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Schools

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PRODUCT APPLICATION GUIDE

A technical bulletin for engineers, contractors and students in the air movement and control industry.

Going Forward: Post COVID-19

Improving Indoor Air Quality in Schools to Improve Teaching and Student Learning

An HVAC primer for Parents, Educators, and School Board Officials on Improving the Student Learning Environment

A healthy school environment contributes to a better learning environment for our children.

It is a well-known fact that the environment affects human performance, both physically and mentally. Our children, the next generation of contributors to society, can be impacted by the quality of air in their learning environment. The federal government has appropriated over $190 billion taxpayer dollars (ESSER funds), distributed to all 50 states, to improve school facilities over the next several years. It is encouraged that parents and school officials engage in a conversation that funds be invested in improving classroom indoor air quality for our children.

The School Indoor Air Quality (IAQ) Problem

In the 1970s the increasing cost of energy required to operate buildings including schools became a concern. One solution was to make buildings "tighter" and to reduce the amount of ventilation resulting in the reduction of energy required to heat and cool outdoor ventilation air. The result of tighter constructed buildings and reduced ventilation led to mold, increased VOCs (Volatile Organic Compounds) and CO_2 (carbon dioxide) levels and building occupant health issues. The term Sick Building Syndrome or SBS was "coined", leading to indoor air quality concerns.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and its members focus on building systems, energy efficiency, indoor air quality, refrigeration, and sustainability with a mission of a healthy and sustainable built environment for all. In 1973 ASHRAE published a standard entitled "Ventilation for Acceptable Indoor Air Quality", Standard 62.1, with numerous revisions since. This standard defines among other items, the acceptable ventilation rates for various nonresidential buildings, including schools. Note that this acceptable ventilation rate is a minimum, where more than the minimum means more oxygen-rich air delivered to students, which can contribute to the effectiveness of learning and teaching. States and municipalities adopt ASHRAE 62.1 into their building codes, and contractors and engineers use this standard as guidance in their HVAC (Heating Ventilation and Air Conditioning) designs.

HVAC systems for schools vary greatly by equipment type as well as age. Over the past 30 years the industry has been focused on improving IAQ as well as conserving energy. However, at times these focus items have conflicted with each other resulting in poor IAQ at the expense of reducing energy.

The School Indoor Air Quality (IAQ) Solution

Recently there has been a lot of focus on improving indoor air, specifically in schools, by improving air filtration.

Replacing lower efficiency filters with higher efficiency filters in existing HVAC systems may help. However the COVID-19 virus and respiratory droplets containing the COVID-19 virus from an infected individual are very, very small. An obstacle to increasing filter efficiency however is that many commercial HVAC systems (fan and fan motor) cannot deliver the required airflow due to the higher resistance to airflow (pressure drop) that higher efficiency filters have.

Another filtration solution proposed or implemented is the additional installation of recirculation HEPA (High Efficiency Particulate Air) filter units in classroom spaces.

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Either or both filter solutions are good, but only solve one part of improving Indoor Air Quality (IAQ), which is the removal of airborne particulate. The second and more important part of improving IAQ is the removal of VOC gaseous pollutants and CO_2.

Harmful gaseous pollutants like VOCs are given off by synthetic building materials. Indoor occupants generate CO_2 by simply breathing in oxygen-rich air and exhaling CO_2. Without the proper amount of oxygen-rich air in schools, students become tired and lethargic, which effects their ability to learn, and the ability for teachers to teach.

The solution to this second and **more important** issue of improving IAQ in schools is adequate ventilation of the space by introducing a sufficient amount of oxygen-rich conditioned outdoor air into the classrooms and exhausting the stale, spent, oxygen-depleted air. This also reduces harmful levels of VOCs. It is the oxygen-rich and conditioned (heated, cooled, humidified, dehumidified, and filtered) outdoor air that will assist in improving student learning ability.

The amount of **outdoor air** flow brought into a building, room or indoor space is the **ventilation rate** per unit time, typically expressed in cubic feet of air per minute (cfm). The **minimum** outdoor ventilation rate calculation in ASHRAE 62.1 states that for K-12 grade students is 10-20 cfm of fresh outdoor air **per student.**

The fact that increased ventilation rates improve students' ability to learn, and the ability for teachers to teach, was confirmed in a 2016 Harvard study entitled ***"Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures."*** This research study revealed that lower indoor CO_2 levels resulting from greater amounts of outdoor (ventilation) air resulted in **61 to 101% higher cognitive scores.** The increase in cognitive scores was achieved by increasing the ventilation rate of outdoor air from 20 cfm to 40 cfm per student.

Another 2021 investigation by Ty Newell, PhD, PE, Emeritus Professor of Mechanical Engineering at the University of Illinois entitled ***"Indoor SARS-CoVid-2 Herd Immunity and Infection Probability Estimates based on Ventilation, Vaccinations, Infections and Face Masks"*** echoes the findings of the 2016 Harvard study and makes the following recommendations:

1. Control fresh air ventilation (to maintain 800 ppm of CO_2), equivalent to **doubling** current building ventilation standards from 20 cfm per person to 40 cfm per person.
2. Recirculate indoor air through high efficiency filters (MERV-13 or better) with a combination of whole building air recirculation and room space filtration systems. Recirculation airflow levels should be similar to fresh air ventilation levels.

Finally, in June of 2020, The U.S. Government Accountability Office published a report (GAO-20-494) entitled ***"K-12 Education: School Districts Frequently Identified Multiple Building Systems Needing Updates or Replacements".***

Of the school districts surveyed, the findings of this report stated:

- About half of districts needed to update or replace multiple systems like heating, ventilation, and air conditioning (HVAC) or plumbing.
- An estimated one-third of schools needed HVAC system updates.
- An estimated 41 percent of districts need to update or replace heating, ventilation, and air conditioning (HVAC) systems in at least half of their schools, representing about 36,000 schools nationwide that need HVAC updates.

Reputable HVAC manufacturers and their representatives can assist and offer recommendations to improve school indoor air quality.

For almost 75 years, Greenheck has engineered and manufactured air movement, conditioning and control equipment to improve indoor air and is recognized worldwide by consulting engineers and contractors as a premier solution provider.

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