Water Consumption of an Evaporative Cooling System in the Midwest

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Summary

Water meters were installed on the evaporative cooling system of a long, low-profile, cross-ventilated dairy in the upper Midwest. The evaporative pad along the west side measured 10 by 350 ft. The water usage per unit surface area of the evaporative pad was 0.29 gallons/hour per square foot of evaporative pad surface area. The total daily water usage per stall averaged 13 gallons with a maximum of 22.7 gallons. Results from this study indicate that peak hourly water usage may be as much as 3 times the average values. The evaporative pad efficiency was 65% between noon and 0800 hours and 79% between midnight and 0400 hours.

Introduction

Consumptive water use on a dairy for heat abatement increases the daily water requirements during summer. Water usage depends on weather conditions, the heat abatement system, and operational characteristics. Evaporative cooling systems cool the air around a cow's body to help minimize heat stress and maintain an animal environment in the thermoneutral zone. Distributors of evaporative pads assume a pad efficiency of 75% regardless of the air properties or air speed. Little information exist describing water demand and water usage of evaporative pads, making it difficult to properly design the water distribution system. The objective of this study was to determine consumptive water usage of evaporative cooling systems on a low-profile, cross-ventilated dairy facility.

Experimental Procedures

Water meters were installed on the evaporative cooling system of a low-profile, cross-ventilated dairy in the upper Midwest. The building was 372 ft wide and 390 ft long with an evaporative pad along the west side that measured 10 by 350 ft. The facility housed 1,200 dairy cows assuming a 1:1 stocking ratio of the freestalls. The cellulose pad was 6 inches thick. Water was delivered to the supply line of the pad by 5 sump pumps. Each pump supplied water to a pad section measuring 10 ft tall and approximately 70 ft long. Automatic data loggers were installed at the inlet to each sump and programmed to record consumptive water use every 15 minutes. Ambient temperature and humidity were obtained at the nearest town from a weather service provider. Water use data were evaluated during 8-hour periods (noon to 2000 hours) from July 1 to 31, 2008. The evaporative pad area was 2.9 ft^2 per freestall. A psychometric spreadsheet model was used to estimate the maximum potential water used assuming 100% efficiency of the evaporative cooling system. Pad efficiency was calculated as the actual water used divided by the maximum potential water that could have been absorbed by the air.

Results and Discussion

During the 31-day period, ambient relative humidity was 63.8 ± 12.2%, ambient temperature was 81.2 ± 4.4°F, and the ambient temperature-humidity index was 76.5 ± 3.5. Total water consumption during the 31-day period was 482,350 gallons. The maximum water used during

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a 24-hour period was 27,231 gallons, and the minimum usage was 5,493 gallons. Average total daily water usage per stall was 13 gallons with a maximum of 22.7 gallons per stall. Water usage exceeded 16.7 gallons/day per stall during 23% of the days. Pad efficiency was 65.0 ± 16.2% during the 31-day period between noon and 2000 hours. Average hourly water usage was 1,028 ± 405 gallons/hour, and average water usage per unit pad area was 0.29 gallons/hour per square foot. Peak hourly usage rate during the 31-day period was 2,655 gallons/hour, resulting in a peak water usage rate of 0.76 gallons/hour per square foot of pad area. Defining peak water usage is critical because the water system must meet this demand. During 4% of the study period, water usage exceeded 1,500 gallons/hour. Average water usage was 358 gallons/hour during the night, when the humidity averaged 86%. The pad efficiency also increased to 79% during the night. It is essential that evaporative pad systems be designed to meet peak demand.