DEVELOPMENT AND EVALUATION OF A TEMPERATURE-HUMIDITY CONTROLLER FOR LIVESTOCK BUILDINGS

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Temperature control wasn't affected by the temperature humidity control (THC) strategy. Pig performance was not affected.

Background

Previous work at PSCI indicates that a specific protection treatment applied to a TDK relative humidity (RH) sensor could substantially increase the sensor's life expectancy and maintain its accuracy under pig barn conditions. This makes humidity control strategies possible.

Computer simulations demonstrated that the type of RH control and setpoints affect air quality and energy requirements. The objective of this study was to implement the modified TDK RH sensor and the new optimized temperature and humidity control (THC) strategy developed at PSCI in an existing heating and ventilation controller and to evaluate the performance of this new THC controller under commercial barn conditions.

The new controller

The TDK RH sensor and the THC strategy were implemented in the "Rapid Control" controller of DelAir Systems Ltd. (Humboldt, Saskatchewan, Canada) by Critical Control (Saskatoon, Saskatchewan, Canada).

The modified controller regulates the temperature with the ventilation system and a Proportional-Integral-Derivative (PID) algorithm. Humidity control is achieved with a Proportional control loop using the ventilation system. The heater is modulated with an on/off control.

In the THC mode with the experimental THC Rapid controller, the user needs to define the room temperature and relative humidity setpoints, the RH P-band and the values of lower limit and upper limit of the minimum ventilation rate. As it has been done for some commercial controllers, the humidity control (HC) is only allowed within the first stage fan between a lower and an upper limit of its rotation speed. This provision prevents some energy wastage associated with too high RH reading from the sensor that would result in high ventilation rate and excessive heating requirements.

The experimental set up

The controller was evaluated in six identical grower/finisher pig rooms for eight weeks in winter and early spring of 1999. Three rooms were provided with THC controllers using a 70 per cent RH setpoint while the other rooms had conventional temperature-only controllers. Each room housed 68 pigs in six pens and was equipped with the same type of fans and heater.

The performances

The new THC controller provided very good control of room temperature and relative humidity.

In conventionally controlled rooms and over the first three weeks, the time period when RH was higher than 70 per cent occurred 36 to 85 per cent of the day. The highest RH reached 86 per cent as showed in Table I. In THC rooms, the relative humidity was controlled around the setpoint for 33 to 63 per cent of the time. The maximum RH level did not exceed 76 per cent.

On average, temperature control was not affected by the THC strategy implementation. However, temperature fluctuations up to 0.8°C over a 15 minute period were observed on some occasions in THC rooms. Figures 1 and 2 show temperature and RH fluctuations during three days in February. In the THC room, the controller was effectively increasing fan rotation speed to maintain RH at the setpoint. The oversized heater and the setting of time parameters in the controller are likely responsible for those temperature fluctuations. Ammonia concentrations were not different in both room types, but CO_2 concentrations were higher in THC rooms. This indicates a lower average ventilation rate. Pig performance was similar with both control strategies.

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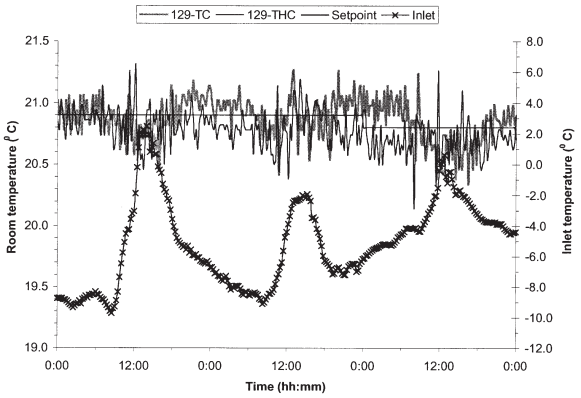

Figure 1 **Rooms and inlet temperature in a pair of rooms (129) from February 20 th to 23 rd, 1999**

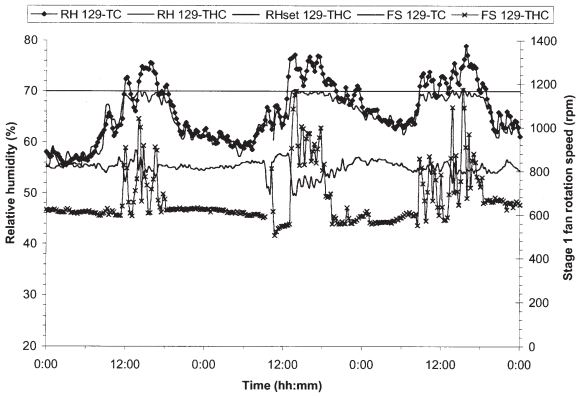

Figure 2 **Relative humidity and ventilation rate in a pair of rooms (129) from February 20 th to 23 rd, 1999**

Table I High humidity conditions in a cold weather period (only stage-1 fan enabled) in two specific rooms.

Week	Parameter	TC		THC	
		RH (%)	Period when RH>70% (hh:mm/day)	RH (%)	Period when RH ≥ setpoint (hh:mm/day)
1	Average	72	9:04	70	7:55
	Maximum	79	(37.8%)*	72	(33.0%)
	Minimum	56		55	
2	Average	73	8:40	70	12:37
	Maximum	86	(36.1%)	76	(52.6%)
	Minimum	59		61	
3	Average	74	20:20	70	15:08
	Maximum	84	(84.7%)	75	(63.1%)
	Minimum	62		59	

* Corresponding percentage for one day.