Understanding how to counter heat stress in dairy cows

There are several different indices for estimating the degree of heat stress in dairy cows. One of these is Zone of Thermal Comfort (ZTC). Farm animals have well known zones of thermal comfort. The range of ZTC depends on the animal species, its individual physiological status as well as the ambient weather conditions such as the relative humidity and air velocity as well as the degree of solar radiation.

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The ZTC of a dairy cow is between 5°C and 25°C. But ZTC alone is not sufficient to measure cow comfort. Another index used to determine where levels of heat stress occur is Thermal Humidity Index (THI).

THI is calculated by using ambient temperature and relative humidity levels. A dairy cow will be affected by heat stress if the THI exceeds 72 (see Fig. 1).

The actual feel of a temperature level increases with relative humidity levels. If the temperature is 18°C and the RH level is below 20%, the cow will feel the temperature as it is. But as the RH levels increase, the temperature is perceived as being much higher.

At an RH level of 80% the cow will feel the temperature is 21°C. This escalates with higher temperature levels. If the temperature is 28°C it is enough with a RH of 30% for the cow to feel a temperature increase of 3°C. At a 90% relative humidity and temperature of 33°C, the heat stress levels are becoming severe.

Although THI is a good indicator of heat stress it does not include wind speed, the cow's weight and production level. These parameters should be included when looking at the problem of heat stress because a high producing cow is more sensitive to high temperatures than a cow with normal production. The wind chill effect and if the animal's skin is wet, will also make the cow feel cooler.

Heat stress can be a problem all year, or just for a part of the year. Providing proper ventilation has a dramatic effect on overall productivity and comfort. Dairy cows not affected by heat stress produce more milk; have lower respiration rates, higher conception rates (resulting in more cow pregnancies) and overall better health.

When cows are comfortable they lie down and thereby produce more milk, so this is the wanted behaviour and it can be induced by using the correct ventilation design and equipment.

Fig. 1. Temperature humidity index (THI)[1] for dairy cows. Modified from Dr Frank Wiersma (1990), Department of Agricultural Engineering, The University of Arizona, Tucson, Arizona, USA.

Temp		Relative Humidity																				
°C	°F	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
23.9	75														72	72	73	73	74	74	75	75
26.7	80							72	72	73	73	74	74	75	76	76	77	78	78	79	79	80
29.4	85			72	72	73	74	75	75	76	77	78	78	79	80	81	81	82	83	84	84	85
32.2	90	72	73	74	75	76	77	78	79	79	80	81	82	83	84	85	86	86	87	88	89	90
35.0	95	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
37.3	100	77	78	79	80	82	83	84	85	86	87	88	90	91	92	93	94	95	97	98	99	
40.6	105	79	80	82	83	84	86	87	88	89	91	92	93	95	96	97						
43.3	110	81	83	83	86	87	89	90	91	93	94	96	97									
46.1	115	84	85	87	88	90	91	93	95	96	87											
48.9	120	86	88	89	91	93	94	96	98													

No stress
Mild stress
Medium stress
Severe stress

[1]THI = (Dry-bulb temperature °C) + (0.36 dew point temperature °C) + 41.2

Detecting heat stress

Cows are able to let the farmer know that they feel the temperature is too high. The signs are that they breathe more rapidly (panting), drink up to double the amount of water, stand up and drool, eat less, become passive and gather at the coolest spot in the barn.

When the cows show signs that they are out of the comfort zone and feel heat stress, the farmers or dairy have a lot to gain from improving the climate system in the dairy barn and milking parlour to avoid the previously mentioned negative impact on the production results, reproduction rates and the increased risk of infections. Results published in 2013 also show that heat stress during the late gestation period, has a negative influence on calves and milk production.

Climate and weather studies seem to agree that more extreme weather types can be expected for the future, including more humid and warm summers, without sparing any part of the world, completely altering the climatic map as we know it.

Counteracting heat stress

From a historical point of view, the highest levels of production results are seen in countries with relatively cold outdoor temperatures.

However today, the right climate system can reduce heat stress for dairy cows and secure a high level of productivity even when it is warm outdoors.

Dairy farmers are generally experiencing strong price pressure from the increasingly large and consolidated dairies and are governed by strict supply contracts, meaning

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that their margins and financial leeway are often very limited. The predictability of such a business is crucial and lower production rates during summer can prove to be disastrous. Keeping the climate as stable as possible inside the barn to mitigate drops in productivity is a necessity for intensive farming of today. The cow's ability to produce milk is dependent on her eating and that the feed intake is consistent. If it is not, production rates will decrease.

Munters focus on a number of parameters when meeting a farmer. The first criterion is the ambient climate condition of the specific location. Average summer temperatures and humidity levels, as well as other specific weather scenarios, are things that the climate control system needs to be ready for, and these facts and statistics are carefully collected and investigated. The control unit at the heart of the system will be configured so that it responds to changes in temperature and humidity, for example, strong winds. The barn system and how the cows are stalled are other parameters that affect the design and layout of the ventilation system.

Installation of cooling equipment of some kind is quite common today. Even shorter periods of warm weather and elevated RH levels negatively affect milk production, fertility, conception and pregnancy rates of the cow.

At moderately high temperature and humidity levels, it can be enough to create a wind chill effect over the animal's body by using fans to generate a high enough air speed (3m/s) over the animal's skin, in order to ensure sufficient heat removal. At higher temperatures and humidity levels it is an absolute necessity to use cooling equipment in order to keep up with required production levels.

Naturally ventilated barns

For naturally ventilated barns, our experts would recommend a misting system which sprays a fine mist over the cows during the hottest period. The nozzles should not be placed with a greater distance than 6m and should always be placed a maximum 1.5m from a wall. The capacity of the nozzles can create a temperature reduction of 5°C.

The use of a misting system has another advantage; it can also be used to soak the barn to prepare it for cleaning.

Naturally ventilated buildings are often constructed with an open ridge. Ridge ventilation provides an excellent combination of ventilation and light dispersion as an integral part of the natural ventilation for livestock barns. The designs of the ridge vent and wind deflector result in a vacuum effect, which effectively sucks out the warm and stale air inside the barn.

By choosing a dynamic wind deflector solution, you enhance your climate control options, manually or automatically, to provide additional protection of your livestock during the times of year with extreme weather conditions.

A natural ridge opening is optimal for light ingression and will serve as a natural daylight inlet.

Ventilation panels provide an excellent combination of ventilation control and light requirements and form an integral part of the natural ventilation for livestock barns.

Insulated and UV resistant polycarbonate sheets form the basis of this solution, developed to accommodate increased requirements for insulation and light dispersion in the barn.

The need of a rugged and weatherproof solution with optimum translucency, performance and ease of operation results in optimal airflow for minimum cold ventilation. Curtains are often used in dairy buildings and there is a wide array of curtains for intensive dairy farm operations, of which the most prominent ones are in TEX glass quality.

This material is UV resistant, allows daylight penetration and is treated against static electricity, which means that dust and dirt does not stick to the material. Curtains form a natural wall inlet that allows for both cross ventilation and ventilation driven by the vertical chimney effect.

At the same time it serves as a climate shield against draughts, rain, snow and hail to ensure that the animal is in the comfort climate zone. Draughts on to the animals can be prevented by a solution where the bottom of the curtain is fixed to the wall and horizontally mounted stingers reinforce the curtain towards the elements. The top of the curtain is suspended in a corrosion resistant wire system which can be operated vertically, either manually or automated.

Much research and attention has been paid to making the curtain operation as safe as possible so that all kinds of crush injuries of both animals and their care takers can be avoided. The challenge with curtains is often that of poor light penetration when they are closed. The TEX glass quality of curtains brings virtually no difference between the open or closed position inside the barn.

The primary use of large circulation fans in livestock housing is to provide comfort cooling to the animals. For this very purpose, it is wise to use specifically designed circulation fans to provide the maximum cooling footprint at animal level.

Dairy barn circulation can be optimised by offering numerous mounting options and the possibility to tilt the fan in order to provide the best airspeed footprint.

The airspeed footprint is defined as the area in which the average airspeed exceeds 2m/s. The airspeed is measured at a level 1m above the ground when the bottom of the fan is mounted 2.7m above the level of the ground, but it is important to note that actual airspeed might be influenced by the animals themselves and structural elements which can stand in the way and alter the airflow.

Fans with large cooling footprint give less 'dead spots' in the barn and equate to improved milk production for the farmer.

Another piece of the natural ventilation puzzle is a high volume low speed ceiling fan, engineered to circulate a vast amount of air, providing an efficient air circulation movement for animal housing.

Such a ceiling fan creates slow, gentle breezes to lower the effective temperature during warm periods and to circulate the rising warm air downward to ground level during cold periods. In addition, the fan will reduce humidity, moisture, condensation and odours, creating a healthier and more comfortable environment.

The vast amount of slow-moving air created by the ceiling fan is gently distributed corner-to-corner, and also helps to keep bedding dry, dissipate smells and ammonia, and to repel birds and flying insects.

Forced ventilation

If we look at enclosed buildings with forced ventilation, which are mainly used in moderate and hot climate areas, cooling is predominantly achieved by use of evaporative cooling pads, framed by a gutter system and serviced by a water tank and pump.

The evaporative process takes place by use of extraction fans usually placed on the wall across from the cooling pads (cross ventilation) or at the gable end of the barn extracting cool air from the pads all along the house (tunnel ventilation). This pad cooling set up can provide up to 10°C reduction depending on the ambient conditions.

The climate components installed in the house are automatically managed by a control unit and by means of a communication system. The farmer can check the climate system in the dairy house directly from his own PC.

Modern controller units receive all inputs, process the data and all output signals are sent by the farm dairy with the ability to control and manage three temperature zones and controls ventilation through THI index values or temperature.

The device can handle the fogging system and soaking cycles as well as curtains to set temperature.

A wind meter sends a signal to the controller when winds are too strong, which in its turn will close the curtains tight. Dips in milk production can be avoided.

In conclusion, a carefully designed and optimised ventilation or climate control system can help farmers anywhere in the world to maintain a sustainable production level and comply with commercial agreements, often at an average payback time of less than three years. ■