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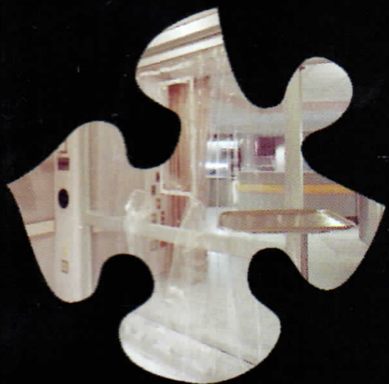

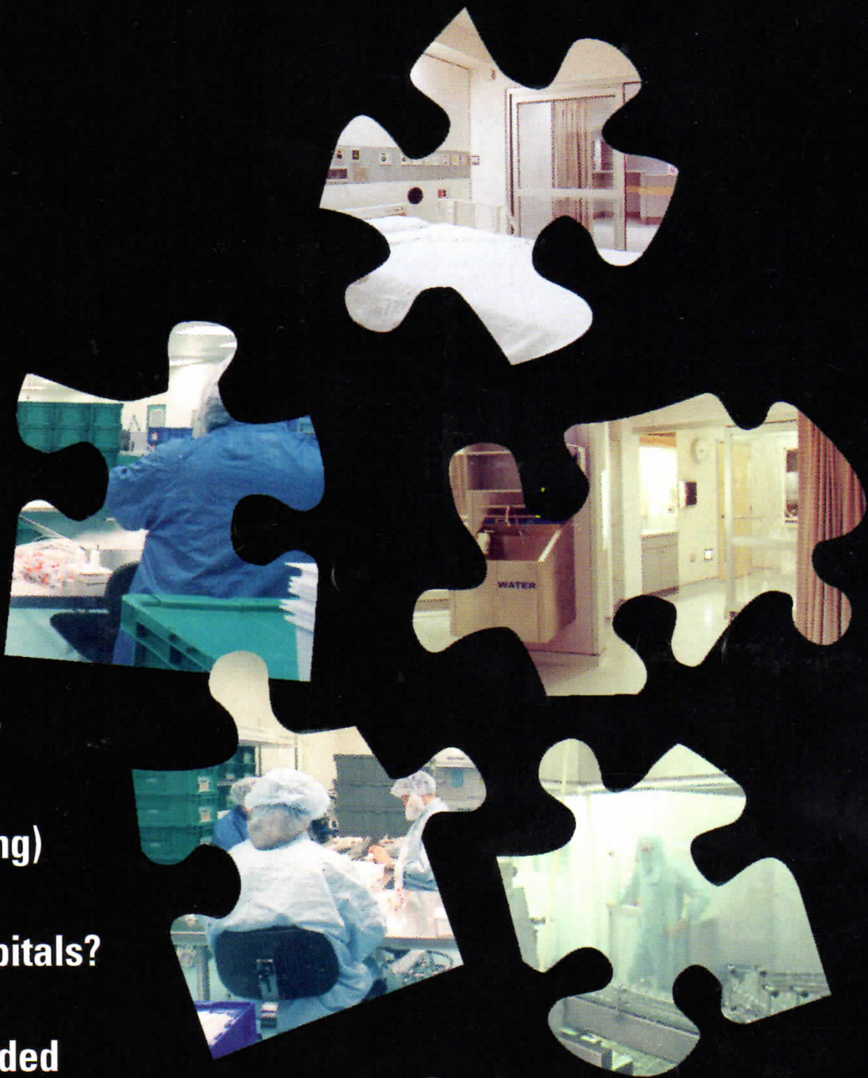

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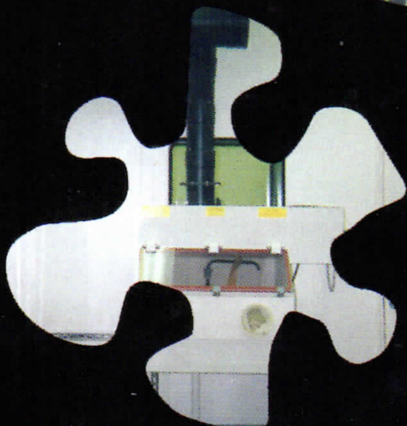

PRACTICAL APPLICATIONS FOR INNOVATIVE HVACR MECHANICAL SYSTEMS ENGINEERS

CONDENSATE CONTROL

Condensate carryover and condensate drips are common causes of wet, dirty, and contaminated hvac systems. Here is how to deal with this problem.

BY WARREN TRENT, P.E., AND CURTIS TRENT, PH.D.

EDITOR'S NOTE: *This is the first of a six-part series of articles devoted to the design of hvac systems that are free of health-threatening and property-damaging problems. This article is adapted from "Condensate Control," by authors Warren and Curtis Trent, in the* HVAC Systems and Components Handbook, *Second Edition, published by The McGraw-Hill Companies (Copyright 1998). This is being reprinted with permission of The McGraw-Hill Companies.*

One of the primary functions of an air conditioning system is to remove water from the air it circulates. Proper collection and disposal of this water is essential to maintaining a dry, clean, and uncontaminated hvac system.

Water can be both the most useful and most destructive of compounds. In an hvac system, the right places — that is, the only acceptable places — for water (condensate) are:

- Surfaces of the cooling coil;
- A "small and well-drained" condensate drain pan; and
- A free-flowing (non-stagnant) condensate drain line.

The wrong places for condensate in an hvac system are:

- Internal insulation;
- Surfaces of walls, top, and floor of air handlers;
- Large condensate drain pans that cover the floor of air handlers;
- Surfaces of the fan motor, fan, fan casing, and blades;
- Internal duct walls;
- Air supply grilles; and
- Surrounding structures that support the air handler.

In these places, water is not only destructive to the hvac system and surrounding property, it creates a growth haven for algae, fungi, and various forms of bacteria (including *Legionella pneumophilia*).

The consequences of these conditions are added costs for building owners-users in terms of service calls, maintenance effort, equipment damage, surrounding property damage, and human health care.

All these consequences are avoided in hvac systems configured to confine the spread of condensate, and eliminate internal system wetness attributable to design deficiencies common to the following areas:

- Condensate carryover and drips;
- Condensate drain pans;
- Seal on condensate drain lines;
- Humidity and temperature in the air supply systems;
- Position of fan (blower) in the air handlers; and
- Condensate drain lines.

Systems designed to be free of internal wetness greatly reduce building maintenance costs and virtually eliminate the air conditioning units as major contributors to Sick Building Syndrome and Building-Related Illness.

This series of articles is designed to identify the problems associated with each of the above areas, define practical solutions, and review the economics of proper hvac system design.

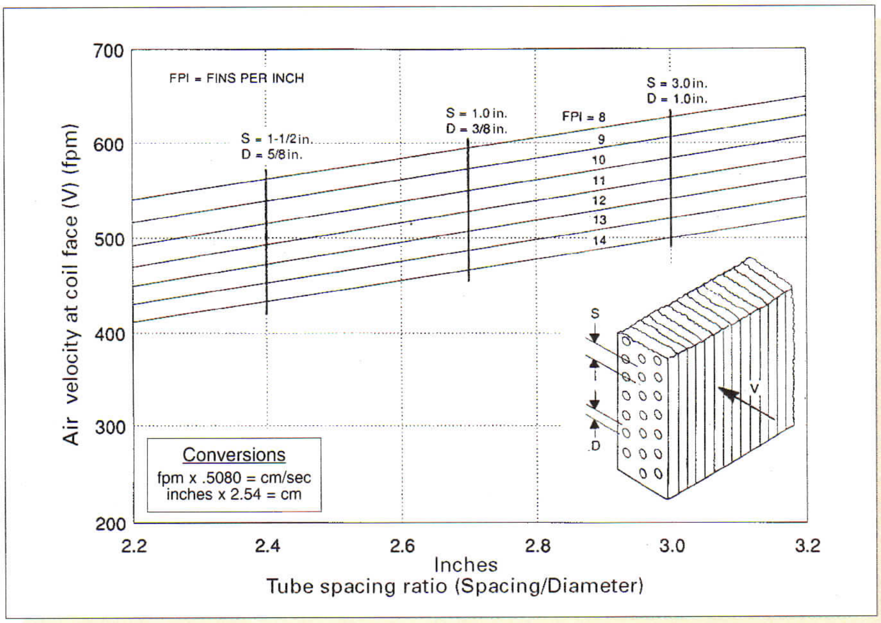

FIGURE 1: Coil face velocity above which condensate carryover occurs; typical cooling coil.

CONDENSATE CARRYOVER AND DRIPS

Condensate carryover and condensate drips are common causes of wet, dirty, and contaminated hvac systems.

Excessive air velocity through the cooling coil will blow condensate from the coil onto the plenum floor and/or onto other components of the system. Sloped cooling coils and non-insulated coolant (refrigerant or circulated fluid) lines often allow condensate to drip onto internal surfaces, damage equipment, and cause contamination inside the air handler.

Critical design factors —

Condensate carryover:

The capacity of a particular cooling coil design to resist condensate blow-off (carryover) depends upon a number of factors, including the following:

- Velocity of the air approaching the cooling coil;
- Diameter of tubes;
- Distance between tubes;
- Number of fins per inch;
- Thickness of fins; and
- Amount of condensate present on surfaces of the cooling coil.

The velocity of air approaching the cooling coil (coil face air velocity) is too low to entrain condensate and cause carryover. However, as air passes through the coil, it is accelerated to higher velocities.

Whether this velocity reaches a level sufficient to entrain condensate from the coil surfaces depends upon the reduction of flow area affected by tubes, fins, and the condensate held on the coil surfaces.

How these variables interact to affect condensate carryover is illustrated in Figure 1, for a typical cooling coil design. For this particular coil type, coil face velocities greater than those shown will result in condensate carryover. Other coil designs may exhibit somewhat different characteristics, but the variables and their general relationships remain the same. (For a specific coil design, applicable data are usually available from the coil manufacturer.)

Cooling coil design arrangements that permit condensate to be carried downstream are unsuitable for hvac applications. Large drain pans extended to protect the floor from condensate carryover are of little value. The floor still becomes wet, as do fan surfaces and other downstream components.

Condensate carryover "moisture eliminators," placed at the leaving (trailing) edge of the coil, are unsuitable as a preventive measure. They introduce appreciable air pressure losses that increase energy consumption.

In addition, they not only create costly maintenance problems, but their wet surfaces also promote the growth of health-threatening fungi and bacteria.

Condensate drips from sloped coils:

Sloped cooling coils allow condensate to drip away from the coil surfaces. At low slope angles, surface tension may be adequate to retain the condensate and allow it to drain into the condensate pan. However, foreign deposits on the coil can easily destroy the effects of surface tension and cause dripping to occur.

Extending the condensate drain pan to catch condensate drips introduces another equally serious condition — large drain pans (to be discussed in the second article in this series).

Under no circumstances should an air filter be placed beneath a sloped coil. A wet filter forms an ideal place for the growth of contaminating organisms.

Condensate drips from cooling coils and their detrimental effects are easily avoided by using only vertically oriented coils.

Condensate drips from coolant lines:

Non-insulated coolant lines that are exposed to conditioned air inside the cooling airflow path, form condensate that will drip onto the floor and system components, damaging equipment and contaminating the hvac system. Condensate drips from coolant lines and their detrimental effects are easily avoided by applying proper insulation to all exposed lines.

Economic factors —

Changes in cooling coil design for the purpose of reducing air velocity and the potential for condensate carryover will almost certainly add some cost to the hvac unit. That is, reducing the air velocity at the coil face (to reduce condensate carryover) from 600 to 500 fpm can be expected to increase coil cost by about 15%. This, however, is a small cost compared to the potential savings.

For example, preventing condensate carryover removes any possible justification for extending the condensate pan more than a few inches downstream of the coil. Thus, the cost of fabricating and installing a large, stainless steel condensate pan is eliminated.

Far more significant, however, are the savings that accrue as a result of preventing condensate from being blown onto hvac components and ductwork downstream of the cooling coil. Easily recognized by the building owner-user, these savings appear in the form of reduced maintenance, reduced property damage, reduced indoor air contamination, and longer equipment life.

The hardware costs for eliminating sloped coils depend upon the angle of slope involved. Costs for insulating coolant lines are minimal to insignificant. Regardless of initial costs, however, highly sloped coils and non-insulated coolant lines represent unacceptable design compromises.

SUMMARY

Condensate carryover and drips – and their detrimental effects – can be easily avoided by proper system design. The requirements are simply that:

1. The condensate cooling coil be designed to accommodate the maximum airflow of the hvac unit, with a condensing rate of at least 90 grains (0.013 lb) of water per pound of dry air, without allowing condensate carryover.

2. All cooling coils be installed vertically, without slope.

3. All coolant lines in the air-handling unit be insulated unless they pass directly over the condensate drain pan. **ES**

Next month: *A look at drain pans, and why a properly designed drain pan is essential to the successful removal of condensate from an hvac system.*

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