Insulation for Swine Housing
Michigan State University
Cooperative Extension Service

Authors:
Vernon M. Meyer, Iowa State University
Ralph W. Hansen, Colorado State University
Brian Holmes, University of Wisconsin
Douglas Overhults, University of Kentucky
Reviewers:
Keith Bjerke, Northwood, North Dakota
Ray Hunke, Oklahoma State University
Byron Leu, Iowa State University

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Concern for energy conservation is one good reason to consider high levels of insulation in swine buildings. Increasing insulation levels from poor to adequate will reduce fuel requirements in a farrowing and nursery building and may make supplemental heat unnecessary in some buildings. Insulated walls have less temperature difference between the inside wall surface and the inside air temperature (see Figure 1). This cuts radiant heat loss from the animals and makes them more comfortable. It also helps keep swine buildings dry by eliminating sweating or condensation on inside surfaces. The condensation has a high concentration of ammonia and other dissolved gases and is very corrosive. Proper insulation will therefore prolong building life. In an unheated building, insulation will conserve more of the heat produced by the animals so that ventilation works more effectively. Summer comfort will also be improved with insulation.

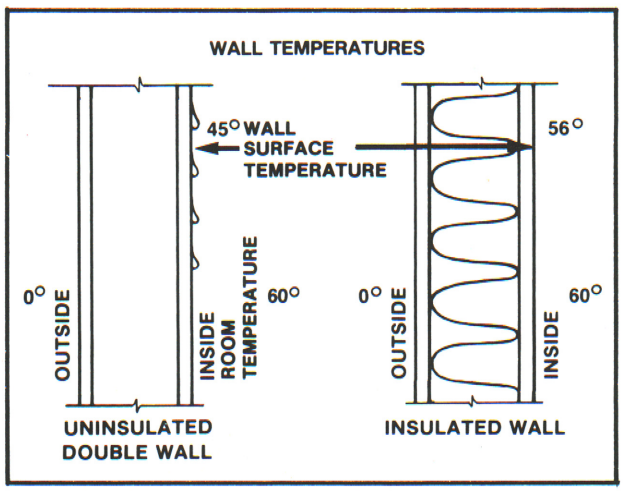

Figure 1. Insulation can make a difference in whether condensation occurs on inside wall surfaces. With air temperature at 60°F and a relative humidity of 75%, condensation starts when air is cooled to 53°F.

Insulation Materials

There are three commonly-used types of insulation available. They may be classified as follows:

Loose-fill: The loose-fill type insulation is most often used in ceilings. It is usually not recommended for walls because it may settle and leave a part of the upper wall without insulation. This problem can be avoided if the material is properly blown or packed into the wall. The loose-fill mineral fiber materials, such as fiberglass and rock wool, are fire-resistant. *Cellulose fiber materials, however, require fireproofing treatment.* Select cellulose insulation to meet specification ASTM C-739 of the American Society of Testing Materials or GSA HAI-515C of the General Services Administration.

Batts or blankets: This type of insulation is often used in the walls in stud-frame construction and also in ceilings or under the roof of a naturally ventilated building (see Figure 2). For most swine buildings, the batts and blankets are sized to fit between studs spaced 2 ft. on center. Mineral fiber is a common batting material, but cellulose fiber, correctly treated for fire resistance, can also be used.

Rigid insulation: This insulation material is available in board form of two general types. One is wood or cellulose

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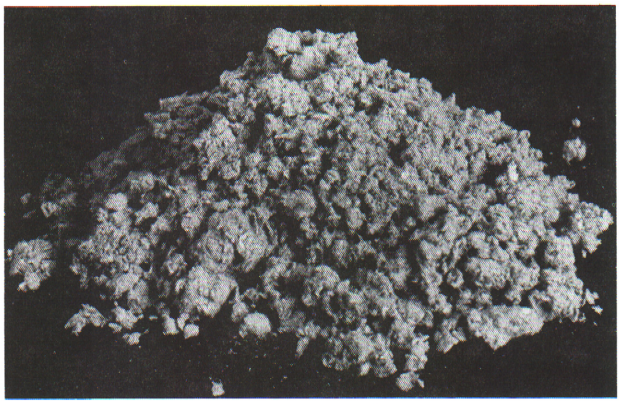
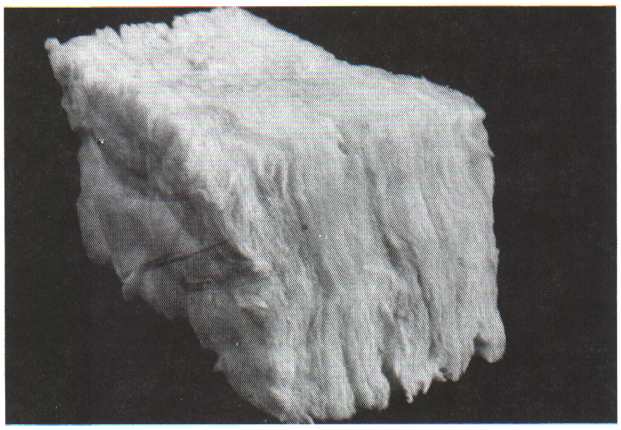
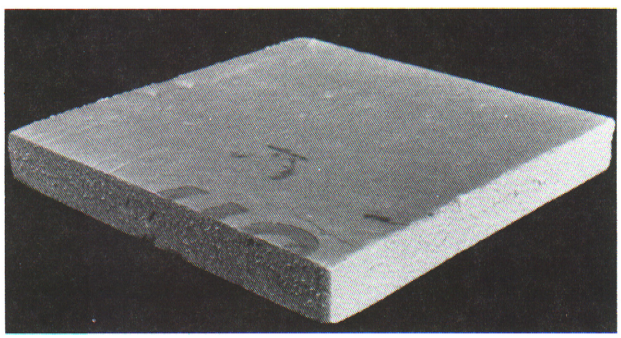


Loose-fill



Batts or Blankets



Rigid

fiberboard, and the other is foamed plastic insulation. The first type is used mostly for its structural strength as sheathing. Its insulation value contributes only a small part of the total insulation value required in a well-insulated building. The second type of rigid insulation, including polystyrene and polyurethane, has little structural strength. Rigid foam insulation must be covered on the interior surface with a fire resistant material. Check with your insurance company for its requirements before purchasing this insulation. Figure 3 is an example of rigid insulation used under a roof.

R-Value

Insulation is rated in R-values, which indicate the material's effectiveness to resist heat passage. The higher the R-value, the greater the insulation. To compare the insulating value of one material with another, divide the R-value of one into the other. For example, 1 in. of mineral fiber has an R-value of about 3.3. For sand and gravel concrete the R-value is 0.08/in. Dividing 3.3 by 0.08, determines that inch for inch, mineral fiber is more than 40 times as efficient an insulator as concrete. To compute the insulating or R-value for a typical building section, use Table 1. Figure 4 shows how to use Table 1 for determining the R-value of a wall section.

How Much Insulation?

Heated buildings (farrowing and nursery): In the northern part of the United States minimum R-value of 14 in the walls can be justified on the basis of fuel savings. When a 2 x 4 stud space is filled with insulation, an R-value close to 14 usually results. In the extreme northern United States, 2 x 6 stud walls with a resulting R-value of over 20 when the space is filled can be justified (see Table 2). Because of possible rodent damage and insulation deterioration, it may be advisable to install an R-value 25% higher than the minimum for your climate.

Better ceiling insulation is obtained when the ceiling joists are covered with insulation (see Figure 5). Otherwise, in very cold weather the ceiling joists with an insulation value of only R=5 (2x4) or R=7½ (2x6) can have lines of condensation on the ceiling under each joist. This protection usually requires 6 to 8 in. of loose fill to cover the top of the ceiling joist. Table 3 lists approximate equivalents of insulation for R-values of 6, 14, and 25.

Unheated buildings: Pig and worker comfort, as well as improved feed efficiency, encourage adequate insulation in the finishing, breeding, and gestation houses. Finishing pigs perform better at temperatures of 50°F and above in winter. Many finishing units use natural ventilation with adjustable inlets and outlets to control inside temperatures to this level. Using insulation levels presented in Table 2 will permit this temperature control when the barn is properly stocked.

The main purpose of the insulation of R-6 under the roof in cold buildings is to minimize condensation and dripping.

Vapor Barriers

Since the moisture content of the air in swine buildings is quite high, it is necessary to install a vapor barrier to keep the insulation dry. When wet, insulation of all types will have a significantly lower R-value.

Moisture in the form of water vapor can move through most building materials. In winter, the water vapor will move from the warm, moist inside to the dry, cold outside. As it moves outward, it is cooled until the vapor condenses in the insulation. This condensation not only reduces the insulation value but can cause structural damage to the wall. To prevent this problem, install the vapor barrier on the warm side of the insulation just under the inside lining material. The most common vapor barrier is 4- to 6-mil polyethylene film. It must be installed carefully to avoid punching holes or tears in the plastic. Even if a blanket insulation has a self-contained vapor barrier, it is advisable to install the separate plastic film since without it moisture can move through the wall at the joint between the insulation and the structural member.

Any opening like those that might exist in corners or around door frames are more critical with a positive pressure ventilation system. Moist air can be forced into wall cavities through any opening. This can result in wet spots in insulation, a lowered insulating value and a more rapid deterioration of the structure.

Table 1. Insulation values.
Most values are from the 1981 ASHRAE *Handbook of Fundamentals.* Values do not include air films unless noted otherwise. All values are approximate.

Item	R-value Per inch (approximate)	R-value For thickness listed
Batt and blanket insulation		
Glass or mineral wool, fiberglass	3.00-3.80*	
Fill-type insulation		
Cellulose	3.13-3.70	
Glass or mineral wool	2.50-3.00	
Vermiculite	2.20	
Shavings or sawdust	2.22	
Hay or straw, 20″		30+
Rigid insulation		
Expanded polystyrene		
Extruded, plain	5.00	
Molded beads, 1 lb./cu. ft.	5.00	
Molded beads, over 1 lb./cu. ft.	4.20	
Expanded rubber	4.55	
Expanded polyurethane, aged	6.25	
Glass fiber	4.00	
Wood or cane fiberboard	2.50	
Polyisocyanurate	7.04	
Foamed-in-place insulation		
Polyurethane	6.00	
Building materials		
Concrete, solid	0.08	
Concrete block, 3 hole, 8″		1.11
Lightweight aggregate, 8″		2.00
Lightweight, cores insulated		5.03
Brick, common	0.20	
Metal siding	0.00	
Hollow-backed		0.61
Insulated-backed, ⅜″		1.82
Softwoods, fir and pine	1.25	
Hardwoods, maple and oak	0.91	
Plywood, ⅜″	1.25	0.47
Plywood, ½″	1.25	0.62
Particleboard, medium density	1.06	
Hardboard, tempered, ¼″	1.00	0.25
Insulating sheathing, 25/32″		2.06
Gypsum or plasterboard, ½″		0.45
Wood siding, lapped ½″ x 8″		0.81
Asphalt shingles		0.44
Wood shingles		0.94
Windows (includes air films)		
Single glazed		0.91
with storm windows		2.00
Insulating glass, ¼″ air space		
Double pane		1.69
Triple pane		2.56
Doors (exterior, includes air films)		
Wood, solid core, 1¾″		3.03
Metal, urethane core, 1¾″		2.50
Metal, polystyrene core, 1¾″		2.13
Air space (¾″ to 4″)		0.90
Air films		
Inside surface		0.68
Outside surface		0.17
Floor perimeter (per ft. of exterior wall length)		
Concrete		1.23
Concrete, with 2″ x 24″ rigid insulation around perimeter		2.22

*The R-value of fiberglass varies with batt thickness and manufacturer; check the label.

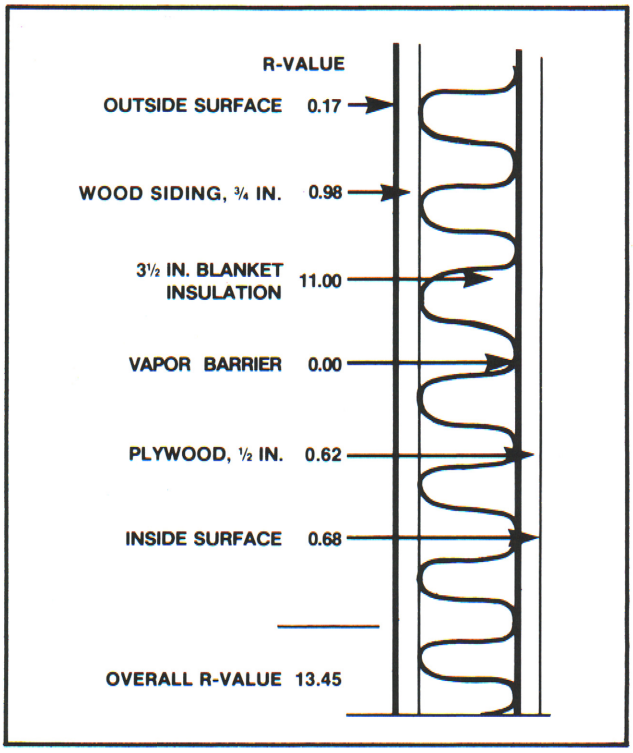
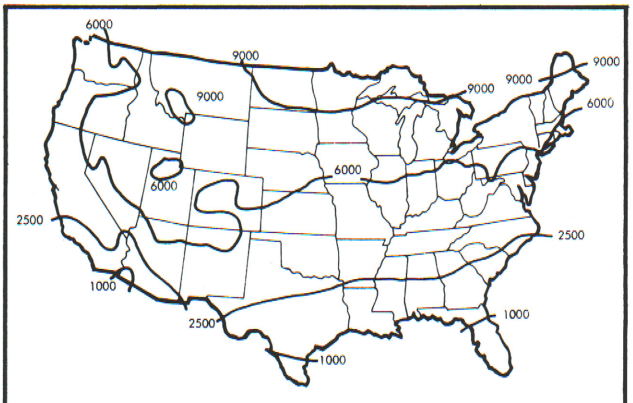


Figure 4. How to determine the R-value of a wall.



Winter degree days: These are estimates of winter season severity by comparing weather data with 65° F. The number of degree days for each day is calculated as the difference between 65° F and the day's average temperature. The number of degree days during the heating season is the total of the daily differences for the season.

Table 2. Minimum insulation levels for swine buildings. R-values are for building sections.

Winter degree days	Recommended minimum R-values: Cold building* Walls	Cold building* Roof	Modified environment Walls	Modified environment Roof	Supplementally heated Walls	Supplementally heated Ceiling
2,500 or less	—	6	6	14	14	22
2,501-6,000	—	6	6	14	14	25
6,001 or more	—	6	14	25	20	33

Note: Information from MWPS AED-13, *Insulation and Heat Loss.*

* Inside temperature no more than 5° higher than outside temperature in winter.

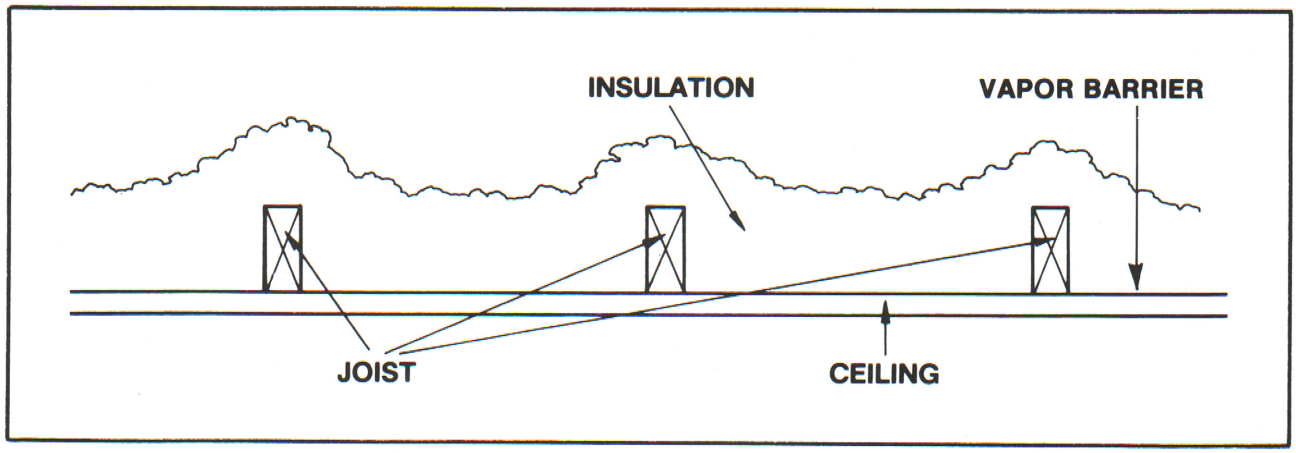


Figure 5. Cover ceiling joists in northern climates.

Table 3. Approximate equivalent insulation thicknesses.

Inches	Material
	Wall (R = 14)
3½	Fiberglass
3	Polystyrene, molded beads
2½	Expanded polystyrene
2	Expanded polyurethane, aged
2	Polyisocyanurate
	Ceiling (R = 25)
12	Vermiculite
9	Fiberglass
8	Cellulose fiber, fill-type
5	Expanded polystyrene
	Roof, ceiling, and walls (R = 6)
1½	Expanded polystyrene, extruded or plain
2	Fiberglass batt
1	Polyisocyanurate

Rodent Baiting: Because it is difficult to keep all rodents away from the building, a persistent and routine baiting program is recommended. The key to effective control using current rodent baits is providing ample bait and baiting locations so that all rodents have an opportunity to feed on the bait for several days. Therefore, proper placement of baits and the proper spacing of all baits is important for successful control. Baits must be located where rodents are living. For mice, place baits no farther than 10 ft. apart; placements for rats can be 25 to 50 ft. apart. Check all baits weekly and replenish baits as needed.

Perimeter Insulation

Many hog houses have cold floors, especially along the foundation, because of a lack of perimeter insulation. Cold floors can chill pigs and create health problems. Moisture can condense on the cold floor and cause dunging in the sleeping area, a wet floor, and chilled pigs.

You can insulate the perimeter in several ways. One is through placing insulation on the outside of the foundation (see Figure 6a). Depending upon the climate, provide 1 to 3 in. of polystyrene or equivalent and extend at least 16 to 24 in. below grade.

Protect the insulation by using a nonasbestos mineral board or by coating the insulation with a cement-fiberglass plaster. Seal the bottom with treated lumber, or add a concrete barrier to discourage rodents.

Another possibility is to extend the wall insulation down 2 ft. (see Figure 6b). Another method of providing perimeter insulation is to pour the foundation with insulation in the center (see Figure 6c). Place the rigid insulation in the center of the form, and fix it in place. Carefully pour concrete on both sides at about an equal rate. Since the insulation is less dense than concrete, it tends to float. Vibrating increases this tendency to float, so be careful to properly secure the insulation before pouring the concrete.

There are concrete form ties available that permit placing the insulation against one side of the form, pouring half the concrete, moving the forms out from the insulation, and pouring the other half of the wall on the other side of the insulation. Even though more time and labor are involved, the insulation is easier to hold in place with this method.

Precast concrete panels can be purchased with insulation installed within the core.

Windows and Doors

Windows and uninsulated doors have very low R-values (single-glazed windows, R = 0.80), permitting a large amount of heat loss. A glass window will lose 15 times more heat than a well-insulated wall section of the same area. An insulated wall is also less expensive to build than windows. Thus, windows are not recommended.

If the building does have windows, consider constructing insulated panels that can be installed in the window frame during the heating season and removed when heat is no longer needed. One or two windows may be kept uncovered to provide the operator a view to the outside, but the hogs don't need sunlight. The insulation value of windows can be improved by adding a sheet of clear plastic to the inside and outside of the window frame.

Doors should be insulated and weather-stripped to reduce heat loss. You can purchase manufactured insulated doors, or you can construct them using 2-in. framing lumber and plywood (see Figure 7).

Summary

Insulation of swine housing is a recommended practice. With the proper use of insulation materials, fuel requirements are lowered, air temperatures inside the housing remain more constant, and pig and human comfort within the facilities is improved.

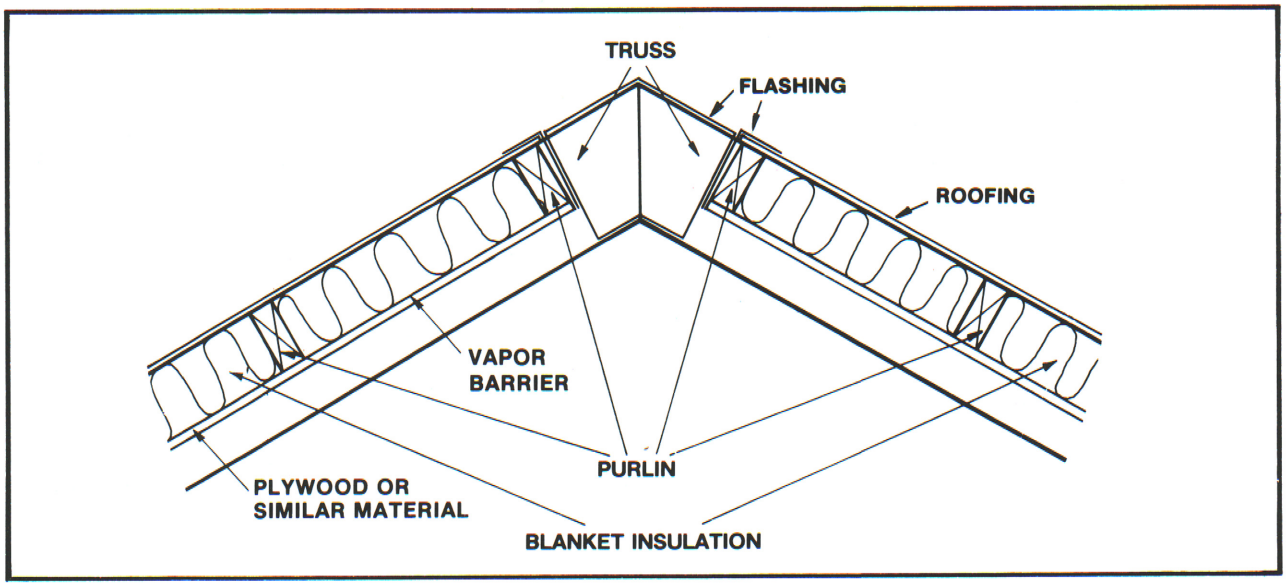


Figure 2. Blanket insulation in a roof.

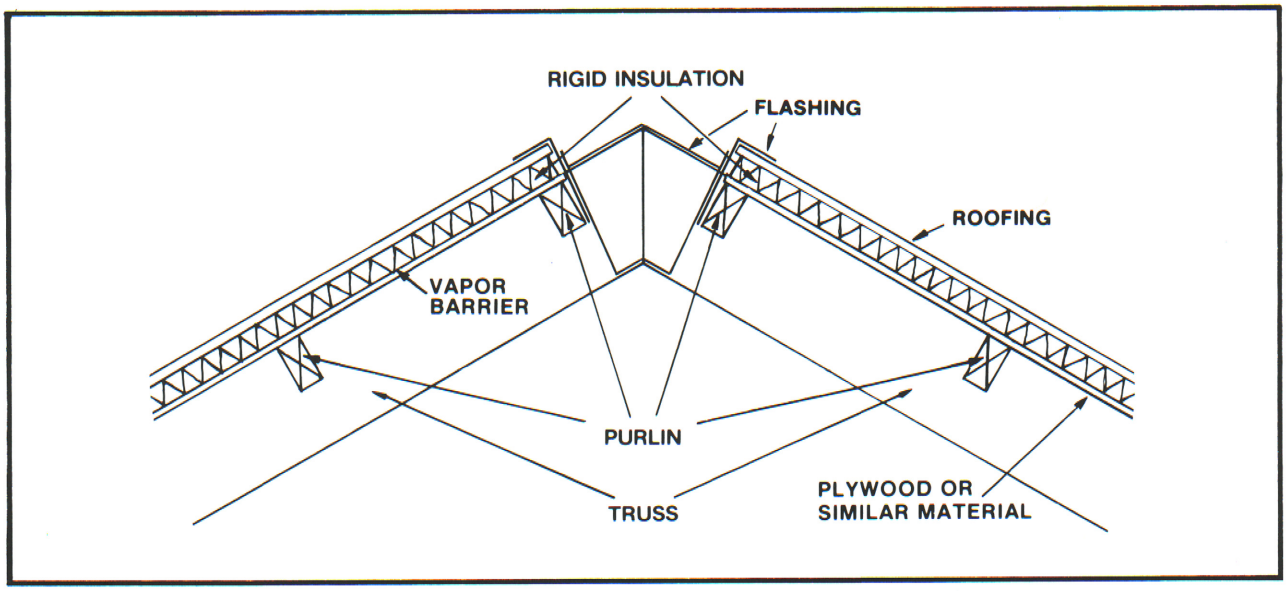


Figure 3. Rigid-type insulation in a roof.

An exhaust ventilation system has an advantage since it draws air in through any opening and results in fewer wall moisture problems. With either ventilation system the vapor barrier is important.

Protect from Rodents

Rats and mice can destroy insulation in a building in 3 to 5 years unless it is properly protected. Three steps involved in rodent control are (1) rodent proofing, (2) sanitation, and (3) rodent baiting. See PIH-107, *Controlling Rats and Mice in Swine Facilities.*

Rodent Proofing: By gnawing, rats can gain entry through any opening greater than ½ in. across. Mice can enter a building through any opening larger than ¼ in. across. To prevent rodent entry, seal all such holes with durable materials. Some recommended materials are: (1) concrete, (2) galvanized sheet metal 24 gauge or heavier, and (3) hardware cloth or wire mesh; use 24 gauge ¼ x ¼ in. to keep out mice and rats.

Close openings around augers, pipes, and wires where they enter the building. Use portland cement and fiberglass mortar or a metal collar.

Another common entry point is the unprotected end of corrugated or ribbed metal siding. If not blocked with metal or mortar, these openings provide access into wall spaces and the building interior. Rubber or vinyl weather stops do not stop gnawing mice. Install angle iron or heavy duty flashing to keep mice out.

Make sure doors fit tightly with no more than ¼ in. between the bottom of the door and the threshold. Install flashing or a metal channel on the lower edge of doors.

Sanitation: Clean up spilled feed around the building and eliminate places for the rodents to hide and live. Mowing grass or weeds and removing old woodpiles makes the environment less attractive to rodents and helps in their control. Also, a clean 3-foot weed free perimeter around structures will permit easy detection of rodent activity.

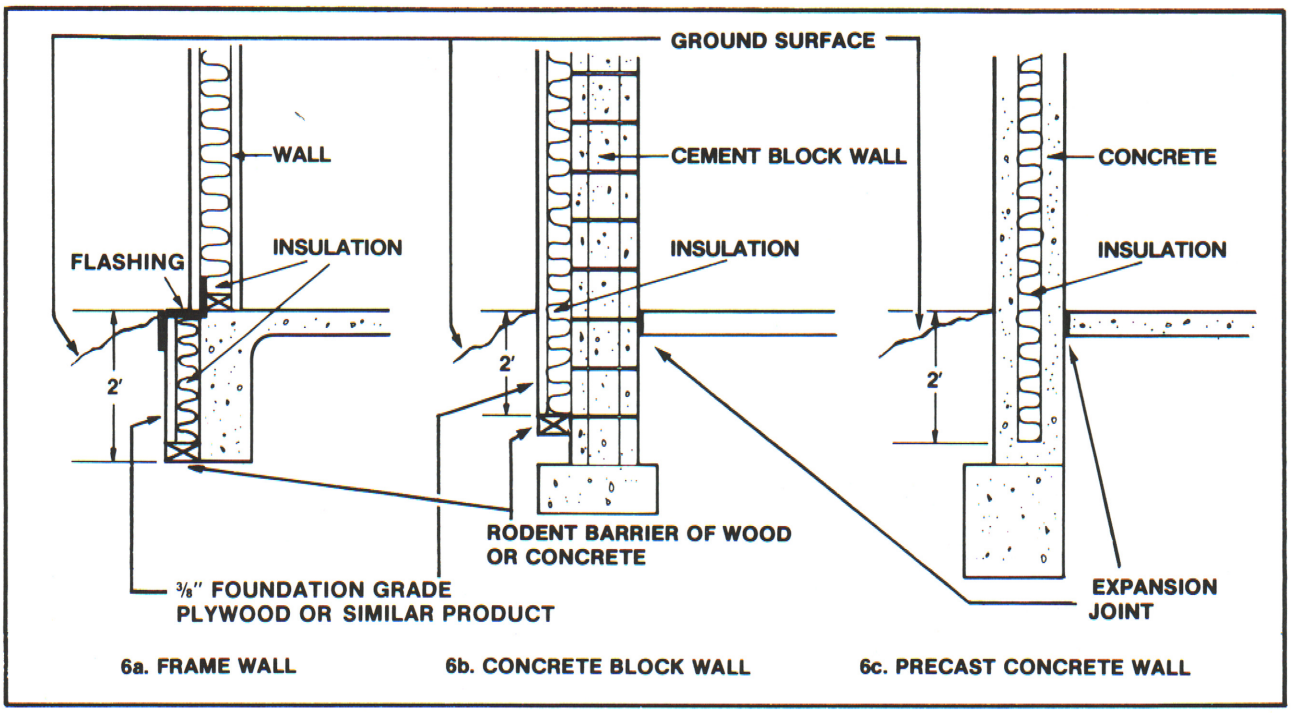


Figure 6. Insulation should be installed around foundations.

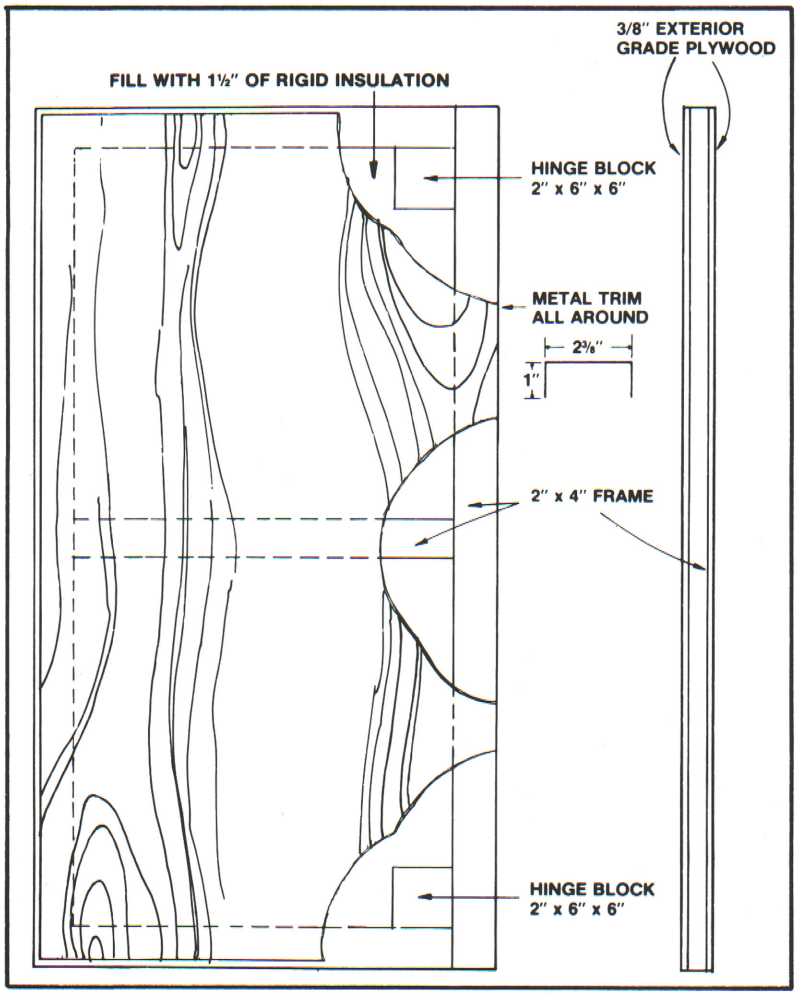


Figure 7. Insulated door construction.

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