FAQ

Sizing Instantaneous Replacement for Storage Water Heating

Commercial instantaneous water heating plants are increasingly replacing old storage based systems. It is important to select the correctly-sized water heating equipment. Consideration must be given to the application, formerly stored energy and possible over-sizing of the original system.

Question: Can I select replacement equipment based on existing BTU Input or Recovery Rate?
Answer: No, as this would not account for the amount of BTUs stored in the tank.
Note: Be careful when using recovery rate to compare water heaters. Recovery rates are stated for a given temperature rise. Comparing one unit's recovery rate at 40-140°F is not the same as another heater rated at 50-140°F.

Q: How do you calculate the energy stored in a tank and the equivalent flow rate?
A: Standard accumulator-style storage tanks are considered to have between 70-80% "usable" hot water available before the temperature drops too low to use. The peak load duration must also be known. A tank will supply hot water during the peak hot water usage, and so must be sized to at least support that load duration. The following equation can be used to calculate the replacement energy requirements.

$$\text{Energy} = \frac{\text{Storage Volume} * \text{Useful \%} * 500 * \text{Temperature Rise}}{\text{Peak Load Duration}}$$

Example 1: A 1200 gallon tank storing 140°F water and supporting a 30-minute peak load.

$$\frac{1200\ \text{gal} * 0.8 * 500 * 100°\text{F}}{30\ \text{min}} = 1600\ \text{MBH}$$

Example 2: A 1200 gallon tank storing 140°F water and supporting a 10-minute peak load.

$$\frac{1200\ \text{gal} * 0.8 * 500 * 100°\text{F}}{10\ \text{min}} = 4800\ \text{MBH}$$

Without knowing the peak load duration, the estimate to replace a storage tank can vary wildly.

Q: If I assume a peak load duration, can I replace like-for-like?
A: Yes, but it is not advisable. Tanks are often very oversized, and this may lead to an overly-large instantaneous system. Safety factors of 200% or more are frequently added to storage systems.

Additionally, instantaneous water heaters often allow for a lower setpoint, which would reduce the total energy required. Tanks must be heated to a minimum of 140°F. Most domestic applications only require 120-130°F. Since an instantaneous water heater has no stagnant water, the setpoint may be set to exactly the desired temperature.
Example: A system requiring 60 gpm at 40-140°F rise compared to 60 gpm at 40-120°F rise. At 100°F ΔT, the required output is 3000 MBH. At 80°F rise, the required output is only 2400 MBH.

Q: What is the best method to size instantaneous replacement for storage?

A: If the peak demand flow is known, it is simple to size required energy input for an instantaneous system. Simply use the formula BTU/hr = 500 * flow (gpm) * temperature rise (ºF). See "Method 3" below.

If peak demand flow is not known, it can be calculated using a fixture count. The ASHRAE Handbook provides general guidelines, and water heater manufacturers may provide a sizing tool that can guarantee sizing results. Contact your local manufacturer's rep for assistance.

If fixture counts are not known, an approximate like-for-like sizing can be calculated using the existing system's total input, stored water volume, and estimated peak demand duration.

Example: A 120 room hotel would like to replace two atmospheric water heaters and two storage tanks with a fully instantaneous system. The required setpoint is 125ºF, and the coldest groundwater temperatures during the year are 40ºF.

Method 1: Sizing like-for-like. The heaters are each 1000 MBH, and tanks each 500 gallons. The total peak load is estimated to be 30-minutes long. Since the minimum tank setpoint is 140ºF, the estimated energy content of the tanks is

$$\frac{1000 \text{ gal} * 0.8 * 500 * 100ºF}{30 \text{ min}} = 1333 \text{ MBH}$$

Combined with the 2000 MBH of the atmospheric heaters, this system requires 3333 MBH using this sizing method.

Method 2: The hotel peak demand is not known, so a fixture count is used. Using the known fixtures in the hotel of 120 private lavatories, 6 public lavatories, 120 private showers, and 4 janitor sinks produces a total fixture count of 286 standard fixture units as per ASHRAE. The ASHRAE Handbook for HVAC Applications, Chapter 50, Figure 28 gives an approximate peak flow rate of 55 gpm using the Modified Hunter Curve. The water heater manufacturer is also asked to size this unit, and provides a 42 gpm estimate using a proprietary modified curve.

Since the setpoint can now be lowered to 125ºF, the BTU required will be 2338 MBH by the ASHRAE curves and 1785 MBH by the manufacturer's curves.

Method 3: The actual hot water use is measured over a period of several months, and the highest demand found is 35 gpm.

Using the formula for BTU; 500 * 35 * (125-40) = 1487 MBH required.

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