gives the customer the added satisfaction of knowing that they have been freshly baked for them.

## **Product quality**

When used to cook puff pastry, the nature of microwave heating mentioned earlier gives a superior product to that of conventional heating.

A product cooked in a microwave combination oven can produce more evenly spaced and well risen laminations than conventional cooking, giving a perception of better value for money as there is no void when the product is eaten.

A major food company is investigating the use of this technology as an on-line quality check of the puff pastry, which can be performed before additional labour and other ingredients are added to the product which could then end up as waste when baked off.

Although not directly linked to profitability, food hygiene regulations are having an increasing effect on food production companies, and just one customer complaint about food can cost an awful lot of money!

My company was recently approached by one major international food company, which had a problem. It wished to market a range of food which was currently cooked by more conventional means, but when tested, the core temperature of the product was failing to achieve that required by regulations.

By designing a custom oven using combination microwave oven technology, the core temperature was achieved in considerably less time, while product appearance either matched or exceeded that obtained in the original grill.

## **Innovation**

Two years ago, we were approached by representatives of a major supermarket chain wanting a new oven which was safe for any member of staff to use, but allowed the production of crisp pastry items. Any existing solution would lead to the oven being too hot to touch. A solution was needed that left the oven cavity cool.

The eventual solution was a combination of existing microwave technology and lateral thinking, and consisted of three main parts:

- a high velocity source of very hot air which was targeted on the food
- a concentric source of cold air which contained then mixed with and cooled the hot air once it had done its job
- a piece of metallic coated card called 'susceptor' material which becomes very hot under the action of microwaves.

When the oven is started, the hot air impinges on the top of the product, sealing the surface and preventing the pastry from becoming soggy due to moisture generated by the microwave action on the filling.

The microwave energy also heats up the surface of the susceptor card, which is placed under the product. The end result is a crisp pastry product, lacking in the 'floppy' feel normally associated with microwave re-heating of pastry products.

This concept of a hot air source with a concentric thermal curtain of cold air was so novel that it has been patented. This product is now available as the Turboaire.

Although this paper is primarily to do with combination microwave ovens, I feel it is important to mention that a commercial microwave - the Turboaire mentioned earlier operating in microwave only mode - can also be used to generate profit in the bakery. The catalyst for this innovative system was again a major UK supermarket chain with in store bakeries looking for a new technique.

Merrychef worked with ingredient manufacturers, packaging companies and the supermarket bakery to develop a versatile system to replace the traditional method. Fondant glazes and chocolate coatings are now supplied in small, microwavable containers. The factory pre programmed microwave oven allows the preparation of these in a matter of minutes, rather

than the lengthy time taken using bains maries. Wastage is eliminated and you achieve product portion control, excellent quality and versatility.

As mentioned, the microwave is now 50 years old - so in terms of cooking history it is still in its infancy. There is enormous potential for new and exciting developments, so I'll look into my crystal ball:

- food products with multi-stage cooking instructions encoded as barcodes the oven simply reads the code and follows the instructions to ensure a perfect end result.
- smell sensors to detect the aromas and automatically determine the end of cooking cycle. Some ovens now measure temperature, humidity and weight using sensors linked with fuzzy logic controls to offer single cook button operation.