UNIT III - BUILDING CONSTRUCTION

Lesson 9: Heating, Cooling, and Ventilation

Competency/Objective: Identify factors affecting the heating, cooling, and ventilation of agricultural structures.

Study Questions

1. Why insulate buildings?
2. What are the different types and methods of insulation?
3. Why is ventilation important?
4. What type of heating systems are available?
5. When is passive solar heating feasible?

References

1. *Agricultural Structures (Student Reference).* University of Missouri-Columbia: Instructional Materials Laboratory, 1999, Unit III.
2. Activity Sheet
   a) AS 9.1: Heating, Cooling, and Ventilation Needs

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TEACHING PROCEDURES

B. ***Review***

Lesson 8 discussed roofing materials and how they are used for agricultural structures. Lesson 9 introduces the basics of heating, cooling, and ventilation. While not all agricultural buildings will require elaborate insulation, heating, or ventilation, these factors are important to consider, because they may affect the design and construction of a structure.

C. ***Motivation***

Discuss how temperature and weather conditions affect agricultural structures and their uses. Topics for discussion include how heat or cold can affect the livestock being housed in a structure and the effect of freezing on plumbing.

D. ***Assignment***

E. ***Supervised Study***

F. ***Discussion***

1. Ask students why insulation is used in buildings. Discuss the purposes of insulation with students.

Why insulate buildings?

a) Insulation enhances a structure's ability to regulate temperature.
b) A particular insulation's ability to resist the transfer of heat is expressed mathematically as an R-value.

2. Have students list some types of insulation they have seen. Discuss the materials and the methods of insulation used. If possible, bring in some samples of insulating material and show them to the class.

What are the different types and methods of insulation?

a) Types of materials
    1) Natural/organic - generally cheaper but do not insulate as well
        (a) Cotton
        (b) Cellulose
        (c) Shredded Bark
        (d) Shavings
        (e) Sawdust
        (f) Straw
    2) Manufactured - higher R-value per inch of thickness
        (a) Fiberglass
        (b) Rockwool
        (c) Expanded mica
        (d) Fiber board
        (e) Cellular glass
        (f) Expanded polystyrene
        (g) Expanded polyurethane

(h) Urea formaldehyde
(i) Polyisocyanurate

b) Methods of insulation
1) Blanket
(a) Consists of wide rolls of material, often with foil covering on one or both sides and an insulating material like fiberglass in the middle
(b) Used for insulating metal buildings and covering large sections of walls
(c) Usually stapled to the inside walls of the structure on wide, flat surfaces
2) Batt
(a) Provided in rolls of material in precut sections, usually 8 feet in length and 16 inches wide with a thickness of 4 to 6 inches, although the exact size of this material varies with the intended application
(b) Fits between the studs in the walls or other framework in structures
(c) Fastened in place with staples
3) Rigid
(a) Available in the form of sheathing (usually 4′ × 8′) in varying thicknesses
(b) May be made of a number of materials but is most commonly Styrofoam
(c) Often covered with foil on one or both sides
(d) Usually nailed in place on the outside walls of a structure before siding is applied
4) Fill
(a) Comes in a loose form
(b) Generally made of fiberglass or expanded mica
(c) May be emptied from bags where needed or mechanically blown in place through a large hose that feeds the material to the desired place
(d) Sometimes mixed with chemicals to make it adhere to a horizontal or overhead surface and then blown into place

3. Discuss the importance of ventilation with the class.

Why is ventilation important?

a) Controls temperature
b) Controls inside moisture levels
c) Reduces the growth of microorganisms
d) Diminishes odor problems
e) Prevents the accumulation of dangerous gases

4. Ask student to list some types of heating systems they have seen. Discuss the types of systems commonly used in agricultural structures.

What types of heating systems are available?

a) Radiant
1) Heat passes through the air until it comes into contact with an object and passes on its energy as heat.
2) The system will not heat objects out of its path.
3) Gas or electricity may be used to power these systems.
b) Floor
1) The systems are usually designed to heat specific areas.
2) Hot water pipes or electric elements are buried just below the surface of the floor.
3) These systems may be powered by electricity, natural gas, or ground-source heat pumps.
c) Unit
1) These heaters are used to heat the air in a general area of a structure.

2) They often use fans to circulate the air after heating it.

3) Unit heaters may be powered by a variety of fuels, such as propane, natural gas, or electricity.

d) Boilers and furnaces

1) Boilers and furnaces are large commercial appliances utilizing a system of pipes, ducts, or vents to transfer heat to where it is needed.

(a) Boilers - hot water pumped to radiators

(b) Furnaces - heat air and blow it through ductwork to the rest of the building

2) They may be powered by fuels such as propane, natural gas, electricity, or wood.

5. Discuss when passive solar heating might be used. Have students complete AS 9.1.

When is passive solar heating feasible?

a) Passive solar heating is feasible if a building has a consistent solar exposure not obstructed by trees, other buildings, clouds, or other items that block the sun's rays.

b) Positioning a structure so that its south wall has windows and an unrestricted plane will allow solar energy to enter the structure naturally.

c) Covering the windows with an insulating material at sundown will help the structure to retain the heat.

d) Strategically placing large water containers or building with stone or masonry where they can be warmed by the sun allows them to act as storage units that collect and hold the sun's heat.

G. ***Other Activities***

If possible, have a local HVAC contractor speak to the class.

H. ***Conclusion***

Heating, cooling, and ventilation are important factors to consider when building an agricultural structure. Insulating structures creates a slower heat transfer rate. Many different materials and methods of insulation are used to insulate buildings. Adequate ventilation is often imperative for a structure to function safely. Structures may also need to be heated, and several different types of heating systems may be used. The sun can be a good supplemental heat source. A well-designed building may be able to use a passive solar heating system to provide all the heat necessary.

I. ***Answers to Activity Sheet***

J. ***Answers to Evaluation***

1. b
2. b
3. a
4. d
5. a

6. Answers may include any two of the following: controls temperature, controls moisture levels, reduces the growth of microorganisms, diminishes odor problems, and prevents the accumulation of dangerous gases.

7. Hot water pipes or electric elements are buried just below the surface of the floor.

8. If a building has a consistent solar exposure not obstructed by trees, other buildings, clouds, or other items that block the sun's rays.

9. Insulation enhances a structure's ability to regulate temperature.

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EVALUATION

Circle the letter that corresponds to the best answer.

1. R-value indicates:

   a. Residual heat.
   b. Heat-transfer rating.
   c. Thermal units.
   d. The amount of heat available.

2. _____ insulation comes in rolls of material in precut sections.

   a. Adhesive
   b. Batt
   c. Rigid
   d. Fill

3. Which type of insulation consists of wide rolls of material and is used for insulating metal buildings?

   a. Blanket
   b. Batt
   c. Adhesive
   d. Fill

4. Which of the following types of insulation is loose in form?

   a. Blanket
   b. Batt
   c. Rigid
   d. Fill

5. Which type of heating system will only heat objects in its path?

   a. Radiant
   b. Floor
   c. Unit
   d. Furnace

Complete the following short answer questions.

6. What are two reasons that ventilation is important?

   a.

   b.

7. What is a floor heating system?

8. When is passive solar heating feasible?

9. What is the purpose of insulation?

Lesson 9: Heating, Cooling, and Ventilation Name _

Heating, Cooling, and Ventilation Needs

Objective: Assess the heating, cooling, and ventilation needs for a farm building.

Select one of the following buildings: greenhouse, calving barn, broiler house, machinery shop, crop storage building, or any others suggested by your instructor. Prepare a short report on the heating, cooling, and ventilation needs for that building. Be sure to address the following questions.

1. What are the specific temperature requirements for this type of building?

2. Why and when will this building need to be ventilated?

3. What are the optimal temperatures for this building?

4. What are the various heating, cooling, and ventilation systems that could be used in this type of building?

5. Are there any types of heating, cooling, and ventilation systems that should not be used? Why not?