Reliability Improvement
Solving Problems in Steam and Condensate Systems

By Novi Leigh

Overview
Steam is used widely in industrial plants and commercial buildings. In a facility where steam is used, steam generation, distribution, utilization and condensate return systems affect plant performance. Problems in steam and condensate-related systems can reduce plant safety and reliability, as well as unnecessarily increase utility costs. However, steam and condensate problems are commonly overlooked as long as the plant can maintain productivity.

The following describes problems in steam and condensate return systems that occurred in a commercial building due to improper design and sizing related to increased capacity or facility size.

Background
A hospital in Texas encountered problems in the building heating. The hospital has several air handling units (AHU). AHU performance is very important in order to provide comfortable room conditions. Steam or hot water is used to supply heat in reheat coils. There are 12 AHUs utilizing steam, with the remainder using hot water for the reheat coils.

Although all condensate lines are connected to the main that is routed to the tunnel, the 12 steam-using AHUs drain condensate to the sewer. Due to back-pressure problems in the condensate return system, the system cannot provide sufficient building heating without dumping the condensate. A vacuum pump installed to withdraw the condensate keeps failing.

Problems Encountered
Figure 1 illustrates the existing diagram of the steam and condensate system.

The AHU reheat coils are supplied with 5 psig steam during summer. The steam pressure can go up to 12 psig during a severely cold winter. Vacuum pump failure again results in condensate from AHUs being dumped to the drain.

The problem in the condensate return system of the AHUs is an insufficient pressure differential to move condensate through the steam trap. This is due to the "stall" condition. Stall occurs primarily in heat transfer equipment where steam pressure is modulated to obtain a desired output. During mild winters, the heat load for space heating is less. Due to light load demand, it requires a lower pressure of steam. The vertical lift of the condensate line makes the condition worse, because it causes back-pressure problems in the condensate line.

Condensate from high-pressure and low-pressure drip traps, AHUs, and heat exchangers are tied into the same line and collected in flash tanks (FT). The flash tanks are supposed to produce low-pressure steam. The flash steam line from the top of the flash tanks is tied into the LP steam main but no check valve is installed on this line. Practically, the flash tanks cannot produce LP flash steam. LP flash steam can be produced only if high-pressure condensate is discharged to it. The only source of high-pressure condensate is the drip trap. The heat exchangers and some drip traps that discharge condensate to flash tanks operate at low pressure.

Discharging condensate from multiple pressure steam lines into the same condensate return line can create problems. The flash steam from the high-pressure condensate and the possible leaks from the failed traps tend to pressurize the line and restrict the discharge of the low-pressure condensate.

There are two condensate receivers with electric-motor-driven pumps in the tunnel. Condensate
from these receivers is pumped to the main collection tank that is located in the boiler house. Another steam trap discharge from a hot water converter in the penthouse is tied into the pumped condensate line from the tunnel.

Mixing pumped condensate and trap discharge can create problems. Trap discharge is basically a mixture of condensate and flash steam, whereas condensate from pump discharge is pressurized and at a lower temperature. This biphase system can create water hammer. It has tremendous and dangerous force that can overstress gauges, bend mechanisms, rupture fittings and heat exchange equipment and even expand piping.

The root cause of the problem in the building is the failing condensate return system. Poor condensate return causes major energy losses and insufficient heating. Most steam users have condensate return systems that do not function properly due to the back-pressure and pump failure problems.

**Proposed Measures**

The key points to solve the problems are:

- Avoid the vertical lift of condensate lines.
- Avoid the mixing of condensate from high-pressure and low-pressure discharge on the same line.
- Avoid the mixing of condensate from trap discharge with pumped condensate on the same line.

Therefore, the following measures are recommended:

1) Install a pump trap with a receiver to collect the condensate that allows gravity drainage.
2) Drain condensate from high-pressure drip traps to sewer. Collecting condensate from
high-pressure drip traps in a separate collection system is not feasible economically.

3) Route steam trap discharge from the converter in the penthouse directly to the vented receiver in the tunnel.

It is necessary to install a new main line to handle condensate from all sources in the building. Flash tanks can be eliminated, as they do not function properly due to incorrect installation. Figure 2 illustrates the proposed measures to fix the problems.

**Conclusion**

Steam and condensate systems need to be reviewed when plant capacity increases. The efficiency of steam-using equipment is also dependent on the efficiency of condensate drainage arrangements. Only properly sized steam and condensate piping as well as other steam system components can assure an efficient system.

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