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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?
 _____°F 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)

				<u>Blanket or Batt</u>
___.	___.	___.	___.	Glass wool, mineral wool or fiber glass
				<u>Loose fill</u>
___.	___.	___.	___.	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

Month	Temp deg F	Bldg Loss Btu/Hr	Supp Heat Btu/Hr	Ventilation CFM	CFM/sow	Cost \$/Mo.
January	27	62052.21	64943.10	435.00	15.00	\$ 267.70
February	33	53500.38	53594.83	435.00	15.00	\$ 199.55
March	41	42759.25	39341.38	435.00	15.00	\$ 162.17
April	54	25039.81	17787.05	820.96	28.31	\$ 70.96
May	63	13140.31	6768.43	2465.23	85.01	\$ 27.90
June	75	4355.27	296.12	4019.94	138.62	\$ 1.18
July	80	1618.79	0.00	5044.24	173.94	\$ 0.00
August	78	2605.77	0.00	4576.02	157.79	\$ 0.00
September	68	9123.55	3873.38	3162.59	109.05	\$ 15.45
October	57	20934.93	14680.95	1757.35	60.60	\$ 60.52
November	41	42348.75	38796.67	435.00	15.00	\$ 154.77
December	31	55621.22	56409.19	435.00	15.00	\$ 232.53

Projected total fuel cost = \$ 1192.72

TEMPERATURE & VENTILATION GUIDE

Temp	Supp Heat	CFM	CFM/sow
0	113332.15	435.00	15.00
5	104253.53	435.00	15.00
10	95174.91	435.00	15.00
15	86096.29	435.00	15.00
20	77017.66	435.00	15.00
25	67939.05	435.00	15.00
30	58860.42	435.00	15.00
35	49781.80	435.00	15.00
40	40703.18	435.00	15.00
45	31624.55	435.00	15.00
50	22545.94	435.00	15.00
55	13467.31	435.00	15.00
60	4388.69	435.00	15.00
65	0.00	1086.38	37.46
70	0.00	5800.00	200.00
75	0.00	5800.00	200.00
80	0.00	5800.00	200.00
85	0.00	5800.00	200.00
90	0.00	5800.00	200.00
95	0.00	5800.00	200.00
100	0.00	5800.00	200.00

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:

	current R-Value
6.0 R-value for all doors	2.6
3.0 R-value for all windows	0.0
20.0 R-value for all walls	5.4
30.0 R-value for all ceilings	4.9
8.0 R-value for all foundations	1.5
2.22 R-value for all perimeters	1.23

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

Modified heat loss values					Annual Savings
	Btu/Hr/F	% Bldg Loss	Btu/hr/F Saved	\$ Saved	
doors	= 23.33	6.5	30.3	5.66	\$ 28.41
windows	= 0.00	0.0	0.0	0.00	\$ 0.00
walls	= 112.13	31.0	302.6	56.56	\$ 282.95
ceiling	= 90.00	24.9	465.6	87.03	\$ 432.89
foundations	= 27.81	7.7	121.5	22.72	\$ 114.02
perimeter	= 108.11	29.9	87.0	16.27	\$ 81.64
TOTAL	= 361.38 Btu/Hr/F		1006.9	188.23	\$ 912.39
Ventilation	= 447.4 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)