National Food and Energy Council

AT-115

END USES:
Sanitize Dairy Equipment
Wash Up: Livestock/Workers
Veterinary Use, All Farms

APPLICABILITY:
Easy Control, OFF-Peak
Easy Large-Tank Replacement
Ample Hot Water Supply

OBJECTIVES:
Peak Clipping
Strategic Conservation
Strategic Load Growth

STATUS:
Equipment Available
Control Programs In Place

Ag Technical Brief

This work done under contract with the Electric Power Research Institute.

Water Heating for Production Agriculture

DESCRIPTION

This brief addresses only the hot water needs and electric water heating practices on farmsteads (i.e. outside the home). It focuses upon dairy farms. Hot water use on hog, poultry, cattle and sheep farms is often more of a convenience than a necessity. On dairy farms it is **essential** for producing high quality products.

Hot water requirements vary greatly from one dairy farm to another, due to number of cows milked and type of milking equipment used. Therefore, information primarily relates to those farms with from about 25 to 200 milking cows.

Electric water heaters have distinct advantages over fossil fueled units. They are more efficient as there are no flue losses. They can be heavily insulated to reduce storage tank heat loss. They can be located near point of heaviest hot water use to minimize heat loss from water lines.

The amount of water that must be heated within the thermal storage unit depends, to a large degree, on whether the dairy farm is equipped with a heat exchanger that recovers heat from milk to preheat water for general use.

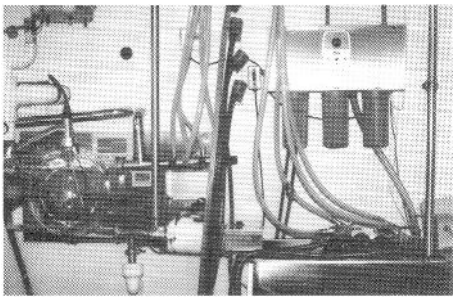
Water for washing pipeline milking equipment should be a minimum of 160°F at the heater. Large amounts of hot water are used in a short time period. Consequently, **uncontrolled** heaters are energized during or shortly after the morning and evening milkings. For many electric power suppliers, this water heating load coincides with the utility's peak electrical demand, creating generation system inefficiencies.

Because of their thermal storage capacity and ease of super-insulating, electric water heaters are ideal loads for OFF-PEAK control, causing no problems for dairymen if storage capacity is properly selected.

Specifications

Pipeline milking systems are used on almost all dairy farms with 40 or more cows. To assure proper cleaning of the milk handling equipment, it is essential to use water of the proper temperature for each procedure as follows:

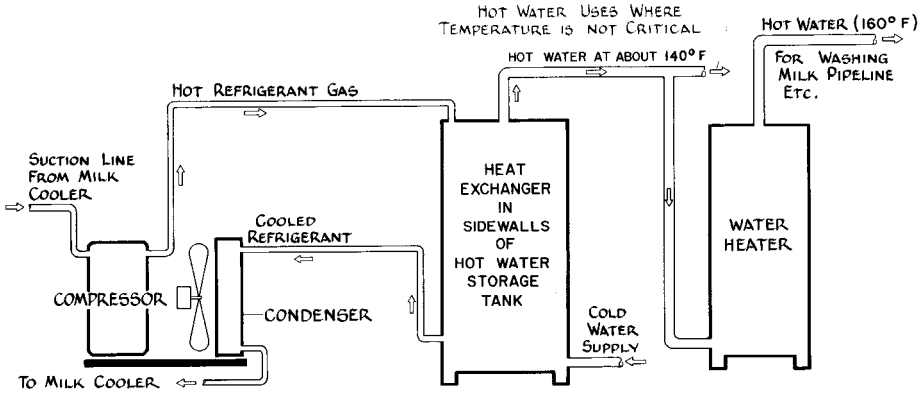
- Immediately after milking, rinse pipeline and other equipment with water between 95 and 110°F. (Cold water causes milk fat to stick to equipment; hot water causes deposition of minerals and protein.)
- Wash milklines with hot water as recommended by manufacturer of the cleaner used. Generally, it is recommended that hot wash solutions circulate for 10 minutes, maintaining a minimum temperature of 120°F. To **finish** the wash cycle with the cleaning solution at 120°F, it is normally necessary to start with a water temperature of 160°F, or higher. (Fat and protein will come out of solution and deposit on the equipment when the water temperature drops below 110°F.)



Dairy farms with pipeline milkers use 2.5 gallons of hot water per day per cow milked.

- Rinse equipment with hot water at 120°F, minimum.

The amount of hot water required for the two rinses and wash cycle depends upon the size and length of milklines, but 60 gallons or more is typical. Hot water required for washing cow's udders and other equipment needs to be about 120°F. On dairy farms with pipeline milking equipment, water heating capacity should be at least 120 gallon when only one tank is used. On farms **without** milk pipeline systems, an 80 gallon tank is the minimum size recommended.

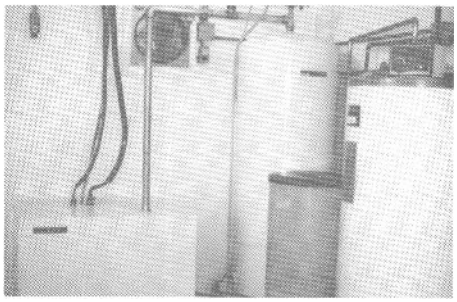


Typical dairy farm water heating/heat exchanger arrangement.

Applicability

For reducing electrical peak demands, water heaters can be more easily controlled than other electric loads. Where one power supplier serves a large number of farms, some means of water heater control can provide significant benefits to farmer and electricity supplier, alike.

Water heater control **ON-periods** must be long enough to heat the entire tank capacity to desired temperature, normally 160°F, before subsequent milking operations. This is not a problem when water heaters are properly selected and equipped with 4.5 KW elements, which are most common. As an example, assume a 120 gallon heater has an average water temperature of 80°F after all hot water needs are met for one milking. One 4.5 KW element could heat the 120 gallons from 80°F to 160°F in about 5½ hours.



Milk cooler heat exchangers (at left) can provide up to 75 percent of hot water needs, depending upon type of exchanger.

Implementation Considerations

The large amount of energy use for heating water, and the corresponding potential savings, must be recognized. Energy for heating water on many dairy farms will amount to 20% of the total electricity used in the dairy operation. Properly sized heat exchangers in the sidewalls of the storage tank can reduce water heating costs by nearly 75%. These exchangers can heat water, stored in a second tank, to 130°-140°F before flowing into the water heater. Its temperature is then increased to 160°F minimum. Water may be drawn directly from this secondary storage tank for washing udders and other uses where water temperature is not critical.

Milk sanitarians and inspectors should be contacted to assure that any proposed promotional program meets with their approval. An adequate hot water supply can be assured by recommending proper size of tank, correct thermostat setting, and prudent control periods. Overall efficiency is enhanced with adequate tank insulation, heater location, proper pipe insulation and U-traps placed in water lines above the heater.

EVALUATION

Availability

Well insulated water heaters are available from numerous manufacturers. The type of water heater control that is most desirable will depend upon the magnitude of peak utility demands, the relative amount of farm load, the number of water heaters that could be controlled and the cost of inaugurating various control systems. Many control devices are readily available.

Cost Per Unit

Receivers for a radio, power line carrier or ripple control will cost $100 or more per installation. Transmitting equipment costs may be in the $25,000 to $100,000 price range so the average total cost per installation varies considerably with the number of water heaters and other electrical loads that will be controlled.

Time clocks are the simplest and least expensive type of control that can be used for controlling water heaters. Power outages of any significant length of time, however, require that many must be reset to maintain the desired control periods. Timers that switch over to spring-wound or battery operation during power interruptions are available.

Reliability

Time clocks have been used for controlling water heaters on off-peak rates for many years by some utilities. Farmers with water heaters properly sized for their hot water usage have generally experienced no problems. The direct utility control systems now available have been performing satisfactorily and provide power suppliers with a means for direct control of the KW demand on their system.

Utility System Benefits

Data obtained in 1984 indicate that the water heater accounts for about 20% of the peak load on a typical dairy farm. Controlling these loads is most practical for utilities with farm load peaks that coincide with system peaks. The water heater load can be shifted from ON-peak to OFF-peak on most systems with the OFF-peak control periods being 3 hours or less. By so doing, data from one power supplier indicated that an average of 1.8 KW per water heater could be shifted off their evening peak.

Many utilities have an incentive rate structure or rebate program to encourage farmers to voluntarily participate in an electric water heater control program. By promoting the advantages of controlled electric water heating, utilities should also be able to convert more farmers from fossil fuel to electric water heaters.

Customer Benefits

Farmers can be assured of having an adequate supply of hot water at the proper temperature, when they need it and at reasonable cost. The cost of water heating with electricity can be lower than with fossil fuels in areas where dairy farms are concentrated and power supplier rates recognize mutual benefits.

Customer Acceptance

Most farmers prefer heating water with electricity unless fossil fuels have a significant operating cost advantage. They like its cleanliness, lack of a flue, low maintenance and dependability so long as operating costs are reasonable.

Related Utility Programs

Some utilities have developed their farm energy management/marketing program by combining the promotion of **controlled** electric water heaters with the installation of milk cooler heat recovery systems. By controlling some 3,000 farm water heaters, one upper midwest power cooperative has shifted an estimated 5.4 MW of ON-peak demand to OFF-peak within a two-year period.

Comments

For additional information see Ag Tech Brief AT-117, **Milk Cooler Heat Exchangers**. Also, contact the National Food and Energy Council, Inc. for a recent report entitled, "Dairy Farm Water Heaters and Their Control", or see EPRI Report EM 4578 for information on 225 utility water heater control projects with over 1,000,000 controlled residential water heaters.