Fry & Fry Again:

Cooking Systems for Coated Products

Fryers and cooking ovens form the core processing modules in a coated products manufacturing line. This article gives a comprehensive overview of the range of cooking systems, including two-stage frying lines, available to producers as well as discusses the selection criteria and key operating parameters that producers should consider in their pursuit of quality.

By Paul Heness

CONSIDERABLE value can be added to a food product through the use of effective coating. However, the application of this coating could prove to be an expensive exercise if not performed correctly. In the coating process, the added value is directly aligned with the cost of the procedure. Not only does the cost incorporate food material, ingredients and the process consumables but also, to a large extent, the cost of the correct machinery applies.

The selection of coating machinery is a multi-faceted decision, which has to encompass areas of functionality, operational needs, marketing and consumer needs in addition to hygiene integrity and legislative requirements. Furthermore, market opportunities require the machinery to contend with current products and situations in addition to having the ability to comply with possible future needs and requirements. It is widely accepted that the most expensive machinery components of coating systems are the cooking and freezing functions.

Typically with coated food products, the coating material is cooked/set onto the raw material using either a fryer or an oven. These appliances can be used in conjunction with each other or individually depending on the coating material or situation of the processor.

Figure 1 below shows an example of a two stage frying, spiral oven and spiral freezer processing line.

An example of a breaded product type fryer.

Frying and oil quality

Frying could be considered the most common method of setting the coating on coated foods. Nevertheless, it can be an expensive operation not only in terms of capital expenditure but also for ongoing cost; therefore it is vital for processors to ensure they get optimum return on costs.

In order to maximise their return on fryer systems, the processor should take into consideration several areas of concern when selecting fryers:

- Is the machine suitable for all current and future oil types?
- How much oil will absorb into the product during frying?
- What are the expected production throughput rates?

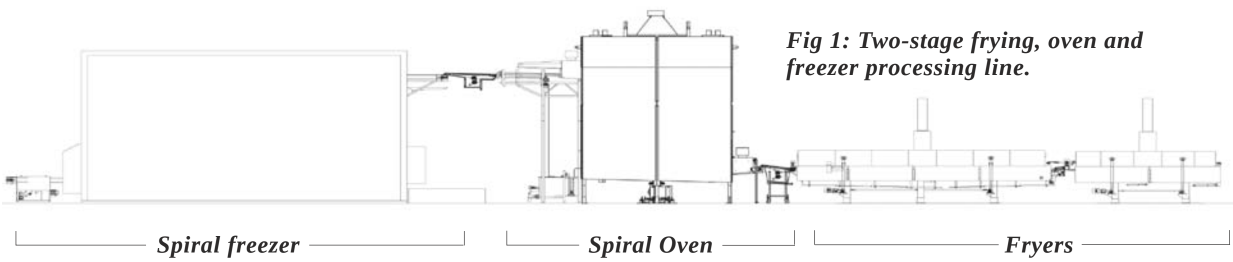
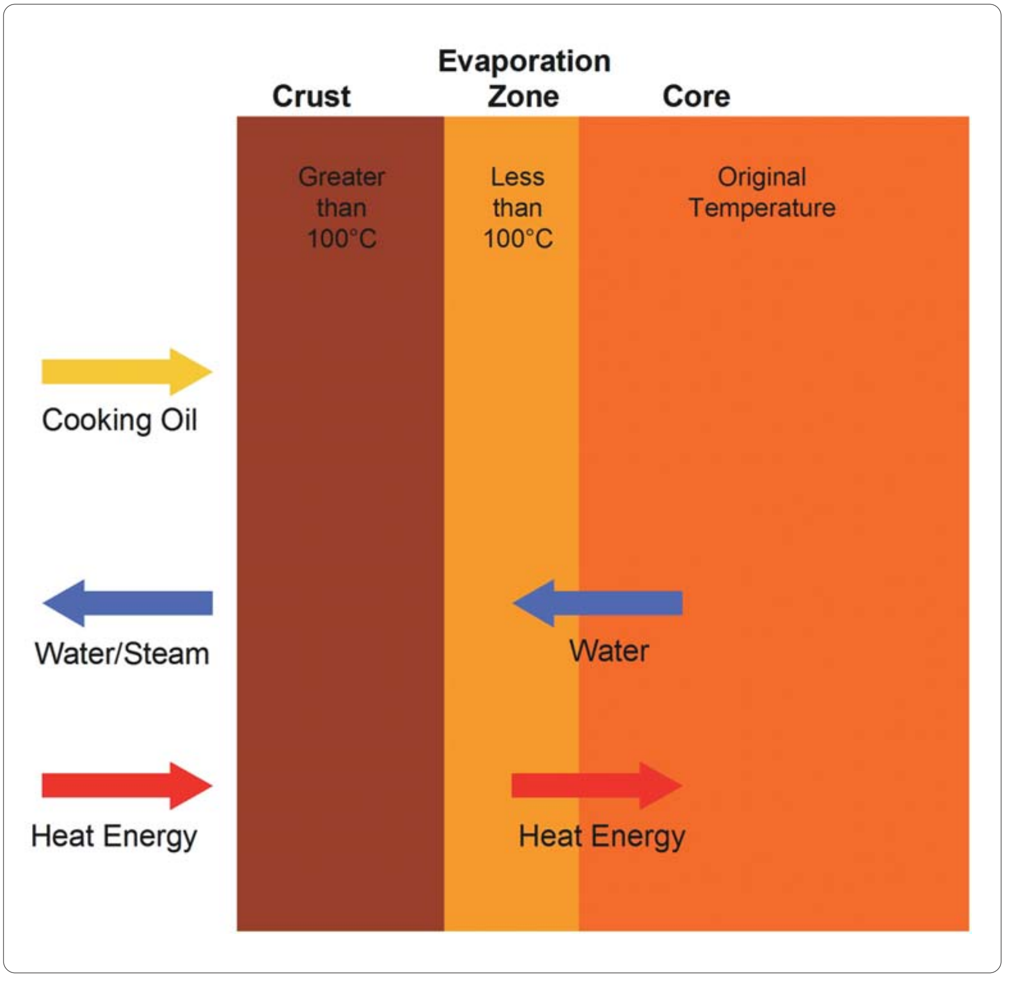


Fig 1: Two-stage frying, oven and freezer processing line.



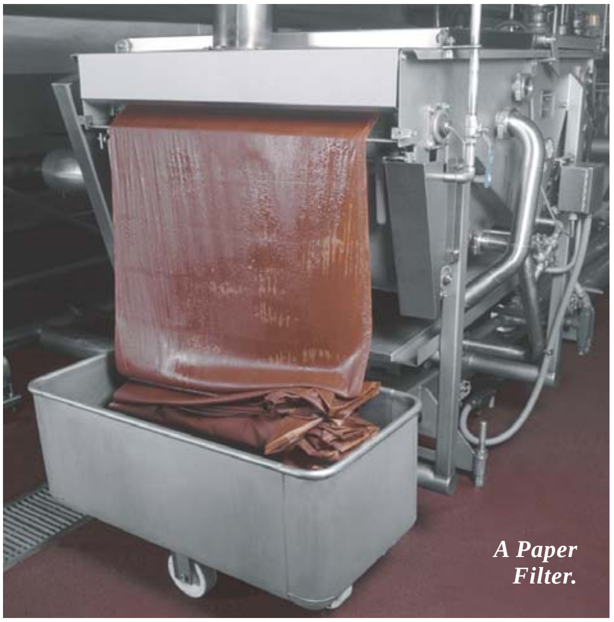
• What is the physical size and shape of the product?
• What is the most economical type of heating for my process?
• How easy is it to clean the fryer?
• What are the oil filtration requirements?
• Does the product have a batter or breading final coating?
• What will be the oil turnover rate?

As the use of suitable frying oils is a major ongoing cost and concern, food processors must endeavour to maximise the oil life used in their frying process. There are a considerable number of areas that interact in the pursuit of a sustained oil quality including but not limited to the following:

• The use of the correct oil for the product and the fryer system.
• Effective oil filtration.
• Correct production rate suited to the fryer system.
• Correct fryer design.
• Effective oil handling and storage.
• Correct fryer operation practices and protocols.
• Overall operating costs of the finished product in $/kg

During the frying process, heat energy from the hot oil creates a chemical reaction which forms a crust on the coated product. One reaction is where water from the coating is heated to form steam which creates a bubbling effect that is normally associated with the initial frying of food. The skin then deepens to form a crust, releasing steam from within the product as well as in the area where this evaporation is occurring. In this evaporation zone (see disgram above), the temperature is not seen to rise above 100˚C. As the pressure from the escaping steam reduces, hot oil enters and fills the voids within the crust that are left after the water has evaporated.


Sludge from a Continuous Belt Filter.



Oil filtration

As the moisture escapes from the surface it explodes into steam and removes some of the surface material from the product. As a result of frying coated products the cooking oil can quickly degrade. To maintain oil quality these excess material particles need to be removed from the oil via a filtration system(s). Should these pieces remain in the oil, they will not only damage the oil but also disrupt the fryer efficiency, make it harder to clean the fryer and, ultimately, produce an inferior cooked product. Typically on medium- to large-sized machines, the oil passes through a filter designed to remove the larger foreign pieces after which a percentage of the oil bypasses from the system through a secondary or polishing filter, which is designed to remove the fine material and then allows the clean oil to be returned to the system.

Two-stage frying

Shown in figure 1 is a two stage frying process. This process is used to reduce the operating costs and increase product quality of coated products. In a two stage frying process the dirty stage of the cooking is confined to the first stage fryer. This drastically reduces the operating cost of the system by reducing the volume of tainted oil in the system. Another significant advantage is that due to the coating being set in the first stage fryer, the product can now be placed on top of each other, effectively increasing the belt load provided the product will be not be degraded by this processing technique. This higher belt load in turn will reduce the overall length of the frying system when compared to using one single fryer for the whole frying process.

To facilitate the oil management in a two stage frying process the fresh oil make up is added to the system at the second stage fryer. This ensures that the cooked product is finally cooked in the freshest oil which assists to extending shelf life and product quality. Further production gains are also possible in the second stage fryer by incorporating an outside belt return which ensures that the total oil volume of this fryer is also kept to a minimum.

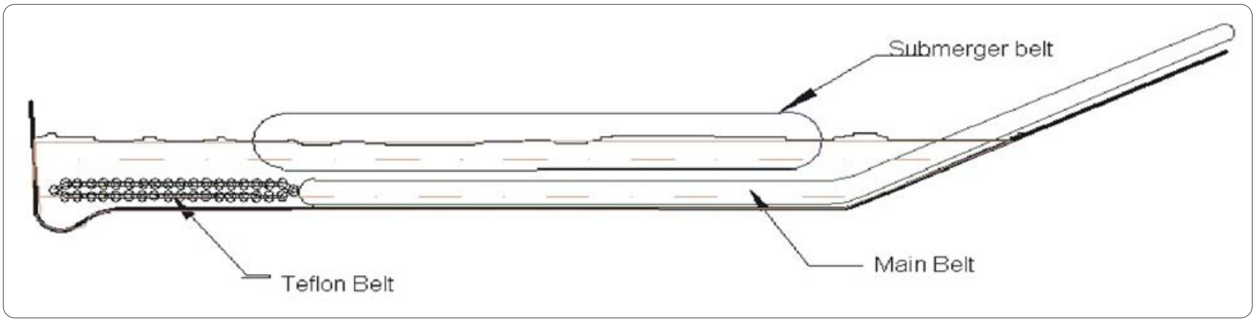
Oil make up for the first stage fryer is taken from the second stage fryer.

Indirect heated fryers

Indirect heated fryers work on the principle that the oil and product flow in the same direction. This feature ensures that any particles that come off the product during the frying process stay in suspension and are quickly removed form the cooking process by a continuous filter and further filtering by secondary filters such as continuous belt filters and paper filters.

Non-stick belts

Where the product is fed into the fryer, quality breaded-product fryers may be optioned with some form of non-stick belt arrangement. If the product is coated only in batter, a Teflon infeed allows the product to develop a skin before being transferred to the normal belt configuration and so dramatically reduces product damage and therefore enhances product yield and throughput. Further most fryers of this type incorporate a submerger type belt to keep the product fully immersed during the cooking process. An example of this type of arrangement



Above: A large Multi-Purpose Oven.
Below: An Air Force Impingement Oven.

can be seen in the drawing on the previous page.

Cooking just the coating

There are some processing situations where only the coating is required to be cooked/set, in which case the body of the product should remain unaffected. In this instance, a common practice is to fry the product at a high temperatures (e.g. 190˚C-200˚C) for the shortest possible period of time. This method can be applied when processing large food portions that are required to be fully cooked. The fryer will cook the coating and substrate interface and an oven will finish cooking the whole product. However if the product is small enough and is required to be fully cooked, the desired result can be produced using a lower fryer temperature (e.g. 180˚C-185˚C) for a longer cooking duration.

Ovens

As mentioned previously, ovens can be used in conjunction with fryers to fully cook a breaded portion or used independently, however the use of the machinery is entirely dependent upon the product characteristics and requirements.

Depending on the situation, the oven can be either a batch or continuous process. Each process has associated strengths and weakness but essentially the product is cooked in a heated and controlled environment. During a batch operation, the cooked product is typically removed and stored on trays or trolleys after which the oven is re-filled with fresh product before recommencing the cooking process. Although this process is less expensive in terms of capital costs, these systems have limitations in production capacities and risk the possibility of not being able to deliver uniform cooking throughout the oven.

Larger and more sophisticated oven systems use a continuous production operation thereby increasing production rates and capacities. In order to deliver a constant and uniform cooked product, a good continuous oven system should be designed to ensure a uniform heat distribution

A Twin Spiral oven with walls removed.

throughout the entire oven. The size of the systems can vary from small mobile units to large dedicated systems as shown in the pictures on this and the previous page.

Humidity control

As mentioned, moisture can be lost from the product during frying. However during the cooking process in an oven the product's crust may be already set. This would allow moisture from within the product to migrate to the product surface where it will evaporate, thereby making the product lighter. Some ovens help to minimise this product loss and still deliver a suitable product by increasing the humidity within the oven.

The level of humidity within an oven is dependent upon each situation and circumstance. It needs to be monitored and controlled very carefully as too little humidity may mean product loss; while too much humidity may mean product damage. Using increased humidity within an oven can also reduce the possibility of material adhering to the inside walls of the oven and therefore make the oven easier to clean.

However situations may arise wherein reduced- or no added humidity is required for an oven and today, most ovens should cater for such a requirement.

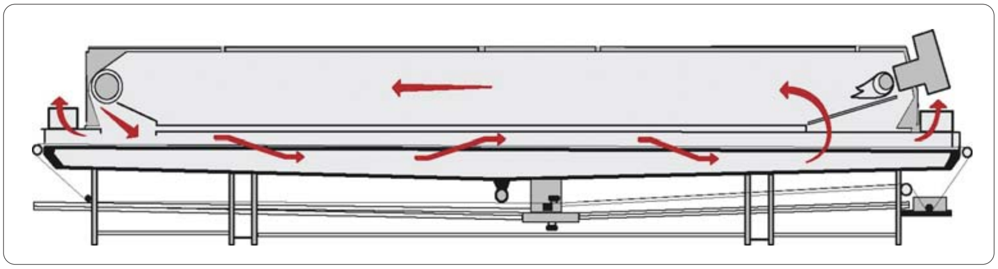
As opposed to using the fryer/oven cooking combination, a simpler process would be to solely use an oven to cook the coated product. In spite of the simplicity of this method, it can cause a higher degree of yield loss and care must be taken to minimise product loss.

There are various types of ovens available on the marketplace to suit a variety of products and situations. Some examples of these are listed below:

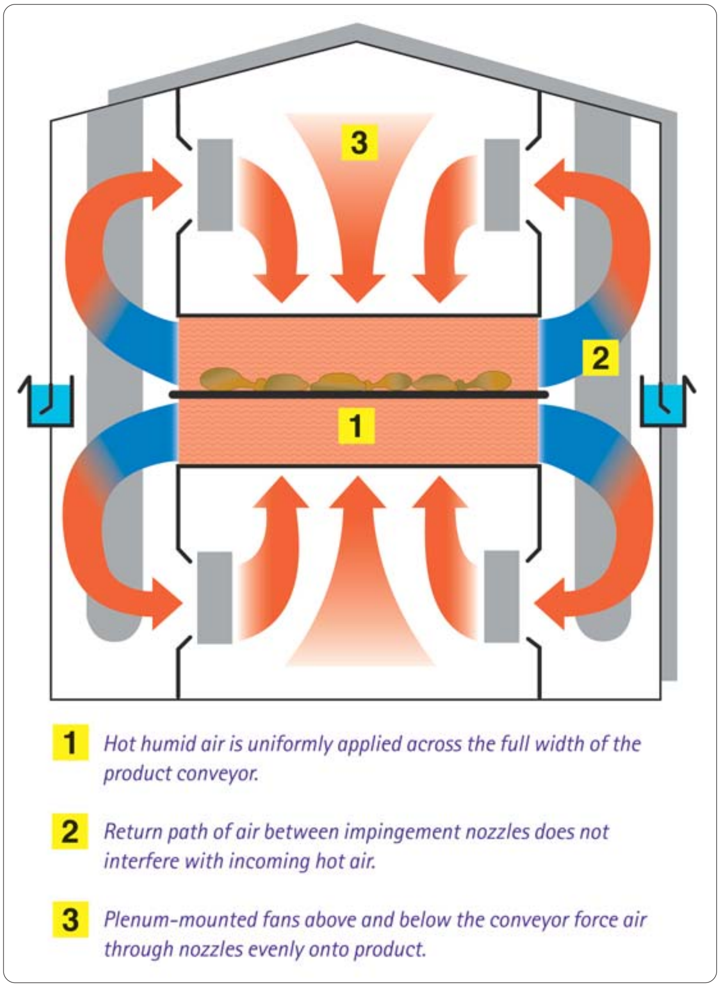
Spiral Ovens

These systems have a continuous belt that spirals around a central drum which allows for an extensive cooking regime in addition to occupying less space than a conventional oven with similar capacity. Later versions of these systems utilise twin spiral systems, creating the opportunity to have different cooking zones within the one machine. In this case, a degree of versatility is created for greater product ranges or enhancements. Furthermore, most machines come with a Clean in Place (CIP) system

A Mini Impingement Oven.



Design and air flow within a convection type oven.



Typical air flow diagram inside the Airforce Impingement Oven.

as well as steam injection and provide a relatively uniform air flow through the entire oven.

Air Forced Impingement Ovens

Air Impingement ovens carefully direct hot air onto the product thereby transferring the heat into the food faster, resulting in a higher production rate than that of a normal oven. This faster cook time is a result of the hot air stripping away the insulated boundary layer of steam which is around the product when being cooked in a normal oven.

This method, however, can have a tendency to dry out the product more than a conventional oven. To combat the drying effect, these systems utilise a controlled humid environment to help retain as much moisture as possible. As shown in the diagram on the left, air is directed to the product via the top and bottom and the cooking of the product is found to be relatively quick and uniform.

Convection Ovens

These use convective heated air currents to perform the cooking of food. Higher end machines have features which include self cleaning belts, water cooled oven pans and “Clean-in-Place” systems usually available as optional extras. These ovens can be either direct or indirect heated. The picture above shows the design and air flow within a convection type oven.

Microwave Ovens

Incorporating a microwave oven into your process to preheat product prior to final cooking provides many advantages. An expected yield increase of 5% to 15% and a 35% to 50% throughput increase is possible when compared to cooking the product in just an oven alone. The yield gain is achieved by preheating the product with minimum yield loss prior to going into the oven. The throughput gain is achieved by reducing the total cook time required.

By choosing the correct processing equipment for your product, you the processor will be able to ensure you can achieve the required throughput with the desired end product quality.

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