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Computerized heat loss evaluation of farrowing houses (1982)

H C. George

C K. Spillman

Robert H. Hines

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?

_____^{o}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)

North	East	South	West	
____	____	____	____	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) Heigth 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	Ventilation 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

	Btu/Hr/F	% Bldg Loss	Btu/hr/F Saved	$ Saved	Annual Savings
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.

Minimun ventilating fans often remove much more heat from livestock buildings than producers realize. For the building as initally 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:

Minimun ventilation fan	==>	435 CFM	Continuious operation
Maximum ventilation fan	==>	5365 CFM	Hot weather operation
Furnace output	==>	131489 Btu/Hr	Set at 72 (F)