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Steam Water Heaters

Introduction

Water heaters are available which utilize various sources of energy, including electricity, steam, fuel gas, geothermal (heat pump) and solar. Today, the most commonly used energy source for domestic water heating is electricity, followed by natural gas. At the NIH campus in Bethesda, steam is the source of energy used to heat domestic and laboratory water as well as numerous other applications. Alternate heating sources for water heaters may only be used for special applications and with pre-approval by ORF.

A Brief Evolution of Water Heating

The first water heater was invented in 1868, which lead to the invention of the first storage tank-type gas water heater in 1889. At that time fossil fuels such as natural gas, oil, and coal were commonly used to heat water. Then, as electricity became commercially available electrically-powered water heaters grew to be popular, assisted by their ease of installation and low first cost. As it became more commonplace, heated water was utilized for many purposes, from residential to industrial applications.

Efficiency

Electricity is typically generated at a fairly low overall efficiency when considering the energy source is used to generate it and the transmission losses. For instance, the use of coal in a traditional power plant may convert approximately 30 to 35% of the source energy into electricity. When the transmission losses are factored into the overall efficiency, that overall system efficiency would be even lower. Using common sources of energy, such as natural gas and fuel oil, steam can be produced efficiently with fuel to steam efficiencies that exceed 80%. At NIH, the use of steam is extensive. It is utilized in several systems such as sterilizers, autoclaves, cage washers, HVAC systems and domestic hot water generation. Section 6.3.7 of the NIH DRM describes some of the characteristics of the NIH steam system.

Steam Water Heaters

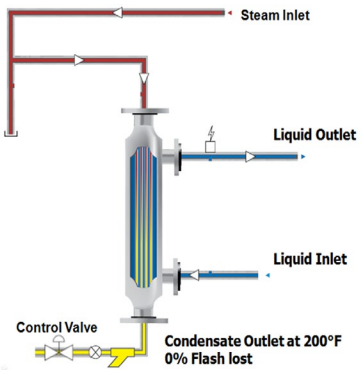
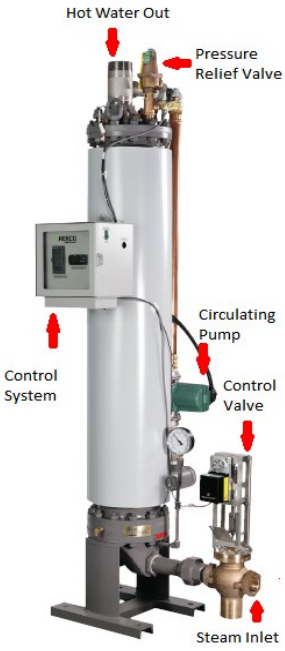


Figure 1 Basics of a Steam Domestic Water Heater [1]

Water heating is achieved by taking advantage of available steam using one of the various types of water heating systems. Heat exchange for water heating at NIH is accomplished using semi-instantaneous shell and tube steam type or indirect water (where high temperature water is available) heaters. A graphical example of equipment is shown in Figure 1. Appropriate materials of construction of heater shell and tube materials is essential to provide corrosion resistance as well as suitability for potable water applications. Accurate hot water temperature control is provided using modulating fail-safe pneumatically actuated or electric modulating fast positioning (with position feedback type) control valves. NIH requires that such water temperature control shall heat the water to 60°C–63°C (140°F–145°F) and tempered down to 52°C–54°C (125°F–130°F) for general potable water system distribution by a American Society of Safety Engineer (ASSE) 1017 master thermostatic mixing valve (arranged in parallel to provide N+1 redundancy). Shell and tube semi-instantaneous heaters have the advantage of requiring smaller space, as they operate without the use of a storage tank and circulating pump. Figure 2 shows a vertical double wall instantaneous water heater with a control system that includes a control valve and a built-in circulating pump. Heat exchangers utilized for potable and laboratory hot water heaters shall be double wall type. Some of these heat exchangers may require additional components, such as a storage tank and a circulating pump, which may be required to satisfy high peak demand loads. When a storage tank is required, the minimum temperature of the water shall be 60°C–63°C (140°F–145°F) to provide control of microbial growth, unless higher temperatures are needed for special applications.



Conclusions

Several factors should be considered when selecting a shell and tube, semi-Instantaneous heater, which are detailed in NIH DRM section 8.3. Hot water heaters and distributions systems are sized using Hunter's curve and compared to actual fixture / equipment to identify flowrate and maximum demand conditions.

For additional Reading

1. http://aerco.com/product/u-tube-double-wall
2. http://cemline.com/product-list/ht/
3. http://www.asse-plumbing.org/chapters/NOH_HeatTransfer-Spirax.pdf
4. https://www.phcppros.com/articles/2632-water-heater-types-and-selection-considerations
5. https://www.orf.od.nih.gov/PoliciesAndGuidelines/Pages/DesignRequirementsManual2016.aspx