Don't get caught in a (condensate) trap of your own

by Jon Summers, The Trane Company

■ The past 10 years have seen a dramatic change in the design and function of air handlers, due in part to the challenges associated with indoor air quality.

Moisture in hvac systems is one area of concern since, if not properly managed, it can lead to the spread of micro-organisms to the conditioned space.

Sloped drain pans and antibacterial surfaces and agents, coupled with regular preventive maintenance, can help prevent bacterial growth. But if the cooling coil condensate drain in the air handler is improperly trapped — or not trapped at all — any such efforts are wasted.

A properly functioning and properly designed condensate trap provides for discharge of water from the cooling coil drain pan, while the water seal (the water level maintained in the trap) prevents the flow of ambient air into or out of the air handler.

Several problems result from improperly trapped systems, some of which can severely impact indoor air quality. These problems generally center around negative-pressure systems, since trap failure in a positive pressure environment simply results in air being exhausted through the drain line.

Under normal conditions, condensate runs down the coil fins and drips into a condensate pan. In situations where no trap is installed, the unit is functioning without a seal, and negative pressure causes air inflow through the drain line. This incoming airstream has sufficient velocity to launch the water droplets forming at the base of the coil into the air, with an action reminiscent of a percolating coffee pot.

Air flowing through the coil can then spray condensate into the fan intake, which can propel the moisture into other parts of the system. The resultant aerosol mist can be carried through the ducts and into the conditioned space, possibly causing bacterial growth and transmission.

Another problem with air inflow is the source of that air. Drain lines typically flow into waste or sewage lines, giving the potential to introduce methane and other biocontaminants from the drain system into the airstream.

Trapping pitfalls

Without a trap (Figure 1), static pressure within the air handler can also prevent proper drainage, causing water overflow, air handler flooding, and possibly property damage.

Improper trapping leads to several problems. If the trap outlet is too short (Figure 2), the negative pressure created at system startup will pull water from the trap into the air handler. The "seal" is destroyed, producing the same effect as an untrapped system.

If the trap outlet is too tall (Figure 3), negative pressure will prevent drainage, causing the condensate to back up into the system, resulting in property and equipment damage.

Sometimes two or more drain pans (from the same unit or separate units) are connected to a single trap. If the fans are operating at different static pressures, or if one fan has cycled off, the unit operating under the greatest negative pressure will draw air through the drain line of the other unit.

This air completely bypasses the trap and can cause all of the problems usually associated with incoming air — even though the trap is designed and functioning properly. Each drain pan should be individually trapped to avoid this situation.

In rare cases, a drain line that is not properly supported will sag, forming an "air lock" that results in water backing up into the system.

There seems to be a misconception that "a good, deep trap" is a cure-all for most trapping situations. Unfortunately, visual estimates and arbitrary trap heights often result in trap failure. The dynamics of "blow-through," or positive-pressure systems, and "draw-through," or negative-pressure systems, result in slightly different trapping solutions. But the fundamentals are the same.

Proper height

In a positive-pressure situation, the fan is forcing air through the cooling coil, with the condensate pan on the other side. The trap must be of sufficient height to account for the static pressure in the unit under normal operating conditions.

In a draw-through system, the fan is pulling air through the cooling coil.

Since the condensate drain pan is on the fan side, there is negative pressure at the drain relative to outside the unit. Here, too, the trap height must account for static pressure; but in the reverse direction. Worst-case static pressure conditions, like those caused by a dirty filter, must be used to calculate the correct trapping height.

If the trap isn't tall enough, the water seal won't hold and air will be drawn through the drain pipe into the system. If it's too tall, water will back up into the system as discussed above. As condensate forms during normal operation, the water level in the trap rises until there is a constant outflow.

Improper trap design accounts for some condensate drainage system failures, but certainly not all.

Incorrect use and maintenance of condensate drain traps can also cause problems. The combination of airborne particles and moisture in the air handler often results in algae formation in the drain pan and trap.

Sloped drain pans help eliminate this problem in the pan, but the trap must be cleaned regularly to avoid blockage that can slow or stop water flow, resulting in backup into the system. Due to this inherent maintenance concern, many traps are equipped with clean-out openings.

One common problem is that these drain "clean-outs" are left open to facilitate easier access in the future. When open, untreated air can flow directly into the system, causing the same problems as no trap at all.

In some cases, the remedy to a plugged trap or drain line has been to simply remove the trap entirely, apparently to relieve the need for future maintenance. It's also common for the water seal to evaporate during the non-cooling season.

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It may be necessary to manually fill the trap at system start-up, or 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.

Condensate drain traps are the accepted industry standard for evacuating condensate water from the hvac system without allowing the inflow of ambient air. Proper trap design, system start-up procedures, and maintenance (debris removal, water level check, 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. By under-estimating the importance of proper condensate trapping, you might end up in a trap of your own!

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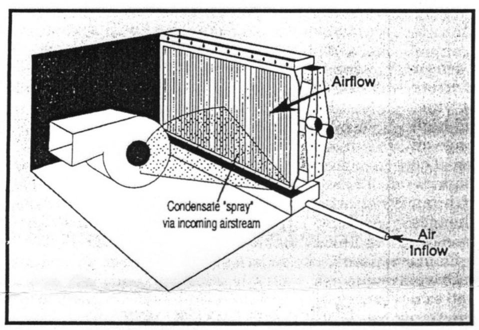

FIGURE 1: No trap on system. Water is carried over to ductwork, admitting contaminated air, leading to bacterial growth and possible water backup.

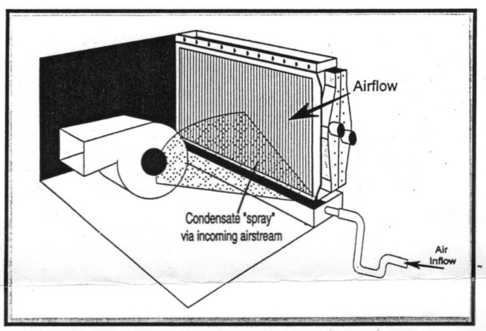

FIGURE 2: Seal destroyed at startup from a too-short trap outlet; same consequences as Figure 1.

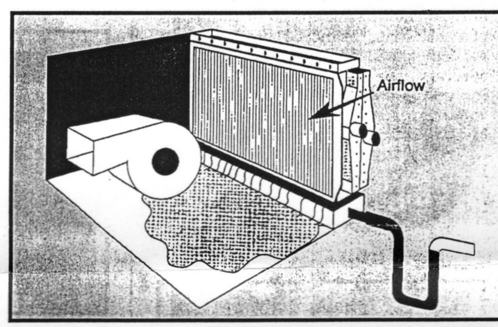

FIGURE 3: Too-tall trap outlet leads to improper drainage, water backup, unit damage, and bacterial growth.

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Trent, W. & Trent, C. (1997, April 28). The troublesome condensate trap: The rest of the story (7.0MB), *Air Conditioning, Heating, and Refrigeration News,* 10.

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Comparison of Condensate Drain System Performance Diana Glawe, PhD, PE, LEED AP, Associate Professor of Engineering, Trinity University, San Antonio, Texas (2013) 62-65.