MARLEN INTERNATIONAL
A DURAVANT COMPANY

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CRITICAL ELEMENTS OF BLAST CHILL CELL DESIGN: THE EVAPORATOR

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INTRODUCTION

Processing facilities typically use different evaporator designs in different applications. In the final stage of heat removal from cooked or partially cooked products, frequently referred to as blast or deep chilling, unique challenges present themselves. Stringent stabilization requirements and compliance guidelines place emphasis on accelerating the final chill stage. But without properly designed and sized evaporator capacity, product damage often occurs.

This white paper is a supplement to Critical Elements of Blast Cell Design and addresses the "evaporator" – the heart of the chilling system.

THE PROBLEM

An undersized evaporator to maintain a 6 degree temperature differential must be operated a minimum of 6 degrees colder to provide the same amount of work as a properly sized evaporator designed to operate at a 12 degree differential. If the lower temperature requirement of the undersized evaporator necessitates an overall lower temperature plant refrigeration system, the processor pays twice.

When operating at colder temperatures, an undersized evaporator surface can produce errant crust-freezing of product thus degrading product quality. Excessive package purge is evidence of this damage. Crust freezing can also retard the thermal conductivity of the product preventing heat from reaching the surface in an efficient manner, slowing the cooling process.

Immediate "deep chilling" practices are to be avoided although some designs with inadequate evaporator surface can make this difficult. More frequent coil defrosting also results. Coil defrost during processing should be considered unacceptable as precious time is lost and the chill cycle must virtually be re-started to capture condensation that would otherwise be deposited on the product.

HISTORY

Final stage air chilling devices have existed in many forms, from engineered systems to the "contractor variety". Most processors understand the difference, an education learned the hard way. With all due respect to refrigeration contactors, few seem to adequately understand the impact of their solution on the product. The "win by low bid" mentality usually results in undersized evaporators.

Many of the systems engineered by thermal processing equipment suppliers can also come up short for the same reason. An undersized evaporator in a manufactured "reverse-smokehouse" design virtually guarantees poor temperature uniformity with some product under-chilled, and some crusted with ice crystals. Under-chilled product is a food-safety liability and crusting damages the cellular structure of the product surface and it cannot hold moisture as it would normally. Again, package purge results.

Regardless of the source, whether contractor or manufacturer with an inadequate design, an undersized evaporator is also costly in terms of electrical energy used to produce refrigeration. A blast cell operating on a 10 degree suction system instead of 0 degree yields a savings of 17 motor horsepower.

HISTORY (continued)

Processors should insist evaporation surfaces are sized to a minimum of 12°F operating differential across the coil itself. They should also be equally insistent that evaporator design and sizing take into full account the thermal conductivity of the product being processed. Also, any need to take product through the latent heat phase (chilling products below their freezing point) must be understood for proper equipment sizing. This match **which results in surrounding the product with conditions that allow it to give up its heat most efficiently** should not be compromised.

Some evaporator designs harbor more bacteria than others. Besides being properly sized, the evaporator must be designed to be sanitized, to a microbiological level.

"Tube-coils" are to be avoided. Just as the HVAC industry moved away from the tube-coil, so must manufacturers of chilling equipment for the food industry. The bond between tube and fin deteriorates over time and the cant of the spiral fin itself makes the coil difficult to sanitize without manual touchups.

The classical "tube and fin" coil design wins out for simplicity, efficiency and ease of cleaning. Metal tubing, with press-fit sheets of metal fin material equally spaced, spans between supply and return headers to form the conventional "radiator". Material selection should consider the ability to deliver long life and best heat transfer properties.

SOLUTION

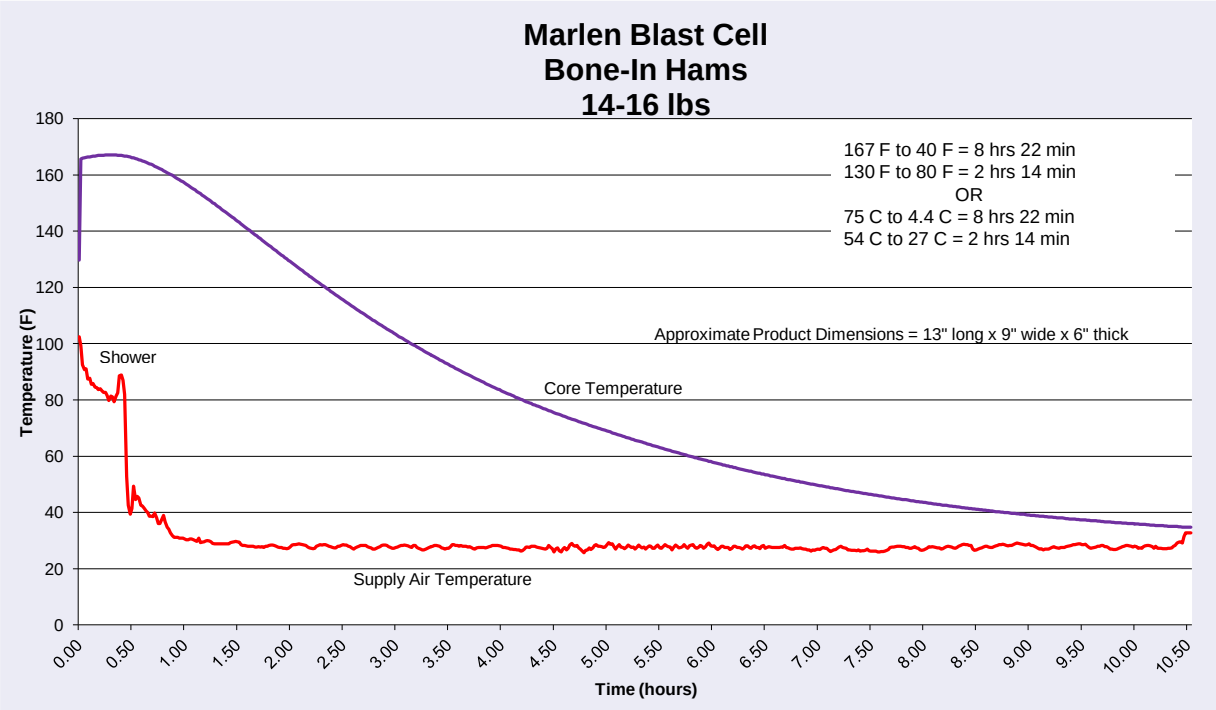
There may be only one manufacturer that understands the best evaporator design criteria, balancing operating efficiency with properly sized evaporator surfaces, while delivering a sanitizable design with excellent heat transfer properties. Marlen International takes an interesting approach to balancing efficiency and longevity.

Marlen offers tube and fin evaporators of 100% stainless steel construction, but with the advice that processors should also consider Marlen's stainless tube/electrolyzed aluminum fin option. Both designs when configured within Marlen's highly efficient "looped airflow"; allow processors to meet guidelines for stabilization. But it's their electrolyzed aluminum fins that bring an extra margin of heat exchange efficiency that no other material can match. Concerns for safely sanitizing stainless/aluminum coils, with regard to the aluminum material, go away with Marlen's dedicated clean-in-place (CIP) system**.**

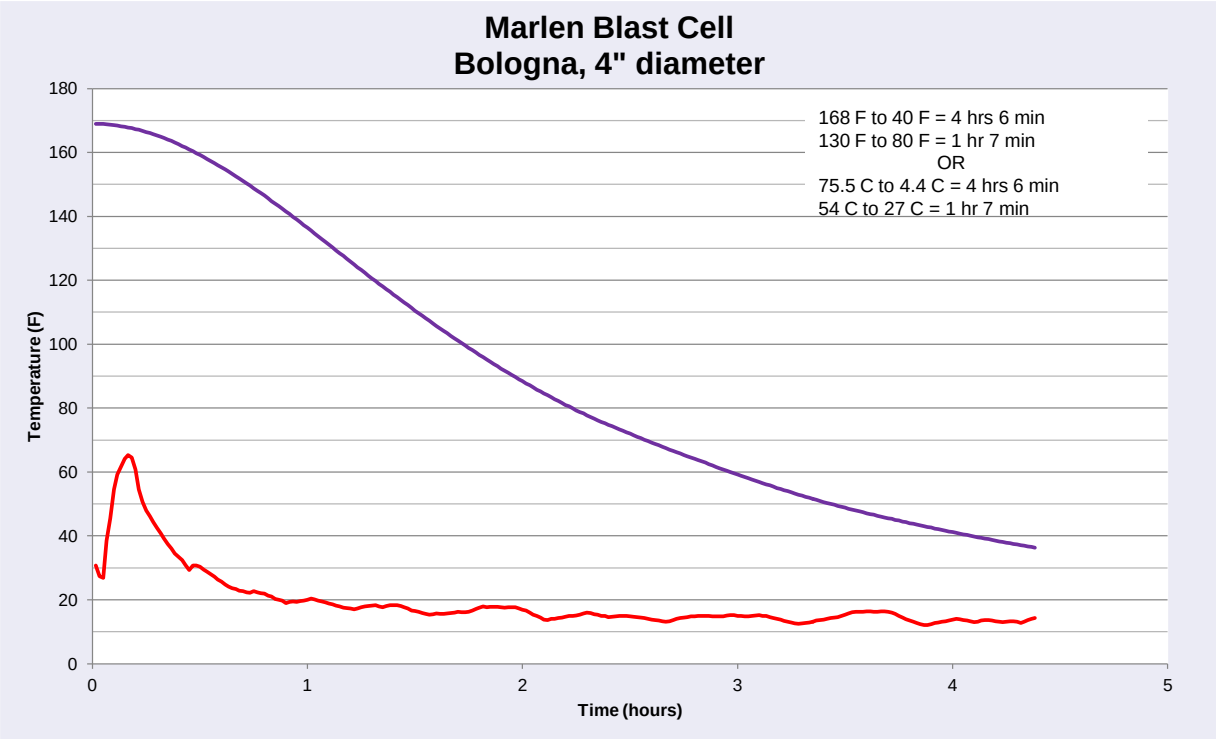
Comparative chilling curves tell the story. The charts on subsequent pages depict how Marlen chills the same volume of product while removing the same amount of heat but with less energy.

SOLUTION (continued)

EXAMPLE ONE: Comparative Chilling – Bone-In Hams



EXAMPLE TWO: Comparative Chilling – Bologna



SUMMARY

Marlen International was the first, and remains the only manufacturer, to understand how to work in accord with the thermal properties of their customer's products. Generous evaporator sizing brings about impressive savings. The 17 horsepower savings cited earlier translates to $12,415.00 annual savings, based on 60 tons of refrigeration and $0.10 per kilowatt per hour. Marlen blast chill cells consistently deliver that kind of savings.

About Faivre Technical LLC

Bill Faivre, dba Faivre Technical LLC, is an independent consultant and serves the meat and poultry processing industry. For more information, e-mail Faivre Technical at bill@billfaivre-consult.com.

About Marlen International

Marlen International is recognized as a leading provider of innovative food processing equipment for a variety of products including meat, poultry, fish, vegetables, fruit, bakery, confectionery, snacks and dairy goods. Marlen International products are sold in many countries under the brand names Marlen and Carruthers and are used for pumping, portioning, filling, dicing, grinding, slicing, shredding, chilling and cooking food. For more information, visit www.marlen.com.