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Laundry Hot Water Systems

Commercial/Institutional Applications using Helitherm Heat Exchangers

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THE AERCO STANDARD LAUNDRY HOT WATER SYSTEM

The AERCO standard system generally recommended for commercial/institutional laundries is illustrated in Figure 1. Inasmuch as laundries are subjected to periodic surge flows, supplementary storage is usually required to reduce rate of change of boiler load to and acceptable level and reduce peak demand for energy by integrating the energy demand over a longer period of time.

This achieves a more stable boiler (energy source) operation and permits better performance of automatic boiler control equipment. 3 to 8% improvement in boiler efficiency is not uncommon as a result of stabilizing boiler operation by keeping the rate of change of boiler load within acceptable limits.

System design is based upon an unrestricted energy source since the boiler equipment is assumed to have the capacity to meet the total energy requirements of the laundry as well as other services. The system design objectives are:

1. To maintain the rate of change of boiler load within acceptable limits.
2. To lower peak boiler demand.
3. To minimize system storage and consequent energy loses.

The system illustrated in figure 1 accomplishes these objectives with the following advantages:

1. Lowest operating cost.
2. Least space requirement.
3. Maximum energy savings, both in terms of fuel consumed and radiation losses minimized.

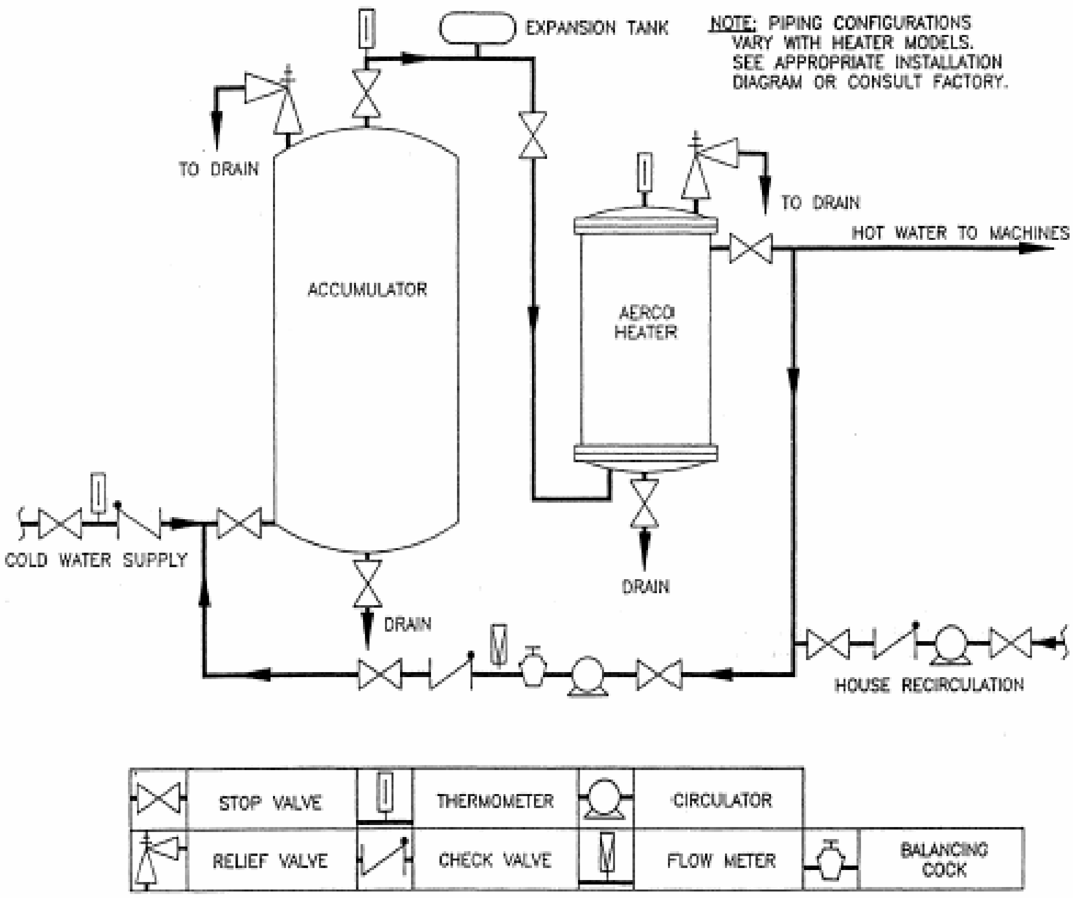
PRINCIPAL OF OPERATION

BTUs are stored in the accumulator on a constant volume variable temperature basis, i.e., the system depends on the mixing of cold and hot eater in the accumulator. The discharge from the system is taken from the outlet of the AERCO heater and not from the accumulator. With this arrangement, the heater acts as a pre-heater during periods of no or low demand and a booster heater during periods of high demand. The tank serves as a “fly wheel” storing energy to meet the next surge flow demand, while the recirculating pump acts as a “governor” of the heat input rate.

Sizing and selecting, the system components are relatively simple, and are covered in the following explanation and example. With properly sized components, the system set-up consists simply of setting the system final outlet temperature and adjusting on balancing cock to set the circulating pump to operate at the correct point on its curve.

DETERMINATION OF LAUNDRY HOT WATER REQUIREMENTS – AVERAGE HOURLY HOT WATER RATE (AHHWR) – Any System

Commercial laundry equipment generally uses 2 gallons of 180°F water per pound of cloths or linens washed. This figure is recommended by most machine manufacturers. Most “heavy” work requires a nominal 1 hour wash cycle, inclusive of loading and unloading the machine, and is based on a 50-60 second fill time. The use of the shorter 30 second fill time will shorten the total cycle only 3 to 4 minutes.



SEQUENCE OF OPERATION

Cold water enters the bottom side of the inlet or the accumulator. Preheated water is drawn from the accumulator, thence through the AERCO heater where it is heated to the set temperature, and passes to the laundry machines.

When there is not demand, water from the top of the accumulator is passes through the heater and back to the bottom of the accumulator at a high flow rate. The circulator is selected to turn over the accumulator in approximately three minutes and with sufficient total discharge head (usually about 20 ft) to overcome the resistance of the piping and heater. The circulator flow rate is set by adjusting the balancing cock until the desired rate is being maintained and the pump is operating at the correct point on its curve. If there is cold water in the bottom of the accumulator, the heater water mixes with the cold water to produce a relatively uniform temperature throughout. When a demand is placed on the system, the water from the top of the accumulator passes through the heater, bringing its temperature to the set point before flowing to the machines. The increased total flow causes an increase in the pressure drop across the balancing cock and heater, thereby causing a reduced recirculation rate and allowing more heat to be transferred to the water to the machines.

House recirculation, when provided, is fed to the discharge of the system circulator and into the accumulator.

An expansion tank in the system is required when insufficient expansion capacity is provided elsewhere. The total expansion capacity required is equal to the expansion of the water in the accumulator when heated through the full design temperature rise of the heater. If the local codes permit elimination of the check valve in the cold water supply, it is recommended but not required.

FIGURE 1 – ACCUMULATOR SYSTEM FOR MINIMUM STORAGE – MODERATE ENERGY INPUT

The shorter cycles often now in more common usage are not shorter because of shorter fill time, but, instead, are achieved by the elimination of a suds- or rinse-cycle or both. These are generally employed with synthetic fabrics which also use lower water temperatures. Thus, the figure of 2 gallons/pound of fabrics being washed can be considered to be 2 gallons/pound of machine capacity for the determination of Average Hourly Hot Water Rate (AHHWR).

If a 30 second fill time is standard for the entire laundry operation, this figure might be increased 6 to 7% to 2.14 gallons/pound of machine capacity. However, the figures used herein are conservative enough to preclude this necessity.

Average Hourly Hot Water Rate (AHHWR) = (2) • (total machine capacity in pounds)

SIZING THE AERCO HELITHERM HEAT EXCHANGER (Standard System)

Since the objective of the AERCO standard system is to introduce into the system the smallest effective storage that will provide an acceptable rate of change of load of the boiler (heat source), the heater recovery rate (instantaneous capacity) must exceed the AHHWR by some amount. Commercial laundry machines use approximately ⅔ of their hourly hot water consumption in 20 minutes or ⅓ of an hour. It is necessary for the heater to be able to produce twice the AHHWR through the full temperature rise. Experience has shown that this will satisfactorily meet the foregoing objective. A larger heater is unnecessary, but would not be detrimental to the system performance. It would simply provide additional sub-cooling surface. Therefore:

$$\text{Heater capacity (recovery rate) in GPM} = \frac{2 \cdot \text{AHHWR}}{60 \text{ min.}}$$

$$\text{OR} = \frac{\text{4GPM} \cdot \text{total machine capacity in pounds}}{\text{60 minutes}}$$

Laundry water is required to be heated to 180°F. A proper heart selection can be made from the capacity tables furnished by AERCO using the approximate full temperature rise for the application for which it is to be used.

SIZING THE ACCUMULATOR (Standard System)

Is it important that the minimum effective accumulator size be established since any selection less than this could result in the system being depleted of heated water, not just in a minor degradation of the final outlet temperature. It must have sufficient capacity to satisfy the longest sustained surge flow without additional heat input to the system. This “worst case” condition is unlikely, but it could occur if all machines were filled exactly sequentially or all simultaneously.

Thus the accumulator capacity should equal the sum total gallons required to fill all machines to their high fill level following an intermediate extraction.

The gallons required to reach high fill level and gallons required for re-saturation for machines of a given size variables only slightly from one machine manufacturer to another. If the true data is available, use it. If not, the following figures are generally accepted averages which will satisfy nearly all situations.

1. To reach high fill level	=	0.30 gallons/pound of machine capacity
2. To re-saturate	=	0.21 gallons/pound of machine capacity
Total	=	0.51 gallons/pound of machine capacity

Therefore:
Accumulator size – 0.51 gallons • total machine capacity in pounds

CIRCULATOR CAPACITY (Standard System)

The circulator should be capable of completely circulating the contents of the accumulator through the heater in approximately 3 minutes (3 minutes being the minimum time lapse between successive fills as called for by the machine program).

$$\text{Circulator capacity in GPM} = \frac{\text{Accumulator capacity in gallons}}{\text{3 minutes}}$$

OR

$$\text{Circulator capacity in GPM} = \frac{0.51}{3} = \text{0.17GPM} \bullet \text{total machine capacity in pounds}$$

DETERMINATION OF MAXIMUM INSTANEOUS DEMAND (MID)

The nominal machine cycle of 45 to 50 minutes exclusive of loading and unloading is generally based on a 50 to 60 second time to fill to high fill level. Many machine manufactures are currently recommending a 30 second time to fill to high fill level. While fill time has no impact on accumulator and circulator sizes, and none on heater capacity, it does impact line sizes and dictates the maximum surge flow through the heater shell which must be accommodated. Therefore, it is essential to be able to determine this flow for various "fill" times and to be certain the heater is provided as may be necessary with properly sized bypass and/or inlet and outlet connections (side flange connections may be required) to accommodate this flow without excessive velocities.

The factors used in the following examples are machine manufactures' recommended factors to account for diversity resulting from a varying number of machines and variations in machine sizes.

2-minute fill time

1 or 2 machines:

MID = 0.15GPM • capacity of largest machine in pounds

3 or more machines:

MID = 0.15GPM • capacity of largest machines in pounds PLUS
0.10GPM • total capacity of all other machines in pounds

1-minute fill time

1 or 2 machines:

MID = 0.30GPM • capacity of largest machine in pounds

3 or more machines:

MID = 0.30GPM • capacity of largest machines in pounds PLUS
0.15GPM • total capacity of all other machines in pounds

30-second fill time

1 or 2 machines:

MID = 0.60GPM • capacity of largest machine in pounds

3 or more machines:

MID = 0.60GPM • capacity of largest machines in pounds PLUS
0.25GPM • total capacity of all other machines in pounds

EXAMPLE (Standard System)

A laundry with incoming water at 40°F in winter, water to machines at 180°F, and steam available at 100 PSIG has the following laundry machines:

2 with 600 pound capacity
1 with 400 pound capacity
1 with 250 pound capacity
\+ 1 with 75 pound capacity
1925 pounds = Total Capacity

Average Hourly Hot Water Rate (AHHWR)

925 pounds • 2 gallons/pound/hour = 3850 GPM

Heater Capacity

$$1925 \text{ pounds} \cdot 4 \text{ GPM} = \frac{7700 \text{ GPM}}{60} = 128.3 \text{ GPM}$$

OR

$$3850 \text{ GPM} \cdot 2 = \frac{7700 \text{ GPM}}{60} = 128.3 \text{ GPM}$$

From AERCO Capacity Tables with 80 PSIG Steam in the coils
Select Model SW1C24 Heater
8981 pounds/hour of steam are required

The optimum control valve selection would be a
2 ½” Type CXT-P for pneumatic control

Accumulator Capacity

1925 pounds • 0.51 gallons/pounds of machine size = 981.75
Use 1000 Gallon Accumulator

Circulator Capacity

1925 pounds • 0.17 GPM/pounds of machine size = 327.25 GPM
Use 325 GPM

Maximum Instantaneous Demand (MID)

30-second fill time

For largest machine	600 pounds • 0.60 GPM	=	360 GPM
For all remainder	1325 pounds • 0.25 GPM	=	331 GPM
	MID	=	691 GPM

1-minute fill time

For largest machine	600 pounds • 0.30 GPM	=	180 GPM
For all remainder	1325 pounds • 0.15 GPM	=	190 GPM
	MID	=	379 GPM

It can be seen that the 30 second fill time would require an 8" hot water main in order to keep the velocity below 7 fps. Only a 5" main would be required for the longer one minute fill time. Similarly, the AERCO heater would require larger inlet and outlet connections to maintain suitable velocities at the faster fill time.

ALTERNATE A - Designing for a Limited Energy Source Using a Stratified Storage Tank

In some cases, it may be necessary to design for a limited or restricted energy (steam or boiler hot water) source, using the smallest heater possible with additional storage to accommodate the laundry's needs. When it is necessary to do this, it is at the expense of the additional heat losses incurred because of the increased storage, the expense of additional floor space, and the additional cost of the increased storage capacity (tank).

Such a system is illustrated in Figure 2, using a stratified storage tank.

PRINCIPAL OF OPERATION

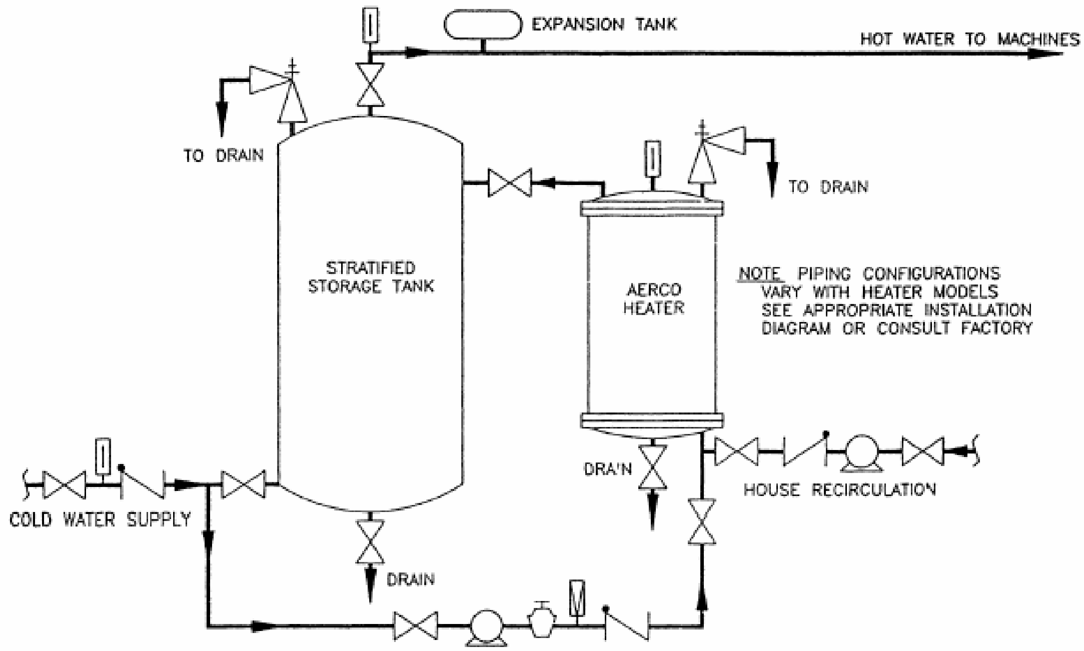
BTUs are stored in a stratified storage tank on a constant temperature-variable volume (of hot water) basis, i.e., the system depends on an absolute minimum of mixing of cold water and hot water in the tank. The discharge to the system is taken from the top of the tank and/or the heater. The supply of hot water in the upper portion of the tank is replenished at a constant rate by the heater operating at a capacity equal the Average Heater Hot Water Rate (AHHWR). Tank storage must be large enough to accommodate the cumulative surge flows that occur in the maximum usage period.

Sizing and selection of components is covered in the following explanation and example. System setup and adjustment consists simply of setting the system final outlet temperature and adjusting one balancing cock to set the circulating pump to operate at the correct point on its curve.

SIZING THE AERCO HEATER (Alternate A)

$$\text{Heater capacity (recovery rate) in GPM} = \frac{\text{AHHWR}}{\text{60 min.}}$$

$$\text{OR} = \frac{\text{2 GPM • total machine capacity in lbs}}{\text{60 minutes}}$$



SEQUENCE OF OPERATION

Cold water enters the bottom side of the inlet of the storage tank and hot water is drawn from the top of the tank. Both tank connections must be sized for maximum instantaneous demand calculated for the laundry.

Water is drawn by the system circulator from the bottom of the tank at a constant rate equal to the maximum instantaneous capacity of the heater. The circulator is chosen with an adequate total discharge head (usually about 20 ft) to overcome piping and heater resistance. The balancing cock is set to maintain the desired flow rate. The water entering the heater is the coldest water in the system. It is heated is a single pass to the set point operating temperature and returned to the top inlet of the storage tank. When the house recirculation is provided, it enters the bottom of the heater and passes through it to the top of the storage tank.

Maximum stratification between hot and clod eater is maintained in the storage tank by a vertical design with a side inlet cold water connection. When there is no demand on the system, cold water from the bottom is continuously heated and pumped to the top of the tank. The boundary layer between hot and cold water falls. When the demand of the system exceeds the circulation rate, the hot water is drawn from the top of the tank, cold water enters the bottom, and the boundary in the storage tank rises.

The expansion tank in the system is required when insufficient expansion capacity is provided elsewhere. The total expansion capacity required is equal to the expansion of the water in the storage tank when it is heated through the full design temperature rise of the heater. If the local codes permit elimination of the check valve in the cold water supply, it is recommended by AERCO, but not required.

FIGURE 2 – STRATIFIED STORAGE SYSTEM FOR MINIMUM CONTINUOUS ENERGY DRAW

SIZING THE STRATIFIED STORAGE TANK (Alternate A)

Approximately 2/3 of the water in the normal laundry machine cycle occurs in a 20 minute period (1/3 hr). During this period, the heater can make only half of this required amount or 1/3 of the hourly requirement.
Than stratified storage tank must provide the other half or 1/3 of a full heater requirement. Stratification within the tank precludes the capacity from being 100% usable. Standard practice has shown that the tank is able to deliver between 60 and 80% of its total capacity without excessive temperature degradation. AERCO recommends using 70% of the total capacity of an un-baffled vertical tank piped as shown in Figure 2.

$$\text{Storage Tank size in Gallons} = \frac{\text{2GPM} \bullet \text{total machine capacity in pounds}}{3 \bullet 0.7}$$

SIZING THE CIRCULATOR (Alternate A)

The circulator size must be selected with a capacity equal to the next available size greater than the heater capacity.

$$\text{Circulator capacity in GPM} = \frac{\text{AHHWR}}{\text{60 min.}}$$

OR

$$\text{Circulator capacity in GPM} = \frac{\text{2GPM} \bullet \text{total machine capacity in pounds}}{\text{60 min.}}$$

EXAMPLE (Alternate A)

Using the same data as in the previous example:

AHHWR = 3850 GPM

$$\text{Heater Capacity (Recovery Rate)} = \frac{3850}{60} = \text{64.17 GPM}$$

From AERCO Capacity Tables with 80 PSIG Steam in the coils
Select Model SW1BII (or other model of equivalent capacity)
4550 pounds/hour of steam are required

The optimum control valve selection would be either a

2” Type CXT-P for pneumatic control, or
2” Type CXT-S for self-contained operation

$$\text{Stratified Storage Tank Capacity} = \frac{\text{2 GPH} \bullet \text{1925 pounds}}{3 \bullet 0.7} = \text{1833 Gallons}$$

Use 1850 to 2000 gallon size.

Circulator Capacity = same as heater capacity = 65 GPM

NOTE: It is important to note that, in comparing these examples, while the stratified storage tank has nearly doubled in size (1000 gallon to 1900 gallon), the maximum instantaneous steam flow has decreased from 8981 pounds/hour to 4550 pounds/hour. Furthermore, the heater is no longer subjected to peak surge flows (MID). It is, therefore, only necessary to size any required bypass for 65 GPM and no side flange connections are required.

ALTERNATE B - Designing for no Supplemental Storage

In a small laundry, 200 to 400 pound total machine capacity, and where fill times of 1 minute or longer are acceptable, with adequate steam supply for the heater, it is practical to consider the use of the AERCO Helitherm Heater without any supplemental storage.

Heater capacity is selected equal to the maximum instantaneous demand (MID) as calculated for the Standard System above.

EXAMPLE (Alternate B)

A small laundry with incoming water at 40°F in winter, water to machines at 180°F, and steam available at 100 PSIG has the following laundry machines:

	2 with 75 pound capacity
+	1 with 50 pound capacity
	200 pounds = Total Capacity

Heater Capacity

MID for largest machine	=	75 pounds • 0.30	=	22.50 GPM
MID for all other machines	=	125 pounds • 0.15	=	+18.75 GPM
		Total MID	=	41.25 GPM

From AERCO Capacity Tables with 80 PSIG Steam in the coils
Select Model SW1B09 (or other model of equivalent capacity)
4550 pounds/hour of steam are required

The optimum control valve selection would be either a

1 ½” Type CXT-P for pneumatic control, or
1 ½” Type CXT-S for self-contained operation

HEAT RECLAMATION

The constant emphasis on cost savings and energy conservation makes the use of heat reclamation equipment a very important consideration for a laundry.

In some instances, as much as 40% of the total fuel consumed for the purpose of heating laundry water can be saved through the use of AERCO designed heat reclamation systems.

Consider a moderately sized laundry with total machine capacity of 1000 pounds, operating 8 hours/day, 250 days/year. They will wash 2,000,000 pounds of laundry, using a total of 4,000,000 gallons of 180°F water. With average cold water temperature of 60°F, 4,000,000 pounds of steam are needed annually. At a cost of $3.00 per thousand pounds, the total annual cost is $12,000. Potential savings up to $4,800 per year may be realized. The same laundry operating 12 hours per day, 365 days per year, as some do, could realize savings up to $10,500 in annual fuel cost.

The larger laundry (1925 pound capacity) used in the examples above for sizing could realize savings from $9,000 to over $20,000 per year, depending on its hours of operation.

Even the small 200 pound capacity laundry could realize savings of $960.00 per year at minimum operation. Why not consider specifying an AERCO Heat Reclamation System on all laundries? AERCO will furnish system design, estimated annual savings, and estimated prices for any laundry on receipt of the required design data.