FMC FoodTech

The optimized oven

How to increase profit by optimizing yield, volume and taste at the lowest cost with the Stein GYRoCOMPACT II Oven

QUICK READ

The new generation Stein GYRoCOMPACT® II Oven (GCO II) with a true, end-of-recipe impingement zone at the discharge offers the best controlled cooking environment to deliver the highest yield, throughput (output per hour) and browning on both sides of the product.

Only the vertical airflow GCO II offers a full menu of programmable airflow in the spiral to suit a wide variety of product and process requirements: up-flow and down-flow with horizontal cross-flow components for a complete product coverage, and Stein-exclusive oscillating Dynamic Airflow Control (DAC™).

The GCO II offers real zone separation and temperature control to establish up to a 200°F (112°C) temperature differential between the spiral stack and the impingement module. Statistical data indicates that only a true, end-of-recipe impingement zone capable of high-temperatures (up to 540°F; 282°C) and air velocities up to 4,000 ft/min (20 m/sec) drives:

- Yield improvement of up to 2% on bone-in chicken wings and up to 4% on boneless, skinless chicken breasts (BSCB),
- Throughput (output per hour) increases of up to 10% on bone-in chicken wings and up to 40% on boneless, skinless chicken breasts (BSCB), and
- Preservation of product moisture, with enhanced product texture and even top and bottom color development.

The GCO II is also physically adaptable to shifts in demand for a wide variety of products and recipes with configurations of as few as eight self-stacking tiers for fast-cooking products and as many as 20 tiers for products lending themselves to high capacity, slower cooking. ●

Values for the improvement in yield, throughput, product moisture, texture and color development are entirely attributed to the use of the new impingement module.

Other cooking refinements in the new generation Stein GCO II Oven can *also* contribute to additional efficiency and product desirability.

EXECUTIVE SUMMARY

The effect of Dynamic AirFlow Control and a true finishing impingement zone

Intensifying consumer demand for better taste — plus, more choice and greater convenience — is driving the fully-cooked market. To sustain and grow profits, processors are under pressure to identify the oven with the best overall cooking environment to deliver the best product yields, throughput (output per hour), uniform color and other desired product attributes.

Only the vertical airflow Stein GYRoCOMPACT II (GCO II) spiral oven from the FMC FoodTech line of ovens offers a full menu of programmable airflows in the spiral to suit a wide variety of product and process requirements: up-flow and down-flow with horizontal cross-flow components for a complete product coverage, and Stein-exclusive oscillating Dynamic Airflow Control (DAC™). Alternating the convection airflow within stack from the top and bottom essentially turns the product over in the heat by turning the heat over on the product — a virtual burger flip. This process retains moisture and ensures even cooking and initial browning on both sides of the product.

In contrast to middle-of-the-process forced convection sections in spiral ovens that lack sufficient zone separation, air velocity and temperature control, lab testing and real world production line data for the Stein GYRoCOMPACT II oven indicates that the key to both better yield and higher throughput (output per hour) is true end-of-recipe impingement cooking. Of course, the substrate and the end attributes being sought determine whether impingement is needed and what operating parameters are used.

Cooking trials by customers at the FMC FoodTech Food Technology Center in Sandusky, Ohio offer empirical data indicating that — like typical two-box linear oven systems — the spiral GCO II offers independent temperature control of each zone to establish up to a 200°F (112°C) temperature differential between the spiral stack (essentially the first box) and the impingement module (the second box).

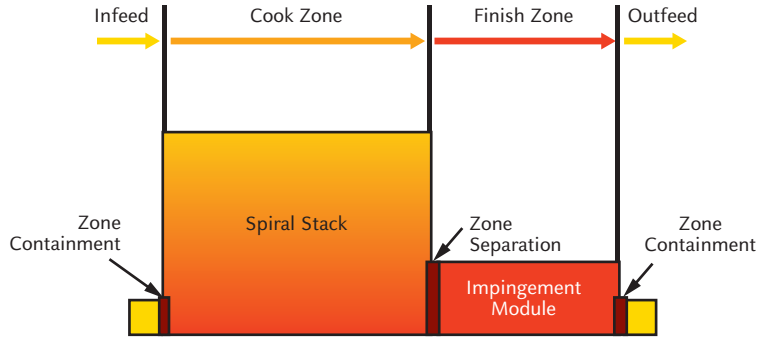
Consistent and repeatable trial and production data for the Stein GYRoCOMPACT II Oven indicates that only a true, end-of-recipe impingement zone capable of high-temperatures (up to 540°F; 282°C) and air velocities up to 4,000 ft/min (20 m/sec) accelerates heat transfer to the core of the product while *simultaneously* developing exterior texture. A true impingement zone also drives:

- Yield improvement of up to 2% on bone-in chicken wings and up to 4% on boneless, skinless chicken breasts (BSCB),
- Throughput (output per hour) increases of up to 10% on bone-in chicken wings and up to 40% on boneless, skinless chicken breasts (BSCB), and
- Preservation of product moisture, with enhanced, even top and bottom color development.

Values for the improvement in yield, throughput, product moisture, texture and color development are entirely attributed to the use of the new impingement module.

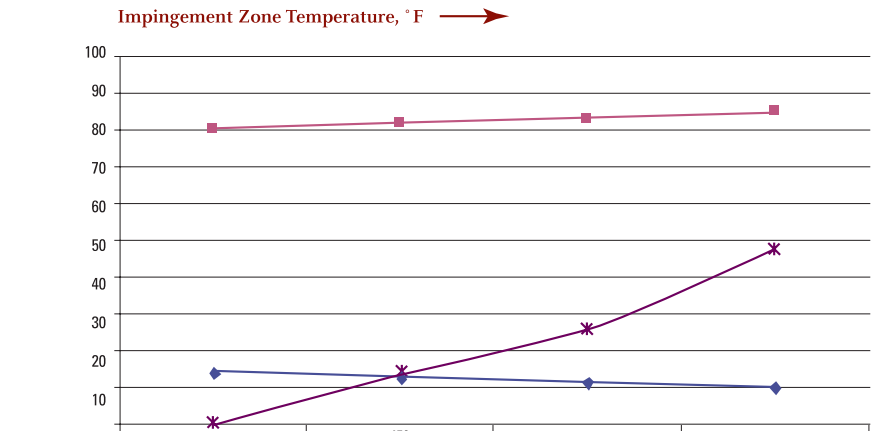
Other cooking refinements in the new generation Stein GCO II Oven can *also* contribute to additional efficiency and product desirability.

Ovens that place forced convection zones for product finishing or to enhance cooking earlier in the process within the confines of the spiral stack are not effective if they do not provide sufficient zone separation or airflow control — and also because they are being used to "finish" products that are only half cooked. By essentially running products under a broiler midway through the cooking process, dwell times are not shortened, while moisture and yield are sacrificed. Throughput (output per hour) drops. ●



MultiPhase Cooking with Impingement in the GCO II: The Right Process (Heat Transfer Mechanism) at the Right Time

Positive separation between zones prevents temperature infiltration between modules. This is essential as minimally insulated walls and the lack of containment reduce independent control over cook and finish zone environments and sacrifices the advantages of a true finishing zone: reduced dwell times, preservation of product moisture, higher yields, greater throughput (output per hour), and enhanced, even top and bottom color development.



	425	450	500	540
cooktime	14	12.5	11.5	10
yield %	80.6	82.0	83.5	85.0
% incr. cap	0.0	13.9	26.1	47.7

Effect on Impingement Module on Product Attributes*

Values for the improvement in yield, throughput, product moisture, texture and color development are entirely attributed to the use of the new impingement module.

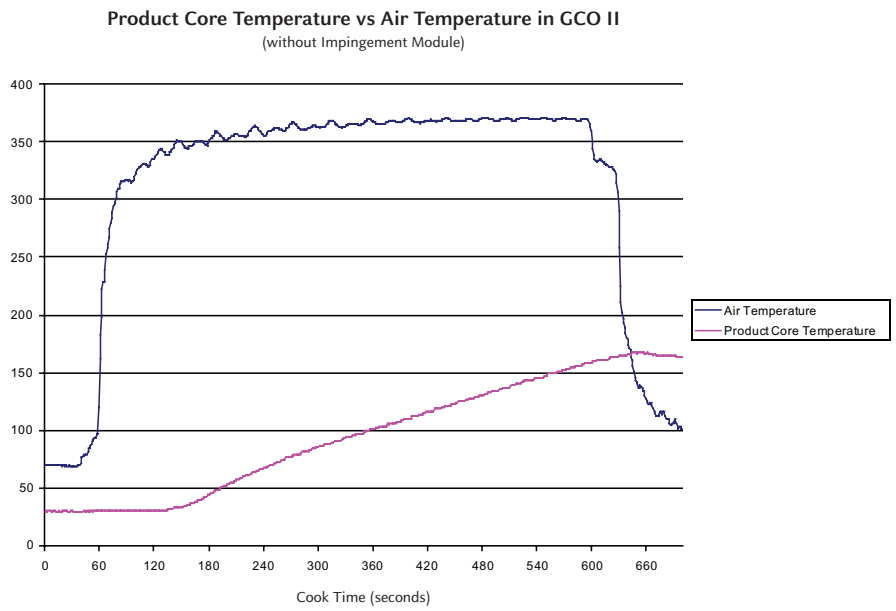
Other cooking refinements in the new generation Stein GCO II Oven can *also* contribute to additional efficiency and product desirability.

Only a true finishing impingement zone capable of high temperatures (up to 540°F; 282°C) with air velocities up to 4,000 ft/min (20 m/s) and effective isolation from the previous cooking zone will *simultaneously* achieve multiple metrics:

- Higher retention of moisture,
- Reduced cook times,
- Increased yield, and
- Improved top and bottom color development.

* Data shown for boneless, skinless chicken breasts flattened to ½ inch (10 mm) thickness.

Cooking without an end-of-recipe impingement zone.



The Conventional Cooking Process

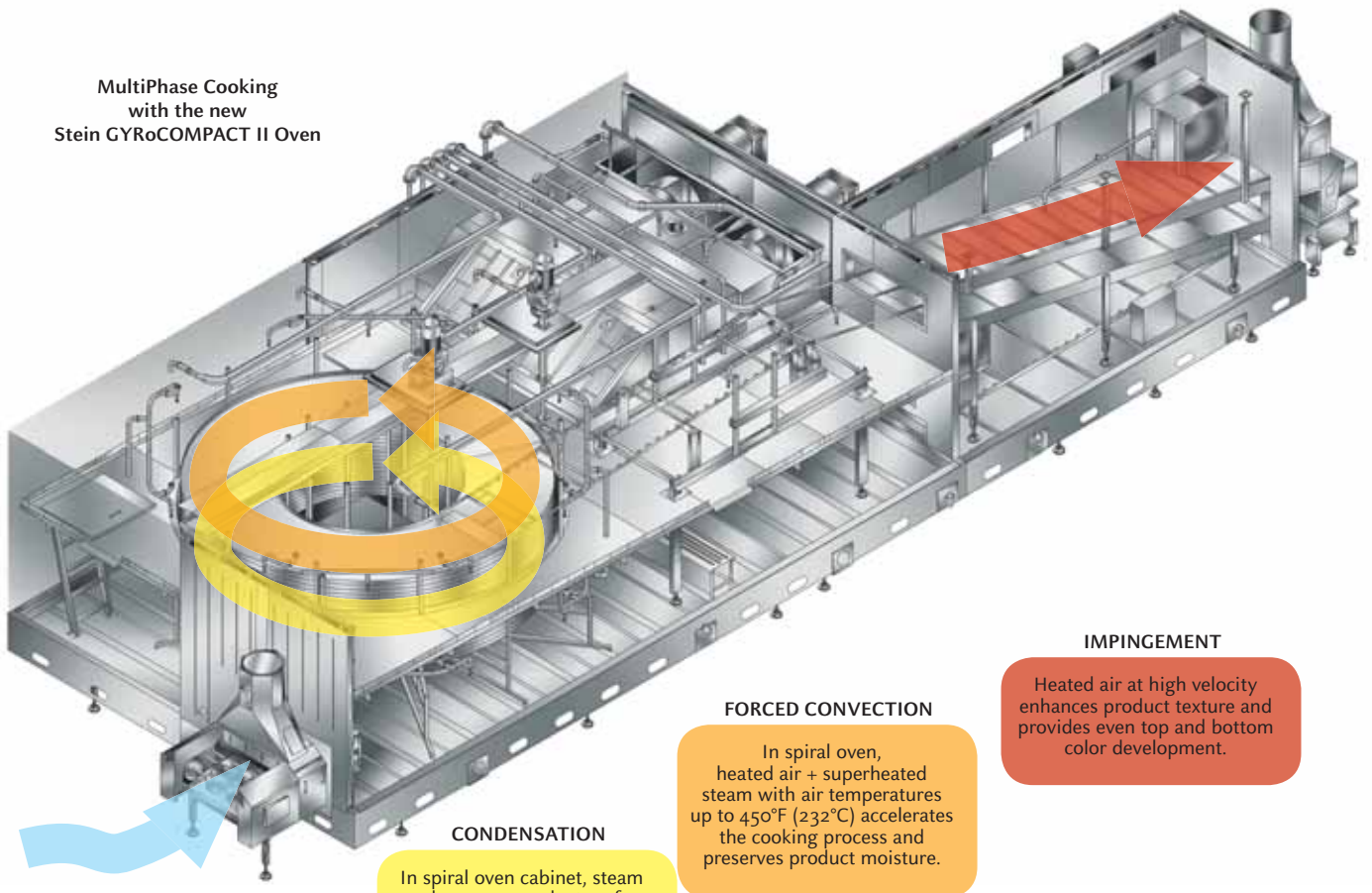
The linear nature of a typical time-temperature progression in a spiral oven illustrates a gradual increase in the product core temperature.

MULTIPHASE COOKING

The right process (heat transfer mechanism) at the right time

To reduce dwell times and reduce moisture loss, the new generation Stein GYRoCOMPACT II Oven adds a high-velocity top and bottom impingement module to augment MultiPhase® cooking pioneered by FMC in the early 90s. An impingement zone with independent temperature and air velocity control offers the perfect finish for the logical progression of heat transfer in the spiral stack:

- Condensation: When frozen or cold product enters the oven, steam condenses on product surfaces below the dew point. Latent heat of condensation begins to rapidly drive energy to the product core.
- Forced Convection: As product spirals up the spiral stack, convection cooking by a superheated air/vapor mixture of up to 450°F (232°C) drives energy to the product and raises surface and core temperatures. Improved humidity control and containment along with even temperature distribution within the stack preserves product moisture. As the product cooks, the temperature differential between the product and the heating medium declines — the rate of cooking (energy transfer) slows.
- Impingement: High temperature air (up to 540°F; 282°C) at air velocities up to 4,000 ft/min (20 m/sec) accelerates cooking and shortens overall dwell time without adversely affecting product moisture and enhancing color.



THE CONVENIENCE TREND

If the breaded, parfried, bone-in Swanson chicken TV dinner introduced in 1953 was a defining product in convenience food history, then a walk down the frozen food aisle in today's grocery or club store offers a new definition: variety. Still, the most representative entrée on today's heat-and-eat menu — a fully-cooked, boneless, skinless chicken breast in a portion-controlled, ethnic-cuisine-themed dinner — is both remarkably similar to the original TV dinner, and yet startlingly evolved.

As social and cultural changes continue to de-emphasize the in-home family dinner, and as both available meal preparation time and interest in cooking everyday meals shrinks, the demand for more variety and convenience in both take-home, heat-and-eat meals and eat-on-the-run meals continues to rise.

While three-quarters of Americans are still eating meals at home each night, the number of meals *prepared* at home continues to decline. A 2006 study by the Institute of Food Technologists found that almost half of the food served at home was either fully-cooked microwave-and-eat meals or ready-to-eat fare prepared outside the home.

In essence, the kitchen for everyday meals is continuing to move out of the home and up the food chain. Consumers now increasingly purchase meal components or heat-and-eat meals rather than ingredients; and grocery, club and other retail stores are rapidly evolving to keep up with demand. Commercial cooking, too, is also moving increasingly further upstream to fully-cooked, value-added products prepared by food processors.

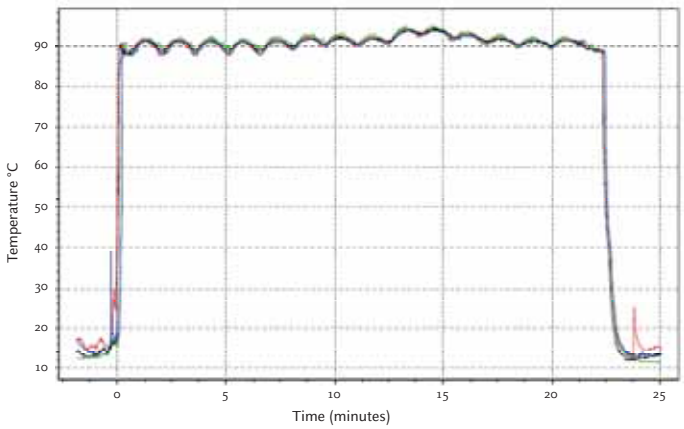
The single spiral advantage

The Stein GYRoCompact II Oven offers more than a smaller footprint compared to an equivalent capacity linear oven system. It is the only oven based on the patented interlocking, self-stacking FRIGoBELT® system that allows for more controllable, annular (cylindrical) vertical airflow through both the belt mesh and lateral airflow through side links. The re-designed conveyor features a variable pitch mesh that compensates for the belt collapse that occurs during turning to maintain cross-belt air temperatures of less than +/- 2°F (1°C).

Meanwhile, spiral ovens with horizontal, unidirectional airflow have to contend with considerably higher cross-belt temperature variations because products nearer the source of the airflow block "downwind" products. Such uneven cooking forces extended dwell times to assure that the core of the least cooked product reaches the minimum target temperature. In turn, product near the source of the convection is overcooked, reducing moisture and yield.

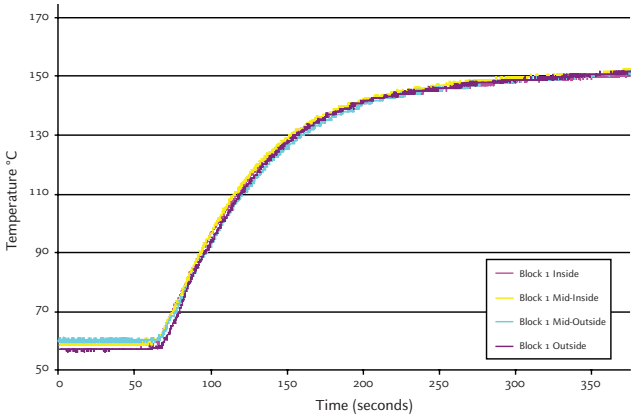
Effects of wind shadow in traditional horizontal airflow spiral ovens may be mitigated by the use of a temperature "equilibration" zone, but in the absence of sufficient zone separation, an equilibration zone offers no advantage, especially when fully loaded and deep in a cooking cycle. Essentially, equilibration is imprecise "corrective" cooking that can potentially increase cook times and magnify moisture loss.

Steam Mode



Heat Mode

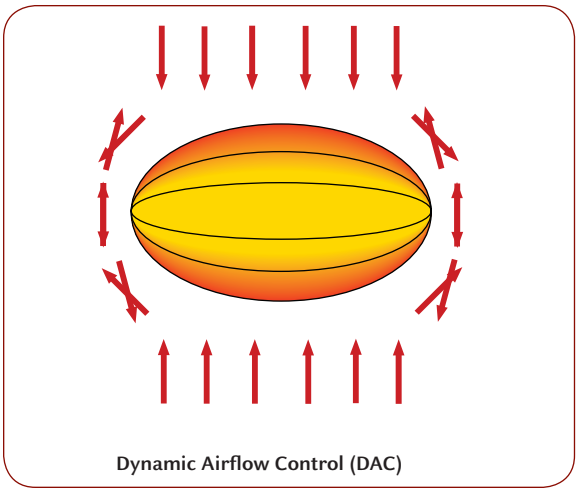
Vertical Airflow Oven



Cross Belt Temperature Variation

In a Stein GYRoCOMPACT II Oven, cross-belt air temperature variations during both steaming and convection cooking are less than +/-2°F (1°C).

Exclusive Dynamic Airflow Control (DAC)



Dynamic Airflow Control (DAC)

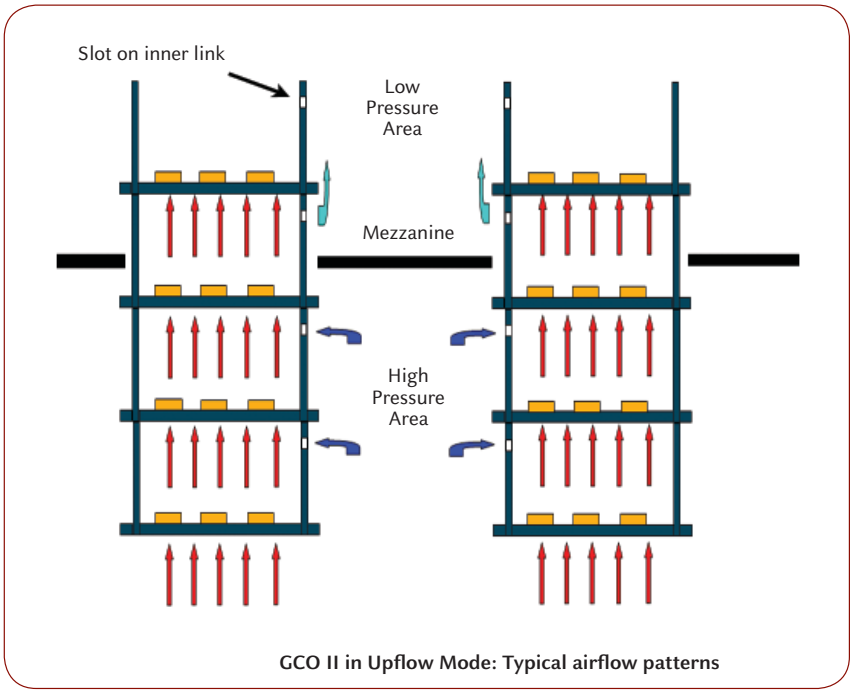
Cooking from both sides of the product.

Only the vertical airflow GCO II offers a full menu of programmable airflows in the spiral to suit a wide variety of product and process requirements: up-flow and down-flow with horizontal cross-flow components, and Stein-exclusive oscillating Dynamic Airflow Control (DAC™). Alternating the vertical convection airflow within the stack from the top and bottom essentially turns the product over in the heat by turning the heat over on the product — a virtual burger flip. This process retains moisture and ensures even cooking and initial browning on both sides of the product.

This is a fully automated feature and the time intervals for the DAC can be pre-programmed into the recipe.

A contained cooking spiral

The patented interlocking, self-stacking FRIGoBELT inherently offers a feature that other open-air belt systems lack: sides that create a contained and consistent cooking environment in each and every tier of the spiral. Additionally, this cooking chamber is separated into a high pressure and low pressure region by means of a mezzanine "floor." This baffle can be externally adjusted to control the airflow in the stack, optimizing the cooking process, especially effective in mitigating uneven cooking due to non-uniform belt loading.



GCO II in Upflow Mode: Typical airflow patterns

The vertical airflow is complemented by horizontal cross-flow components for complete product coverage.

True impingement finishing *vs.* mid-recipe finishing or cooking enhancement section

The original Swanson Chicken TV dinner required a two-step cooking process — the dinner was first cooked covered with foil (steamed), then the foil covering the chicken was folded back during the last phase of cooking (conduction baking). This primitive version of impingement finishing did not reestablish a temperature differential or impingement air velocities to speed finishing and retain moisture; yet it does offer an important lesson in proper cooking sequence: true finishing for product color development is only effective at the end of the cooking process.

While the Stein GYRoCOMPACT II Oven offers true end-of-recipe impingement finishing, positioning an impingement module for product finishing or cooking enhancement in the middle-of-the-recipe position — as is done in conventional spiral ovens — is the metaphorical equivalent of having a chef brown an omelet or chicken breast under the broiler, only to return it to the oven because it is still just half cooked.

High-temperature, high-velocity impingement finishing

By properly positioning the impingement module at the *end* of the cooking cycle, the Stein GYRoCOMPACT II Oven provides an isolated, controllable cooking environment that combines high-velocity convection of up to 4,000 ft/minute (20 m/sec) with temperatures up to 540°F (282°C). This exceptionally high top-end temperature in the impingement module offers an opportunity to reestablish a temperature differential of up to 200°F (112°C) between the cooking environments, a differential that can drive the core temperature of the product the final 5-10°F (3-6°C) in as little as 30 seconds.

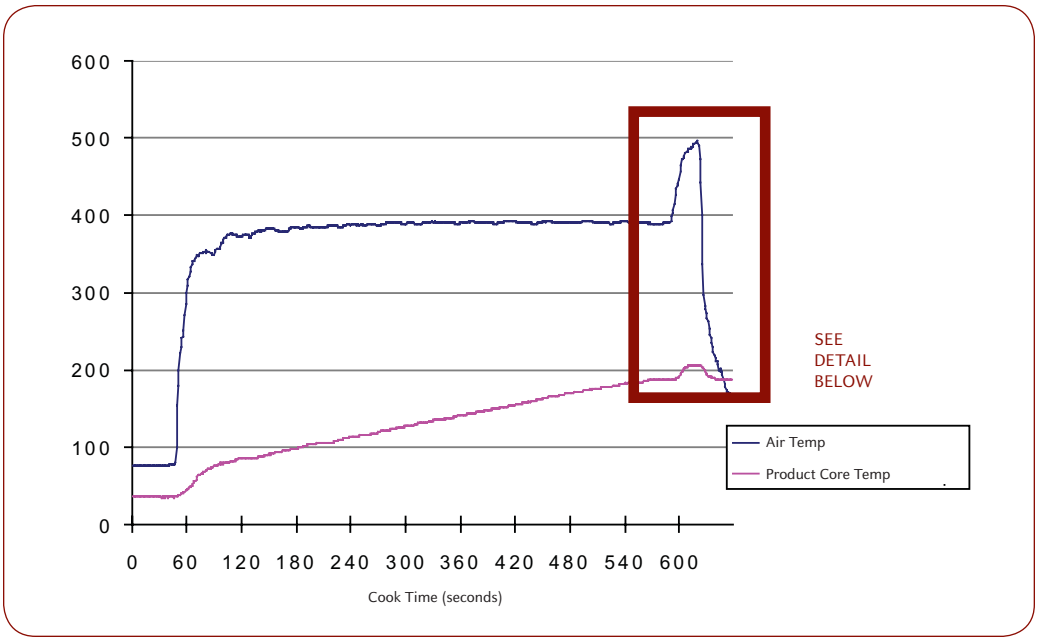
Other right-process-at-the-right-time heat transfer enhancements in the GCO II including superior steam containment and Stein-exclusive Dynamic AirFlow Control, can contribute to moisture retention and increases in yield and throughput. *Independent of other refinements,* the new impingement module:

- Cuts cooking times,
- Increases yield by 2% on bone-in chicken wings
- Increases yield by 4% on boneless, skinless chicken breasts (BSCB), and
- Increases throughput by up to 40% on BSCB.

Arguably, though, the most important benefit of true impingement finishing in the Stein GYRoCOMPACT II Oven is not just moister, faster, higher volume cooking — it's improved product texture and consistent, reproducible color on both the top and bottom of the product.

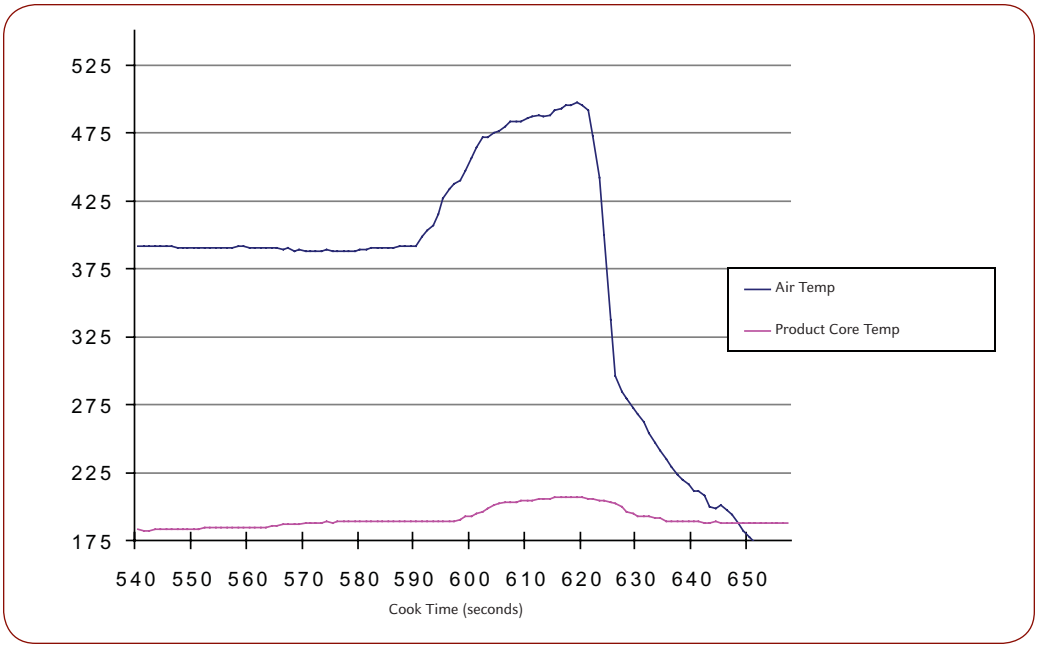
Values for the improvement in yield, throughput, product moisture, texture and color development are entirely attributed to the use of the new impingement module.

Other cooking refinements in the new generation Stein GCO II Oven can *also* contribute to additional efficiency and product desirability.



The effect of zone separation is clearly demarcated in the above graph. The air temperature (in blue) in the main stack is maintained at 390°F (199°C) even very close to the impingement module. The sharp spike in air temperature is experienced by the product only upon entering the impingement module.

IMPINGEMENT COOKING



True impingement finishing in the Stein GYRoCOMPACT II Oven provides an isolated, controllable cooking environment that combines high-velocity convection of up to 4,000 ft/minute (20 m/sec) with temperatures up to 540° (282°C). This coupled with a temperature differential of up to 200°F (112°C) between the cooking environments in the spiral stack and the impingement module can drive the core temperature of the product the final 5-10°F (3-6°C) in as little as 30 seconds.

SEE NEXT PAGE FOR ANOTHER GRAPHIC

Greater and More Uniform Top and Bottom Color Development

Top Surface →

Bottom Surface →

Without Impingement | *With* Impingement

Product Marinated with Salt and Water Only

FULLY COOKED BY STEIN: A REVOLUTIONARY HISTORY

Stein = oven systems innovation

In the mid-1970s, most large-scale cooking focused on breaded seafood products, and horizontal airflow, top-only cooking ovens were standard. In 1978, Stein revolutionized the market with the introduction of the CounterFlow Convection Oven (CFO) utilizing horizontal airflow and a combination of condensational and convection heat transfer to cook product on both sides simultaneously.

As value-added poultry overtook seafood product in the 1980s, Stein responded to demand for improved product color without parfrying with the first commercially proven high-capacity impingement oven. Featuring high velocity jets of hot air to impinge food products from top to bottom, the Stein Jet Stream Impingement Oven (JSO) set a new standard.

In 1990, Stein revolutionized conveyorized convection cooking with the introduction of the GYRoCOMPACT (GCO), a convection spiral oven based on the patented self-stacking FRIGoBELT design from the Frigoscandia Equipment family. Stein's MultiPhase Cooking approach introduced the concept of multiple cooking mediums on a single line to maximize results and achieve desired physical attributes.

In 1997, FMC Foodtech introduced the fourth generation of the Stein Jet Stream Oven, the JSO-IV, utilizing thermal heat transfer technology.

In 2006, the FMC Stein GYRoCOMPACT II integrated the high capacity benefits of the GCO and the versatility of JSO impingement.

Stein spiral oven = a customizable cooking process

Flexibility for tomorrow's markets

Fully cooked chicken wings may be in very high demand today, but tomorrow the market may demand a popular new marinated chicken breast or breaded dark-meat strips. As the market shifts and evolves, an oven's flexibility can be a make-or-break feature.

The GCO II is physically adaptable to a wide variety of products and recipes with configurations of as few as eight self-stacking tiers for fast-cooking products and as many as 20 tiers for products lending themselves to high capacity, slower cooking. With full command over all temperature, speed, time and humidity variables — plus, Stein-exclusive Dynamic AirFlow Control — the GCO II is fully programmable and adaptable to virtually any recipe for any product.

Greater Cooking Flexibility

Product	Chicken Drum Sticks	Chicken Breasts	Breaded Chicken
Cook Time	21 minutes	13 minutes	7 minutes
Hourly Capacity	8,000 lbs (3,629 kg)	9,500 lbs (4,309 kg)	8,000 lbs (3,629 kg)

Data Typical for 14-Tier Oven Configuration

FMC FoodTech Food Technology Center = hands-on customer testing

Real world testing

Processors interested in testing the new GYRoCOMPACT II Oven can arrange to visit — and even ship product to — the FMC FoodTech Food Technology Center in Sandusky, Ohio. The Food Technology Center is the focal point for processor product development and process trials and evaluation. Each year, hundreds of food processing companies from around the world visit the FMC FoodTech Food Technology Center "playground" to test portioning, coating, frying, cooking, chilling, freezing, and food-handling systems in an environment that stresses the protection of proprietary information and processes.

Food Technology Center labs provide an opportunity to exactly replicate an existing or new process, and, most importantly, generate reliable empirical data to compare the yield, volume and quality generated by a cooking process in the new GYRoCOMPACT II Oven to an existing Stein or another oven.

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