BEST PRACTICE NO. 26

CONDENSATE SYSTEM PIPING OVERVIEW

SUMMARY

The best method for improving steam system energy efficiency, reducing chemical costs, and reducing make-up water costs is to return the maximum quantity of condensate to the boiler plant.

There are several factors that impact the reliability, performance, longevity, and maintenance requirements for the condensate piping system. Some of these factors are listed below:

- Condensate line sizing that factors condensate liquid, and flash steam quantities.
- Location of the condensate line with respect to the process equipment.
- Locations of the condensate branch line connection into the main condensate headers.
- Insulation techniques.

An important factor to increase overall steam system efficiency is to maximize the temperature of the returning condensate. This permits high thermal cycle efficiency for the overall steam system.

Figure 1

1. ENERGY

Condensate contains a relatively large percentage (16% in some cases depending on pressure) of the energy that is used to produce the steam. With today's rising energy costs, facilities must return all possible condensate back to the boiler plant. The condensate should be maintained in a high energy state or simply as hot as possible. A typical reason for condensate loss in the system is due to condensate component failure.

We will address the major reasons for component failure in this paper and provide recommendations to permit the plant chart a course on achieving energy savings with a proper operating condensate system.

2. CONDENSATE PIPING CODES

The Power Piping Code B31.1 describes the minimum requirements for construction of power and auxiliary service piping. B31.1 applies to condensate piping when the pressure and temperatures are greater than 100 psi. However, it is a recommended practice to apply these standards to all condensate systems.

3. MAINTENANCE

A reasonable condensate system design specification is to provide a reliable and long operational life span of twenty plus years without a primary condensate system failure. Plant personnel must assume that the designs of condensate systems shall include reasonable maintenance and plant services. Certainly, lacking a proactive maintenance plan will reduce the anticipated lifespan of the condensate system.

4. MATERIALS

The condensate pipelines themselves are potentially subjected to a damaging corrosive element in the form of carbonic acid. The recommended material to use for a condensate system is stainless steel. However, understanding the cost limitations to an all stainless steel condensate system, there are other alternatives.

Condensate piping should be at a minimum, schedule 80, carbon steel. Stainless steel greatly enhances the pipes ability to withstand the corrosive attack and therefore can provide a long reliable operational life. If carbon steel piping is used for economical consideration, schedule 80 pipe is used because of the heavier wall thickness which prolongs the life of the pipe in a corrosive environment.

5. CONNECTION TYPES

Welding the condensate pipe or using tubing with tube connectors will minimize leaks. Condensate pipe will expand and contract during normal thermal cycling of steam system operation unfortunately; steam component manufacturers provide a large number of components with threaded (NPT) connections. The threaded connections are inherently a weak point in the steam/ condensate system and will be the first item attacked by the corrosive carbonic acid particularly the threads near the bottom of the pipe.

Also, the threaded connections do not have the ability to withstand the expansion and contraction of the steam/ condensate system, therefore leaks will occur.

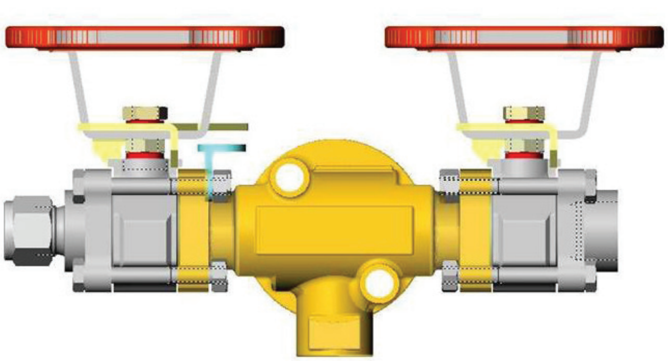

Figure 2

The most common condensate piping connections are listed below in order of preference:

- Welded joints.
- Tube material with tube connectors.
- Flanges.
- Threaded pipe only when necessary.

6. PIPE VS. TUBING

Tubing is an acceptable method of piping yet it is typically underutilized. Tubing provides an improved connection of steam components and other devices in the system. Welding smaller pipe sizes (below 1 in.) is time consuming and expensive. Using tubing material reduces the number of welds that are needed in an installation.

7. MAINTAINABILITY

Most mechanical systems operate at peak performance levels following a new installation. However, it is the design of the system's maintainability which really determines the resiliency and reliability of the system. The system's component, including piping, tubing, steam traps, condensate pumps, etc., must be designed and installed with the consideration of how maintenance will be accomplished. Frankly, if the devices are not accessible by plant personnel, there will be little or no maintenance performed and the overall system integrity will deteriorate.

8. CONDENSATE PIPE/TUBING SIZING

Correct sizing of condensate lines is calculated differently from sizing other fluids transferred in pipes. Although condensate is hot water, sizing a condensate line as if it were hot water would result in an undersized line. Undersized condensate lines will create excessive backpressure in the system and problems (maintenance and process) will occur in the system.

The key item to remember is that there are two major differences between condensate and hot water. Condensate lines will contain two phases, condensate (liquid) and flash steam (gas). Therefore, the correct size of a condensate line is somewhere between a hot water line and a steam line. With proper knowledge, a condensate line may be sized for the following:

- Condensate liquid load.
- Flash steam load.
- Neglect factor.

This is defined as steam loss resulting from faulty steam traps or open bypass valves. This is more common in systems than typically acknowledged. Blow-by steam will add steam flow to the return line and must be included in the calculations. Condensate that is free of flash steam may be pumped and sized as liquid only (single phase flow).

Condensate pipe velocities (liquid and flash steam) must be lower than 4500 feet per minute to prevent system water hammer and other damaging effects. Condensate piping velocities (liquid only) must be lower than 7 feet per second.

9. CORRECT IDENTIFICATION OF CONDENSATE TYPE

The placement of condensate return lines is crucial to insure proper operation of the process equipment. The first step is to understand and identify the type of the condensate line.

Gravity

- This describes all process equipment with a modulating inlet steam valve and a very low steam pressure application that the condensate return line must be at or close to atmospheric conditions. Therefore, the condensate drains by gravity to a vented (atmospheric) condensate collection tank.

Low pressure return

- Condensate return that is less than 15 psi.

Medium pressure

- Condensate return that is between 15 and 100 psi.

High pressure return

- Condensate return piping system pressures of 100 psi or higher.

Most of the condensate system problems are from the location of the condensate lines in a relationship to the heat transfer equipment, steam trap and other drainage type devices.

10. CONNECTING INTO THE CONDENSATE HEADER

It is imperative that all the condensate branch lines are connected into the top dead center of the main condensate header on a horizontal plane. This cannot be overstated and there is no exception to this rule.

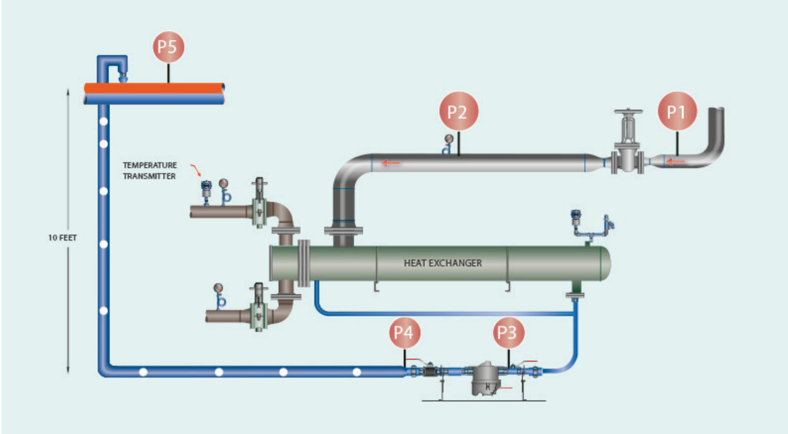

Figure 3

Improper condensate connections are listed below:

- Connection to the bottom of a condensate header.
- Connection to the side of a condensate header.
- Connection to a vertical condensate header.

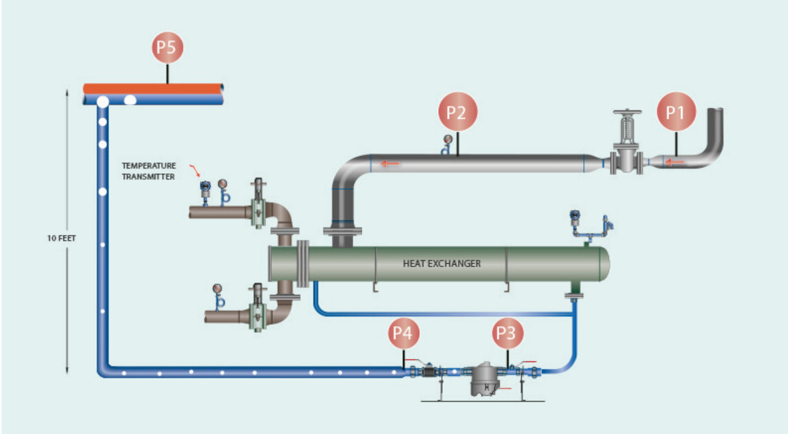

Figure 4

The condensate connections listed above will cause system problems. The primary issue or problem will be water hammer that will result from the improper connection location. Flash steam introduced to the main condensate header due to an improper connection location will interact with cooler condensate causing water hammer. Water hammer is the leading cause of premature component failures in a steam/condensate system.

11. PRESSURE GAUGES

Finally, a note regarding pressure gauges. These devices, when properly installed in the condensate return system are a great advantage to assisting in identifying the process and stem system malfunctions. If pressure gauges are not installed, always put the necessary taps in the system for a pressure gauge. This will allow maintenance personnel to install a gauge during troubleshooting procedures. It is necessary to include a siphon pipe (pigtail) and isolation valve with each pressure gauge. The isolation valve must be rated for the pressure and temperature of the operating system. Additionally, a liquid filled pressure gauge will be more resilient to system vibrations.

Figure 5

CONCLUSION

Condensate contains a high percentage of the energy (typically 16%) used to produce steam. Recover and return all possible condensate back to the boiler plant as hot as possible. Accept no component failure within three years of operation. Install components with maintenance in mind. Size condensate lines understanding the medium will be two phase flow. Utilize connections that minimize leaks. Understand the various pressures of condensate returns available in order to design the piping system with proper flow. Remember to allow for pressure gauge installations throughout system. These inexpensive devices are a key aid in troubleshooting the steam and condensate system. Following these rules will help to ensure a reliable and long life span of the condensate system.