Steam trap test methods cut costs and save energy

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Determining whether or not a steam trap is working properly is often a mystery in a steam distribution and condensate return system. In most cases, it is impossible to see inside a working steam trap because it is made of steel, stainless steel, or cast iron. An untrained person can only guess. Guess right and your energy bill drops. Guess wrong and steam losses add up.

For example, 10 steam traps, each with 1/4-in. orifice on 125-lb steam service and blowing steam, waste 150-lb steam/hr. If it costs $5 (including fuel, makeup water, chemicals, and related powerhouse expenses) to generate 1000 lb of steam, each trap wastes $6300 or a total of $63,000 annually. (The per-trap figure was calculated on this basis: 150 lb/hr X 24 hr/day X 350 days/yr X $5/1000-lb steam.)

In addition, two smaller process traps with a 1/8-in. orifice on 30-lb service are blowing steam at 12 lb/hr. Lost steam from these two traps adds up to more than $1000/yr, for a grand total of $64,000 in annual steam losses.

With this economic incentive in mind, benefits of learning to test steam traps and understanding how each type operates are apparent. There are four basic ways to test steam traps: temperature, sound, visually, and electronically.

Key concepts

Failed or improperly working steam traps waste energy and hike bills.

There are four basic ways to test steam traps: temperature, sound, visually, and electronically.

Understanding trap operating characteristics and learning to test them properly are critical to any effective program.

Temperature method

Steam traps are tested primarily to determine if they are functioning properly and not letting live steam blow through. Measuring the external temperature of the inlet and outlet pipes gives a rough indication of the system's upstream and downstream pressures, assuming the traps are supplied with saturated steam. Although the technique of measuring the temperature differential across the trap is easy, it does not always indicate if the trap is blowing steam

For example, back pressure in a manifold arrangement may increase because one or more traps is blowing through. In this case, back pressure and temperature on all traps on the system rise. When the return piping size is large enough, the failed trap may not cause a rise in back pressure and the temperature differential does not change.

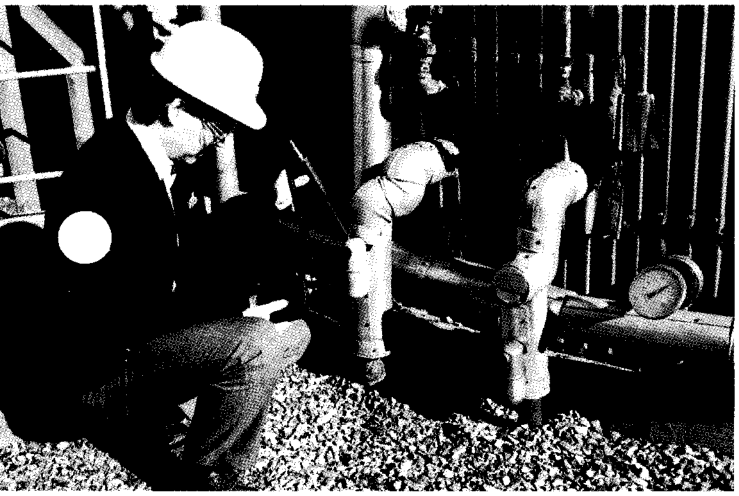

Fig. 1. Sound testing equipment with readout gauges or digital indicators can be adjusted to filter out background noise that can interfere with accurate readings.

In general, the temperature method is the least accurate of the four and should not be the only means used to test trap operation. However, the method is a good starting point because it determines if the trap is hot or cold, an indication of whether steam is coming to the trap.

There is a range of temperature testing techniques.

- ❖ ***Color change:*** Heat sensitive crayons, paints, and stick-on strips change color when the temperature rises above a predetermined level.
- ❖ ***Pyrometer:*** In this more sophisticated approach, the device is placed on the piping to provide a readout of the temperature level.
- ❖ ***Infrared testing:*** An infrared gun is aimed at the trap to sense the heat level. It can be used when the trap is not easily accessible.

All of these techniques are equally effective. Each type indicates by temperature whether the trap is hot or cold. If the trap is cold, it may have failed closed, the steam is shut off, or the system is plugged.

Sound method

The sound method is more reliable, but takes a trained ear to distinguish a trap discharging normally from one discharging live steam along with condensate. Using the sound method requires knowledge of the operating principles and failure modes of the various types of traps.

Sound test methods range from placing the metal end of a screwdriver on top of the trap and the other end against an ear, to using sophisticated stethoscopes and probes. Some devices are even equipped to print out data. Other sound testing products feature readout gauges, charts, and analog or digital indicators.

It is important to filter out background noises, such as pumps, other traps, process equipment, etc., to get a more accurate reading (Fig. 1). When several traps drain to a single header, filtering the noise is more difficult because the sound may travel between the traps through the piping.

A number of listening devices are available. Certain ones filter out all but specific frequencies. Some can be extended on a long pole to reach out-of-the-way traps. Even if a listening device is equipped with an optical gauge or dial, it should also have earphones for a more definitive analysis (Fig. 2).

Using sound testing equipment makes the internal operations of the trap audible. However, the tester must be properly trained to detect deviations from a normal, working steam trap.

Visual method

The visual approach better predicts if a trap is functioning the way it should. As long as the steam system returns condensate to the boiler, the method requires only a pair of discriminating eyes and a three-way valve or a pair of test valves, one on either side of the trap. In addition, the piping configuration must let the operator shut off the condensate return line and allow the trap to discharge to atmosphere.

Fig. 2. A technician uses earphones to analyze the condition of this inverted bucket trap more precisely. Earphones should be used even if the sound test equipment is equipped with an optical gauge or dial to obtain a better analysis.

This test method requires an experienced, trained observer. When condensate reaches the atmosphere, a portion of it immediately flashes to steam. Only a well-trained eye can distinguish between the flash and live steam. Live steam escapes from a trap during or following condensate discharge at a much higher velocity than flash steam. Flash steam appears as a lazy white cloud.

If a valve is placed upstream of the trap, it should be shut off for several minutes to let condensate back up in the line. When the valve is opened, backed-up condensate enters the trap so that the trap can be seen or heard handling more condensate. If live steam following the condensate is evident, the trap likely is leaking steam.

If the system includes a bleed-off valve upstream, the condensate may be drained to reduce the load. If the trap valve is worn, steam can be seen or heard leaking through.

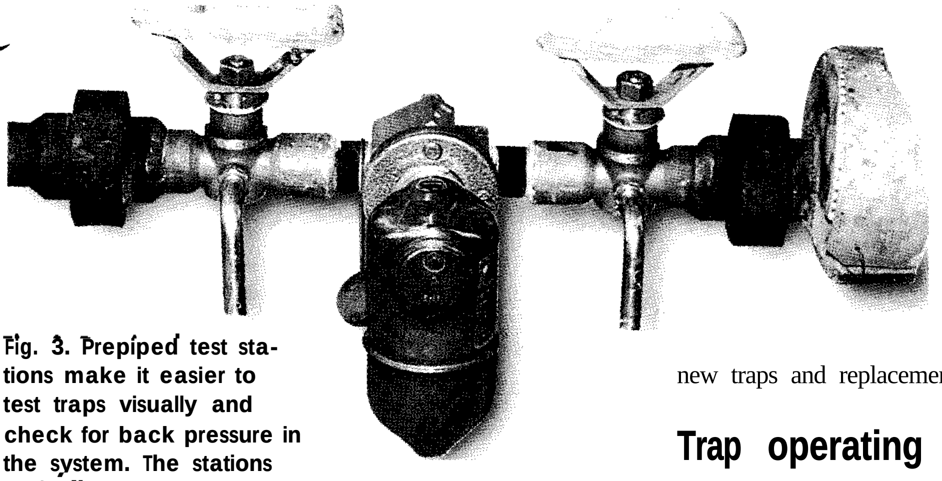

Fig. 3. Prepiped test stations make it easier to test traps visually and check for back pressure in the system. The stations typically include three-way valves on either side of the steam trap.

In both or these options, the person doing the testing can change the condensate load to the trap and observe the corresponding discharge characteristics. If the trap does not respond as it should, it may have failed and should be replaced.

Trap test stations (Fig. 3) are available prepiped with the required traps and valves. Failed traps on the test station can be easily replaced in about 10 min by removing a few bolts.

Electronic method

Several trap manufacturers now offer proprietary tools to make testing easier, quicker, and more accurate. These products identify potentially failed traps by sensing heat or measuring variables across the trap. Some tools are designed specifically for a particular type of trap. One such tool for inverted bucket traps can analyze conditions in seconds with the trap online and in service.

Among the advantages of these devices is the reduction of time required to test each trap physically. For instance, a steam trap survey shows that 75% of the traps in a plant are operating properly. Locating the 25% that had failed meant checking every one in the system. Electronic test equipment lets failed traps be identified rapidly without investing hundreds of hours testing the 75% that are functioning properly.

This method requires minimal training and is highly accurate. Field tests show 100% accuracy for traps that are closed or blowing through. A steam leak is isolated more quickly than with either sound or visual methods.

Electronic testing uses a multiple-sensing probe inserted into the bottom of an inverted bucket steam trap (Fig. 4A and 4B). The probe detects the presence of condensate beneath the bucket and determines the temperature. Data are processed through a PC or PLC and transmitted by modem to any location, local or remote.

The sooner a trap is identified as an energy waster, the sooner it can be replaced. Because electronic testing requires minimal labor, traps can be tested more frequently and failures identified earlier. Replacing failed traps promptly minimizes energy waste. Good traps misdiagnosed as failed by less reliable test techniques no longer need to be routinely replaced, saving the expense of unnecessary new traps and replacement labor.

Trap operating characteristics

The type of trap and its operating characteristics affect performance evaluation. All traps may fail either open or closed.

Inverted bucket traps

This continuous drainage, intermittent discharge-type trap discharges at full capacity, then shuts off. The on/off discharge can be seen and heard. The bucket suspended from the action lever creates a distinctive muffled rattle against the outer chamber, a normal action not indicative of impending failure. Certain models are designed to accommodate advanced, under-the-bucket sensing probes. Such testing devices let a trap failed closed or blowing steam be identified instantly and accurately.

If the air vent at the top of the bucket plugs, trapped air and noncondensable gases cause the trap to fail closed. Because condensate discharges from the top of the trap, dirt is not likely to plug the discharge orifice or bucket vent. The continuous discharge or *dribble* that occurs in this type of trap under some conditions, such as low condensate load, is normal and the trap is functioning normally. It is neither defective nor wasting steam.

Thermostatic traps

The three basic types of thermostatic traps are bellows thermostatic, wafer thermostatic, and bimetallic. The operating characteristics and testing procedures for all three are essentially identical. However, the failure mode varies with the trap's design. Typically, the failure mode is progressive wear and an increasing volume of steam leakage. These modulating devices normally discharge continuously when condensate is present, but may also cycle intermittently.

A sound test reveals the rush of condensate and hiss of flash steam. If a small component of the hissing sound is live steam, it is generally difficult to quantify. As live steam increases, the sound becomes more intense and discernible. Learning to test thermostatic traps takes longer than with any other type because of the trap's operating characteristics. Distinguishing between flash and live steam is among the most difficult test techniques.

Electronic trap testing

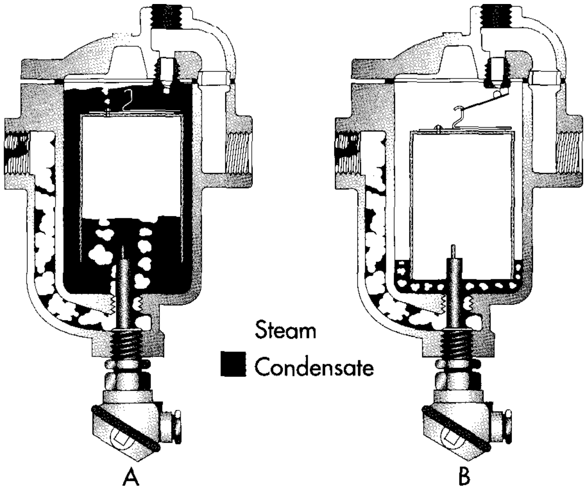

Fig. 4. Electronic testing is easy, fast, and accurate. A multiple-sensing probe in the bottom of the trap detects the presence of condensate and determines the temperature. When the probe makes contact with condensate (A), it indicates an appropriate level. Temperature is also measured and an acceptable signal given if the reading is within a predetermined range. An exposed probe (B) signals a low condensate level which could indicate leaking, loss of prime, or live steam blow-through.

Float and thermostatic traps

These modulating devices have two valves. A thermostatic element opens one valve to vent accumulated air. Under normal operating conditions, sound of air can be heard rushing through the orifice on startup. Testing the operation of a thermostatic element that is venting air is difficult. However, sound of a failed-open valve is continuous and more intense than the sound of air being discharged normally.

The condensate orifice fails primarily because of valve and seat wear and can fail open or closed. Because the discharge valve is at the bottom of the trap, the top cause for an F&T trap to fail open is dirt or scale, which accumulates in the valve and keeps it from seating securely. Testing a trap with an orifice that has failed open requires the ability to distinguish between the sounds of condensate, live steam, and flash steam.

The visual method is effective when the trap has a gauge glass. When the condensate level in the trap drops to the orifice level, it blows steam. The water level must be high enough so that the float functions properly. The ball float that activates the trap's condensate orifice may rupture or collapse causing the float to malfunction and the trap to fail closed.

Disc traps

This trap should be sound tested inline. Cycling of the disc trap is audible because the valve slams against the seat as it opens and closes. If the valve or seat is worn, the sound of steam leaking through can be heard. Cycling rates of 15-20 times/min indicate some wearing of the valve or seat. A rapid, machine-gun-like cycle suggests the trap has failed and is blowing live steam. Additional wear will result in steady blow-through.

Pouring water on top of some types of disc traps makes the internal operation more audible as the trap warms and begins to cycle. This technique alters the internal cycle action of the trap intentionally.

Testing the trap visually should be done with extreme caution because the disc trap cannot withstand back pressure in the range of 50% of the inlet pressure. There is no back pressure when the trap discharges to atmosphere and performance may not reflect inline conditions. Identifying a failed trap is most difficult when many disc traps are installed in a system with a condensate return manifold. Should one trap in the system fail, back pressure may become high enough so that all traps start to fail.

Learning to test steam traps properly to determine if they are functioning as they should saves a significant amount of money. With energy costs as high as they are today, it takes only a few failed traps to generate steam losses of a sizable magnitude. Knowing when traps fail is the key to savings.

Temperature sensing is the least reliable test method available and should be used only for preliminary examination to determine if steam is reaching the trap. Visual testing, when combined with the sound method, reliably indicates how traps are performing. Electronic diagnostic testing is highly accurate for testing certain types of steam traps because it senses actual conditions inside the trap.

Although every plant typically has a wide range of steam traps, each requiring a different test protocol, learning to apply all the various test techniques is a wise investment. A regularly scheduled, conscientious steam trap testing program pays for itself quickly in energy savings and heightened efficiencies.

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