KSU

Preheating Ventilating Air with Solar Energy

C. K. Spillman, F. V. Robbins, and B. A. Koch*

When animals are confined inside buildings, ventilating air is required to remove moisture and odors. Young animals require relatively warm temperatures and do not produce enough heat to offset that lost through walls and to warm ventilating air. Supplemental heat required by young animals does not need to be high quality, and heating the air a few degrees is adequate for much of the fall, winter, and spring. For example, assume that a 26-sow, farrowing house has a 500 cfm fan. Current recommendations are to run that size fan continuously during the winter. If the ventilating air is heated 30 degrees, it requires 16,000 Btu per hour or 1 gallon of LP gas every 4.3 hours.

The greatest demand for heat to increase ventilating air temperature is during cold winter months. That is when the sun's path is low so south sides of buildings receive much solor radiation. Collecting and using the energy is the objective of the system described here.

The system to collect and store solar energy is used to replace the south wall in new buildings, or it can be constructed alongside an existing south wall, as shown in figure 1. The block wall is solid concrete blocks 16 inches thick. Nominal block dimensions are 6 X 8 X 16 inches; each weighs about 50 pounds. A 1/4-inch gap left between blocks allows the air to pass and be heated by the blocks.

The south side of the blocks is painted with flat-black paint to absorb solar energy. Two layers of plastic reduce heat loss from the blocks but allow sunshine to pass through. They also form a channel the ventilating air flows through as it moves into the shelter. The air moves into the building following the path labeled 1, 2, 3, and 4 in figure 1.

A solar heating system 8 feet high and 50 feet long has been installed at the Kansas State University Swine Farm. That size is adequate for a 20- to 24-crate farrowing house. It has been operating since January 5, 1976. By May 1 it had added heat to the ventilating air equivalent to that obtained by burning 40 gallons of LP gas. Heat added during May and June replaced another 100 gallons. Current recommendations for air flow rate, about 1 cfm per square foot of collecting surface, increases temperature an average of about 25 degrees during cold months. Most of the heat is added during night hours when need is greatest.

Data in Figure 2 were collected from February 15 through February 24, 1976, when outside air temperature averaged about 10 degrees above normal for February and solar radiation received was typ-

*Farm structures research engineer, farm structures research assistant, Department of Agricultural Engineering, and swine research nutritionist, Department of Animal Science and Industry, respectively.

ical of that expected 50% of the time. Ventilating air flow rate was 1.1 cfm per square foot of collector and temperature of the air was increased an average of 30.2^{o}F. Less solar radiation is expected during some winter periods; air temperature would be increased less then.

The decision to build should be based on whether the system will pay or provide other benefits. Materials cost $1,400 for our system, so total cost would probably be less than $3,000 with labor. For buildings heated to 60^{o}F., we project a savings in LP gas of around 600 gallons a season so it would take several years to pay for the system with propane at 30 to 35 cents a gallon.

Buildings heated to higher temperatures have a longer heating season so more fuel would be saved; we estimate around 800 gallons per season for our unit. The cost of LP gas is expected to rise so the payout period could be shorter. However, a more important question is whether or not LP gas will be available for heating animal shelters, if it is in short supply. Should the supply situation continue to worsen, animal shelters will be competing for energy during periods of greatest demand; producers than might not be able to purchase their total needs. A solar unit would be more valuable then.

We think the wall would be screened from solar radiation during summer by a plastic sheet or tilt-up panels. We are working on methods of using cool night air to cool off the blocks so we can use them during the day to cool outside air.

Research is still being conducted on the system to determine optimum combinations of materials for covers, ventilation rates, and size of collectors. However, one planning the development of a farmstead or buildings now should locate them so south wall will have good exposure to the winter sun. Then units such as this can be added, if needed.

* Partial funding for this research is from the U.S.D.A. with funds provided by the Energy Research and Development Administration.

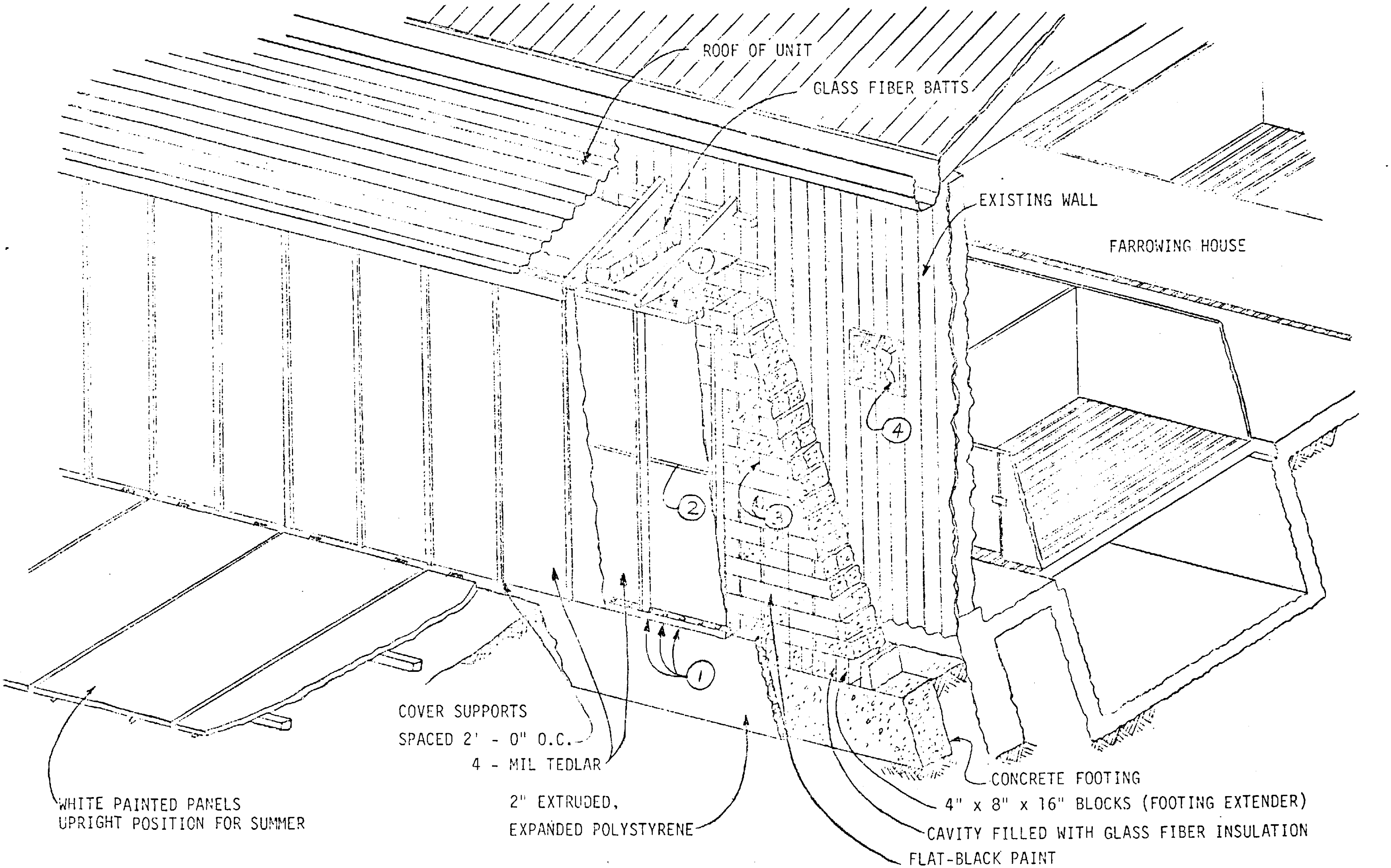

Figure 1. Construction details of the solar collector-storage unit. Ventilating air moving through the system enters at point 1, moves between the covers to point 2, then through the vertical gaps between blocks, point 3, and to the fan where it is moved into the environmental space. The wall is of 6- X 8- X 16-inch solid concerete blocks.

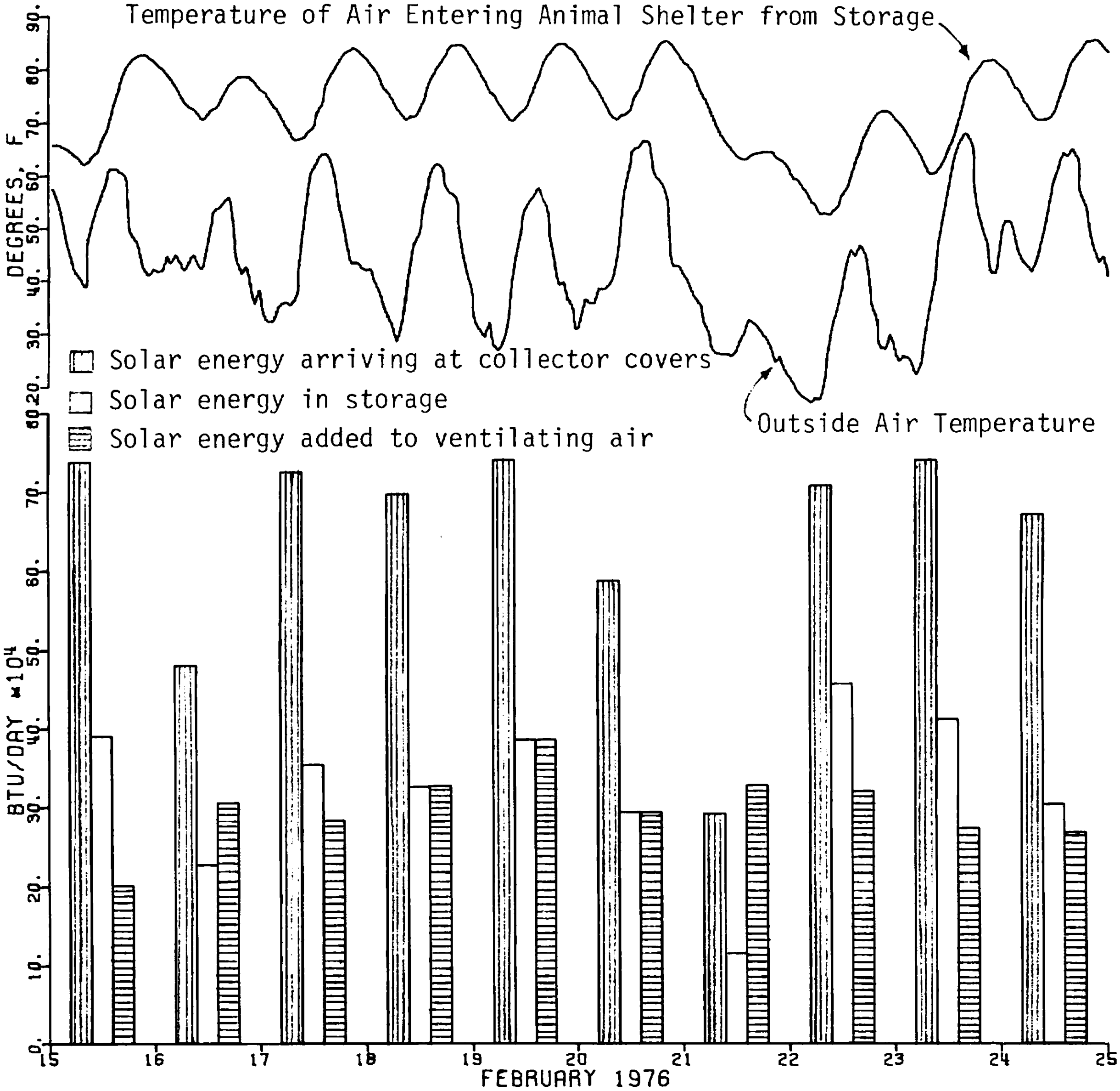

Figure 2. Temperature and energy data for February 15 through February 24 with air flow at 1.1 cfm per sq ft of collector. Collected solar energy is solar energy collected during the day less losses from storage during the 24 hour period and average 51% during this period.