The troublesome condensate trap: The rest of the story

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■ The condensate trap is one of the most deceptive, trouble-prone, and cost-burdening components in the hvac system. When installed in a draw-through system, it causes property damage and maintenance effort which, during the life of the system, may cost the owner/user more than the price of the original equipment.

Moreover, the indoor air pollution that inevitably accompanies trap failures adds to building owners/users' costs in terms of health care, absenteeism, low productivity, and even litigation.

In the past, the problems caused by the condensate trap have been virtually ignored by the industry. However, in recent years, the extent and magnitude of these problems have reached such proportions that it is no longer possible to ignore them.

An article in the November 18, 1996 issue of *The News*, titled "Don't get caught in a (condensate) trap of your own" correctly identifies some, but certainly not all, of the many problems associated with the condensate trap.

These and other more serious trap problems are discussed in Reference 1 (page 12). In this reference, condensate trap problems were divided into three categories: (1) inherent trap deficiencies, (2) trap design deficiencies, and (3) common and unwise field practices.

The article identified and offered viable remedies for many problems in the last two categories. But the most critical problems, those in the first category, inherent trap deficiencies, were only indirectly addressed. The responsibility for overcoming these deficiencies was passed on to others in the industry, by stating the need for "proper" trap design, "proper" system start-up procedures, and "proper" maintenance.

With these provisions, the previous article gave the condensate trap endorsement as an acceptable drain seal, as stated in the last two paragraphs of the article: "Condensate drain traps are the accepted standard for evacuating condensate water from the hvac system without allowing the inflow of air. Proper trap design, system start-up procedures, and maintenance (debris removal, water level checks, etc.) will result in a functional and worry-free trap. A good place to start is to carefully follow the equipment manufacturer's trapping instructions."

The few simple measures discussed here can prevent a wide array of serious problems, such as property damage, health concerns, and even litigation.

The observation that condensate traps are the accepted standard for use with draw-through hvac systems is correct in that it is accepted by most equipment manufacturers, system designers, and mechanical contractors.

For building owners/users, however, the trap is far from acceptable and definitely cannot be regarded as worry-free. That is why it is important to tell the rest of the story.

Depending on the specific conditions under which a condensate trap must operate, its successful use as a drain seal varies between impractical and impossible.

This is because it is not possible to overcome the inherent trap deficiencies by so-called "proper" trap design, "proper" system start-up procedures, and "proper" maintenance, as suggested by the previous article.

Proper trap design

What that article meant by proper trap design is not clear. Any student of high school physics can define the trap geometry necessary to provide an air seal and allow condensate to drain from the pan, under specified operating conditions.

No doubt, the instructions (trap geometry) provided by equipment manufacturers will result in such a trap.

But proper geometry does nothing to overcome the inherent deficiencies of the condensate trap. The term "proper trap design" as used here is an oxymoron, a contradiction and not possible to define. It is, however, relatively easy to define a "proper seal design." It is one that:

1. Allows condensate to flow freely and unimpeded from the hvac unit;

2. Prevents air (which may be contaminated) from being drawn into the system through the condensate drain pipe during system heating operations, cooling operations, and cooling system start-up operations (when p-traps are usually empty);

3. Prevents condensate in the drain pan from being blown into the air conditioning unit and the ductwork (under all operating conditions including system start-up operations);

4. Removes the condensate drain system as a source of an aerosol mist;

5. Eliminates condensate overflow caused by trap blockage and negative pressure inside the system;

6. Is not affected by algae growth;

7. Is not affected by condensate evaporation;

8. Precludes damage from freezing temperatures;

9. Includes no moving parts; and

10. Is self-cleaning and self-regulating.

No current condensate trap design meets these requirements.

Proper system start-up procedures

Special start-up procedures are required only when a seal against airflow is not present at system startup, e.g., for summer cooling. A seal is essential at this time to prevent ingested air from entraining condensate in the pan and blowing it onto internal components, causing damage and system contamination. Also, if a seal is not provided, condensate overflow and flooding can occur.

In the case of an empty trap at system start-up for summer cooling — caused by evaporation — the trap must be filled in some manner to prevent air ingestion and related problems. Manually filling each trap with water was one suggestion offered by the previous article.

Another method suggested was "to run the unit for sufficient time to build up condensate and then turn it off, at which point the trap will fill on its own." It would be very difficult indeed to convince any maintenance manager with several hvac systems to maintain — and some have to maintain hundreds — that filling traps either manually or by cycling each unit on and off at each system start-up is worry-free.

Proper maintenance

How and where an hvac system is used determines the type of trap maintenance needed. In most cases, acceptable trap maintenance is impractical and in others it is impossible.

Because a trap traps water, it also traps debris. And because it holds cool water, it provides an ideal growth haven for algae. Unless removed periodically, these contaminants in combination, generally, cause flow blockage at one- to two-year intervals. Thus, the need for cleaning or replacing traps annually is clearly indicated.

Although time consuming, it is feasible to implement such a maintenance program.

The need for special cooling start-up procedures — for example, filling the trap with water — arises because water evaporates from the trap during non-cooling periods, e.g., during winter months. Accordingly, the trap will operate empty — providing no seal — for some period of time between cooling shut-down and cooling start-up.

Operating an hvac system without a drain seal at this or any other time is unacceptable, because of the possibility of drawing odorous and poisonous gases into the occupied space. Hence, a trap must be filled frequently with water to ensure a drain seal at all times.

When the trap is kept full in this manner there is, of course, no need for special system start-up procedures. But the maintenance effort increases several fold, perhaps requiring bi-weekly filling. Such a maintenance program is certainly feasible, but it is probably not practical and is unlikely to be implemented.

The above conditions are the most favorable possible for use of the condensate trap. They are applicable only to traps exposed to temperatures that are above freezing. In outside locations, where winter temperatures drop below freezing, it is not possible to use the conventional condensate trap as a drain seal, for either winter heating or winter cooling operations.

During the winter heating operation, water in the trap is certain to freeze and destroy the trap and seal. The use of freeze plugs that are expelled during freezing may protect the trap, but they destroy the seal.

During winter cooling, water in the trap will freeze, block condensate flow, and destroy the trap and its capacity to hold water and maintain a seal.

Trap freeze-up and seal destruction, in outside locations, may be avoided by applying heat to the condensate during freezing periods. This, however, requires a heating element and a sensor (both of which are prone to failure and are not cost-free).

Table 1 on the next page provides, in the form of a routine and preventive maintenance program, a summary of activities and time involved in attempting to maintain a conventional condensate trap, during various possible operating conditions.

Clearly, condensate traps that are not exposed to freezing temperatures require the least maintenance effort. Under these conditions, hvac systems that provide both summer and winter cooling (traps always full) pose the fewest maintenance problems. For this type system, it is estimated from Table 1, that the trap maintenance required is about 2 hours per unit per year.

Under the same conditions, systems that provide summer cooling and winter heating require about three times this maintenance effort, or about 6 hours per unit per year. The increase results from the need to fill the trap frequently during non-cooling operation.

No reasonable amount of maintenance effort (even continual monitoring) can ensure that a trap will retain a continuous seal when exposed to temperatures below freezing, for reasons discussed above.

At this point, a very logical question arises: How, with all its problems, did the condensate trap become the accepted drain seal standard for the industry? There are at least three possible reasons:

1. Until recently, there was no viable alternative to the condensate trap.

2. Because they simply cannot maintain condensate traps, building owners/users have been accepting excessive service calls, equipment damage, surrounding property damage, and indoor air pollution caused by condensate traps. They regard these costs as necessary evils, for which they have been offered no solutions.

3. Currently, there is no incentive for equipment manufacturers, system designers, and mechanical contractors to provide an effective condensate drain seal.

In the past, each has escaped responsibility for the excessive damage and costs that the trouble-prone and worrisome condensate trap imposes on building owners/users. And, although it is apparently not perceived as such, the damage caused by the trap actually benefits these three segments of the industry.

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Table 1

Table 1. Routine and preventive maintenance program for the conventional condensate trap.

Trap Located Indoors Or Outdoors, With Outdoor Temperatures **Above** Freezing

1. Frequency and Time of Inspection and Service:

(a) For Systems That Provide Summer Cooling and Winter Heating

During Cooling Operation —

- Annually — at initial system start-up for cooling
- Semi-annually — at initial start-up and at second start-up if facility is shut down annually for a week or more, e.g., schools

During Heating Operation-

- Bi-weekly — between cooling system shut-down and cooling system start-up.

(b) For Systems That Provide Summer Cooling and Winter Cooling

- Semi-annually — at 6-month intervals (one inspection must be made at system start-up, following an annual shut-down of facility for a week or more, e.g., schools)

2. Maintenance Effort Required:

(a) At each annual inspection (and semi-annually if need is indicated) —

- Physically remove flow-blocking algae and/or debris, or replace trap;
- Flush with water;
- Treat with EPA approved biocide; and
- Fill trap with water and add biocide tablets.

(b) At each bi-weekly inspection —

- Fill with water and add biocide tablets, if need is indicated.

3. Equipment and Material Needed:

(a) Internal pipe scraper;
(b) New trap;
(c) Water hose;
(d) Biocide.

4. Estimated Time Required:

(a) Annually and semi-annually —

- 5 minutes per inspection + (25 minutes travel time to and from)
- 0 to 60 minutes per time serviced + (25 minutes travel time to and from maintenance shop and system site)

(b) Biweekly-

- 5 minutes per time serviced + (25 minutes travel time to and from maintenance shop and system site)

Trap Located Outdoors, With Outdoor Temperatures **Below** Freezing

1. Frequency and Time of Inspection and Service:

(a) For Systems That Provide Summer and Winter Cooling and Winter Heating

During Cooling Operation-

- Not possible to maintain drain seal with a trap during winter cooling under these conditions-- flowing condensate will freeze in trap, block flow, and damage trap.

During Heating Operation —

- Not possible to maintain drain seal with a trap during winter heating under these conditions -- unless the trap is filled with water, it will not hold a seal. - When filled, water will freeze and block condensate flow.

Table 2

Table 2. Routine and preventive maintenance program for a properly designed drain seal.

1. Frequency and Time of Inspection and Service:

(a) For Systems That Provide Summer Cooling, Winter Heating and Cooling

- Annually — during cooling operation, when condensate is flowing

2. Maintenance Effort Required:

(a) If condensate is not flowing freely during cooling operation and/or condensate is standing in the pan more than $^1/_8$-inch (3-mm) deep at drain outlet:

- Check for debris inside the device. If present, physically remove and flush inside with water, and
- Check operating pressures per manufacturer's instructions.

(b) Otherwise, no effort is required.

3. Equipment and Material Needed:

(a) Water hose;
(b) Pressure gauge.

4. Estimated Time Required:

(a) Less than 5 minutes per inspection + (25 minutes travel time to and from maintenance shop and system site)

(b) 0 to 30 minutes per time serviced + (25 minutes travel time to and from maintenance shop and system site).

The troublesome condensate trap

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It increases the rate of equipment replacement; adds design effort required for replacing equipment; and contributes to contractor's revenue through excessive service calls and maintenance work. Any justification or rationale behind these reasons for adhering to a condensate trap as a drain seal are rapidly disappearing.

The first reason listed for using condensate traps can now be confidently rejected. There is at least one effective drain seal available for replacing the burdensome condensate trap. The recently developed fluidic flow control device provides a seal that meets all the requirements for a proper seal design, as stated above under the heading of Proper trap design.

This device is free of all the problems that plague the condensate trap. It is reliable and maintainable. Thousands are in the field, and not one has failed to perform satisfactorily. Table 2 summarizes a routine and preventive maintenance program for a system equipped with the device.

The estimated maintenance effort is minimal. In fact, field experience indicates that, in a practical sense, maintenance requirements are virtually nil. Note that, in contrast to the program for the conventional condensate trap in Table 1, maintenance is not affected by how and where the seal is used. That is, it is equally maintainable during all seasons and in all environmental locations.

The physical and performance characteristic of this device are presented in Reference 2. More detailed characteristics are provided in the Second Edition of the McGraw-Hill *Handbook of HVAC Design*, to be released in 1997. In the meantime, all the information necessary for matching the device to any installation can be obtained from the manufacturer, Trent Technologies, Inc., Tyler, Texas. The device is marketed under the trade name CostGard™ Condensate Drain Seal. There of course may be other seals that are as effective.

The second reason given for using condensate traps are being removed by the influence and efforts of three organizations — EPA, OSHA and ASHRAE (Standard 62-89R) — directed toward improving indoor air quality. The guidelines and standards established by these organizations will motivate building owners/users to reject the condensate trap problems they previously accepted as necessary evils.

The requirements set by each of these organizations differ somewhat, but they have one thing in common: They place the requirement for improvements, primarily, on building owners/users.

Although none of these guidelines and standards have been, and may never be, imposed, they are already having influence and will continue to affect what the building owners/users, and the rest of the industry, does to improve indoor air quality.

In new construction, building owners can rid themselves of the condensate trap problems by simply including the requirement for an effective drain seal in the building criteria they issue to their architect. They can do this with confidence because there is at least one proven drain seal available, discussed above, that eliminates the problems associated with condensate traps.

In this way, the architect is made responsible for finding a way to eliminate the problems imposed on the building owner/user by the condensate trap.

The third reason why condensate traps are in common usage will be removed when building owners demand that the industry provide them with a suitable drain seal. In response to the building owner and architect, mechanical designers must offer a proven and acceptable drain seal design. They may provide their own design. On the other hand, they may choose to require the equipment manufacturer to provide an hvac unit with a proven and reliable drain seal.

By rejecting the condensate trap as the industry standard, and requiring that it be replaced with an effective and reliable drain seal, building owners/users can free themselves from excessive costs, related indoor air pollution, and many health problems.

And at the same time, they can respond to and comply economically with certain critical guidelines and standards established by EPA, OSHA, and ASHRAE.

In summary, you cannot get caught in traps if you avoid them. There are better ways to provide a condensate drain seal. To quote a well-known news commentator: "Now you know the rest of the story."

References:

1. W. C. Trent, "The condensate trap: a costly failure," *Air Conditioning, Heating, and Refrigeration News*, February 21, 1994, pp. 3-6.

2. W. C. Trent and C. C. Trent, "Considerations in designing drier, cleaner hvac systems," *Engineered Systems*, August 1995, pp. 38-48.