BEST PRACTICE NO. 18

INVENO ENGINEERING

FLASH STEAM

WHY IT OCCURS AND HOW TO CALCULATE

1. DEFINITION OF FLASH STEAM

Question:
Figure 1 depicts a process application. The steam pressure to the steam process is 100 psig @ 338°F. What is the temperature of the condensate before the steam trap?

Answer:
338°F. The condensate is not at a lower temperature, but in reality, it is the same temperature as the pressure. When condensate passes through the discharge orifice of a steam trap, the high temperature condensate will see a lower pressure, thus leading to the occurrence of flash steam.

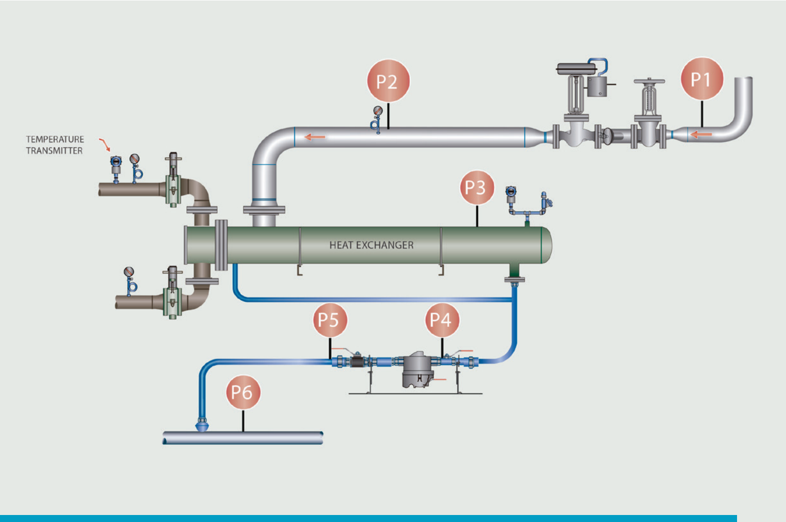

Figure 1: Process Application

Any given saturated steam or condensate pressure has specific values for temperature, sensible heat, latent heat, and specific volume associated with it, which are listed in the steam tables. Condensate at a given pressure discharged into an area of lower pressure automatically adjusts the condensate temperature to the saturated conditions and other values at the lower pressure.

Figure 2: Steam Trap – Discharging Flash

A specific amount of heat energy is released for each lower-pressure condition. The heat energy that is released causes an effect called flash steam, which is a percentage of condensate being re-evaporated into steam at the lower pressure. This phenomenon is called flashing, and the resultant steam is called flash steam.

Review: When high-pressure condensate (with a higher energy content) is discharged through a steam trap, control valve, or other device to a lower-pressure area (condensate return line, flash tank, or other system), the condensate liquid temperature must be at the same saturated condition of the lower pressure. To reduce the temperature of the condensate to the lower pressure, a percentage of the condensate is flashed into steam.

2. WHAT DOES FLASH STEAM AFFECT?

Flash steam can lead to:

- Lost energy
- Increased chemical cost
- Increased makeup water usage
- Water hammer, if not properly piped

To avoid these problems, consider the following issues when dealing with flash steam:

- Condensate return line sizing
- Condensate receiver tank vent sizing
- Steam system testing
- Steam trap discharge piping

The piping sections of this training manual will discuss how to size condensate return lines for flash steam.

3. WHAT IS THE QUANTITY OF FLASH STEAM?

FThe steam tables indicate that each pound of condensate at 100 psig contains 309 Btu (sensible energy), and each pound of condensate at 0 psig or atmospheric pressure condensate contains 180 Btu (sensible energy). High-pressure condensate, therefore, contains 309 Btu (100 psig) sensible energy — 129 Btu's more energy than at zero pressure or 180 Btu's.

To put this in terms of energy conservation, 129 Btu of heat energy are released into the atmosphere and wasted from each pound of condensate returned to the boiler operation if not recovered in the condensate system.

Since the latent heat of steam at atmospheric pressure (0 psig) is 970 Btu per pound of steam at atmospheric conditions, the following equation indicates how many pounds of steam would be produced:

$$\frac{129}{970} = 0.133 \text{ lb.}$$

That 0.133 lbs. of steam will be liberated or flashed off each pound of condensate returned at atmospheric conditions. The flash loss can be calculated for any condition by solving the following formula:

$$\% \text{ Flash Steam} = \frac{[SH - SL]}{LHL}$$

SH: Sensible heat in condensate at higher pressure
SL: Sensible heat in condensate at lower pressure
LHL: Latent heat in the steam at the lower pressure to which the condensate has been discharged.

Given the same conditions, the equation would be:

$$\% \text{ Flash Steam} = \frac{[309 - 180]}{970} = .13.3$$

3.1. Example of Energy Recovery

Process steam consumption:	12,000 lbs. per hour
Process steam pressure:	125 psig
Process steam load:	Modulating
Condensate return pressure:	0 pressure
SH @ 125 psi:	324
SL @ 0 pressure:	180
LHL @ 0 pressure:	970
Percentage of flash:	0.148
Amount of flash steam:	1,776 lbs. per hour
Cost of steam:	$14.80 per thousand lbs.
Loss per year:	**$227,100.00 (24/7 @ 360 days a year)**

This would be the loss if not recovered.

3.2. Energy Loss Example 1

The vent in Figure 3 is flashing 6,100 lbs. per hour (24 hours a day) for 360 days. What is the energy loss?

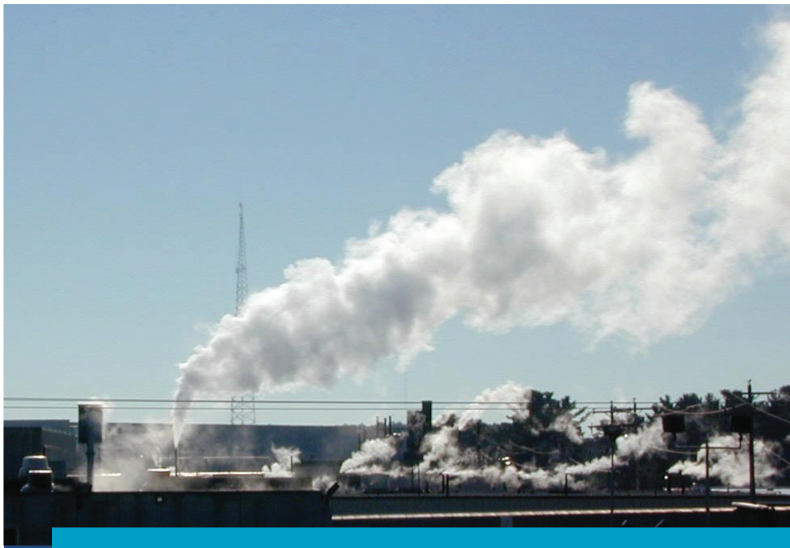

Figure 3: Energy Loss Example 1

3.3. Energy Loss Example 2

The vent in Figure 4 is flashing 2,800 lbs. per hour (24 hours a day) for 360 days. What is the energy loss?

TABLE 1

Initial Steam Pressure in psig	Saturated Temperature in ˚F	Flash-tank Pressure in psig or Condensate Line Pressure										
		05		10	20	30	405	07	5	100	125	150
25	267	5.7	4.1	2.0	1.0	0	0	0	0	0	0	0
50	298	9.0	7.4	6.2	4.3	2.6	1.0	0	0	0	0	0
75	320	11.3	10.8	8.6	6.7	5.0	3.7	2.5	0	0	0	0
100	338	13.3	11.7	10.6	8.7	7.0	5.7	4.6	2.2	0	0	0
125	353	14.8	13.4	12.2	10.3	8.7	7.4	6.3	3.8	1.7	0	0
150	366	16.8	14.8	13.7	11.8	10.2	8.8	7.8	5.4	3.4	1.6	0
175	377	17.4	16.0	15.0	13.0	11.6	10.0	9.0	6.7	4.6	3.0	1.5
200	388	18.7	17.5	16.2	14.4	12.8	11.5	10.4	8.0	6.0	4.4	2.8
225	397	19.7	18.2	17.0	15.4	13.8	12.4	11.4	9.0	7.0	5.4	3.8
250	406	20.7	19.2	18.2	16.4	15.0	13.6	12.5	10.0	8.2	6.6	5.0
300	422	22.4	21.0	20.0	18.2	16.7	15.5	14.4	11.0	10.0	8.5	7.0
350	436	24.0	22.7	21.6	20.0	18.4	17.0	16.0	13.8	12.0	10.4	8.9
400	448	25.5	24.2	23.0	21.5	20.0	18.7	17.7	15.6	13.5	12.0	10.5
450	459	26.8	26.7	24.4	22.7	21.2	20.0	19.0	16.8	15.0	13.4	12.0
500	470	28.2	25.7	25.7	24.0	22.6	21.4	20.4	18.2	16.4	14.6	13.4
550	480	29.2	27.8	27.0	25.3	23.7	22.6	21.6	19.5	17.5	16.0	14.7
660	448	30.2	28.8	28.0	26.4	25.0	23.6	22.7	20.5	18.7	17.3	16.0