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By Ed Light, Member ASHRAE, James Bailey, P.E., Member ASHRAE, Rick Meetre, P.E., Member ASHRAE

About the Authors
Ed Light is president, James Bailey, P.E., is vice president, and Rick Meetre, P.E., is controls engineer at Building Dynamics in Ashton, Md.

Air conditioning over the summer vacation presents significant challenges to school HVAC operators in humid climates, where mold growth is a common occurrence in unoccupied areas. Although health effects of mold exposure are generally limited to sensitive individuals, musty odors and visible growth are unacceptable to occupants and disruptive to school programs.[1,2,3,4] Summer mold growth is sometimes attributed to shutting off school HVAC systems for energy conservation. However, in half of the schools experiencing summer mold growth investigated by the authors, the HVAC was running, but overventilating or over-cooling unoccupied areas.

Water damage is the most common cause of indoor mold growth, but extended periods of high relative humidity or over-cooling can cause similar problems in otherwise dry buildings. The underlying cause of this type of mold growth is relative humidity at the surface (water activity) sustained at a level supporting microbial growth. This occurs where relative humidity at surfaces passes the mold threshold, for example, where surface temperature is below the dew point.5,6,7 Duration is an important factor in mold growth.

For example, several weeks of relative humidity exceeding 80% is generally needed to initiate mold growth in the absence of other moisture sources.7 An important difference between mold growth associated with damage from liquid water and excessive relative humidity is that water contact often causes structural damage necessitating drywall replacement, while relative humidity-related mold growth affects surfaces only and can generally be remediated by treatment with a disinfectant.[4]

Although older school HVAC systems were not designed for humidity control, mold growth does not generally occur unless there are significant equipment, controls or scheduling deficiencies, significant infiltration of humid air, evaporation of excess moisture or there are surface temperatures below dew point of the room air.

Methodology

This review is based on the authors' experience as mechanical engineering/industrial hygiene consultants to school districts in the Washington D.C./Baltimore area, where outdoor dew-point averages approximately 60°F (16°C) during the summer, with some days exceeding 70°F (21°C). These schools are generally not in session from mid-June to mid-August, with many areas remaining vacant. Summer HVAC operation varies widely, with some schools shutting off most systems for the summer to conserve energy, while others run on a normal or reduced schedule.

The authors have investigated a variety of schools subject to summer mold growth. (See sidebar, "Surveyed School Descriptions" for generalized description of typical school.)

Site surveys generally included

Review of HVAC plans, maintenance tickets, automation trend logs and schedules of HVAC operations and building activities.

Environmental inspection to note locations of visible growth and moisture damage (i.e., bowed ceiling tiles), building envelope openings, site orientation, etc.

Site measurements including relative pressurization, air distribution, surface temperatures, air temperatures and relative humidity.

HVAC evaluation to check control sequences, thermostat calibration, chilled water temperature, damper operation, exhaust fan operation and pipe sweating.

Identification of root causes and contributing factors to mold growth.

Recommendations to improve humidity control.

Findings

The authors found that problem schools fell into one of three categories: (1) HVAC generally off; (2) overventilation; or (3) over-cooling. In the majority of schools investigated, mold growth was localized and re-occurred year after year in the same areas. Where over-cooling was the underlying problem, schools experienced a widespread, one-time mold growth episode.

HVAC Off for the Summer

Mold growth only occurs in some schools when HVAC systems are deactivated for the summer.

In each of those school investigated by the authors, mold growth was limited to areas where other contributing factors were present:

Unit ventilators valves remaining open. HVAC sequences of operations typically have open control valves when systems are off during cold weather. In two-pipe systems, these valves often remain open in the cooling season with HVAC fans off and the chiller running, allowing chilled water to flow through the coils. When humid outdoor air infiltrates around outdoor air dampers/louvers, condensation forms inside and on the cover of the unit ventilator, surrounding floors, and the underside side of nearby furniture.

Negative pressure. In some schools where supply fans had been de-activated, exhausts remained on, drawing in humid air through the building envelope. Mold growth tends to be localized in areas with greatest infiltration (i.e., openings through the envelope, proximity to exhaust fans).

Reduced solar loads. Relative humidity is generally higher in rooms with a northern exposure or tree shade.

Rooms with high paper loads. Porous materials in libraries retain moisture and are susceptible to mold growth. Closed storage closets with no air circulation can also be problematic.

Outdoor air dampers remaining open with fans off. Open dampers allow unconditioned, outdoor air infiltration to pass though the unit and into the building.

Areas with excessive moisture evaporation. This may be produced from poorly drained sites, high water table, ongoing leaks, chilled water pipe sweating, standing water in condensate trays or summer cleaning activities.

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