PLANT ENGINEERING

POWER SYSTEMS

Best practices for ultrasound testing of steam traps

Follow these steps to use ultrasound testing for steam traps with inverted bucket operation, float and thermostatic operation, thermodynamic operation, and thermostatic operation.

BY KELLY PAFFEL, SWAGELOK COMPANY MAY 12, 2011

The most versatile and accurate steam system diagnostics tool kit available today is ultrasonic testing equipment. Ultrasonic steam trap testing is the final test method in the steam trap testing program for detecting faulty steam traps.

The ultrasonic unit allows the operator to hear sounds undetectable by the human ear. This equipment receives a high-frequency signal (typically between 20 and 100 kHz) and heterodynes the signal, providing an audible sound for the operator to hear with the aid of headphones. The sensitivity of most high-frequency monitoring equipment allows the testing person to hear not only completely failed steam traps (blowing steam), but even leaking steam from a steam trap in operation. This test method provides early signal of steam trap wear and is a predictive tool for steam trap monitoring.

The operator uses the stethoscope module to contact the discharge side of the steam trap, and has the ability to sense and detect subtle changes in operational characteristics or malfunctions.

Ultrasonic testing permits the testing person to hear the internal operation of the steam trap to determine the effectiveness of the steam trap operation. When listening to the ultrasound testing unit, remember that condensate will crackle and steam will whistle during testing with the ultrasound equipment.

What Are the Correct Settings?

20 to 150 psi = 80% to 85%

150 to 300 psi = 74% to 78%

300 to 600 psi = 60% to 65%

600 psi or higher = comparison method

Selecting Testing Procedure

Simplify testing of steam traps by classifying all steam traps as follows:

- On/Off operation
- Continuous flow

Comparison Method

When testing a steam trap, use the comparison method. The comparison method includes taking a minimum of three or more individual ultrasonic readings upstream and downstream of the steam trap. When using the comparison method, adjust the sensitivity to achieve an accurate test of the steam trap performance.

Discharge Orifice of the Steam Trap

To test using ultrasound, the measurement must be downstream of the discharge orifice of the steam trap. The downstream location is the location of the highest and clearest ultrasound generation.

Inverted Bucket Operation

1.) Points about the steam trap

a. Mechanical steam trap

b. (On/off operation)

c. Test point – downstream of the discharge orifice

2.) Visual inspection

a. The steam trap should be level to the eye.

b. Check the flow arrow to ensure correct installation of steam trap.

3.) Temperature measurement

a. Take temperatures before and after steam trap.

b. If temperatures are below 212 F or 100 C, the steam trap is not in operation.

c. Take temperature at the process inlet. Temperatures at the process inlet and the steam trap inlet will be relatively close

b. Long off periods can cause “loss of prime.”

5.) Discharge operation (discharging condensate)

a. When the inverted bucket drops due to the loss of buoyancy, this will bring the valve away from the discharge orifice. This action will allow the steam trap to discharge the condensate.

b. The ultrasound indicator will rise due to the increase in ultrasound from the discharge cycle. The ultrasound will stay high or full scale until discharge of condensate from the steam trap. The ultrasound level (meter) should deflect more than 30% of scale.

c. When condensate is completely discharged, the inverted bucket will rise, due to buoyancy, and bring the valve in contact with the discharge orifice. The steam trap is now in the off position. The ultrasound level should be at zero or minimum.

d. Ultrasound level should proceed to full or high ultrasound level during the discharge cycle and return to minimum scale reading or zero after the discharge is complete.

e. Condensate will crackle and steam will whistle during testing with the ultrasound equipment; therefore, during the cycling, there will be a crackling and whistling sound during the discharge cycle (steam and condensate passing through the orifice of the steam trap).

f. The steam trap should stay in the off position for at least 15 seconds before cycling, or less than 15 seconds if the steam trap is undersized.

g. Discharge – ultrasound meter should increase the ultrasound level

h. The steam trap has a fast on/off operation.

6.) Light condensate load operation

a. Ultrasound levels will cycle on and off at low ultrasound levels. This is an indication of low condensate flows.

7.) Failure modes

a. Leaking steam:

Steam trap valve wear or linkage will cause the steam trap to leak steam (se

e below)

The following are

indicators of leaking steam:

- Ultrasound meter does not return to zero or baseline after condensate discharge cycle.
- Ultrasound levels are continuous off baseline and there is not distinct cycle/no cycle operation.

- Ultrasound meter is at full scale
- Hearing a dominant whistling sound and no crackling

Float and Thermostatic Operation

1.) Points about the steam trap

a. Mechanical steam trap

b. Continuous condensate flow operation

c. Test point – When testing the float and thermostatic design steam trap, two points must be tested. The float and thermostatic design has two discharged orifices, one for the removal of condensate (main discharge orifice) and an air vent orifice for the removal of air and non-condensable gases.

2.) Visual inspection

a. Steam trap should be level to the eye.

b. Check to make sure the float is in the correct position.

c. Check flow arrow to ensure correct installation of steam trap.

3.) Temperature measurement

a. Take temperatures before and after steam trap.

b. Temperatures below 212°F or 100°C, steam trap is not in operation.

c. Take temperature at the process inlet. Temperatures at the process inlet and the steam trap inlet will be relatively close.

4.) Off position during operation

a. This very seldom happens, because the steam trap always allows discharge of condensate.

b. Ultrasound level should be low or zero on the ultrasound meter.

5.) Discharge operation (discharging condensate)

a. When the condensate levels increase in the steam trap, the buoyancy of the float will bring the valve away from the discharge orifice. This action will allow the steam trap to discharge the condensate on a continuous basis.

b. The ultrasound indicator will rise due to the increase in ultrasound during the discharge cycle. The ultrasound level will have some cycling to the measurement due to the linkage arrangement.

c. The testing person must check the air vent to ensure proper operation. The level of the air vent ultrasound should be less than the level of the condensate discharge orifice ultrasound.

d. Condensate will crackle and steam will whistle during testing with the ultrasound equipment; therefore, during the cycling, there will be a dominant crackling and whistling (very small amount)

f. The steam trap has a slow continuous operation.

g. See below test points

- A – Condensate discharge
- B – Air Vent
- Air vent ultrasound must be lower in ultrasound levels than the condensate discharge orifice

6.) Failure Modes

a. Leaking steam: Steam trap valve wear or linkage will cause the steam trap to leak steam.

The following are indicators of leaking steam:

- Ultrasound meter is steady, there is no cycling action
- Very little or no crackling sound

b. Blowing steam: Steam trap valve or linkage failure will cause the steam trap to blow steam directly through the steam trap.

The following are indicators of leaking steam:

- Ultrasound meter is at full scale
- Hearing a dominant whistling sound and no crackling

c. Air Vent Failure: Steam trap air vent device has failed. The following is an indicator of air vent failure:

- Air vent ultrasound is higher than the condensate discharge air vent

7.) Free Float Steam Traps

a. Use same test methods as the standard float and thermostatic steam trap

Thermodynamic Operation

1.) Points about the steam trap

a. Thermodynamic steam trap

b. On/off operation

c. Test point – downstream of the discharge orifice

2.) Visual inspection

a. Steam trap should be in a horizontal plane

a. Take temperatures before and after steam trap

b. Temperatures below 212°F or 100°C, steam trap is not in operation

c. Take temperature at the process inlet. Temperatures at the process inlet and the steam trap inlet will be relatively close

4.) Off position during operation

a. Ultrasound level should be low or zero on the ultrasound meter

b. Steam trap should be in the off position for more than 15 seconds

5.) Discharge Operation (discharging condensate)

a. When the steam pressure is above the disc, the steam trap will discharge the condensate or steam

b. The ultrasound indicator will rise due to the increase in ultrasound due to the discharge cycle. The ultrasound will stay high or full scale until condensate or steam is discharged from the steam trap. The ultrasound level (meter) should deflect more than 30% of scale

c. Steam (live) or flash steam passing under the disc will cause a pressure drop to occur, and the steam trap will shut off. The steam trap is now in the off position. The ultrasound level should be at zero or minimum.

d. Ultrasound level should proceed to full or high ultrasound level during the discharge cycle and return to minimum scale reading or zero after the discharge is complete.

e. Condensate will crackle and steam will whistle during testing with the ultrasound equipment; therefore, during the cycling there will be a crackling and whistling sound during the discharge cycle (steam and condensate passing through the orifice of the steam trap).

f. The steam trap should stay in the off position for least 15 seconds before cycling (less than 15 seconds the steam trap is passing live steam and is an energy loss).

g. Discharge – ultrasound meter should increase the ultrasound level.

h. The steam trap has a fast on/off operation.

6.) Failure Modes

a. Leaking steam: Steam trap valve (disc) wear or seat surface wear will cause the steam trap to leak steam. The following are indicators of leaking steam:

- Ultrasound meter does not return to zero or baseline after condensate discharge cycle
- Ultrasound levels are continuous off baseline and there is not distinct cycle/no cycle operation

b. Blowing steam: Steam trap valve (disc) or seat wear will cause the steam trap to blow steam directly through the steam trap. The following are indicators of leaking steam:

Thermostatic Operation

1.) Points about the steam trap

a. Thermostatic operation

b. On/off operation

- Slow movement per the cycle

c. Test point – downstream of the discharge orifice

2.) Visual inspection

a. A steam trap can be mounted in any position. The steam trap should be mounted at eye level.

b. Check flow arrow to ensure correct installation of steam trap.

3.) Temperature measurement

a. Take temperatures before and after steam trap.

b. Temperatures below 212 F or 100 C, steam trap is not in operation.

c. Take temperature at the process inlet. Temperatures at the process inlet and the steam trap inlet will be relatively close.

4.) Off position during operation

a. Ultrasound level should be low or zero on the ultrasound meter.

5.) Discharge operation (discharging condensate)

a. When the temperature of the condensate is reduced to the sub cool point of the steam trap, the bellows will contract pulling the valve away from the discharge orifice. This action will allow the steam trap to discharge the condensate

b. The ultrasound indicator will rise due to the increase in ultrasound due to the discharge cycle. The ultrasound will stay high or full scale until condensate is discharged from the steam trap. The ultrasound level (meter) should deflect more than 30% of scale

c. When condensate is completely discharged, the temperature in steam trap cavity will increase, causing the bellows to expand into the discharge orifice and shutting the steam trap off. The steam trap is now in the off position. The ultrasound level should be at zero or minimum

d. Ultrasound level should proceed to full or high ultrasound level during the discharge cycle and return to minimum scale reading or zero after the discharge complete

e. Condensate will crackle and steam will whistle during testing with the ultrasound equipment; therefore, during the cycling there will be a crackling and whistling sound during the discharge cycle

6.) Light condensate load operation

a. Ultrasound levels will cycle on and off at low ultrasound levels. This is an indication of low condensate flows

7.) Failure Modes

a. Leaking steam: Steam trap valve wear or linkage will cause the steam trap to leak steam. The following are indicators of leaking steam:

- Ultrasound meter does not return to zero or baseline after condensate discharge cycle
- Ultrasound levels are continuous off baseline and there is not distinct cycle/no cycle operation

b. Blowing steam: Steam trap valve or linkage failure or over sizing (loss of prime) will cause the steam trap to blow steam directly through the steam trap. The following are indicators of leaking steam:

- Ultrasound meter is at full scale
- Hearing a dominant whistling sound and no crackling

For more information, visit www.swagelokenergy.com

The above material is part of Swagelok Energy Advisors' series of Best Practice papers, authored by Kelly Paffel. Kelly is a recognized authority in steam and condensate systems. He is a frequent lecturer and instructor on the technical aspects of steam systems. In addition, Kelly has published many papers on the topics of steam system design and operation. Over the past 30 years, he has conducted thousands of steam system audits and training sessions in the United States and overseas, which has made Kelly an expert in trouble-shooting actual and potential problems in the utilities of steam. Kelly is a member of the U.S. Department of Energy's (DOE) Steam Best Practices and Steam Training Committees.

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