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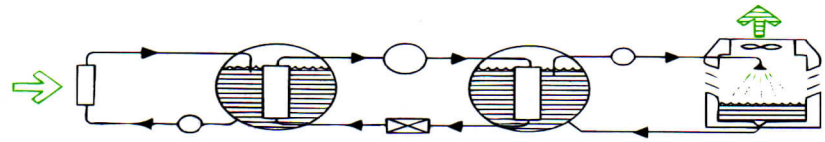

by C. Curtis Trent, Ph.D and Warren C. Trent, M.S., P.E.

The Problem

Building owners and users in the United States spend billions of unnecessary dollars each year on excessive maintenance and replacement of heating, ventilating and air conditioning (HVAC) systems. These expenditures are manifested in terms of undue outside service calls, damaged equipment and damaged surrounding property, along with indoor air contamination problems and costly litigation.

Contrary to the claims of many in the HVAC industry and governmental agencies, these costs are not primarily due to poor HVAC system maintenance as OSHA assumes in its "Proposed Rules on Indoor Air Quality" (Federal Register, 1994). They are, instead, the result of system design deficiencies. In fact, some systems are so deficient in design that they are virtually impossible to maintain, regardless of the available budget and the number of maintenance personnel assigned. Tens of thousands of such systems are now in operation in buildings across the country, and the numbers are growing.

Field Conditions

During the past two cooling seasons, we examined scores of air conditioning units in buildings throughout the Southeastern United States. We found a majority of the units soaking wet inside; various types of algae growing in stagnant water in the drip pans and unit floors; and build ups of mold, mildew, and other fungi on the inside walls and duct work. Many of the units were rusting and deteriorating, and there was evidence of frequent overflows.

We were able to trace the conditions described above to one or more of eleven design deficiencies in the systems. The design deficiencies we observed were:

- Excessive air flow;
- Deficient air flow;
- Inadequate provisions for ventilating air;
- Non-insulated coolant or refrigerant lines in the airflow path;
- Improper blower (fan) location;
- Inadequate filters and filter holders:
- Highly slanted cooling coils;
- Unsuitable drip pan drain ports—position and design;
- Long, undulating, and poorly routed condensate drain lines;
- Unduly large condensate drip pans; and
- Inadequate seals on condensate drain lines.

The most flagrant and most detrimental of the deficiencies observed was "inadequate seals on condensate drain lines." The industry practice of depending upon a condensate trap to provide a drain line seal is the source of this deficiency. Because the trap is so unreliable, most of the draw-through systems we observed were operating without a seal or with a dysfunctional seal on the condensate drain line.

Indoor Air Pollution and Property Damage

There are many sources of indoor air contamination, but the one that is nearly always present is the heating, ventilating, and air conditioning system (HVAC). And draw-through type systems are the worst offenders.

A primary function of an air conditioner is to remove moisture (water) from the air. During the cooling process, condensate (water) collects on the cooling coil and drips into the catch pan located below. From there, it is, ideally, drained away from the unit to a suitable disposal place.

Unfortunately, the draining of condensate from a draw-through type air conditioner (a common type found in all types of buildings) is no easy task, particularly if the unit is operating without an adequate seal on the drain pipe.

Investigations have shown that a draw-through HVAC system operating without an adequate seal on the drain pipe (a not uncommon condition) can draw in air through the drain pipe at velocities above 30 mph. The air flow can draw in outside contaminated air and gases. It can become strong enough to blow condensate from the drip pan into the system and duct work where it provides ideal conditions for the reproduction and growth of harmful microorganisms. These microorganisms can be spread by the blower, directly into the conditioned space. This air flow can impede the flow of condensate and cause the unit to overflow, resulting in extensive damage to the air conditioning unit and the building.

Air filters will not eliminate the growth of bacteria and fungi generated within the HVAC system. They are

for Building Owners and Managers in Specifying

HVAC Systems

located in the wrong place to prevent internally grown microorganisms from being blown into the conditioned space.

The key to alleviating the situation is the proper removal of condensate and preventing ingestion of outside air—which results in the blowing of condensate from the drip pan into the system and duct work.

Conventional water type P-traps are recognized failures as seals for condensate drain pipes because, more often than not, they are improperly designed, become blocked periodically and cause overflow, are often removed by service personnel, require extensive maintenance, and if located outside, tend to freeze and break in cold weather.

The heating and air conditioning industry is aware of the maintenance, property damage, and pollution problems caused by draw-through HVAC systems. It is also aware of remedies (proper engineering practices, which include a reliable seal on the drain line of draw-through systems). The industry, however, hasn't been prompted to take corrective action because building owners and managers are not fully aware of the causes of their problems.

The Solution

The technology now exists to design HVAC systems that will remain dry inside (except for the cooling coil and a small drip pan) and prevent the ingestion of outside air and gases through the condensate drain line of draw-through systems during all operating conditions.

New technology is available which will negate the destructive problems caused by the condensate trap and

> ***" Building owners and users spend billions of unnecessary dollars each year on excessive maintenance and replacement of HVAC Systems"***

allow architects and designers to specify cleaner, drier, lower user cost systems. It is up to building owners and managers to take the initiative and insist that such systems be made available.

Fortunately, to improve the situation, owners and managers do not have to understand the technical details of what constitutes a well designed HVAC system. They simply need to know the criteria necessary to ensure cost effective HVAC systems and suitable indoor air quality. Such a set of criteria is presented in the accompanying box.

If building owners and managers will demand that architects and system designers adhere to these criteria, when planning new construction or renovations, they will not only avoid the exorbitant costs of excessive maintenance, property damage (including walls and ceilings inside buildings) and early equipment replacement, but they will find themselves in a less vulnerable position should a litigation situation arise.

HVAC System Design Criteria

The HVAC system shall:

1. Remain dry inside (except the cooling coil and a small drip pan), during all operating conditions.
2. Prevent outside air and contaminated gases from being drawn into the system through the condensate drain line, under all operating conditions.
3. Be capable of controlling temperature and relative humidity of the occupied space within the human comfort zone under all operating conditions, established by the ASHRAE 1993 Handbook Fundamentals, page 8.13, Figure 5.
4. Maintain a positive pressure, within buildings, of 2 Pascals (.008 in.wc.) minimum and not over 10 Pascals (.040 in.wc.), during normal operating conditions. (hot humid climates)
5. Meet or exceed the provisions stated in ASHRAE Standard 62-89 or the most recent version of that Standard.
6. Comply with applicable Building, Mechanical and Plumbing Codes.

Adhering to the above design criteria is neither difficult nor expensive. It requires only that designers utilize current technology and proper engineering practices.

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