LEAFLET 96
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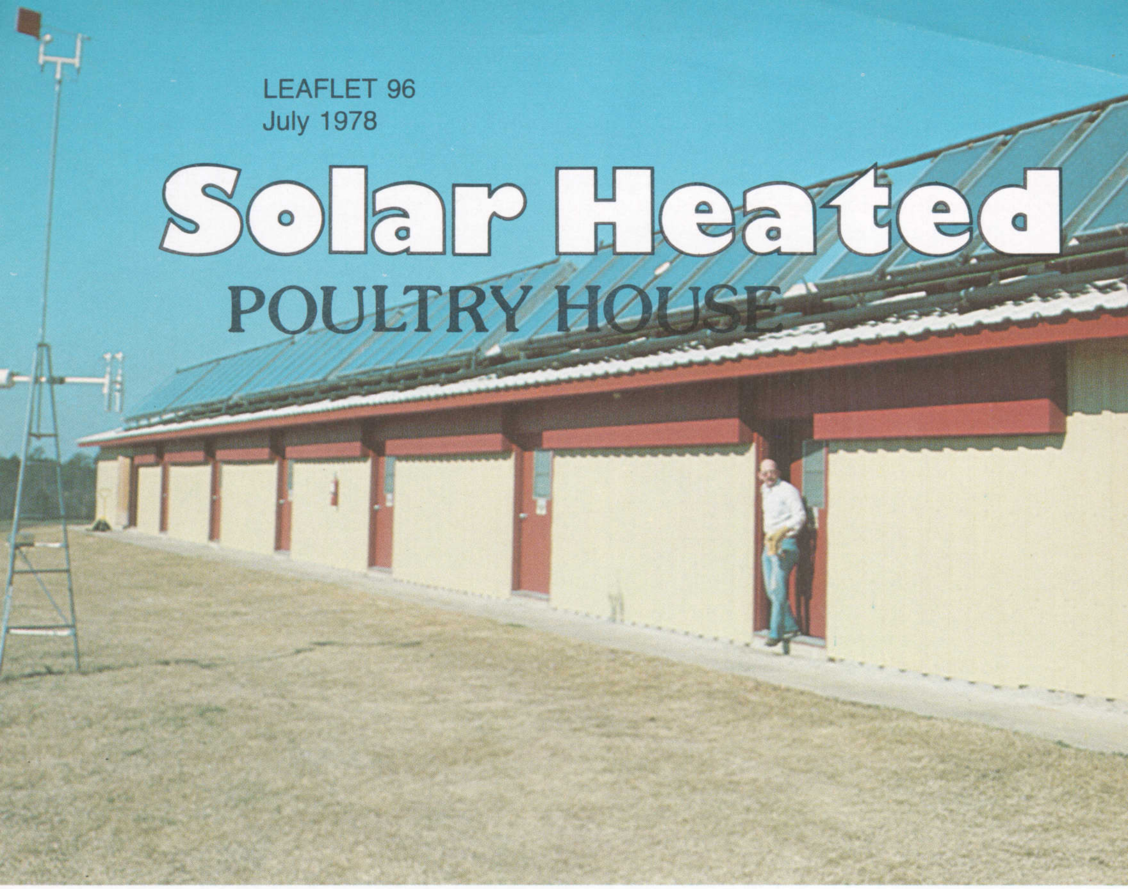
Solar Heated
POULTRY HOUSE



R. N. BREWER and C. A. FLOOD[1,2]

EFFICIENT PRODUCTION of poultry meat and eggs requires a cheap and plentiful source of heat for brooding and growing young poultry. At present, fossil fuels, especially LP gas, furnish most of this energy. Predicted short supplies and high prices of these products have pointed up the need for development of alternate energy sources.

The summary objective of the research being conducted at the solar facility of the Auburn University Agricultural Experiment Station is to adapt solar energy to poultry production programs, and to find ways to make it an acceptable form of heat energy. A multi-phase research program is being conducted to accomplish this objective. The primary title of the program is "Potential for Conversion and Utilization of Solar Energy in Poultry Production."

RESEARCH OBJECTIVES

Specific, long term objectives of the research project are:

1. To evaluate solar heated poultry brooding system design criteria devel-

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[1]Associate Professor, Department of Poultry Science, and Assistant Professor, Department of Agricultural Engineering.

[2]Other members of the solar research team are J. L. Koon, Department of Agricultural Engineering; Morris White, Department of Agricultural Economics and Rural Sociology; G. R. McDaniel, Department of Poultry Science; R. I. Vachon, Department of Mechanical Engineering; and S. E. Taylor and Roger Getz, Environmental Studies Service Center.

AGRICULTURAL EXPERIMENT STATION/AUBURN UNIVERSITY
R. DENNIS ROUSE, Director
AUBURN, ALABAMA

oped during preliminary phases of the research program.

2. To monitor local solar radiation and other meteorological parameters, evaluate climatological variability of these parameters, and integrate these findings into the solar system optimization.

3. To determine the economic gain or loss from growing poultry in facilities equipped with solar brooding units.

4. To develop a poultry production system encompassing the solar hot water brooding system determined most effective to date and to make use of innovative poultry brooding practices.

The determination of design criteria was based on tested and proven poultry rearing practices. The modern commercial poultry industry depends on brooding systems which deliver a uniform source of heat, particularly during the brooding period. Historically, space heating with LP gas brooders, hot water radiant heat, or forced air furnaces has satisfied these requirements. Preliminary research and modeling indicated that solar heated water would work well as a source of brooding heat when combined with an acceptable form of auxiliary heat.

The research facility described herein was designed with these factors in mind.

RESEARCH FACILITY DESIGN

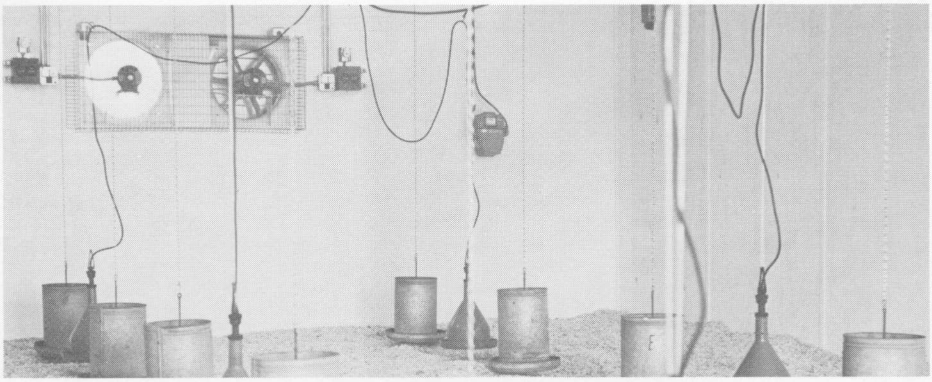
The solar research facility was designed to allow for practical and statistical comparison of various poultry brooding regimens. The solar collection, storage, and delivery system was designed to allow maximum latitude in the solar systems optimization studies. The data acquisition and storage systems were planned to allow for assimilation of needed evaluation data.

RESEARCH BUILDING

The 36- × 170-foot building consists of six 36- × 20-foot research pens, a 36 × 30 shop and storage area, and a 36- × 20-foot instrument laboratory and equipment room. Partitions between research pens are removable, which permits pen length to be varied from 20 to 120 feet in increments of 20 feet.

Construction is typical of that recommended in the Southeast for totally enclosed, environmentally controlled broiler housing. It is of pole and truss construction using rough cut 6- × 6-inch poles and steel trusses placed 10 feet on center. Roof and outer walls are painted sheet metal. Side and end walls contain 6-inch fiberglass batts. Inside walls are ½-inch plywood. Insulation at ceiling level is 2-inch polystyrene tongue and groove board. Pen partition walls are sandwich panels. Panel framing is of 2 × 4's, while the skin is ½-inch plywood. The panels are filled with 3½-inch fiberglass batt insulation. Access doors to

Sub-metering of circuits for fans, lighting, and outlets in each pen provides data on energy use in test pens.



Pen ventilation is provided by two fans mounted on the north wall, controlled by two-stage thermostat and percentage timer. An LP gas meter is located to the right of the fans.

each pen are located along the south sidewall.

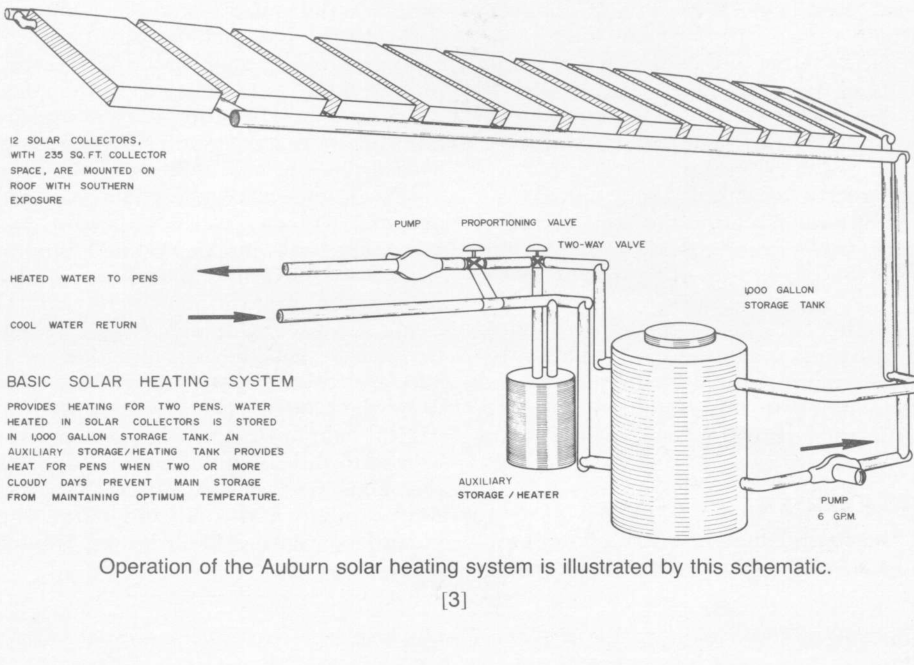
The 400-amp electrical service to the building is split into two 200-amp feeders, each serving one-half of the building. Individual distribution boxes serve each pen. A fan circuit, a lighting circuit, and an outlet circuit are sub-metered in each pen. Submetering in the equipment room is provided for each pump and each auxiliary heating unit.

Plumbing and meters for LP gas service are provided in each pen.

The ventilation system consists of two two-speed fans mounted on the north wall of each pen and a baffled-slot inlet on the south wall. Control of the fans is by two-stage thermostat and percentage timer. Elapsed time meters on each speed of each fan will permit determination of total volume of ventilation air. Light screens on both fan discharge and slot inlet will permit restricted light studies to be carried out.

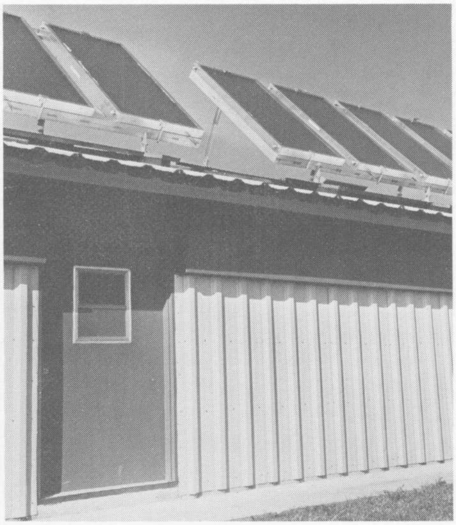
SOLAR SYSTEM

Details of the system are shown in the schematic. There are three identical sys-

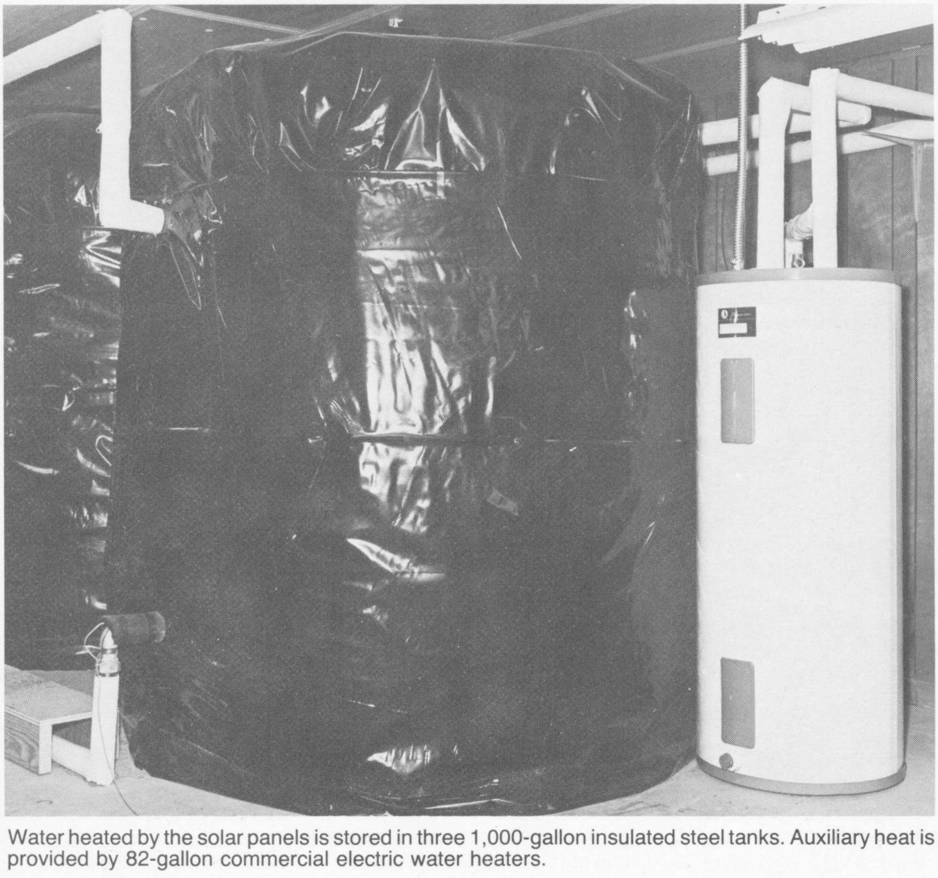


Operation of the Auburn solar heating system is illustrated by this schematic.

The 36 double glazed copper plate solar collectors comprise a collector area of about 700 square feet. Access doors to research pens are located in the south wall.



tems with each devoted to two of the research pens. Each system has 12 double glazed copper plate collectors manufactured by Revere Copper and Brass Company. The 36 units comprise a collector area of about 700 square feet. Collectors are mounted in angle iron frames which hold groups of six collectors. Frames are anchored to redwood 4 × 4's, which are in turn anchored to 2 × 6 roof purlins. Pin connections permit tilting frames to any angle with the horizontal. Currently they are tilted to an angle of 45 degrees.



Water heated by the solar panels is stored in three 1,000-gallon insulated steel tanks. Auxiliary heat is provided by 82-gallon commercial electric water heaters.

The system uses water as the heat transfer medium with complete interconnection of collector, storage, and delivery systems. No heat exchangers are used to separate components of the system. Operation as a drain down system in which water drains back into storage when solar energy cannot be collected removes the need for freeze point depressants. Collector pump operation is controlled by a differential thermostat with a fixed 27F differential on start up and 3F differential on shut down.

Storage is held in three 1,000-gallon insulated steel tanks. Adjustment of plumbing will permit operation of each at less than full capacity. Interconnection of the tanks would permit operation of a storage system at greater than 1,000 gallons.

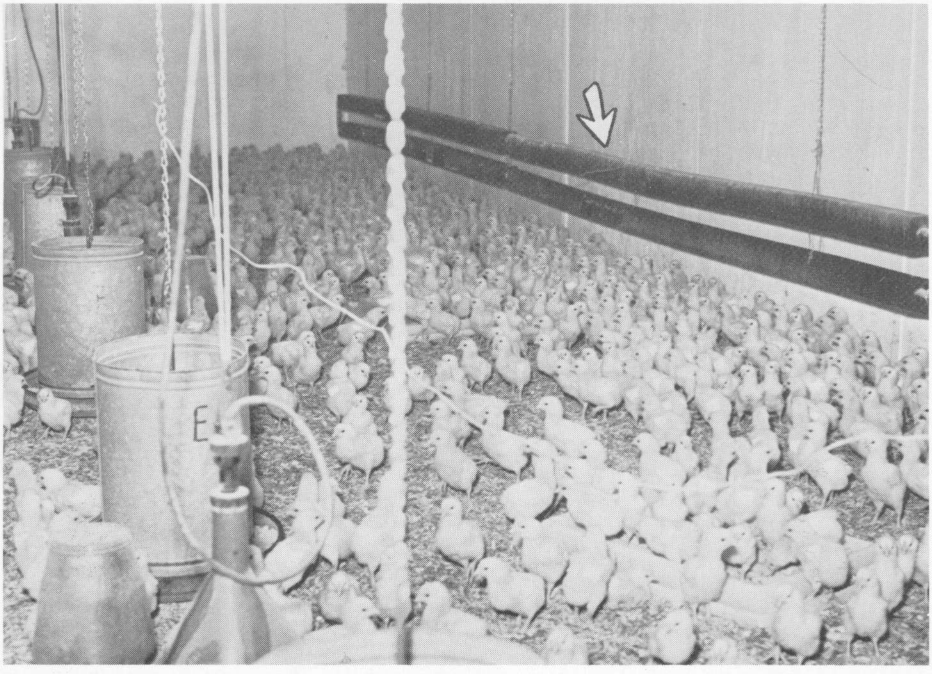
An attempt is made to take advantage of any temperature stratification which may occur in storage. Water going to collectors is pumped from the bottom of storage while hot water from collectors is returned to the top of storage. Hot water delivered to research pens is pumped from the top of storage and cold water returns to bottom of storage.

Auxiliary heat for each system is by 82-gallon commercial electric water heaters. Auxiliary heat may operate as either 4.5 or 9 kw. Switching between storage and auxiliary is by means of two-position, three-way pneumatically actuated bronze valves. Switching occurs whenever storage temperature drops below a preset minimum.

Continuous flow of constant temperature water to the load (research pens) is provided via pneumatically actuated three-way mixing valves. These valves mix return water from the load with water from storage to provide a constant temperature water for delivery to load.

Water flow through the delivery system in each pen is controlled by a proportioning valve. A major portion of the research will involve development and evaluation of delivery (brooding) systems.

Two delivery systems have been in-



One heating system being evaluated uses 1-inch diameter finned tubing. Two 30-foot lengths (arrow) are installed at 12- and 18-inch heights above the floor to transfer heat from water into the chick brooding area.

A second delivery system being tried involves the use of concrete slab brooders (arrow) having a total area about half the size of the pen. Circulating heated water warms the slab to keep the chicks warm.

vestigated. One uses 1-inch diameter finned tubing. Two 30-foot lengths are installed along one wall of the research pens approximately 12 inches and 18 inches above floor level. Two rooms are equipped with concrete slab brooders having a total area approximately half the size of the research room. Circulating heated water warms the slab to brood birds. Other brooding arrangements will be tested as the research progresses.

Solar system efficiency is measured with the aid of on-site meteorological monitoring equipment. Available instrumentation monitors frequency and intensity of sunshine, ambient temperature, wind direction, and velocity and dewpoint.

DATA SYSTEM

Data collection consists of temperature and flow measurements at critical points in the water system, air temperatures in the research pens, significant temperatures in each brooding system, and weather data. Temperature measurements are made with copper-constantan thermocouples. Water flow measurements are made with turbine type flow meters. Weather data collected are wind velocity and wind speed, ambient dry bulb and dewpoint temperature, daily maximum and minimum dry bulb, solar radiation on a horizontal plane and also on the plane of the collector surface, and thermal radiation. Sensors are scanned periodically by a 118-point data logger. Data are recorded on digital magnetic tape. Tapes are removed to the computer center once per day. Data are then transferred to permanent storage and analyzed using the central computing facilities of Auburn University.