Introduction
Ventilation has become increasingly complex in the past five to ten years. New and improved methods of ventilating the pigs environment are continually being introduced into the swine equipment market. The continuous changes in the methods and equipment are causing problems in the area of production and environmental management. Any given swine unit could have multiple types of control units, fans and inlets. Operation, management and maintenance of multiple types of equipment can be overwhelming to an operator, owner or production manager.

In the next section of lab exercises, the following ventilation concepts will be discussed:
The Lab exercise sheets are attached. The printed documents are intended to be used in the hands lab experiments.

• How to determine if the equipment is operating at full capacity.
  - Fans
  - Inlets
  - Evaporative Cooling
• Calculations associated with setting up a building to maintain proper minimum ventilation
• Choosing the correct equipment for proper ventilation
• Proper use of instruments to evaluate the pig’s environment properly.

Determining Ventilation Equipment Working Capacities

Fans
It is very important that you know the capacity of all the fans used to control the pigs environment. Fans are one of the most neglected pieces of equipment on the farm. Many employees pass by the fans everyday and never stop to evaluate their efficiency. Fan capacity outputs can be obtained from the manufacture or from independent lab data. An example of agricultural fan performances and efficiencies can be obtained from www.bess.uiuc.edu. Just remember, the results from the manufacture and independent labs resemble the performance of new fans. These results may be different from a ten year old fan in poor repair. In order to determine the efficiency of older existing fans, you must have the proper tools and formulas to calculate the fans efficiency or lack of. One of the first evaluations is a visual check of the fan. Ask the following questions: 1. Are the fan louvers hanging down when the fans is in full
operation, or are the louvers projecting straight out?  2. Is the fan belt flopping up and down?  3. Is the fan belt sunk down into the pulley or riding out to the pulley approximately 1/8 of an inch?  These observations will give the operator a quick daily fans performance evaluation. Once you have determined there is a problem, the following tools and calculations will be needed to further evaluate the performance of the fan. The tools need for the evaluation is simple, an anemometer and a photo-tach. These instruments are relatively inexpensive and can be obtained on line or from a local livestock equipment dealer.

Calculation: The first calculation involves determining the CFM’s of an existing fan. Review the example evaluation attached.

FIGURE FAN CFM’S

<table>
<thead>
<tr>
<th>Formula Square Feet of Fan</th>
<th>Formula Quantity of Air Produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>( A = \pi \text{Radius}^2 )</td>
<td>( Q = A \times V )</td>
</tr>
<tr>
<td>( A = 3.14 \times \text{Radius} )</td>
<td>( Q = \text{Fan Size} \sqrt{\text{ft}} \times \text{Velocity} )</td>
</tr>
<tr>
<td>( A = \frac{\text{sq}/\text{in}}{144} )</td>
<td>( Q = \text{Cubic ft/min} )</td>
</tr>
<tr>
<td>( A = \text{Square Feet of Fan Space} )</td>
<td>Fan Discharge</td>
</tr>
<tr>
<td>*144 Cubic Inches = 1 Square Foot</td>
<td>Example: Quantity of Air Produced by 48” Fan</td>
</tr>
</tbody>
</table>

Example: Quantity of Air Produced by 48” Fan

\[ Q = A \times V \]
\[ Q = 12.56 \text{ sq ft} / 1,850 \text{ ft min} \]
\[ Q = 23,236 \text{ Cubic ft/min} \]

Calculation: Determine the fan speed (RPM’s) of the fan. Do this by measuring the RPM’s of a new or reconditioned fan and then compare the RPM’s of older fans. This comparison will help you quickly determine if fans need new belts, louvers or guard repair. It is very easy to have a 20% reduction in fan efficiency when the fan belt is worn or the louver and fan blades are dusty. Note; be sure to buy a good photo-tach that will detect the movement of all types of blades.

Points to remember: 1. Most direct drive fan motors (blades attached to the motor) turn 1725 RPM’s. 2. Belt drive fans have a fan deduction drive. Example: A 3 inch pulley on the motor and a 10 inch pulley on the fan shaft. This combination of pulleys results in the fan blades turning 517 RPM’s instead of 1725. You must know the fan reduction before you can determine if the fan is operating a full capacity.
Example: Note; a 10 inch pulley on the fan shaft. Note; a 3 inch pulley on the motor. Math: 10 divided by 3 equals 3.33 to 1 ratio. Divide 1725 (motor speed) by 3. 33 equals 517 fan shaft RPM’s. See attached picture:

Inlets

Inlets and fans must be sized together in order to deliver the correct amount of air at the correct speed and static pressure. Many people take the following approach to inlet size, “That’s about the right amount of inlet space.” This approach is detrimental to pig health, especially during the winter months, correct inlet adjustment is essential to reduce drafts and save energy. The infrared picture below shows the inlet flow of air moving across the ceiling and warming up before falling on the pig. This inlet is sized properly with the fan output.

Calculation: The calculations below represent one method of calculating proper air flow through an inlet. The example below will walk you through proper building setup and maintaining static

**CALCULATING AIR INLET OPENING FOR PROPER STATIC PRESSURE**

In a negative static pressure ventilated building the air inlet slot must be adjusted according to the CFM of air exiting the exhaust fans. The ideal static pressure to provide proper air is dependent on the width of the building and the placement of inlets. The measurements can
be measured by either a photohelic or manometer. The following table is a guide of how far to open your air inlet baffles in order to achieve the proper static pressure.

<table>
<thead>
<tr>
<th>Static Pressure</th>
<th>Velocity thru Slot</th>
<th>Amount of Opening per 1000 CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>.02”</td>
<td>500 fpm</td>
<td>288 sq. in.</td>
</tr>
<tr>
<td>.03”</td>
<td>600 fpm</td>
<td>240 sq. in.</td>
</tr>
<tr>
<td>.04”</td>
<td>700 fpm</td>
<td>205 sq. in.</td>
</tr>
<tr>
<td>.05”</td>
<td>800 fpm</td>
<td>180 sq. in.</td>
</tr>
<tr>
<td>.06”</td>
<td>900 fpm</td>
<td>160 sq. in.</td>
</tr>
</tbody>
</table>

**Example:**

Nursery Pigs
The has 600 pigs based on .09 cfm/lb @ 50 each = 2700 cfm
2700 cfm ÷ 800 fpm = 3.375 sq. ft x 144 = 486 sq. in.
Assume: (4 – Baffles 4 ft long) = 192 lineal inches
486 sq. in. ÷ by 192 lineal inches = 2.53” openings

**Problem #1:**
Minimum Ventilation Requirement
720 head finisher 40’ x 160’
Place Pigs 50 lb
Exit pigs 240 lb
Static Pressure .05
Inlets – 10 – 4 sided ceiling diffusers inlets (Factory stats: 2000 cfm’s per diffuser.
48” fan minimum
36” fan stage 2
48” fan stage 3
48” fan stage 4

**Questions:**
1. What is the minimum ventilation requirement at pig placement (50 lb)?
   __________ CFM

2. If all ceiling diffusers are open, what percentage of capacity are the units at placement under minimum ventilation requirements? __________ %

3. What is the minimum ventilation requirement for the pigs at 240 lbs (No Death Loss)? ______________ CFM

4. What is the percentage of the capacity of the ceilings diffusers being used at 240 lbs?
   __________ %

5. With all the fans running at full capacity how many CFM’s of air will be moved through the house? ______________ CFM’s Total
6. How many minutes/seconds should the minimum fan (48”) run at placement?

___________min/sec

**Problem #2:**
Minimum curtain opening for 720 head finisher 40' x 160’
Curtain regulates static pressure
No ceiling diffusers
Fans on north wall
Adjustable curtain on south wall

**Questions:**
How much should the curtain be open at pig placement? (50 lb pig) _______________in.
Is it possible to maintain?
How far will the air travel across the ceiling before it drops on the pigs?

**Points to Remember:** In a mechanically ventilated building, the air flow must come into the building at a sufficient velocity so the cooler air current can cling to the ceiling and warm up before it falls on the pigs. A proper static must be maintained to meet minimum air flow requirements. If the inlet is sized correctly, the pigs will not feel a cold air draft. Inlets must be adjusted and maintained to deliver the proper air flow.

**EVAPORATIVE COOLING**
Evaporative cooling has the capacity to reduce the temperature of a barn by 15 degrees, if it is maintained properly. A neglected cool cell is very ineffective, as This infrared photograph depicts a poorly maintained cool cell pad. Most of the distribution holes are not working. Only one small area of water is flowing through the pad (Note: 71.6 degrees in the cool section compared to 82 degrees where no water is flowing.) Poor water distribution across the pad surface reduces the effectiveness of the pad. The following list of potential problem should be addressed on a regular basis to improve cooling efficiency.

**Potential Cooling Problems:**
1. Algae growth on the pad
2. Mineral deposits
3. Dirt accumulation on pad surface
4. Clogged discharged holes
5. Clogged filters

There are solutions to each of these problems. These problems have been discussed at previous Healthy Hog Seminars. Research the files for solutions

[http://mark.asi.ncsu.edu/HealthyHogs/default.htm](http://mark.asi.ncsu.edu/HealthyHogs/default.htm)
Calculation: Using a sensitive digital thermometer compare the difference between the outside and inside temperature. Determine the percentage difference in the two reading. This simple test will determine pad efficiency. Another important calculation is to determine the potential to cool the building by determining the difference between the dry bulb and wet bulb temperature using a psychrometer. If the air is dry the potential to cool is increased. As the difference between the wet bulb and dry bulb increase, the potential to cool is increased significantly. The chart below shows the cooling potential of a cool cell pad.

Effective Temperature with Pad Cooling (AeroTech Inc.)

<table>
<thead>
<tr>
<th>Pig Weight = 48 lbs. With Pad Evaporative Cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Setup For Proper Minimum Ventilation</td>
</tr>
<tr>
<td>Building setup is essential to maintain the proper ventilation for pigs a placement. Each group of pigs have their own ventilation requirements due to the size of the pigs, type of inlets, and the CFM’s of the minimum ventilation fans. Other unique building characteristic play an important role in maintaining proper minimum ventilation. These include the age of the building, curtain condition and overall equipment condition. Stress management is the key to efficient pig production. The building should be maintained in the best possible condition. A well maintained facility allows the management to properly setup the house for individual groups of pigs. The formulas below are a guide to proper minimum ventilation setup.</td>
</tr>
</tbody>
</table>
FORMULA FOR MINIMUM VENTILATION REQUIREMENTS ON WEANED PIGS TO MARKET PIGS

Formula: (#) of Pigs X lbs. each = _____ ÷ 100 = _____
X 9 = _____ TOTAL CFM’S

Formula: (#) of Pigs X lbs. each pig x CFM needed per lab body wt. (.06/.09) = TOTAL CFM REQUIRED

Timer Setting: (5 min. – 300 sec/10 min – 600 sec)

Total CFM Required ÷ CFM of Time Fan X Timer (sec) = Seconds Run Time

Example: 720 X 50 X .09 = 3240
3240 ÷ 10,000 x 300 = 97 sec or 1.61 min

CAUTION: As pigs grow their ventilation requirements change. The minimum ventilation should be refigured each week and changed to match their average weight. This will insure that each pig is properly ventilated where by allowing it to grow normally and have good health.

Choosing the Correct Equipment for Proper Ventilation

Fans are not created equal. The following lab exercise will help you determine which fan to purchase that will give you the most CFM’s for your dollar (CFM/Watt). Fan replacement should not be taken lightly in today’s economy. An efficient fan is worth the extra initial cost in long term electrical savings. Attached below is a worksheet and an example problem. Insert your figures and compare the cost of operation. Note; in the example problem, the better performing fan saved the owner $717 dollars in one year on energy cost.

Determine Which Fan to Purchase

Fan CFM’s Per Watt

Formula

Required Information:

Rate of Electricity ($ KWH) ____________ (Existing Power Rate)

CFM’s required in Building ____________ (Minimum or Total)
Average Hours per year of Operation _____________ (There are 8,760 hrs. in a year; Average Fan Operation 2,920 hrs.)

CFM per Watt of Fans __________ vs ___________ (Chose Two Fans From Bess Labs Fan Data or use existing fan information)

**Formula:**

\[
\text{Required CFM} \times (1000) \times (\text{Hrs. Year}) \over \text{CFM Watt} = \text{Annual Cost of Operation}
\]

**Example:** 1

\[
\left( \frac{1}{\text{CFM Watt}} \right) \times (1000) \times (\text{Hrs. Year}) = \$\]

\[
\left( \frac{\text{Hrs. Year}}{\text{CFM Watt}} \right) = \$
\]

**Example:** 2

\[
\left( \frac{1}{\text{CFM Watt}} \right) \times (1000) \times (\text{Hrs. Year}) = \$
\]

\[
\left( \frac{\text{Hrs. Year}}{\text{CFM Watt}} \right) = \$
\]

**Savings:** $ _________________ (per year)

**Determine Which Fan to Purchase**

Fan CFM’s Per Watt

**Required Information:**

- Rate of Electricity ($ KWH) .08 (Existing Power Rate)
- Total CFM’s required in Building 180,000 (Minimum or Total)
- Average Hours per year of Operation 2920 (There are 8,760 hrs. in a year; 1.3 of 8760 = 2920)
- CFM per Watt of Fans __22___ vs __16___
Formula: \[
\frac{\text{CFM}}{\text{(Elect. Rate) x (1000) x (Hrs. Year)}} = \text{Annual Cost of Operation CFM Watt}
\]

Example: 1
\[
\frac{180,000}{(0.08) x (1000) x (2920)} = \frac{2,628}{16} = 2,628
\]

Example: 2
\[
\frac{180,000}{(0.08) x (1000) x (2920)} = \frac{1,911}{22} = 1,911
\]

Savings: \[2,628 - 1,911 = 717\] (per year)

Proper Use of Tools and Instrument to Help Evaluate the Pigs Environment

This section of the lab will discuss the proper use of tools to evaluate the pigs environment. All of the information discussed earlier has very little benefit to the producer if the tools are not available to evaluate the situation. There are slight to extreme barn differences. Someone or a group of individuals need the tools and expertise to evaluate individual situations. Proper instrument utilization will be discussed in the lab setting. Listed below is a list of essential ventilation instruments.

1. Digital Thermometer Pen
2. Humidity Sensor Pen (High degree of accuracy)
3. Photo-tach
4. Digital temperature gun
5. Hand held photohelic
6. Anemometer (Air speed measuring device)

Take Home Message

1. Be prepared to evaluate all ventilation situations.
2. Do not guess at the proper ventilation settings
3. Know your equipment
4. Have the tools necessary to get the job done
5. Train employees on proper ventilation techniques