Managing swine ventilation controller settings to save energy

Ventilation is by far the largest source of heating energy loss in swine facilities. To maintain air quality, it is essential to provide proper minimum ventilation, but it is also important to avoid expelling excessive energy from the building. Most buildings use electronic controllers that activate fans, heaters, and cooling systems and are designed to interlock the equipment operation to avoid conflicts that waste energy. For instance, if fans and heaters are controlled separately, there can be occurrences when heaters are cycling at the same time the ventilation rate has increased, thereby wasting a great deal of heating fuel. Modern controllers prevent heater operation and ventilation above the minimum rate from occurring at the same time, but improper settings can still contribute significantly to excessive energy consumption.

Terminology

Before addressing how controllers work, it is important to define common terminology. Actual terminology varies among companies that manufacturer controllers.

Setpoint (SP) is a basic temperature setting within the controller that is adjusted as animals grow and their thermal needs change. SP is sometimes called desired room temperature (DRT). When the room temperature is above the SP, ventilation increases to facilitate cooling. Likewise, for room temperatures below the SP, the heater may begin to cycle. Setpoint is not the average temperature, but establishes the line between heating and cooling. During periods of heating, such as during winter when pigs are small, the room temperature will remain a little below the SP. During periods of cooling, room temperature will be above the SP.

Heaters normally have two parameters, both set in the controller. Many controllers use a heater "on" and "off" temperature, while others use a ***differential***, the number of degrees between when the heater comes on and when it goes off, and an ***offset***, the number of degrees below the SP at which point the heater turns off. For example, if the SP was set to 68°F, the differential set to 1°F and the offset set to 1.5°F, the heater would start when the room temperature drops to 65.5°F (SP minus the sum of the differential and offset). The heater would then run until the room temperature reaches 66.5°F as shown in Figure 1.

Variable speed fans are used for most swine ventilation systems to provide minimum ventilation. Two settings are required for basic fan control. ***Minimum speed*** is a setting in the controller that represents the minimum ventilation rate. The value displayed by the controller may or may not correspond to the percentage of full speed air flow or motor RPM. Most variable speed fans move 50% of their rated airflow at approximately 65% of their full speed rpm. The minimum ventilation fans operate at the minimum speed any time the temperature is below the SP. Above the SP, the minimum ventilation fans gradually increase speed as the temperature rises. The number of degrees it takes the fan to reach 100% is called the ***bandwidth*** or ***range***.

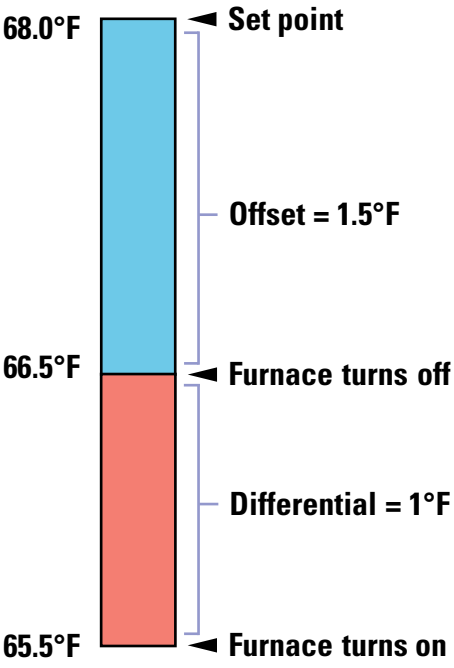

Figure 1. Differential and offset.

IOWA STATE UNIVERSITY
Extension and Outreach

PM 2089T March 2012




Potential problems

High energy consumption can be associated with improper heater settings. When the building temperature drops to the heater "on" temperature, the heater ignites and provides heat until the controller senses the heater "off" temperature. Because air is a fluid, it takes some time for the heat to circulate throughout the building, especially if heaters are oversized. This causes the temperature to continue to rise even after the heater has shut down. This is why the heater "off" temperature is set 1.5 to 2°F below the SP. When the heater shuts off at a temperature too near the SP, the room temperature may exceed the SP, which will cause the minimum ventilation fans to increase their speed. This effectively means that the heater has used fuel to heat the room and then the fans are exhausting that heated air to cool the room, because the temperature has crossed into the range of cooling temperatures. This can cause a tremendous waste of energy. Figure 2 shows an example of such an occurrence.

The left side of the graph shows the furnace run time when it was set to come on 2°F below SP and turn off at 1°F below. The right side shows the furnace stopped running when the off temperature was changed from 1°F below to 1.5°F below SP. This resulted in a savings of 3.75 gallons of fuel per furnace per day. In this case, a small increase in the temperature difference between the SP and when the heater turns off prevented the cycling and reduced fuel usage significantly.

If the furnace size is relatively large compared to room or facility size, as observed by the furnace not running for long even in extreme cold conditions, the off temperature must be set lower relative to the SP to avoid the problem of exhausting heated air when the room temperature continues to rise as the rapidly heated air disperses throughout the building.

A similar situation can occur if sensors are improperly located. Sensors should be located where they are representative of the mixed air in the building. They should not be impacted by sprinklers, cold air from inlets, or hot air from heaters. Proper controller settings can have a big impact on energy usage. Even a slight change may dramatically improve energy efficiency and yield immediate savings.

No endorsement of products or firms is intended, nor is criticism implied of those not mentioned.

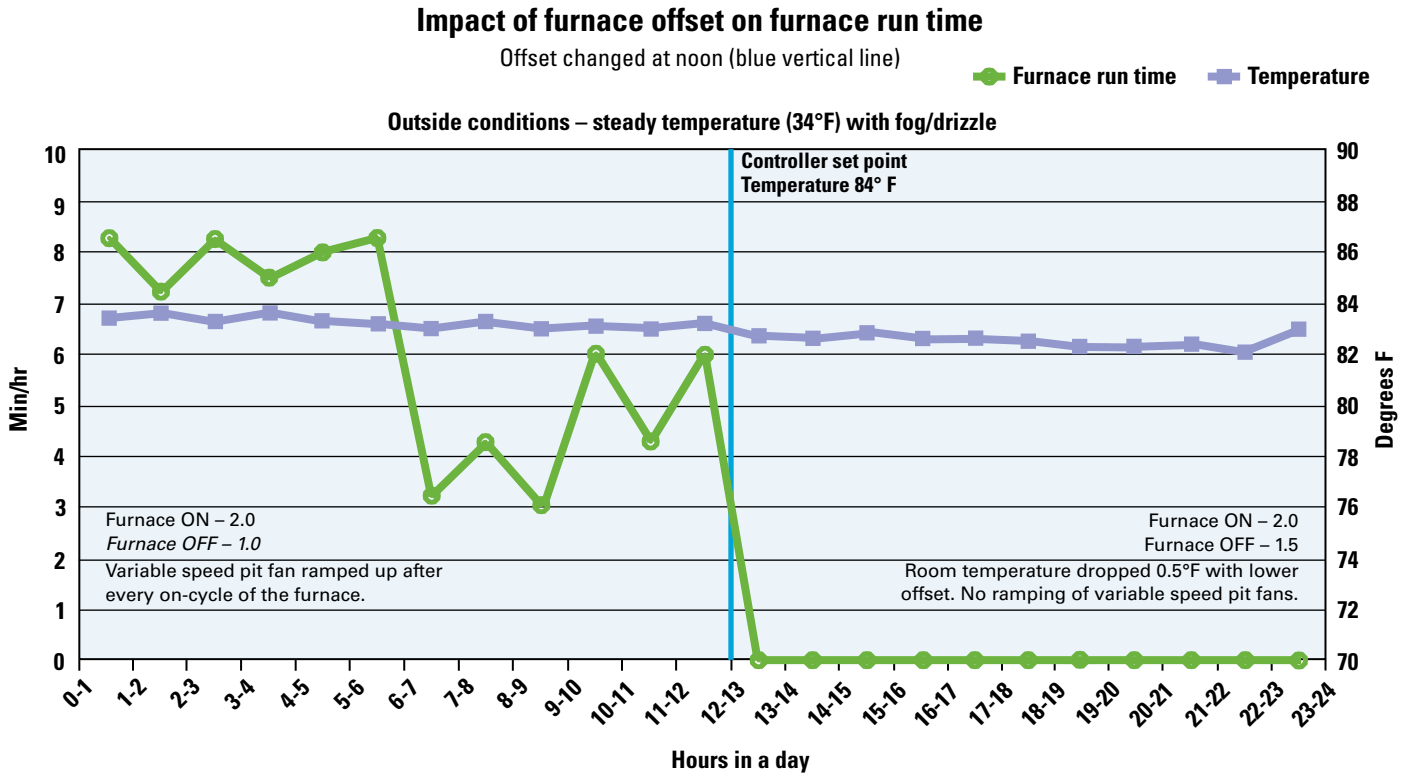

Figure 2. Impact of furnace offset on furnace run time. *Courtesy of Brumm Swine Consultancy.*

Prepared by Jay Harmon, professor, ag and biosystems engineering; Mike Brumm, professor emeritus in animal science at University of Nebraska-Lincoln and Brumm Swine Consultancy; and Dana Petersen, program coordinator, ISU Farm Energy Initiative; Iowa State University Extension and Outreach. Sponsored by the Iowa Energy Center.