
# Ventilation Management

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TAKE HOME MESSAGES:

1. Look at the pigs and note their behavior. Ask yourself: What is their lying pattern? Are they avoiding certain locations in the pen? Are they evenly distributed between lying, drinking/feeding, and moving around?
2. Note the outdoor temperature and set point, then look the controller and note the stage, and what equipment is being called for and/or speeds, openings, etc. Ask yourself: Does this match with what the equipment is doing in the barn?
3. Routinely inspect equipment for anything abnormal. Make sure all equipment operates (turns on and off), operates the way it is supposed to, and is well-maintained.

## Background

The goal of ventilation systems is to exchange the air inside the barn that contains dust, noxious gases, airborne pathogens, heat, and moisture with fresh, outdoor air. Ventilation affects: air temperature, relative humidity, moisture condensation on surfaces, air temperature uniformity, airspeed across the pigs, odor and gas concentrations, airborne dust and pathogen levels, and combustion fumes from unvented heaters.

The basic ventilation process is:

1. Bring fresh air into the building through planned openings (ceiling inlets, curtains, etc.).

2. Thoroughly mix outside and inside air to pick up heat, moisture, and air contaminants, which lowers room air temperature, relative humidity, and contamination levels.

3. Exhaust warm, moist, contaminated air from the room.

Failure to provide any step of this process results in inadequate ventilation. During cold weather, the goal is to remove the extra moisture and noxious gases (CO, CO2, NH3) generated by the pigs, manure, and combustion from unvented heaters.During mild/hot weather, the goal is to remove heat generated by the pigs to minimize the increase in air temperature inside the barn (relative to outside) and provide elevated airspeed to increase heat removal from the pigs.The relationship between ventilation system components and how they affect the environment inside the room are depicted for cold (figure 1) and hot/mild (figure 2) weather.

## Definitions

**Airflow** [Cubic Feet per Minute (CFM)]. Describes how much or amount of air is being exchanged (ventilation rate). Exhaust fans will have a rated airflow for a given static pressure and ceiling inlets will have a rated airflow capacity.

**Static pressure** [inches of water column (in. wc)]. Amount of airflow resistance between inside and outside the barn. Measured with a manometer or transducer. Too high static pressure indicates a restriction in the path of air and can be identified by a door slamming. Too low static pressure across ceiling inlets results in cold air dropping directly below inlets.
**Airspeed (windspeed)** [Feet per Minute (FPM)]. Describes how fast the air is moving. Measured with an anemometer.

**Air exchange rate**: Can be assessed as Air Changes per Hour (ACH) or Seconds per Air Change (SAC). Describes the time it takes for the total volume of air in the room to be exchanged. Formula: ACH = 60 x total fan airflow [CFM] at a static pressure divided by room volume [ft3]. SAC [s] = room volume [ft3] divided by (total fan airflow [CFM] at a static pressure divided by 60)

**Heat (power)** [British Thermal Unit per hour (BTU/h)]. Describes the amount of heat provided by supplemental heaters.

**Air quality concentrations** [Parts per Million (PPM)]. Describes the level of pollutants or contaminates in clean air that can affect the health and productivity of pigs. Measured with handheld meters or sensors.

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## Equipment

**Exhaust fan(s)**: Exchange air (provides ventilation rate) and can be mounted on the wall or as a pit fan. Each fan or fan groups turn on in stages to provide the desired increase in ventilation as the room temperature increases and turn off as room temperature decreases. Fans can be variable speed or on/off.

**Ceiling inlets:** Distribute fresh air in cold to mild weather. At minimum ventilation the goal is to achieve a 600 fpm airspeed at the inlet opening, and 800 fpm at the inlet opening for subsequent stages.

**Sidewall curtain:** Opens/closes to allow outside air into the room for ventilation. In naturally ventilated barns, they are fully opened to allow wind to pass through the barn in mild/hot weather and operated intermittently in cold weather.

**Controller:** Controls all equipment (fans, curtains, actuators), reads sensors (temperature), and contains control logic to operate all equipment according to user settings.

**Soffit:** Unrestricted intake for air to enter the attic. This allows air to freely pass to the ceiling inlets. Soffits should be cleaned and open. During winter, soffits on the north side of the building can be closed to prevent snow and wind effects.

**Actuator:** Opens and closes the ceiling inlets and curtains.

## Assesement and Troubleshooting

- Temperature. Determine: outside temperature, set point temperature on the controller, and average room temperature.
    - » Cold weather: If outside air temperature is less than set point temperature, room temperature should be within about 2°F of set point temperature (most often slightly below set point). If room temperature more than 2°F below set point temperature, consider decreasing heater offset, ensure the temperature sensors are located in an area reflective of the conditions, seal uncontrolled infiltration sources, reduce minimum ventilation rate.
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    - » Hot/mild weather: If outside air temperature is greater than set point temperature, room temperature should be within 5°F of set point temperature (often warmer than outside). If room temperature is greater than 5°F warmer than outside temperature, increase stage ventilation rate, make sure fans are clean (clean shutters) and fully functional (tight belts, aligned pulleys), and there is no restrictions for air coming into the barn.
- Cold drafts. Adjust ceiling inlet openings to achieve at least 600 fpm at minimum ventilation and seal exterior infiltration sources. Fresh air not entering the room through planned openings (i.e., inlets) short-circuits creating drafts but also reduces the ability to achieve the desired airspeed at the inlet openings. This could also be caused by the second stage fan being too large.
- Gas/odor that is noxious and undesirable. Typically, improving air distribution/mixing or increasing the minimum ventilation can reduce gaseous concentrations. This may be caused by other factors.
- Excessive relative humidity. This can cause condensation on building surfaces (adjust room temperature, increase minimum ventilation, check ceiling insulation – loose fill may have shifted). If near air inlets (could be improper mixing of cold fresh air with room air, so check inlet insulation). If near exhaust fans (install covers around fan and seal fan perimeters).
- Does the speed of the minimum ventilation fan(s) or a second stage fan come on shortly after the heaters turn off? If yes, this wastes heating fuel and can be solved by increasing the heater offset temperature (or decreasing the heater on temperature).

## Observing the Pigs

Before walking in the barn and disturbing the pigs, look into the room. Ask yourself: Where is the dunging area? What is their behavior? What is their lying pattern?

Dunging area will indicate where the most undesirable area in the pen is. This can be created underneath inlets because the cold air is dropping and not mixing properly. If this occurs, often during colder weather, reduce infiltration and achieve 600 fpm at the inlet opening. If it is near the sidewalls, this could be caused by cold drafts due to leaks or some uninsulated walls/curtains.

Behavior, such as tail biting, lethargic pigs, anxious pigs, etc., may indicate a level of uncomfortableness with the environment. This may be caused by elevated levels of humidity and noxious gases. Consider increasing the minimum ventilation rate and/or improving the mixing of fresh air.

Lying pattern is an indicator of thermal comfort, that is, if the pigs and too warm, too cold, or just right and is illustrated in figure 3. Pigs will huddle and pile when too cold (about one and hlf pigs deep is considered a pile) and when pigs are too hot, they will spread out, lie on their sides, and play with drinkers, and wallow (dirty) to increase heat loss to keep cool.

## Use a Checklist

Before the transition into summer and into winter, there is a critical need to inspect the facility and ventilation system to prepare it for the upcoming weather change. Typically, around April, the Summer Checklist (https://store.extension.iastate.edu/Product/16839) is used to prepare for summer cooling and greater ventilation rates. Meanwhile, typically around October, the Winter Checklist (https://store.extension.iastate.edu/Product/16840) is used to prepare for winter heating and reduced ventilation rates.

Reviewed by: Benjamin Smith

Figure 1. During cold weather, the relationship between ventilation system components and how it affects the environment inside the barn.

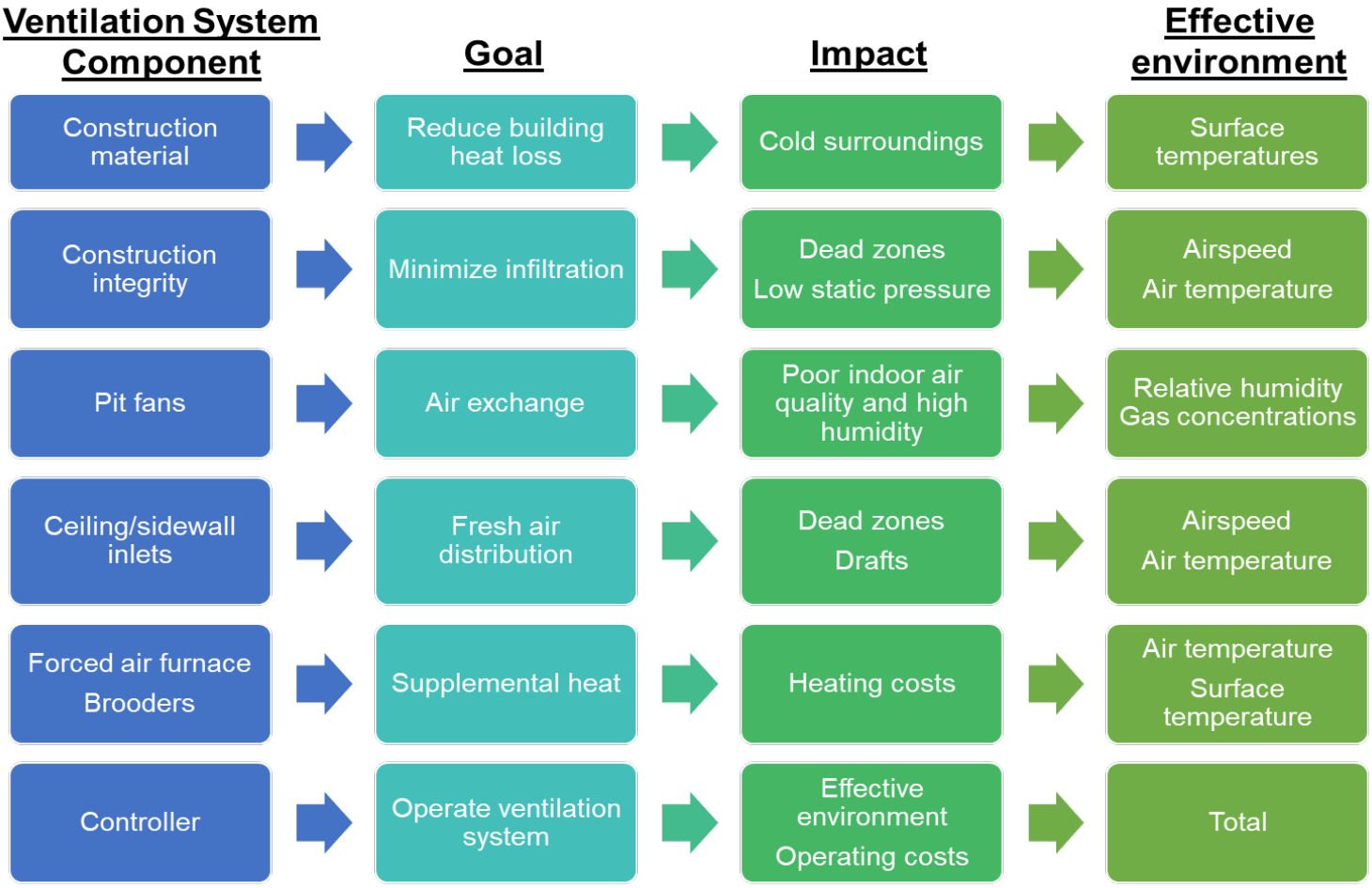


Figure 2. During hot/mild weather, the relationship between ventilation system components and how it affects the environment inside the barn.

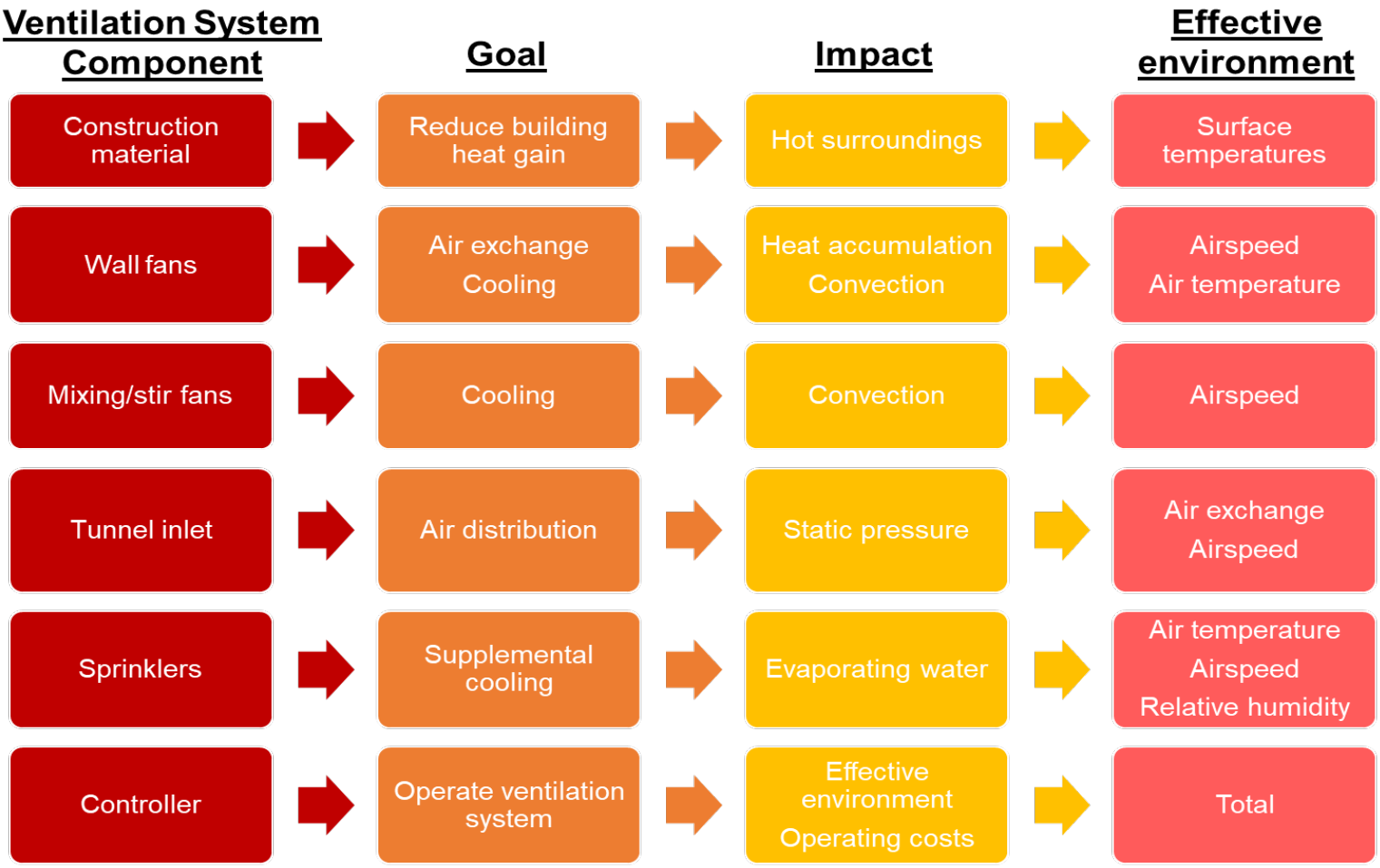
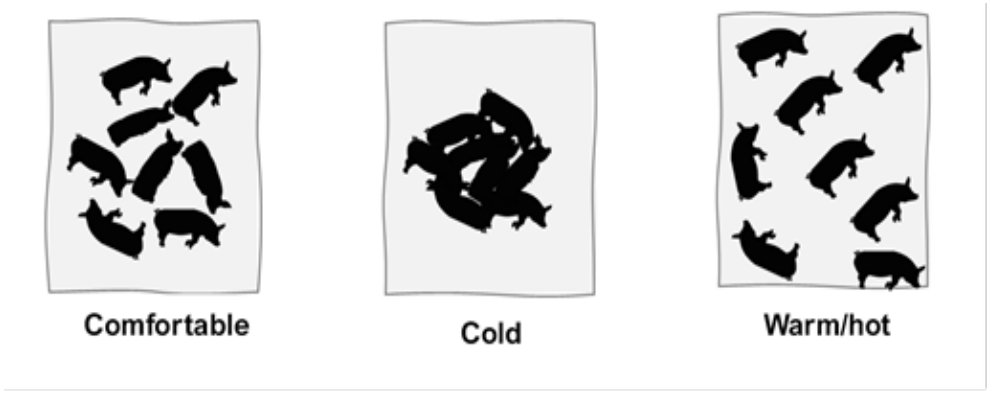



Figure 3. Lying patterns in response to environmental conditions.

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