DOVER FOOD RETAIL

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White Paper

# Microclimates ...

## A Better Way to Store and Display Beef and Chicken

How's the weather? A rather odd question to ask in the midst of a refrigerated display case technology discussion, you say? Not really! As a matter of fact, the response of food retailers to that very question could well determine just how safely and cost-effectively they are storing and merchandising fresh meat, such as beef steaks and chicken, for sale in their store. Just as many people decide where they wish to live based on what they consider their "ideal desirable climate" to be, the perishable nature of fresh meat products dictates certain 'climate' requirements that must be met by a refrigerated display case in order to best maintain the product integrity and safety of the meat during storage and display. Food retailers have strongly vested reasons for making sure that their perishable meats are "happy" in their display case climate, not the least being profit and food safety. Failure to provide the needed climate for the meat can result in loss of sales, reduced profits, and in some cases, the introduction of microorganisms that can cause foodborne illnesses which can have devastating consequences for any affected food retailer.

So, what exactly is it that makes for a refrigerated display case climate that keeps perishable meats happy the longest? The quality of meats is influenced by factors such as packaging, storage condition, gas composition (O2, CO2, inert gases) surrounding the meat tissues, relative humidity (RH), light and temperature[1]. Temperature and RH appear to have the greatest effect on the microbial quality

[1] Singh and Cadwallader, 2004

characteristics of fresh meats held in retail display cases[2]. Furthermore, RH plays the most significant role in loss of water weight from the meat (product shrinkage)[3].

Weight loss from meat is an important economic factor because meat is sold by unit weight (e.g., $/lb.). Furthermore, it is an established fact that the proper moisture content in meat impacts its taste and flavor appreciably – an observation that customers are sure to note! So, back to our original question about the weather for a moment, you can see why the climate in the refrigerated display case merchandising meat products is ever so important to retailers.

Different display case technologies create their respective internal climates in differing ways with differing end results. A recent research work[4] currently under peer-review in the journal, *Food Control*, studies four such full-service display case technologies and their impact on the product integrity and safety of merchandised beef steaks and chicken breasts. The primary difference between the four selected technologies was the way each was designed to "make cold", either by employing means of convection, conduction, or a hybrid of both.

Specifically, the four case technologies were:

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[2] Leclercq-Perlat et al., 2012

[3] Meat Shrinkage, Kansas State University, 1972

[4] Food Control: Evaluation of Shelf Life and Quality of Beef Steaks and Chicken Breasts in Refrigerated Display Cases Using Four Unique Cooling Technologies; completed by the Polymer and Food Protection Consortium at Iowa State University, 2018

1. Conduction Cooling Gravity Assist Service Case (CCGA)
2. Gravity Coil Service Case with Partial Conduction Coil Base Deck (PCC)
3. Gravity Coil Service Case with Serpentine Assist (GSA)
4. Blower Coil Service Case with an Additional Fogging System (BCF)

Traditionally, retail food stores have used display cases that create their internal climate by using convection cooling to circulate chilled air over the product. This is achieved either by using fans to circulate the cooled air (forced convection) or relying on the natural tendency of cold air to sink and warm air to rise (gravity-cooled), or a combination of both. The alternative to convection cooling is conduction cooling, an approach that has steadily been gaining in popularity over recent years. Conduction cooling creates a climate through the direct physical contact of two surfaces at different temperatures where heat flows from the warmer surface (product) to the cooler surface (deck pans) until they are equal. In a display case using conduction to create its climate, the bottom of the display area consists of a special type of deck pans through which a chilled fluid flows to cool them to a desired temperature. When product is placed on the deck pans, it is conductively-cooled to the desired temperature by its contact with the deck pans and the subsequent transfer of heat.

The major advantage of display cases cooled by conduction over those using convection is that the physical contact between the product and the chilled deck pans creates a very special kind of climate called a “microclimate” [5]. A “microclimate” is defined as the climate in a small, specific place in an area as contrasted with the climate of the entire area. So, whereas a convection-cooled

[5] The Free Dictionary, 2018

case creates a climate at the surface of the product with temperature and relative humidity that is essentially the same as the ambient air in the case enclosure, a conduction-cooled case establishes a microclimate at the product surface that has lower temperature and higher relative humidity than that of the case ambient air.

This microclimate offers distinct advantages in extending the product life of meat and seafood beyond the expectations of traditional gravity coil or blower coil refrigeration systems.

The complete conduction cooling case (CCGA) used in the *Food Control* study offered further technological innovation in the form of pulse-flow control of the glycol refrigerant supplied to the deck pans and heat exchanger (at the top of the case and used to maintain case air temperature). The flow of coolant through these elements is constantly cycled between a low setpoint of 29 °F (coolant is shut off) and a high setpoint of 33 °F (coolant flows). Besides the effective and efficient temperature control of the microclimate created at the product surface by this technology, an even greater benefit is derived from the effect it has on tiny amounts of moisture in the air surrounding the deck pans that alternately freezes and thaws because of the coolant's pulse- flow control. This constant freezing and thawing of the minute amounts of moisture creates a high humidity area immediately surrounding the deck pans and any product situated on them, thus minimizing product shrinkage due to moisture loss. Likewise, the heat exchanger at the top of the case exhibits the same mechanism from the coolant cycling which results in helping keep the case ambient humidity at optimum levels. In traditional convection-cooled type cases, a common way to reduce the loss of moisture is through the use of misting (fogging) systems which carry the inherent potential for increased bacterial growth issues.

The *Food Control* study validated the fact that the Conduction Cooling Gravity Assist Service Case (CCGA) utilizing pulse-flow control, through its creation of a microclimate controlling temperature and relative humidity at the product surface, was superior to the other three technologies studied in its ability to create a favorable climate for the product integrity and safety of meat products.

The beef steaks placed in the four different refrigerated display cases were observed over an 8-day period of time while the chicken breasts were evaluated over a 5-day interval. Looking at the specifics of the study results, the coldest product tissue temperatures were observed for steaks and chicken breasts placed in the CCGA (Conduction Cooling Gravity Assist Service Case) display case while the warmest tissue temperatures tended to occur when the cuts were placed in the PCC (Gravity Coil Service Case with Partial Conduction Coil Base Deck) case. The CCGA case had 2.95 °F (1.64 °C) cooler product tissue temperature than the PCC case. Putting this in perspective, although the number may not seem big at first sight, an approximately 3 °F differential in meat product temperature is very significant when it comes to the growth potential of harmful microorganisms (bacteria).

Besides the notable advantage of lower product tissue temperature, the CCGA conduction cooling case realized benefits from its ability to keep relative humidity at properly elevated levels and minimize decreased product weight due to moisture losses. The steaks lost more weight when held in the PCC case and therefore exhibited a higher product shrinkage. By day 8, steaks held in the PCC case had lost 10.8% of their weight compared to 9.7% for steaks held in the CCGA case. Steaks lost more weight each day they were held in the PCC case than the CCGA case except on day 8, where steaks in both cases lost the same amount of

weight. Weight loss from meat is an important economic factor because meat is sold by weight. The larger weight loss for steaks in the PCC display case is attributed to a lower relative humidity resulting from a more rapid circulation of air within the display case. These results agree with overall relative humidity measurements taken daily in the four display cases where the lowest RH consistently tended to occur in the PCC case.

The *Food Control* study concluded that the novel CCGA (Conduction Cooling Gravity Assist Service Case) display case used in the study has the greatest potential for extending shelf life, due to the microclimate it creates at the product surface level resulting in lower overall tissue temperatures and reduced shrinkage of meat products held in the CCGA case. This represents opportunity for food retailers.

So, if you're a food retailer, the next time someone asks you, "How's the weather?", your reply may take on a whole new meaning … for you … your customers … and your profits!