Cooling Strategies During Heat Stress

The summer heat can raise numerous issues on dairy operations. Reduced feed intake and subsequent milk production losses coupled with reduced pregnancy rates negatively affect your customers’ bottom line. Heat stress is not isolated to warmer parts of the US; it is experienced in all parts of the US and in most other countries. With a proactive approach to heat stress management, your customers’ cows can achieve increased summer fertility, greater milk production, and maximum cow comfort.

What is Heat Stress?

Sum of all the forces acting on the cow that act to increase body temperature above normal limits.

Regulation of Body Temperature and Implications for Cooling Cows

The average dairy cow has an internal body temperature of 100.9-101.5°F. The early embryo in the first 1-3 days of life is not able to develop when body temperature rises to 104°F (40°C).

As the external temperature increases, cows must increase heat lost to the environment. The ability to remove heat requires that cows reduce feed intake. As a result, cows exposed to heat stress often experience increased body temperature. The process of increased body heat loss is called hyperthermia.

How is heat exchanged?

Sensible Heat Loss Mechanisms: Conduction, Convection, and Radiation

- The variables between the animal’s surface temperature and the temperature of the object in the environment with which the animal is exchanging heat. Example: If the cow’s skin temperature was 86°F and the air temperature was 90°F, then the cow would be experiencing a net gain in heat from the air.

Latent Heat: Evaporation

- Latent heat loss refers to heat associated with the evaporation of water. Water is evaporated when produced on the skin (sweating, rain, immersion in water, etc). It takes 500 times the amount of heat to evaporate an ounce of water as it does to raise the temperature of that water by 1°F.

How to Measure Heat Stress

Temperature-Humidity index (THI)

- Formula based on dry bulb temperature and humidity that is used to estimate the magnitude of heat stress affecting a cow. (See THI Chart)

  $Tdb - (.55 - (.55 \times RH/100) \times (Tdb - 58))$

- Milk yield begins to decline due to heat stress in high-producing cows when THI hits 65 or greater.

Body Temperature

- Rectal temperature is the best way to indicate level of heat stress.
- A good rule of thumb is that cows experiencing rec-
Technical Services

Cooling Strategies During Heat Stress (cont.)

Tal temperatures of 102.2°F in the afternoon are at risk of reduced milk yield and fertility.
- Measurements should be taken in the afternoon (3:00-5:00pm) when cows are most likely to be experiencing elevated body temperature.
- Place thermometer into the rectum for a full minute to give the thermometer time to stabilize.
- While measuring rectal temperature, measure respiration rate by counting the number of flank movements for 30 seconds and multiplying it by 2 (a respiration rate greater than 60 breaths per minute indicates that a cow is experiencing heat stress).

Advanced Body Temperature Measuring Techniques:
- Thermocron® iButton (Figure 1)
- Stainless-steel encased computer chip with a built-in real-time clock and ID number to measure and record temperature at user set intervals of 1-255 minutes.
- Data can be downloaded by touching the iButton to an interface plugged into a personal computer.
- The iButton fits securely in a hollowed out space in the center of a blank CIDR® device.
- Internal body temperatures can be measured at key marks throughout the day to determine specifically when cows are experiencing heat stress (freestall, holding area, parlor, in transit to the parlor, etc.). This information can be used to determine if existing cooling strategies are being effective.

*Thermocron® iButton from Maxim in Sunnyvale, CA

Benefits of cooling dry cows:
- During elevated temperatures, placental function is compromised so that hormones like placental lactogen that prepare the mammary gland for the next lactation are reduced in secretion. Keeping dry cows cool promotes greater mammary tissue secretion in subsequent lactations.
- Housing dry cows in a barn with fans and sprinklers increased subsequent milk yield by 16.5 lb.day (74.3 lb/day vs. 57.8 lb/day) as compared to cows housed in a similar barn without fans and sprinklers. (do Amaral et al., 2009)

Emerging Ideas in Strategic Cooling:
- The follicle that ovulates today started growing 3-4 months earlier.
- Heat stress can affect that follicle for at least the last 26 days of its growth.
- Heat stress damages the oocyte once it has been released from the follicle at ovulation.

Heat Stress in Dry Cow and Heifer Pens

While it has been well documented that lactating cows are more prone to hyperthermia, this does not mean that minimal efforts should be given to heat stress prevention in non-lactating animals. Young calves can experience heat stress. Hutch-reared calves have slower growth when born during periods of heat stress (Broucek et al., 2009).

Figure 1: Thermocron® iButton

26 days of its growth.
- Heat stress damages the oocyte once it has been released from the follicle at ovulation.

*Thermocron® iButton from Maxim in Sunnyvale, CA
Cooling Strategies During Heat Stress (cont.)

- The embryo is sensitive to heat stress until about day 3 of pregnancy when it becomes resistant to maternal hyperthermia.

**Implications of Strategic Cooling:**
- The effects of heat stress cannot be avoided by limiting insemination to the cooler part of the day.
- By the time of insemination, the follicle has already been damaged.
- If an embryo is formed, it is susceptible to heat stress for the next 48 hours.

It may be advantageous to cool cows subjected to timed AI protocols from about 3 days before insemination until 3-4 days after insemination.

**Temperature-Humidity Index (THI) Table**

- **Stress Threshold:** Respiration rate exceeds 60 BPM. Milk yield losses begin. Repro losses detectable. Rectal temperature exceeds 38.5 °C (101.30° F)
- **Mild-Moderate Stress:** Respiration rate exceeds 75 BPM. Rectal temperature exceeds 38.0 °C (102.20° F)
- **Moderate-Severe Stress:** Respiration rate exceeds 85 BPM. Rectal temperature exceeds 40.0 °C (104.0° F)
- **Severe Stress:** Respiration rate 120-140 BPM. Rectal temperature exceeds 41.0° C (106.0° F)

**Works Cited**


<table>
<thead>
<tr>
<th>Temperature</th>
<th>% Relative Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°F 0°C</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>72</td>
</tr>
<tr>
<td>10</td>
<td>73</td>
</tr>
<tr>
<td>15</td>
<td>74</td>
</tr>
<tr>
<td>20</td>
<td>75</td>
</tr>
<tr>
<td>25</td>
<td>76</td>
</tr>
<tr>
<td>30</td>
<td>77</td>
</tr>
<tr>
<td>35</td>
<td>78</td>
</tr>
<tr>
<td>40</td>
<td>79</td>
</tr>
<tr>
<td>45</td>
<td>80</td>
</tr>
<tr>
<td>50</td>
<td>81</td>
</tr>
<tr>
<td>55</td>
<td>82</td>
</tr>
<tr>
<td>60</td>
<td>83</td>
</tr>
<tr>
<td>65</td>
<td>84</td>
</tr>
<tr>
<td>70</td>
<td>85</td>
</tr>
<tr>
<td>75</td>
<td>86</td>
</tr>
<tr>
<td>80</td>
<td>87</td>
</tr>
<tr>
<td>85</td>
<td>88</td>
</tr>
</tbody>
</table>

**FATAL CONDITIONS**