

Improving a Building's Indoor Environment Quality

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Abstract

The quality of indoor air is directly related to the amount of Ventilation in a building. A person's health, comfort and well-being can be significantly affected by the quality of the indoor air. Building ventilation systems are used to introduce fresh air from outdoors into the building while exhausting "old" air.

The amount of ventilation in a building affects the indoor air quality by introducing clean outside air into the building. The heating or cooling system will have to work harder to maintain a comfortable interior temperature. In order to mitigate the effects of ventilation on the heating and cooling system, most mechanical heating, ventilation and cooling (HVAC) systems are designed to re-circulate a significant portion of the indoor conditioned air. The recirculation of old air has a detrimental effect on the indoor air quality and should be monitored to verify that the air still meets the minimum standards for building occupancy and use.

Mechanical Ventilation System

Active (mechanical) ventilation systems use fans to draw fresh outside air into the building. Mechanical ventilation systems can provide consistent air flow to interior spaces and can be designed to maximize the indoor environment quality by controlling factors such as air speed, air quality, temperature and humidity. High efficiency filter systems can improve indoor air quality when they are integrated into building's HVAC system.

- Passive Ventilation System
- Cross-Ventilation System
- Stack Ventilation
- Hybrid Integrated Ventilation Systems

Methods of improving indoor air quality during Construction

Construction activities can produce a significant amount of air pollution that can pose a health threat to construction workers and future building occupants. There are many strategies to avoid indoor air quality problems during construction and to mitigate long term effects. Most of the methods for controlling indoor air quality during construction must be planned and implemented before construction begins.

Construction Air Quality Plan

An indoor air quality plan should be prepared and implemented before construction of the building. The plan should address the following factors.

- Methods for controlling the pollutant source
- Mitigation of indoor air contaminant dispersion

- Education for employees and subcontractors regarding the method of pollution control
- Ways to verify implementation of the plan

Improving air Quality during Construction

Proper cleanup and material storage during and after construction can significantly reduce the amount of air pollution generated by construction activities. Some good procedures to follow include;

- Protecting porous materials from air contaminants before and after installation
- Using a vacuum with high-efficiency filter to clean up debris
- Using wetting agents to control dust

Keywords: Indoor Air, Air quality plan, Passive ventilation, Cross Ventilation, Stack Ventilation

1. Improving a Building's Indoor Environment Quality

The quality of indoor air is directly related to the amount of ventilation in a building. A person's health, comfort and well-being can be significantly affected by the quality of the indoor air. Buildings that do not have proper ventilation tend to be stuffy, smelly and uncomfortable and may produce unhealthy environments (such buildings often are referred to as "sick" buildings). Studies show that people who work in buildings with improved indoor air quality are more productive and have fewer sick days. Building ventilation systems are used to introduce fresh air from outdoors into building while exhausting old air.

1.1 Measuring Indoor Air Quality

The amount of ventilation in a building affects the indoor air quality by introducing clean outside air into the building. Often the outside air is a different temperature from the temperature desired for air inside the building. For example, if the outside air is cold, then drawing it into the building for ventilation will introduce cold air into a heated space and cause discomfort for the occupants. The heating or cooling system will have to work harder to maintain a comfortable interior temperature. In order to mitigate the effects of ventilation on the heating and cooling system, most mechanical heating, ventilation and cooling (HVAC) systems are designed to re-circulate a significant portion of the indoor conditioned air. The re-circulation of "old" air has a detrimental effect on the indoor air quality and should be monitored to verify that the air still meets minimum standards for building occupancy and use. It is virtually impossible to measure the actual amount of outside air included in the ventilation to an interior space. However, the amount of carbon dioxide (CO₂) a common byproduct in "old" air, can be measured to provide an indicator of air quality. CO₂ monitoring systems are commercially available and range from simple measuring devices to systems that can be integrated with other building systems to maximize the efficiency of the whole building. Air quality is one of the factors in indoor environment quality. The overall quality of the indoor environment also takes into account factors such as temperature and humidity. Current technology using building management computer software and sophisticated measurement devices allows us to manage and control indoor environment quality. Some systems are simple devices that automatically open and close windows in accordance with measured level of indoor CO₂ and air temperature. Building management computer software allows input from measurement devices to guide the remote operation of building systems. Among the factors that can be manually or automatically controlled are heating, cooling, ventilation, the angle of exterior shade devices and humidification. Measuring and controlling indoor environment quality is critical to maintaining a healthy and efficient building space.

1.2 Mechanical Ventilation Systems

Active (mechanical) ventilation systems use fans to draw fresh outside air into the building. Mechanical ventilation systems can provide consistent air flow to interior spaces and can be designed to maximize the indoor environment quality by controlling factors such as air speed, air quality, temperature and humidity. High efficiency filter systems can improve indoor air quality when they are integrated into building's HVAC

system. It is important for them to be highly efficient to avoid increasing the building's energy consumption. Well-designed mechanical ventilation systems are integrated with the heating and cooling systems. For example, outdoor air can be preheated before it is introduced into building by integrating a heat exchanger into the HVAC system. The heat exchanger draws heat from the building's exhaust air. This heat is then used to preheat the outdoor air before it is introduced into building's ventilation system.

1.2.1 Passive Ventilation System

Passive ventilation uses natural ventilation strategies to provide fresh outside air to the building without using mechanical systems. Well-designed passive ventilation systems are simple and require no maintenance or electrical power. Passive ventilation systems depend on outside air temperature and weather patterns and may not be as efficient at different times of day or during different seasons. Humidity control of passive ventilation systems may be a challenge in areas that have extreme temperatures. The use of natural ventilation helps to decrease or eliminate the use of a building's mechanical ventilation systems, thereby saving energy. Passive ventilation systems strategies are based primarily on the fundamental principles of cross and stack ventilation.

1.2.2 Cross Ventilation

This system uses high and low pressure zones created by wind to draw fresh air into a building. Passive ventilation design strategically orients the building on the site in order to take advantage of prevailing wind patterns. The high and low pressure zones created as wind flows around a building can be used to provide natural airflow to the inside of the building. Ventilation device are strategically located within and integrated into the building façade.

1.2.3 Stack Ventilation

This system uses high and low pressure zones created by rising heat and the associated convection currents. As warm indoor air is vented from the building, it creates negative pressure in the building that can be used to draw outside air into the ventilation system. A passive ventilation system can move air by using heat generated by computers, lights, atria and people. Outtake air vents are placed at the top of the building to exhaust warm air, while intake air vents in the lower levels of the building allow cooler air to enter.

1.3 Methods for Improving Indoor Air Quality during Construction

Construction activities can produce a significant amount of air pollution that can pose a health threat to construction workers and future building occupants. There are many strategies to avoid indoor air quality problems during construction and to mitigate long term effects. Most of the methods for controlling indoor air quality during construction must be planned and implemented before construction begins.

1.4 Construction Air Quality Plan

An indoor air quality plan should be prepared and implemented before construction of the building. The plan should address the following factors.

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1.5 Improving air Quality during Construction

Proper cleanup and material storage during and after construction can significantly reduce the amount of air pollution generated by construction activities. Some good procedures to follow include;

- Protecting porous materials from air contaminants before and after installation
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Many of the Materials used during construction are odorous, irritating and/or harmful to the health of the construction workers and building occupants. The storage and use of such materials should be specifically controlled to mitigate impacts on the indoor air quality. The amount of contaminants that a product emits is generally associated with the amount of Volatile Organic Compound (VOC) it contains. VOCs are carbon compounds that transform into a gaseous form when exposed to the environment. The gases produced by materials with high VOC levels can be harmful, and they interfere with the comfort of people in the building.

Many building material products are available with few or no VOCs and they perform as well or better than traditional materials. Recommendations for specific VOC limits for different building materials can be found in the USGBC's LEED Reference Guide for Green Building Design and Construction, Version 3. The following materials generally contain VOCs and should be evaluated prior to use to determine whether reasonable substitutes exist.

- Adhesive and Sealants
- Paints and Coatings
- Carpeting and composition flooring
- Composite wood products

Once construction is complete, and before the building occupants move in, the building should be flushed out to remove any residual air pollution. This can be accomplished by blowing fresh outside air into the building (through filters) while controlling temperature & humidity. The USGBC recommends supplying a total air volume of 14,000 cubic feet of outdoor air per square foot of building floor area while maintaining a temperature of at least 60 °F and maximum relative humidity of 60%.

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