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Evaluate the efficacy of "heat stress audits" of your cooling system through core body temperature

Abstract

A project to evaluate the degree of heat stress in individual dairies was carried out in the summer of 2005. The object of this project was to develop a method to evaluate or audit how effective an individual dairy is in manag-ing heat stress. Approximately 45 herds in 20 different states were audited for the degree of heat stress cows experienced during a 72-hr period. Dairies were selected based on geog-raphy, climate, and facility design. Lactating cows 40 to 100 days in milk (DIM) and dry cows within 30 days of calving were evalu-ated. Vaginal temperatures of 8 cows located in the same group were collected every 5 min by using data loggers (HOBO U12®) attached to a vaginally placed insert (blank CIDR®). Ambient climatic data were collected on the project dairies by using logging devices that collected temperature and relative humidity at 5-min intervals. Census data were collected at each dairy, and included pen sizes, milking frequency, milking times, average milk pro-duction, DIM, parity, holding-pen design, and timing of cow movements. Data were im-ported into Excel (Microsoft, Redmond, WA) as individual cow files aligned by time. The data for an individual cow were then averaged with all other cows in the pen in hourly incre-ments over a 24-hr period. Each hour of the 24-hr period is then a summary of that hour on 3 consecutive days, with 8 devices contribut-ing 12 points per hour per day to the sum-mary. So each hour is a summary of 12 data points x 8 cows x 3 days, or 288 data points per hour. Information was summarized graphically in PowerPoint (Microsoft, Red-mond, WA) and presented to the individual producers, along with recommendations on how to improve their heat-stress abatement practices. The project was not designed as a controlled experiment; therefore, caution is advised in over-interpreting the results. That being said, the project does demonstrate the feasibility and usefulness of using intra-vaginal temperature recording to monitor how well an; Dairy Day, 2006, Kansas State University, Manhattan, KS, 2006;

Keywords

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EVALUATE THE EFFICACY OF "HEAT STRESS AUDITS" OF YOUR COOLING SYSTEM THROUGH CORE BODY TEMPERATURE

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Summary

A project to evaluate the degree of heat stress in individual dairies was carried out in the summer of 2005. The object of this project was to develop a method to evaluate or audit how effective an individual dairy is in managing heat stress. Approximately 45 herds in 20 different states were audited for the degree of heat stress cows experienced during a 72-hr period. Dairies were selected based on geography, climate, and facility design. Lactating cows 40 to 100 days in milk (DIM) and dry cows within 30 days of calving were evaluated. Vaginal temperatures of 8 cows located in the same group were collected every 5 min by using data loggers (HOBO U12®) attached to a vaginally placed insert (blank CIDR®). Ambient climatic data were collected on the project dairies by using logging devices that collected temperature and relative humidity at 5-min intervals. Census data were collected at each dairy, and included pen sizes, milking frequency, milking times, average milk production, DIM, parity, holding-pen design, and timing of cow movements. Data were imported into Excel (Microsoft, Redmond, WA) as individual cow files aligned by time. The data for an individual cow were then averaged with all other cows in the pen in hourly increments over a 24-hr period. Each hour of the 24-hr period is then a summary of that hour on 3 consecutive days, with 8 devices contributing 12 points per hour per day to the summary. So each hour is a summary of 12 data points × 8 cows × 3 days, or 288 data points per hour. Information was summarized graphically in PowerPoint (Microsoft, Redmond, WA) and presented to the individual producers, along with recommendations on how to improve their heat-stress abatement practices. The project was not designed as a controlled experiment; therefore, caution is advised in over-interpreting the results. That being said, the project does demonstrate the feasibility and usefulness of using intravaginal temperature recording to monitor how well an individual dairy is managing heat stress.

(Key Words: Body Temperature, Cooling, Heat Stress.)

Introduction

Effects of heat stress on animal production are well known and have been investigated and documented for a number of years. It is commonly accepted that a temperature humidity index (THI) $\geq$ 72 creates a stressful environment for lactating dairy cattle. When ambient temperature conditions approach body temperature, the only viable route of heat loss is through evaporation. If ambient conditions

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exceed body temperature, heat flow will reverse and an animal will become a heat sink. Therefore, estimating the impact of the thermal environment around animals is necessary to understand their cooling needs. Because of the typical location of cooling equipment relative to animals, and the large variety of animal positions and locations, a wide range of microenvironments exist within a facility. As a consequence, cows experience differing degrees of heat stress within a day. Thus, accurately determining the degree of heat stress a cow experiences over time is a challenge.

Heat Stress Audits 2005

During the winter of 2005, a project was designed to record intravaginal temperatures of lactating and dry mature dairy cows by using a continuous temperature logging device (Hobo U12 Stainless Temperature Data Logger, Onset Computer Corporation Bourne, MA) attached to a blank intravaginal insert. The observational period was 72 hr, and temperatures were recorded at 5-min intervals. Cows were selected according to days in milk (DIM) and milk production, or days carried calf for dry cows. The data loggers were inserted into 8 cows per pen. Census data collected at each dairy site included pen size, milking frequency, milking times, average milk production, holding-pen facility design, and timing of cow movements. Ambient temperature and humidity were collected at the dairies by using logging devices that collected temperature and relative humidity at 15-min intervals over the same 72-hr period as the data loggers. If ambient devices were not available, outside temperature and relative humidity data were gathered by using global positioning system (GPS) coordinates of the facility and WeatherPlot. Data were downloaded from each intravaginal insert. All data were aligned by 5-min intervals and then imported into Microsoft Excel. The individual device data was then collapsed in a pivot table to be examined in hourly increments over a 24-hr period. Each hour of the 24-hr period represents a summary of that hour on 3 consecutive days, with 8 devices contributing 12 data points/hour/day. Specifically, each hour is a summary of 12 data points × 8 cows × 3 days, or 288 individual data points within that hour.

Results and Discussion

During this collaborative effort, data were collected in 20 states, from more than 45 herds, from dairies milking approximately 125,000 cows. A consistent observation throughout the auditing was the impact of holding-pen cooling or the lack thereof. A holding pen (designed to allow 15 ft^2/cow) without proper cooling is an area where dairy cows may experience severe heat stress (Figure 1). If the holding pen is properly cooled, however, vaginal temperatures will be reduced each time cows are brought to the milking parlor (Figure 2). Another observation was the impact of shade, compared with no shade (Figure 3). Lactating cows provided with shade had lower core body temperature during the hottest times of the day, compared with those without shade. It is no surprise that the benefit from shade was greatest when outside temperatures were the hottest. Implementation of feed-line misters without shade was compared with shade alone, and shade alone maintained lower core body temperature than misters alone (Figure 4).

Audits also can be used to evaluate different types of cooling systems. Figure 5 contains the results of comparing two Korral Kool systems and one oscillating fan and mister system. The observations on this particular herd were impressive in that core body temperature was lowest for cows housed under the 5-Hp Korral Kool system and highest for those housed under the 2-Hp Korral Kool system. The core body temperature of cows housed under the ADS-ST fans was intermediate, suggesting that the 5-Hp system was doing a better job of maintaining core body temperature than fans were. Fans, however, seemed to be out-performing the 2-Hp Korral Kool system.

As mentioned earlier, we collected data from a variety of facilities throughout the summer of 2005. Within a facility, the minimum, average, and maximum core body temperature temperatures from all cows were collected, but only averages were typically reported. Figure 6, however, shows both the average, minimum, and maximum core body temperatures observed from 8 multiparous cows housed in a tunnel-ventilated barn with evaporative pads in western Kansas. Regardless of the time of day and outside ambient temperature (80 ± 10°F), the maximum core body temperature was never more than 1°F higher than the minimum, and overall average core body temperature did not exceed 102.4°F. This audit demonstrates the value of providing a cooler environment for the cow.

One primary goal of this project was to develop a system that could be used to evaluate how well heat stress is managed. Gathering and attempting to understand data from a wide array of differing facilities, in different climates, and with different production levels and management schemes is intended to allow us to move forward into more-specific targeted use of the recording devices in subsequent summers. In general, our results tended to agree with what our current knowledge predicted, (i.e., cows get hot when climatic and management factors subject them to conditions that exceed their inherent ability to dissipate heat generated and absorbed). These data should allow us to refine our expectations. Observations from this project indicate that the data loggers are an effective tool to monitor and ultimately fine tune currently installed heat abatement systems, as well as suggesting a need for future improvement. More work needs to be done to completely understand the problem. As new technologies come to market, however, these data should prove useful in answering questions of how and when such technology can fit into a particular dairy production system. This technology allows core body temperature to be monitored and recorded 24 hr per day as cows move throughout a facility. Using a core body temperature probe to continuously monitor vaginal (core body) temperature allows an accurate determination of where and when cows experience the most heat stress. As a consequence, management decisions can be made to improve cooling and reduce heat stress, thus improving cow performance.

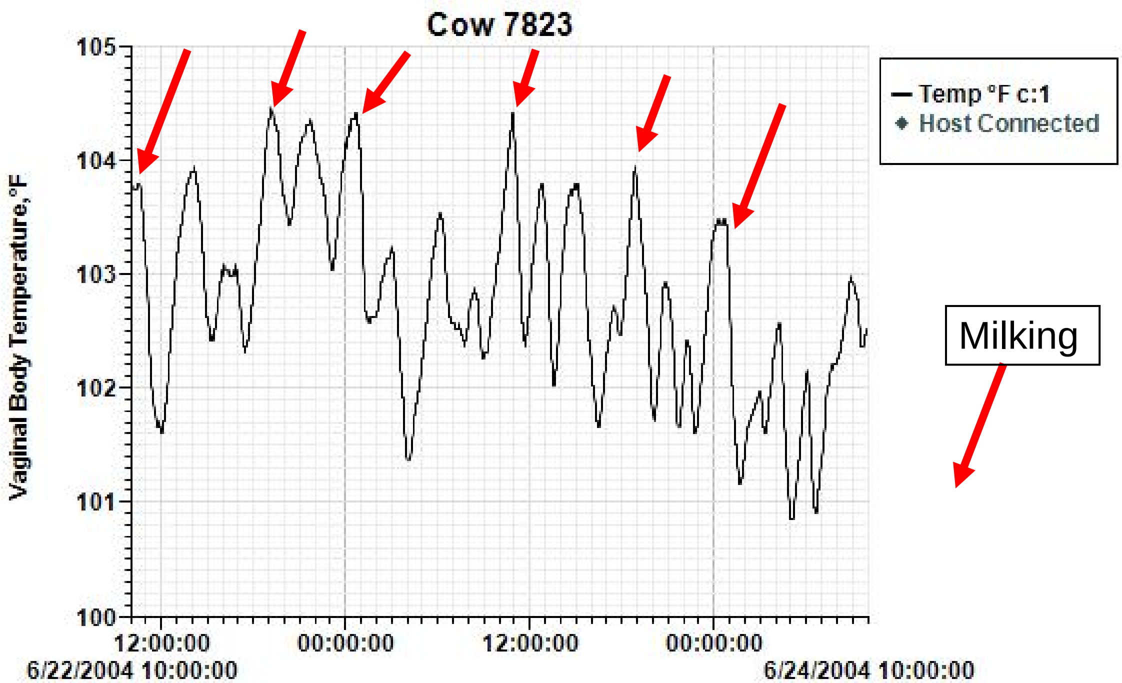

Figure 1. Two 24-hr Periods of Core Body Temperature from a Single Cow in a Holding Pen.

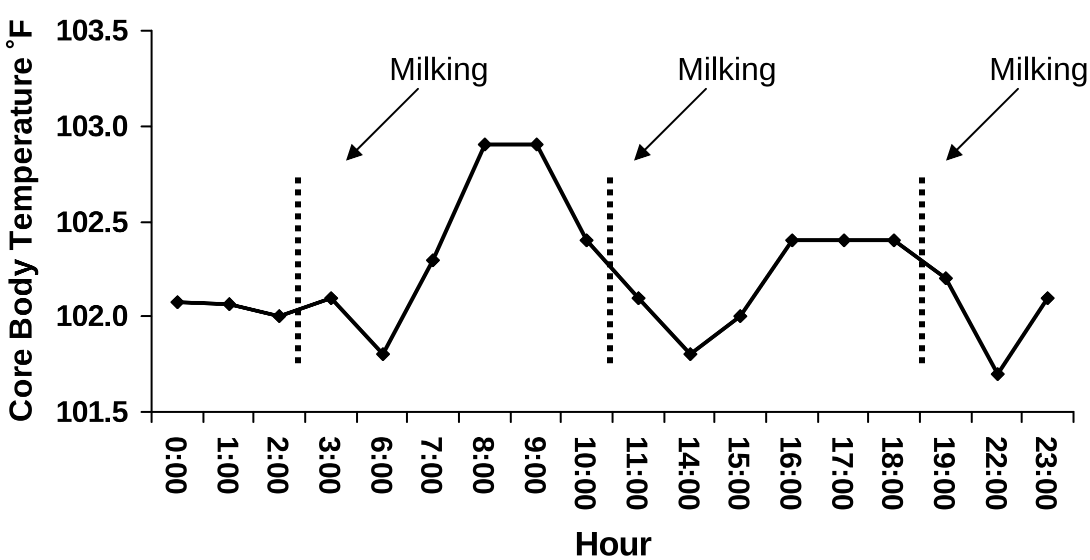

Figure 2. Effects of Core Body Temperature of Cows Experiencing Excellent Cooling of Holding Pen and Parlor Exit Lane.

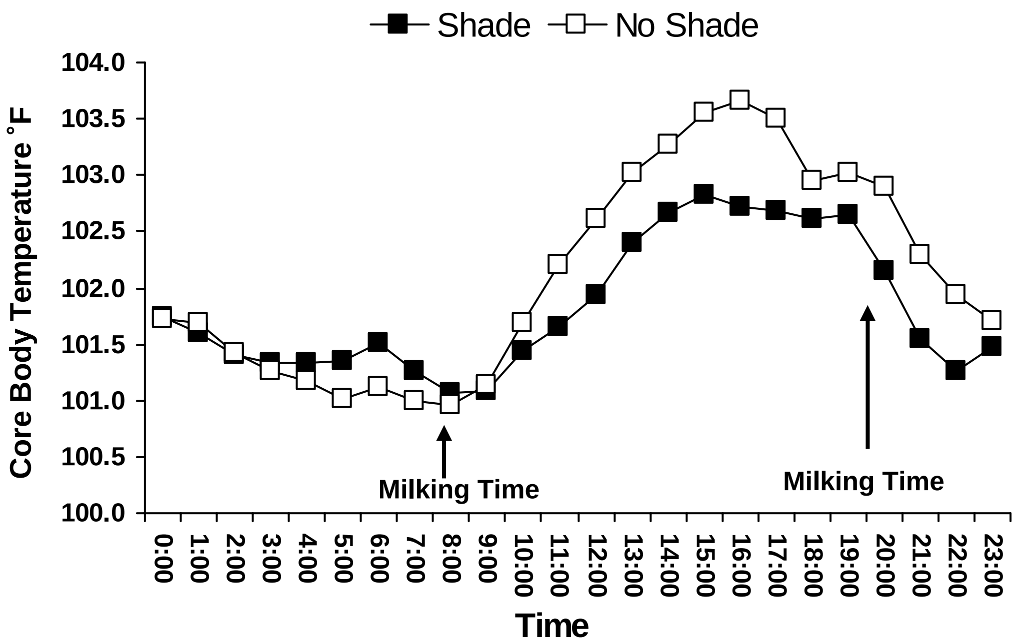

Figure 3. Core Body Temperature, With or Without Shade.

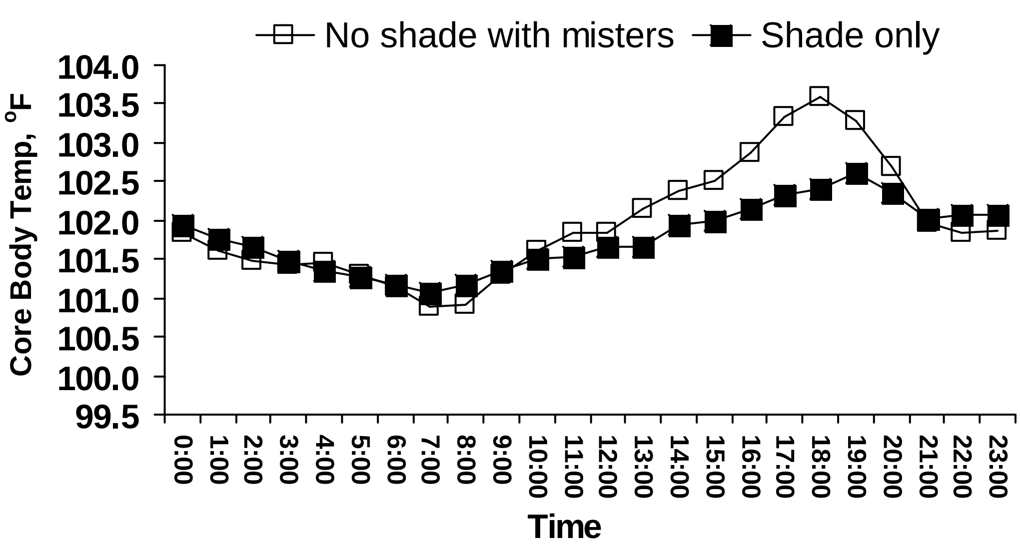

Figure 4. Impact of Core Body Temperature for Close-up Dry Cows Provided Shade, With and Without Feed-line Misters.

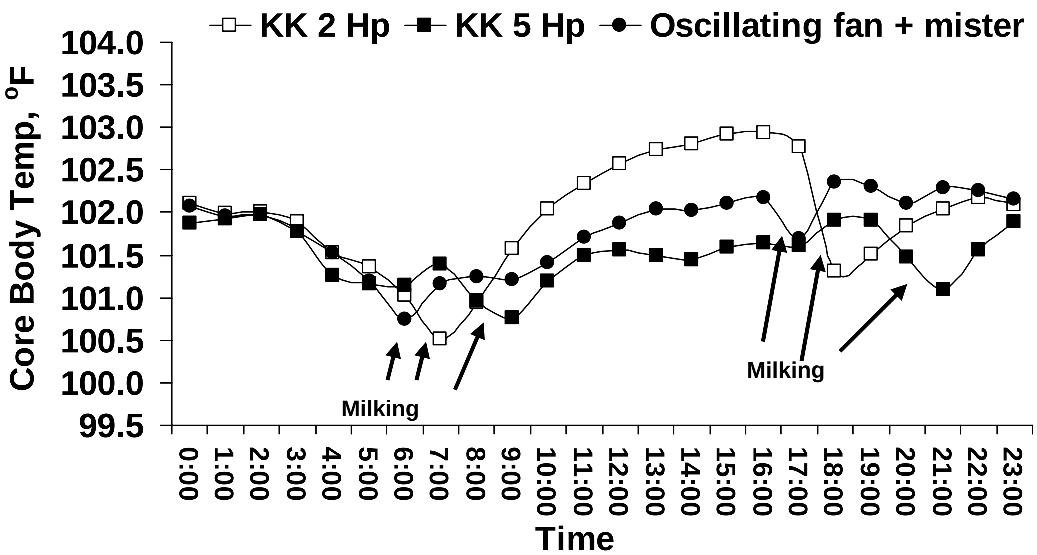

Figure 5. Effects of Core Body Temperature of Multiparous Lactating Cows Housed in a Dry Lot Facility with 2- or 5- Hp Korral Kool Coolers or Oscillating Fans with Misters.

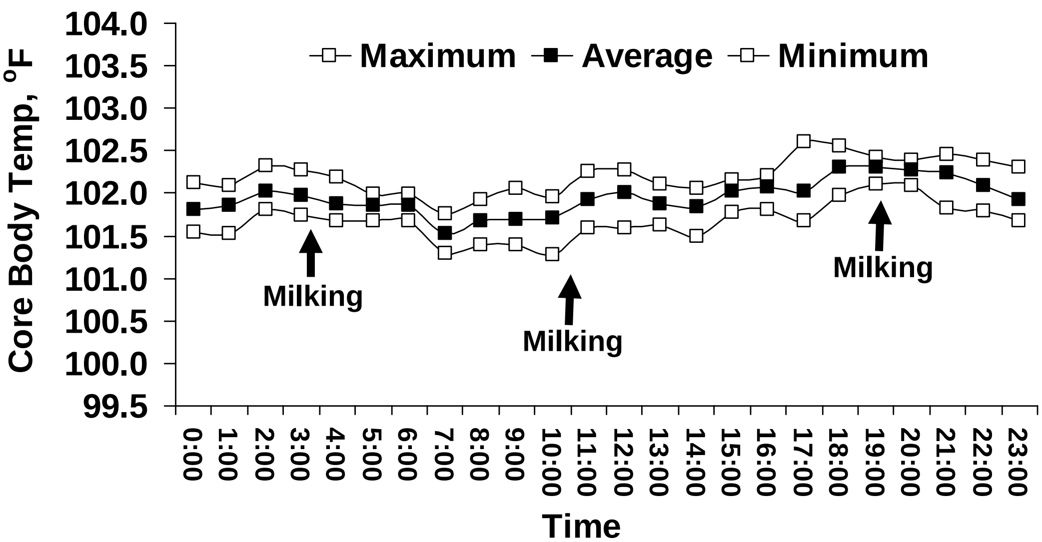

Figure 6. Core Body Temperature of Multiparous Lactating Cows Housed in a 4-row Tunnel Ventilated Freestall Barn.