HUMIDITY CONTROL STRATEGIES FOR WINTER CONDITIONS

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Background

Most control systems used in swine facilities are temperature controlled, relying on a constant minimum ventilation rate (MVR) for relative humidity (RH) and contaminant controls during the cold season.

A survey conducted with 15 grower-finisher farms of the Prairies confirmed that conventional control systems are used and less than half the farms surveyed used recommended MVR settings. In more than half the farms, MVR adjustments were done to keep it to its minimum or to adjust it when the barn operator felt that the humidity was too high.

Underestimating MVR results in high RH and contaminant concentrations. Overestimating MVR results in higher energy cost for ventilation and supplemental heating. A system that could automatically adjust the ventilation according to the room humidity could improve the overall conditions in the building and optimize energy requirements.

Modelling

A computer model has been developed to evaluate the benefits of temperature-humidity control (THC) systems that take into account the room RH over a more conventional temperature control (TC) system. A full-scale grower-finisher room supplied with commercial equipment and control systems was simulated under Prairie winter conditions and under different control strategies.

Simulations

The comparison of heating and ventilating systems was based on average temperature, energy demand and respective fluctuations of humidity and carbon dioxide concentrations. For THC systems, Proportional (P) and Proportional-Integral-Derivative (PID) controls were simulated from November through March under Saskatchewan winter conditions. Based on simulations, a TC system provides effective humidity control considering that the minimum ventilation rate is adequately set and adjusted throughout the growth period. Figure 1 presents the RH obtained with three specific strategies: TC; THC with a PID control and a RH setpoint of 77 per cent; and THC with a P control with a 75 per cent setpoint and a 5 per cent P-Band.

As shown on Fig. 1, THC strategies keep the RH at the setpoint approximately 30 per cent of the time. A much wider variability is obtained with TC strategy. Furthermore, THC strategies are more appropriate as the ventilation is being adjusted to the room moisture production that can fluctuate within a day or as a result of sporadic water wastage.

In THC control, decreasing the setpoint from 80 to 70 per cent increases energy requirements by a factor of two. For a given RH setpoint, PID control requires more energy than P control as it keeps the RH at that setpoint or lower. However when equivalent RH conditions are maintained (75 per cent setpoint with P control and 77 per cent setpoint with PID control), energy requirements are similar or lower with PID control as shown in Fig. 2 and Table I.

Ventilation controllers. This Rapid controller system was modelled in computer simulations to find out what settings delivered the best humidity control and energy efficiency. The results were then checked against real world conditions (see "Development and Evaluation of a Temperature-Humidity Controller for Livestock Buildings").

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Optimum strategy

Overall with specific setpoints, PID (77 per cent) compared to P control (75 per cent-5 per cent) provides higher RH and CO_2 concentrations but differences are lower than 2.5 per cent. Considering simulation results, the controller complexity, the expected accuracy of those controller and humidity sensors, the strategy selected as being optimum was THC with P control, a 75 per cent RH setpoint and a proportional band of 5 per cent (THC-P-75 per cent-5 per cent P. Band).

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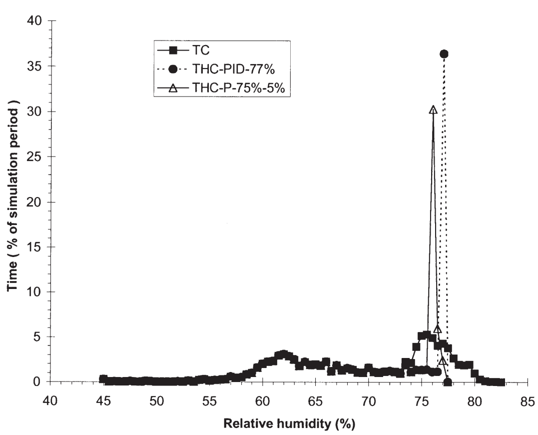

Figure 1 Comparison of the RH level for the different control strategies.

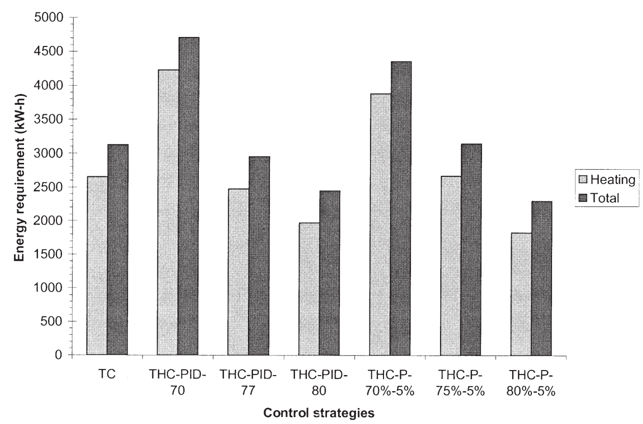

Figure 2 Energy requirement for different control strategies

Table I Comparison of different control strategies for a similar RH control

Control strategy	Energy requirement (kW-h)		Relative humidity (%)		CO_2 concentration (ppm)	
	Heating	Total	Mean	Max	Mean	Max
TC	2649	3127	69.5	81.7	2820	3675
THC-P-75%-5%	2667	3145	69.3	76.8	2809	3737
THC-PID-77%	2474	2951	69.7	77.0	2827	3786