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Abstract
Accurate and concise heat loss analysis is available through a computer program to help producers. The economic benefit of insulating a new structure or increasing the insulation level of each of the building parts (ceiling, walls, windows, etc.) is calculated by the program. Ventilation is evaluated to assist the swine producer in understanding proper ventilation rates.; Swine Day, Manhattan, KS, November 11, 1982

Keywords
Swine day, 1982; Kansas Agricultural Experiment Station contribution; no. 82-614-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 422; Swine; Heat loss; Farrowing houses; Ventilation

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Computerized Heat Loss Evaluation of Farrowing Houses

H.C. George, C.K. Spillman, and R.H. Hines

Summary

Accurate and concise heat loss analysis is available through a computer program to help producers. The economic benefit of insulating a new structure or increasing the insulation level of each of the building parts (ceiling, walls, windows, etc.) is calculated by the program. Ventilation is evaluated to assist the swine producer in understanding proper ventilation rates.

Introduction

The declining energy supply and the generally increasing cost of energy have made it essential that producers emphasize the reduction of heat losses in livestock buildings.

Through computer analysis, insulation and ventilation levels are evaluated for farrowing houses.

Energy cost is most intensive in the farrowing to weaning portion of swine production. Kansas Extension publication MF-263 points out that utility costs make up 7 percent (%) of the variable cost in the farrowing operation or 5.6 percent (%) of the total cost of raising feeder pigs (up to 40#).

Procedures

Heat loss calculations tend to be very time consuming. However, through a set of questions and answers, building heat loss for farrowing houses may be evaluated using a computer to handle the calculations. All questions are written in terms producers can understand. The program requires little or no computer experience to operate.

A sample of the worksheet of questions asked by the computer and a sample printout of information follows.
WORKSHEET FOR FARROWING HOUSE HEAT LOSS *

OWNER
Name and address

BUILDING SIZE
______ ft 1. Building length
______ ft 2. Building width

______ 3. How many sow stalls will be in the building?

______ OF 4. What will be the thermostat setting for the furnace in the winter?

LOCATION
5. Which section of Kansas is the building located?
___ NW Kansas ___ EC Kansas
___ NC Kansas ___ SW Kansas
___ NE Kansas ___ SC Kansas
___ WC Kansas ___ SE Kansas
___ C Kansas

HEAT SOURCE
6. Which fuel are you using for heating?
___ Electricity
___ Natural Gas
___ Propane or butane
___ Fuel oil

7. What is the price of the fuel per unit?
$____.___ / unit (KWH, gal, 1000 cf)

DOORS
(ENTER the number of doors of each type which opens to the outside)
___ Solid Core wood 1 3/4 inch
___ + Wood Storm
___ + Metal Storm
___ Metal, urethane core 1 3/4 inch
___ Metal, polystyrene core 1 3/4 inch
___ Other <= specify Total R-Value

______ 8. Total number of doors

WINDOWS
(ENTER the number of each type of window to the outside)
___ Single glass
___ + storm
___ Twin glazed
___ Triple glazed
___ Other <= specify Total R-Value

______ 9. Total number of windows

______.ft 9a. Average window width?

______.ft 9b. Average window length?
WALL Mark (X) the material used or the thickness of insulation for each of the four walls. If there are walls of similar type, only complete one wall, but circle the names of the similar walls. Include the R-Value of materials used but not listed.

NOTE ==> Circle the wall(s) of the same type.

North, East, South, West,

Exterior Siding: (mark (X) one per wall)

____ ____. ____ ____. Wood, 8 inch beveled siding
____ ____. ____ ____. Wood, 8 inch drop siding
____ ____. ____ ____. Metal, farm building (unbacked)
____ ____. ____ ____. Metal, residential (hollow backed)
____ ____. ____ ____. Metal, residential (insulation backed)
____ ____. ____ ____. Other <= specify Total R-Value

Insulation (installed between siding and studs):

ENTER thickness (inches)

____ ____. ____ ____. Extruded Polystyrene
____ ____. ____ ____. Molded Polystyrene
____ ____. ____ ____. Fiber glass
____ ____. ____ ____. Exp. Polyurethane (aged), 1.5#/cu ft
____ ____. ____ ____. Other <= specify Total R-Value

Insulation (installed between the studs):

ENTER thickness (inches)

____ ____. ____ ____. Blanket or Batt
____ ____. ____ ____. Glass wool, mineral wool or fiber glass
____ ____. ____ ____. Loose fill
____ ____. ____ ____. Glass or Mineral wool
____ ____. ____ ____. Vermiculite
____ ____. ____ ____. Shavings or sawdust
____ ____. ____ ____. Milled paper or wood pulp
____ ____. ____ ____. Other <= specify Total R-Value

Interior Siding: (mark (X) one per wall)

____ ____. ____ ____. Plaster or Gypsum board
____ ____. ____ ____. Plywood, 3/8 inch
____ ____. ____ ____. 1/2 inch
____ ____. ____ ____. Fiber board sheathing, 25/32 inch
____ ____. ____ ____. Particle board, med. density
____ ____. ____ ____. Metal, farm building (unbacked)
____ ____. ____ ____. Other <= specify Total R-Value

Wall Size

____ ____. ____ ____. (ft) Length of the wall
____ ____. ____ ____. (ft) Height of the wall
______ ft 10. What is the average height of the foundation above soil level?

FOUNDATIONS: (mark ( X ) one)
   ____ Concrete, inches thick ____
   ____________________________________________
      Concrete blocks
   ____ Sand and Gravel 8 inch
   ____  12 inch
   ____ Lightweight 8 inch
   ____  12 inch
   ____ + Vermiculite in cores 8 inch
   ____ + Vermiculite in cores 12 inch

Exterior foundation insulation:
ENTER thickness (inches)
   ___ Extruded Polystyrene
   ___ Molded (bead board) Polystyrene
   ___ Glass fiber
   ___ Other <= specify Total R-Value

Y or N 11. Is the exterior foundation insulation covered with a protective material?

Y or N 12. Is the foundation below soil level insulated?

CEILING: (mark ( X ) one)
   ____ Plaster or Gypsum board
   ____ Plywood, 3/8 inch
   ____  1/2 inch
   ____ Fiber board sheathing 25/32 inch
   ____ Particle board, med. density
   ____ Metal, farm building (unbacked)
   ___ Other <= specify Total R-Value

Ceiling Insulation:
ENTER thickness (inches)
   Blanket or Batt
      ___ Glass wool, mineral wool or fiber glass
   Loose fill
      ___ Glass or Mineral wool
      ___ Vermiculite
      ___ Shavings or sawdust
      ___ Milled paper or wood pulp
      ___ Other <= specify Total R-Value
SAMPLE OUTPUT

Farrowing house  "1 inch insulation in walls & ceiling"

MONTHLY AVERAGE VALUES

<table>
<thead>
<tr>
<th>Month</th>
<th>Temp deg F</th>
<th>Bldg Loss Btu/HR</th>
<th>Supp Heat Btu/HR</th>
<th>Ventilation CFM</th>
<th>Ventilation CFM/sow</th>
<th>Cost $/Mo.</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>27</td>
<td>62052.21</td>
<td>64943.10</td>
<td>435.00</td>
<td>15.00</td>
<td>$ 267.70</td>
</tr>
<tr>
<td>February</td>
<td>33</td>
<td>53500.38</td>
<td>53594.83</td>
<td>435.00</td>
<td>15.00</td>
<td>$ 199.55</td>
</tr>
<tr>
<td>March</td>
<td>41</td>
<td>42759.25</td>
<td>39341.38</td>
<td>435.00</td>
<td>15.00</td>
<td>$ 162.17</td>
</tr>
<tr>
<td>April</td>
<td>54</td>
<td>25039.81</td>
<td>17787.05</td>
<td>820.96</td>
<td>28.31</td>
<td>$ 70.96</td>
</tr>
<tr>
<td>May</td>
<td>63</td>
<td>13140.31</td>
<td>6766.43</td>
<td>2465.23</td>
<td>85.01</td>
<td>$ 27.90</td>
</tr>
<tr>
<td>June</td>
<td>75</td>
<td>4355.27</td>
<td>296.12</td>
<td>4019.94</td>
<td>138.62</td>
<td>$ 1.18</td>
</tr>
<tr>
<td>July</td>
<td>80</td>
<td>1618.79</td>
<td>0.00</td>
<td>5044.24</td>
<td>173.94</td>
<td>$ 0.00</td>
</tr>
<tr>
<td>August</td>
<td>78</td>
<td>2605.77</td>
<td>0.00</td>
<td>4576.02</td>
<td>157.79</td>
<td>$ 0.00</td>
</tr>
<tr>
<td>September</td>
<td>68</td>
<td>9123.55</td>
<td>3873.38</td>
<td>3162.59</td>
<td>109.05</td>
<td>$ 15.45</td>
</tr>
<tr>
<td>October</td>
<td>57</td>
<td>20934.93</td>
<td>14680.95</td>
<td>1757.35</td>
<td>60.60</td>
<td>$ 60.52</td>
</tr>
<tr>
<td>November</td>
<td>41</td>
<td>42348.75</td>
<td>38796.67</td>
<td>435.00</td>
<td>15.00</td>
<td>$ 154.77</td>
</tr>
<tr>
<td>December</td>
<td>31</td>
<td>55621.22</td>
<td>56409.19</td>
<td>435.00</td>
<td>15.00</td>
<td>$ 232.53</td>
</tr>
</tbody>
</table>

Projected total fuel cost = $ 1192.72

TEMPERATURE & VENTILATION GUIDE

<table>
<thead>
<tr>
<th>Temp (deg F)</th>
<th>Supp Heat Btu/HR</th>
<th>Ventilation CFM</th>
<th>Ventilation CFM/sow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>113332.15</td>
<td>435.00</td>
<td>15.00</td>
</tr>
<tr>
<td>5</td>
<td>104253.53</td>
<td>435.00</td>
<td>15.00</td>
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<td>10</td>
<td>95174.91</td>
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<td>15.00</td>
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<tr>
<td>15</td>
<td>86096.29</td>
<td>435.00</td>
<td>15.00</td>
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<tr>
<td>20</td>
<td>77017.66</td>
<td>435.00</td>
<td>15.00</td>
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<td>25</td>
<td>67939.05</td>
<td>435.00</td>
<td>15.00</td>
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<td>435.00</td>
<td>15.00</td>
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<tr>
<td>35</td>
<td>49781.80</td>
<td>435.00</td>
<td>15.00</td>
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<tr>
<td>40</td>
<td>40703.18</td>
<td>435.00</td>
<td>15.00</td>
</tr>
<tr>
<td>45</td>
<td>31624.55</td>
<td>435.00</td>
<td>15.00</td>
</tr>
<tr>
<td>50</td>
<td>22545.94</td>
<td>435.00</td>
<td>15.00</td>
</tr>
<tr>
<td>55</td>
<td>13467.31</td>
<td>435.00</td>
<td>15.00</td>
</tr>
<tr>
<td>60</td>
<td>4388.69</td>
<td>435.00</td>
<td>15.00</td>
</tr>
<tr>
<td>65</td>
<td>0.00</td>
<td>1086.38</td>
<td>37.46</td>
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<tr>
<td>70</td>
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<tr>
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<td>0.00</td>
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<tr>
<td>100</td>
<td>0.00</td>
<td>5800.00</td>
<td>200.00</td>
</tr>
</tbody>
</table>
This 90 X 30 farrowing house with 29 sows has an average January heat loss of 62052.2 Btu/hr at the desired temperature of 72.0 degrees (F).

The heat loss from each building component is:

- doors = 53.6 Btu/hr/F or 3.9% of total
- windows = 0.0 Btu/hr/F or 0.0% of total
- walls = 414.7 Btu/hr/F or 30.3% of total
- ceiling = 555.6 Btu/hr/F or 40.6% of total
- foundations = 149.3 Btu/hr/F or 10.9% of total
- perimeters = 195.1 Btu/hr/F or 14.3% of total

TOTAL = 1368.3 Btu/hr/F

Ventilation = 447.4 Btu/hr/F

TOTAL Heat loss = 1815.7 Btu/hr/F

Ventilation = 24.6% of the total heat loss.

Located in NC Kansas, this building would have a heating cost of $1192.72/year, using a fuel price of $3.50 for Natural Gas per 1000 cubic ft.

If all areas were insulated at the recommended rate of:

<table>
<thead>
<tr>
<th>Component</th>
<th>R-Value</th>
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</thead>
<tbody>
<tr>
<td>doors</td>
<td>2.6</td>
</tr>
<tr>
<td>windows</td>
<td>0.0</td>
</tr>
<tr>
<td>walls</td>
<td>5.4</td>
</tr>
<tr>
<td>ceilings</td>
<td>4.9</td>
</tr>
<tr>
<td>foundations</td>
<td>1.5</td>
</tr>
<tr>
<td>perimeters</td>
<td>1.23</td>
</tr>
</tbody>
</table>

The new values would lead to a January heat loss of 16388.5 Btu/hr at the desired temperature.

<table>
<thead>
<tr>
<th>Component</th>
<th>Btu/hr/F</th>
<th>Bldg Loss</th>
<th>Saved</th>
<th>Saved</th>
<th>Annual Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>doors</td>
<td>23.33</td>
<td>6.5</td>
<td>30.3</td>
<td>5.66</td>
<td>$28.41</td>
</tr>
<tr>
<td>windows</td>
<td>0.00</td>
<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>walls</td>
<td>112.13</td>
<td>31.0</td>
<td>302.6</td>
<td>56.56</td>
<td>$282.95</td>
</tr>
<tr>
<td>ceiling</td>
<td>90.00</td>
<td>24.9</td>
<td>465.6</td>
<td>87.03</td>
<td>$432.89</td>
</tr>
<tr>
<td>foundations</td>
<td>27.81</td>
<td>7.7</td>
<td>121.5</td>
<td>22.72</td>
<td>$114.02</td>
</tr>
<tr>
<td>perimeter</td>
<td>108.11</td>
<td>29.9</td>
<td>87.0</td>
<td>16.27</td>
<td>$81.64</td>
</tr>
</tbody>
</table>

TOTAL = 361.38 Btu/hr/F

Ventilation = 1006.9 Btu/hr/F

TOTAL Heat loss = 808.81 Btu/hr/F

Ventilation = 55.3% of the total heat loss.
Minimum ventilating fans often remove much more heat from livestock buildings than producers realize. For the building as initially designed, an increase in the minimum ventilation rate from 15 CFM to 20 CFM would increase the fuel cost for heating only by $27.88 during an average month of January.

When selecting equipment for this 90 ft x 30 ft farrowing house for 29 sows, to operate at 72 (F) in NC Kansas, consider equipment which will meet the following minimum requirements:

| Minimum ventilation fan       | 435 CFM | Continuous operation |
| Maximum ventilation fan       | 5365 CFM| Hot weather operation |
| Furnace output                | 131489 Btu/Hr | Set at 72 (F) |