BEST PRACTICE NO. 2

INVENO ENGINEERING LLC

Select, Design, and Operate an Atmospheric Vented Condensate Pumping System

A number of engineering steps should be taken when preparing to install a vented condensate pumping system, and several considerations must be addressed. The following is an outline of considerations to be taken when installing an efficient steam system.

TANK INSTALLATION

- **Vertical Installation**
  Installing a tank vertically allows for a smaller footprint in exchange for a more height clearance. Vertical tanks allow for easy adjustments to thepump's net positive suction head (NPSH).

- **Horizontal Installation**
  Installing a tank horizontally requires less clearance at the expense of a larger footprint. Horizontal tanks have a fixed NPSH for the pump.

CONDENSATE VOLUME AND FLOW

The condensate load can come from multiple steam components. The amount of condensate entering the condensate tank is equal to the sum of the steam-consuming capacity of all equipment plus end users of the steam with condensate discharging into the condensate return line. It may be useful to convert pounds per hour (pph) to gallons per minute (gpm); to do so, use the following formula:

$$gpm = \frac{(pph/8.33)}{(60\ min/h)}$$

NET POSITIVE SUCTION HEAD (NPSH)

- **Cavatation**
  When liquid condensate enters the eye of the impeller in a centrifugal pump, it causes a pressure reduction. If the absolute pressure of the condensate drops to the vapor pressure of the fluid, flash steam vapor bubbles will occur in the flow stream. These flash steam vapor bubbles travel in the fluid along the vanes of the impeller; the pressure then increases, causing the vapor bubbles to collapse. The act of the bubbles collapsing is called pump cavitation. Cavitation can create a loud noise—sounds something like rocks in the impeller—and will severely damage the pump impeller, shaft, and seal.
  NPSH is essentially a measure of suction pressure. Specifically, it is the minimum suction pressure required to prevent the forming and collapsing of flash steam vapor bubbles. As state previously, there is a natural change in system pressure (Ps) as the condensate flows through the impeller. To prevent cavitation, Ps must be higher than the condensate vapor pressure.
- **Horizontal Installation**
  Installing a tank horizontally requires less clearance at the expense of a larger footprint. Horizontal tanks have a fixed NPSH for the pump.
- **NPSH Selection**
  In selecting a condensate pump, it is important to select one with an appropriate net positive suction head (NPSH). Common pumps are only appropriate at condensate temperatures less than 200F, and condensate in most industrial applications reaches temperatures close to atmospheric saturation temperature at 212F. Without the right NPSH, pumps may show signs of cavitation and damage in a short period of time. In addition to temperature, NPSH selection is driven by altitude, static head, and capacity. Condensate pumps are available that have been specifically designed to handle low NPSH, preventing cavitation and allowing for operation at higher temperatures.

- NPSH and Pump Orientation

  To calculate NPSH, use the following formula (all units in feet): NPSH=barometric pressure+static head on suction- friction losses in suction piping-vapor pressure of liquid

INLET CONNECTION SIZING

The maximum velocity at which condensate should enter the condensate tank is 4,500 fpm. Such velocities ensure the separation of condensate and flash steam, which is further promoted by offsetting the condensate tank inlet. If the condensate line is sized correctly, most of the flash/ condensate separation will take place in the condensate line before it ever reaches the tank inlet.

OUTLET VENT SIZING

Precautions should be taken to ensure tank outlet flash steam velocities do not exceed 3,000 fpm. Outlet velocities can be calculated using the following equation:

$$v = \frac{(2.4 \times \text{flow} \times \text{velocity})}{(\text{area})}$$

- *Flow in lb./h (PPH)*
- *Velocity in cu. ft./lb.*
- *Area in sq. in.*

SIGHT GLASS SELECTION

A sight glass is installed on all tanks so the condensate level within the tank is visible to plant personnel. It is important to properly protect the sight glass in order to prevent hot condensate from leaking from the tank. In most cases, the sight glass should be more robust than the simple glass tube with lightweight rods.

OVERFLOW PIPING

A proper overflow system is critical on condensate tanks in a vented operation. If the condensate tank overfills, a "burping action" results, causing a large amount of condensate to discharge through the flash steam vent piping. Such a reaction is a major safety risk and can cause serious damage and personal injury. To prevent tank overfill, loop piping, also called "Devon's Loop," discharges condensate in the tank and reduces the risk of burping action.

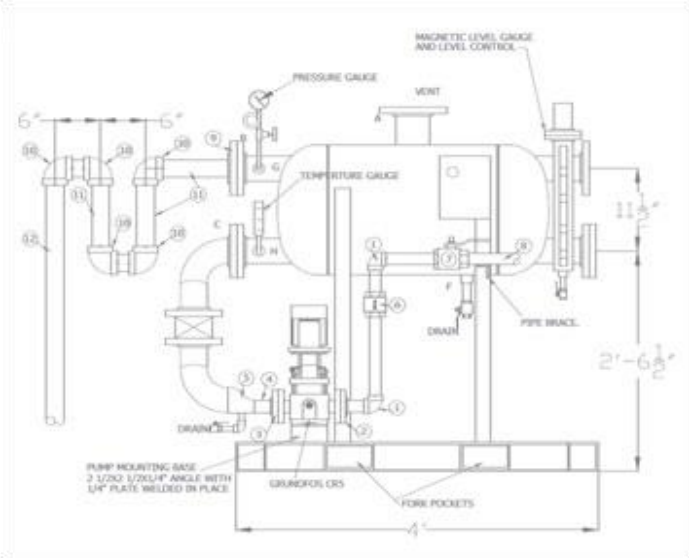

Figure 1: Left side of tank (Devon's Loop)

SUCTION PIPING

Suction piping remains on the bottom of the tank, extending suction up into the bottom tank 6-10 in. This ensures the effects of corrosion are not delivered into the pump suction. Strainers installed on the suction piping can also cause loss of NPSH.

SIGHT GLASS SELECTION

Ensure pressure gauges and temperature sensors are properly installed; these can be used to monitor the performance of the system and alert of any malfunctions. Further, data collected via the gauges and sensors can be analyzed to track pressure and temperature over time.

CONDENSATE RETURN

In order to achieve optimal efficiency, it is critical that the plant install a condensate return system for delivering condensate back to the boiler. This will reduce cost of water treatment operations and will improve the overall output of the system.

ABOUT US

Inveno personnel are experts in the field of steam and condensate systems engineering.

Our services include design engineering, requests for quotations, standard operating procedures, root cause analysis, system optimization, steam balancing and project management. We can review your entire steam and condensate system from steam generation to distribution to end user processes and condensate recovery.

Inveno Engineering provides current and relevant world class steam system training globally. Please visit our website for our current training calander.

We also offer fully customized training. We have an extensive topic library of over 88 different steam subjects that can be tailored to in- depth training for you and your plant personnel.