

# Fry A Different Route:

## Increasing Effective Yield of Breaded Products Using Indirect Heated Fryer Systems

Choosing the right fryer is a vital step in improving the effective yield of breaded products.

This article explains how indirect heated frying systems incorporate design elements that help lower both system oil volumes and oil film temperatures, raise filtration efficiency, reduce the risk of product damage and simplify cleaning.

By Nigel Morrison

**Y**IELD, in terms of cooking systems, is usually used as a measure of the weight change during the preparation and cooking process. By widening this term to include other causes of profit erosion a more informative production *performance measure* can be obtained. This measure can be termed as “Effective Yield”. Some of the issues that play a part in reducing effective yield are:

- Loss of productivity from inadequate operator training
- High rates of cooking oil degradation and discard
- Unplanned downtime through lack of spare parts or manufacturer service availability
- High rates of second grade product through inferior equipment or poor operation
- Failure to match the process to the technology

In this article we will focus on one machine in the process line – the fryer – and examine some of the benefits that can come from applying the right technology.

### Frying objectives

Put simply, we fry food because it tastes good. However there are also other practical outcomes that we are looking for in the frying process:

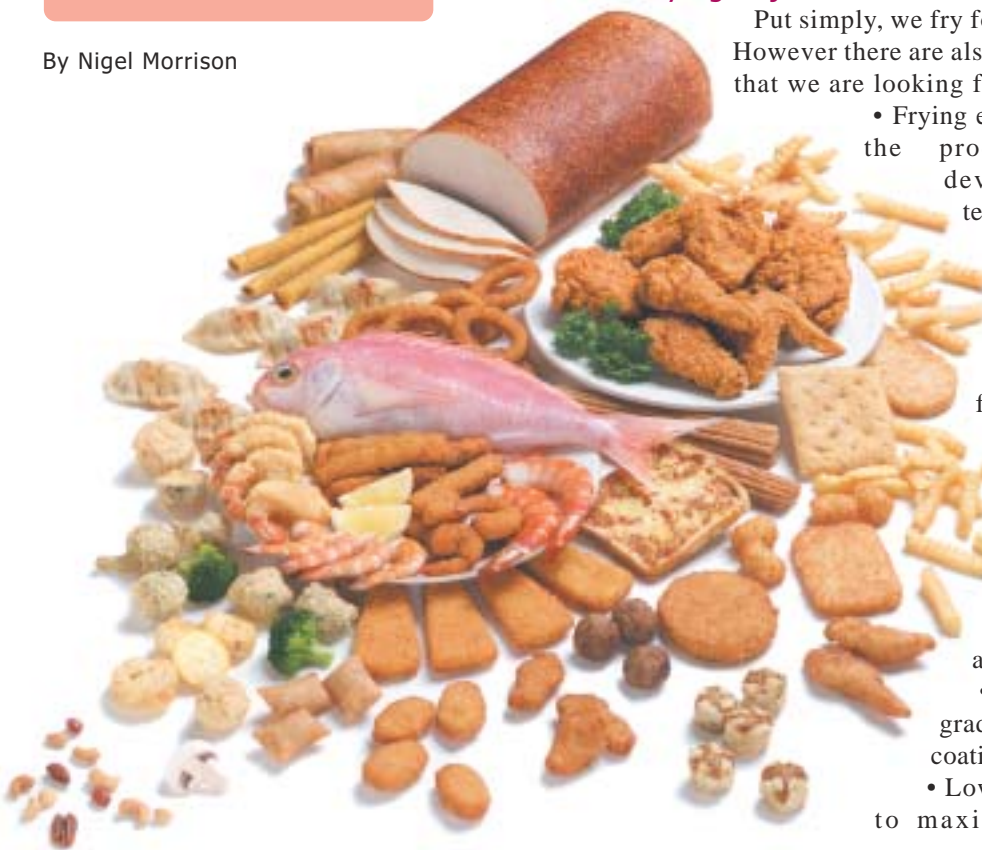
- Frying enhances the appearance of the product through colour development and surface texture.

- Many of the coatings that are applied to a product for flavour, mouth feel colour and texture need to be set-up by flash frying after application.

- A delicate product or coating can be made more robust to better endure subsequent freezing, transportation and storage.

- Maximum number of first grade products unblemished by coating flaws and burnt-in fines.

- Low rates of oil degradation to maximise shelf life of the



product and eliminate odours and off-flavours.

Traditional technology in breaded products frying can fulfil the basic objectives, but often falls short of satisfying those objectives which can provide a competitive edge in both product quality and cost competitiveness – they cannot deliver the same *effective yield*.

### Types of fryer systems

There are two different types of fryer systems available: Direct heated fryers and Indirect heated fryers. Direct fryers are those in which the cooking oil is heated by an internal source in the fryer pan. Indirect fryers on the other hand are those in which the cooking oil is heated by a source external to the fryer pan. The main characteristics of the two fryer types are listed in the table on the right.

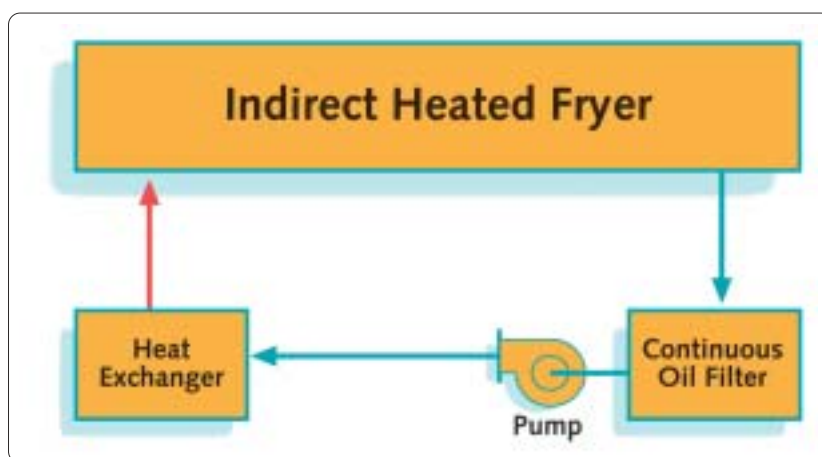
Because of the need to have heating elements built into direct fryers, the pans of direct heated fryers are always deeper than the equivalent capacity indirect fryer and therefore hold more oil. This has an adverse effect on both product and oil quality which will be discussed later.

An additional complication of this effect results from the frequent need to base the size of a fryer for a particular product and capacity, not on the space required to cook the product but on size of the heating elements to achieve sufficient heat transfer. This may result in fryers up to 25% longer than an equivalent indirect fryer which in turn further increases the total system oil volume.

### System oil volume

In most frying operations the free fatty acid level of the cooking oil will rise to an

Direct Fryers and Indirect Fryers: A Comparison	
Direct Fryers	Indirect Fryers
Still oil bath	Continuous oil circulation
By-pass filtration only	Full flow filtration
Total system oil volume is filtered between 1 and 4 times an hour	Total oil volume in system is filtered approximately every 60 seconds
Fast temperature response	Fast temperature response
Size of the fryer governs heat input	Fryer is sized on the space required to cook the product
Fines removal is difficult	Fines are kept in suspension for ease of removal by filtration
Straightforward installation requirements	Modular design makes installation straightforward
Large system oil volumes due to pan depth	5-50% less system oil volume



*Oil flow in an indirect heated frying system.*

unacceptable level if the total volume of oil in the system cannot be turned over within seven to eight hours. Turnover occurs by the pick-up of oil into the products as they pass through the fryer and this oil is replenished with fresh oil. Many breaded and meat or fish based products do not have a very high rate of oil pick-up and to achieve an acceptable turnover time it is critical that the volume of oil in the system be kept as low as possible.

Typically an indirect fryer has between 25% and 50% less

system oil volume than the equivalent capacity direct fryer. This substantially lowers oil turnover times and helps keep free fatty acids) at acceptable levels.

In terms of outcomes this means that products may have better flavour and smell and give better shelf life when cooked in an indirect fryer. To achieve equivalent results using a direct fryer it may be necessary for the processor to discard oil from the fryer and replace it with fresh oil which dramatically increases the operating costs of the fryer.



*A direct fire heat exchanger reduces the oil film temperature and thus improves the cooking quality of product in an indirect fryer.*

### Oil film temperature

When using a hot gas to oil heat exchange, the cooking oil film temperature is approximately 15°C above that of the cooking temperature set point. Because of the heat transfer factors involved, the film temperature in a thermal fluid to cooking oil heat exchange is likely to be somewhat higher than this. (With a liquid to liquid heat exchange the temperature of the heat exchanger tube will be close to the average temperature of the two liquids, whilst in gas to liquid exchange the tube temperature will be much closer to that of the liquid.)

In terms of outcomes this means that the cooking oil will

suffer less thermal degradation and will discolour less quickly, smoke less and reduce the amount of carbon build up in the fryer. Once again this will reduce the need to prematurely discard cooking oil from the fryer. This improvement is only obtained when using a direct fired heat exchanger. Indirect fryers with indirect fired heat exchangers, such as external thermal fluid heat exchangers, will see the same film temperatures as direct fryers with internal thermal fluid heat exchangers.

### Oil filtration

In an indirect fryer, fitted with full flow primary filtration, the entire system oil is passed through the primary filter approximately every 60 seconds. Because of this oil circulation, fines are many times more likely to remain in suspension in the fryer until removed by the filter. In comparison, a direct fryer with by-pass filtration passes the oil through a filter typically between one and four times an hour.

A micro-fine secondary filter is often installed on indirect fryers processing those products that produce very small fines particles. To prevent any possibility of build up of these charred fines and the risk of oil degradation resulting, all system oil is circulated through the secondary filter at least four times per hour.

The outcomes of this filtration are the almost total elimination of black particles (burnt fines) on the finished product, reduced carbon

*An indirect fryer is generally easier to clean as it contains only the product conveying system, which is lifted from the pan by motorised screw jacks to allow pan cleaning.*

build-up, discolouration and smoke and improved oil life.

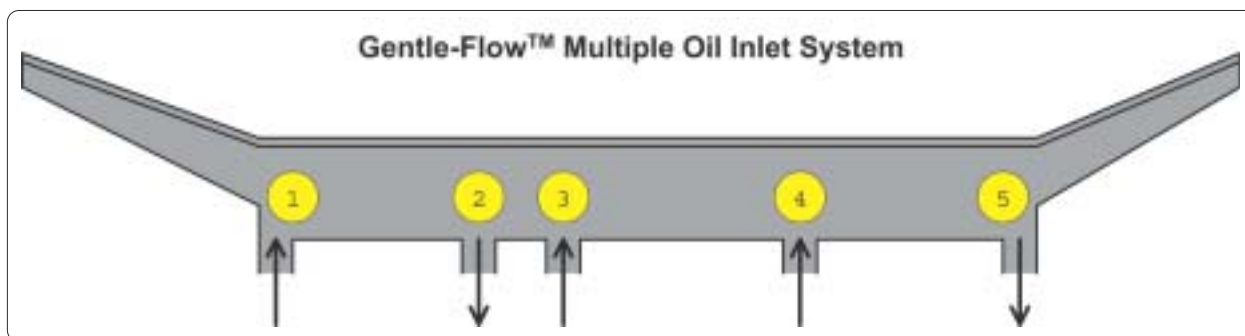
### Product handling

When coated product first enters a fryer the coating is at its most fragile and at risk of damage. In a direct fryer the product must be moved through the still oil at the same constant rate regardless of its position in the fryer. This requires the product to push through the oil, risking coating wash-off and being moved against other product and forming “marriages”.

In an indirect fryer with Heat and Control’s Gentle-Flow multiple oil inlet system, the oil flow at the inlet end of the fryer (between sections 1 to 2 as shown in the diagram next page) can be adjusted to almost match the product transport speed. This ensures minimum relative movement between oil and product during this fragile stage, avoiding washing off the coating and forcing products into each other. Extra opportunity to maintain product orientation is achieved from this combination of matched oil and transport velocities and the small oil depth. Very soon after entering it begins to set and become less vulnerable, so that oil flow can be increased.







Gentle-Flow offers three further advantages over most direct fryers:

1. The oil temperature drops most rapidly when cold product enters the fryer (section 1). By removing a substantial portion of this oil at the first zone boundary (section 2) and replacing it with oil direct from the heat exchanger (section 3 inlet) effective cooking and colour development is maintained down the pan. Further hot oil can be introduced at subsequent zone inlets (sections 4 & 5) if the product requires it.

2. At the first zone boundary the

removal of cooled oil also takes with it the majority of the fines which mainly come off the product at the start of frying. This means that these are even less likely to appear as burnt black specks on the finished product.

3. The multiple inlets allow the maintenance of precise temperature control across the width as well as along the length of the fryer.

### Cleaning

Generally an indirect fryer is easier to clean, and keep clean, than a direct fryer of similar throughput

capacity. Firstly the fryer itself contains only the product conveying system. There is no heat exchanger, sediment conveyor or sediment removal systems to contend with. Drapes on the underside of the main conveyor belt also continually sweep the pan clean during operation, moving any sediment to the fryer oil outlets. The conveying system is lifted from the pan by the motorised screw jacks to allow pan cleaning after processing is complete. A full Clean-in-Place (CIP) system allows controlled sanitation between shifts or as required. The CIP process cleans the entire pan and conveying system, stacks, hood, heat exchanger, circulation and filter systems and because there is less surface to clean the cycle time and sanitation manpower level can both be reduced.

### Conclusion

The benefits are clear. An indirect-heated fryer can help food manufacturers achieve better yields by reducing oil turnover rates, improving filtration and reducing downtime for cleaning. To get the most value from your products, an indirect-fired fryer with an optional Gentle-Flow multiple oil inlet system might just be the answer you are looking for.

Enquiry No: 013



*A support module for an indirect heated frying system.*

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