HVAC Basics of Microbial Growth

Most people involved in the area of indoor air quality (IAQ) agree that it is a complex, multifaceted issue. No "silver bullets" exist to remedy every problem there are simply too many potential contaminant sources and their diversity is too great. Not only do contaminants originating inside a building threaten the quality of its environment, but those brought in from outside through the ventilation system and infiltration must be considered as well.

The most common indoor contaminants are the volatile organic compounds (VOC's) outgassed from interior furnishings. Microbiological contaminants ( namely bacteria, mold, mildew and fungi ) run a close second. Ventilation and filtration certainly provide a means of combating these contaminants by diluting their concentrations within a building. However, the basic long-term IAQ strategy for any building should ultimately be contaminant source control.

HVAC System Types

We understand the sources and causes of microbiological contamination within a building. Put simply, microbes need four basic ingredients to thrive: (1) organic nutrients or "food"; (2) moisture in the form of standing water or humid air; (3) a surface on which to grow; and (4) darkness. Therefore, if we keep the air conveyance system clean and dry, we can significantly reduce the potential for microbial contamination within a building. How we accomplish this objective is determined by the manner in which air is delivered to a building's occupied spaces.

HVAC systems, the principal means of air delivery in a building, can be divided into two general categories: central systems and terminal systems. A central HVAC system includes a central air-handling unit (installed either inside or outside the building) that distributes ventilation air and recirculated air through ducts to control terminals located in the individual zones. By contrast, a terminal HVAC system relies on a dedicated fan-coil unit, unit ventilator or heat pump in each zone to handle the ventilation, filtration and comfort conditioning duties of that space.

Why Microbes Love HVAC Systems

In the normal process of dehumidifying a building, outdoor ventilation air and recirculated air pass through a cooling coil that lowers the mixed air temperature below dew point. This causes some of the water vapor held in the air to condense on the cold coil. The condensate collects in a drain pan beneath the coil and eventually flows to the building drain. In the process, it washes much of the particulate matter (dirt) from the passing air stream into drain pan. This wet, dark, temperature-controlled environment creates an excellent habitat for mold and fungal growth. The HVAC system fan circulates the bioaerosols (airborne microbial contaminants) produced by these colonies throughout the building.
Sloped Drain Pans

Until recently, air handlers and terminal units were equipped with flat condensate drain pans. This design allows water to collect in stagnant pools, fostering the growth of mold and slime and increasing the likelihood of air-stream contamination. It's also promotes another less evident problem: slime can clog the drain line and force condensate water to overflow into the bottom of the air handler. That means more wet interior surfaces and more potential for mold growth, not to mention possible equipment and building damage.

•  "IAQ Basic" #2:

Cleanable Surfaces

Even with proper equipment design, operation and maintenance, unexpected events like equipment malfunctions, power outages or drainage problems can occur, raising the humidity level inside the building. Relative humidities over 60% (along with dirt, which is almost always present in building air systems) promote microbiological growth. Therefore, it's important to regularly inspect the entire air handler and duct system for signs of contamination as a part of normal HVAC system maintenance.

Equally important is the choice of materials used to construct HVAC equipment and air delivery systems. Providing smooth, nonporous surfaces inside ducts and equipment simplifies inspection and cleaning. The type of equipment involved will determine how this can be accomplished. For example, terminal equipment such as fan coils and VAV terminals can be lined with either closed-cell foam or foil-faced insulation. Both materials are washable. Central air handlers, however, demand a more rigid liner like sheet metal (because of their physical size and maintenance requirements. The need for smooth, nonporous surfaces that permit thorough cleaning also applies to drain pans. Only non-corrosive materials should be used to avoid the pitting that corrosion creates. Likewise, the sprayed foam commonly used on drain pans and other interior surfaces in the past is no longer acceptable because it is so difficult to clean.

•  "IAQ Basic" #3:

Accessibility

Obviously, a cleanable surface is of limited value if it cannot be easily accessed. All areas of the HVAC equipment and duct system should be totally accessible for inspection, cleaning and maintenance. It's an established fact that equipment that's easy to service gets serviced first and most often.

In central air handling equipment, the necessary access can be provided with hinged doors and/or removable panels. Areas accessed frequently, such as filter and cooling-coil sections, should be equipped with access doors. At minimum, access to the ductwork interior should be provided at areas where dirt is likely to accumulate -- that is, at turns and other turbulent areas, as well immediately before and after any duct-mounted devices such as humidifiers and fire dampers.

Equipment designs for terminal products should allow easy inspection and maintenance (e.g., filter replacement) with minimal disassembly of the unit. Easy access is especially important for fan coils and unit ventilators. These types of systems typically consist of many units, making inspection a time-consuming process. Although fan-powered VAV terminals do not have cooling coils or drain pans, they must still be designed for easy filter replacement and accessibility for inspection and other normal maintenance within the tight confines of a ceiling plenum.
Remember the "IAQ Equipment Basics"

The key to reducing the potential for microbiological contamination within an HVAC system is to keep it clean and dry. All HVAC equipment must include the "IAQ equipment basics" (sloped drain pans, cleanable surfaces and accessibility).

One final reminder: Consider all aspects of accessibility when selecting and laying out equipment for a project, whether new construction or renovation. Remember that access for inspection and possible cleaning is required in addition to the standard service clearance requirements.