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Steam Flash Tanks

Introduction

Flash steam forms when hot condensate in a vessel passes from a higher pressure to a lower pressure, causing the condensate temperature to drop to the saturated temperature of the low-pressure area. The heat released evaporates a portion of the condensate, generating flash steam.

A flash tank is a pressure vessel used to separate condensate from flash steam in a controlled process so that the condensate can serve as boiler feedwater and flash steam can serve low-pressure applications (e.g., shell-and-tube hot water heat exchangers) or be vented if desired. Depending on the pressures involved, approximately 10%–40% of the energy content from the original condensate can be recovered from flash steam. This article describes flash steam applications, flash tank use and selection, installation considerations, and applicable sections of the Design Requirements Manual (DRM).

Flash Steam Applications and Pitfalls

If flash steam is used to supplement steam mains serving low-pressure equipment, designers must first ensure the pressure of the steam is reduced to that specified by the equipment manufacturer. Condensate lines must also be sized to accommodate the steam that flashes downstream of the condensate trap orifices. Undersized condensate lines risk developing a backpressure that can inundate the trap with condensate, causing steam to flow through the line at excessive velocities and generating waves of condensate that fill the pipe and damage the piping system (i.e., water hammer). High steam velocities can also carry condensate into the flash steam recovery system.

The higher temperatures of high-pressure flash steam delivered to low-pressure applications may result in temperature control issues on the water side of the equipment. The resulting high-temperature, high-pressure condensate may damage downstream low-pressure condensate components like traps and pumps. A properly sized flash recovery system addresses these concerns and ensures the steam is suitable for use.

Flash Tank Components and Sizing

Flash tanks feature an inlet for medium- or high-pressure condensate, an air vent, an outlet for low-pressure flash steam at the top, and an outlet for condensate at the bottom. To safeguard against steam flashing above design pressure, the tanks are fitted with safety relief valves vented to discharge the steam to a safe location above the roof line.

Flash tanks come in vertical or horizontal arrangements. The ASHRAE Handbook--HVAC Systems and Equipment recommends vertical tanks because they are better at separating the steam and condensate, which improves steam quality. Flash tanks shall be stamped in accordance with Section VIII of the ASME Boiler & Pressure Vessel Code, and tanks and condensate lines insulated per DRM Exhibit 6.4. Designers must consider several system pressure and flow metrics and equipment dimensions to properly size a tank. They must also know the pressure in the condensate line serving the tank, the condensate load (in pounds of condensate per hour, or lb/h) and the design pressure inside the tank. This information will determine the percentage of the condensate that will flash into steam, which dictates the necessary tank size.

Steam inlet velocities for flash tanks range from 4000–6000 ft/min. DRM Table 6.3.7.4 requires that low-pressure steam flow at no greater than 6000 ft/min. The internal tank diameter must be large enough to slow the steam velocity in the tank to 10 ft/s, which will stop condensate from entering the recovered flash steam system. The flash steam outlet is typically sized for a velocity of 60 ft/s (3600 ft/min).

Designers must install a trap on the tank condensate outlet piping. Engineering literature commonly cites either a float and thermostatic (F&T) or inverted bucket type; however, DRM Table 6.3.7.3 requires disk thermodynamic type traps for medium- and high-pressure condensate applications. Other system considerations include pitching all condensate inlet lines towards the flash tank and installing swing check valves on these inlets to prevent condensate backflow.

Good design practice ensures that the steam load demand of the equipment using the flash steam is greater than the amount of steam that flashes in the tank. Designers shall also install backpressure regulators—set a few psi above the system design pressure—on the flash steam outlet pipe to prevent the recovery tank from becoming overpressurized in case the low-pressure system serving the connected equipment experiences excess pressure. This requirement is described in DRM 6.3.7.4.G.

Additional Reading

1. ASHRAE. (2020). ASHRAE Handbook—HVAC Systems and Equipment. https://www.ashrae.org/technical-resources/ashrae-handbook/description-2020-ashrae-handbook-hvac-systems-and-equipment
2. TLV Co. (n.d.) Condensate recovery: Mitigation of water hammer in vertical flashing condensate transport piping. https://www2.tlv.com/en-us/steam-info/steam-theory/condensate-recovery/mitigate-water-hammer-in-risers
3. Merrit, C. (2015). Process steam systems: A practical guide for operators, maintainers, and designers. (2nd ed.). Wiley. https://www.wiley.com/en-us
4. Watson McDaniel Product Catalog. https://www.watsonmcdaniel.com/Downloads/Literatures/Watson-McDaniel-Catalog.pdf