

Tips to Improving Air Circulation during Summer Months

Executive Summary

Cooling a warehouse or large building in hot summer weather presents a challenge for even the best managed facilities. High ceilings, heat-generating equipment, and poor ventilation work together to keep industrial spaces warm. This warm, stagnant air can lead to health or morale problems for employees, increased wear on equipment, slick floors in your facility, and a decrease in productivity.

Effective air circulation is essential for keeping employees comfortable. With the introduction of a new National Emphasis Program just over one year ago, OSHA has recommitted to reducing exposure to indoor and outdoor heat-related hazards.¹ The OSHA Technical Manual reports that the most effective way to prevent heat-related illness is to reduce heat stress in the workplace, through increased air movement and a reduction in temperature and humidity.²

Increasing air movement and reducing temperature and humidity have benefits for productivity as well. A 2007 study found that thermal stressors have a substantial negative impact on performance, particularly for those tasks that require controlled body movements.³ The Lawrence Berkeley National Lab estimated a 1.2 percent reduction in work performance per 1°F temperature rise when the temperature is above 80°F.⁴ These productivity effects may be compounded if employees are affected by increased equipment wear, like rust or condensation, and facilities challenges like slippery floors or mold.

This white paper provides tips and best practices for improving air circulation in large buildings and warehouses during the summer months. Facility managers will be presented with multiple effective solutions, including the installation of high-volume, low-speed (HVLS) fans, optimization of industrial HVAC systems, utilization of factory cooling and exhaust fans, and tips to increase outside air.

Introduction

Summer months can be challenging for industrial workplaces, especially those located in hot and humid climates. The same qualities that make warehouses appealing- high ceilings and large open spaces- also make them difficult to cool.

When air molecules are heated, they gain energy and move faster, causing them to spread out and become less dense. As a result, warm air weighs less and rises above the cooler, denser air. In the United States, the average large warehouse ceiling height is 32 feet.⁵ When warm air rises, it can become trapped near the ceiling, creating a temperature gradient that can be uncomfortable for occupants and difficult to manage.

As the facility air stratifies, or separates, by temperature, some warehouses can experience a 10 to 20 degree temperature differential from floor to ceiling. The goal of improving air circulation is to de-stratify the air and increase airflow, to reduce stagnant air pockets and achieve a consistent warehouse temperature.

Warehouses can be very large, with millions of cubic feet of air volume to cool. The larger the space, the more difficult it is to effectively lower the temperature, and the more energy it takes to maintain a comfortable temperature. This can result in high energy bills and increased environmental impact.

To overcome these challenges, warehouse managers may use a variety of air circulating and cooling strategies, such as high-volume, low-speed (HVLS) fans and high-efficiency HVAC systems that are specifically designed for large, open spaces. Factory cooling fans and the addition of outside air can also be used to improve air circulation.

Problem Statement and Background

It's hot and getting hotter. Workplace heat-related issues are becoming increasingly prevalent in many regions. The average temperatures recorded during warm seasons have risen over time, albeit by only a few degrees. However, these slight differences can significantly influence the work environment. With an increased emphasis on protective gear, small ambient temperature differences can have a big impact on employee comfort. As a result, high workplace temperatures can make the same task feel more difficult and sometimes more exhausting.⁶

Poor indoor air quality decreases employee morale and increases turnover. While employees might express their unhappiness with a simple "it's hot!" the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has developed a standard to measure "thermal comfort," and it doesn't simply take into account the air temperature of the environment. Instead, ASHRAE collected data to determine the components of comfort that make a difference to workers, and found that air speed and humidity, as well as a number of other measures, contribute to overall thermal comfort.⁷

Employees who are satisfied with their work environments are 16% more productive, 18% more likely to stay, and 30% more attracted to their company over competitors.⁸ And employee loyalty is good for business - it can cost about one-fifth of a worker's salary to replace them.⁹

Hot and humid air increases the chances of employee heat-related illnesses. Illness from exposure to heat is preventable. But each year, thousands of workers become sick from occupational heat exposure.¹⁰ To protect workers from heat-related illnesses and injuries, OSHA announced a new National Emphasis Program (NEP) on April 12, 2022. The NEP consists of targeted inspections, outreach and compliance assistance.¹ OSHA guidance indicates that core temperatures of 100.4°F and higher are dangerous for workers, while air temperatures that exceed 95°F significantly increase the heat load on the body.¹¹ Heat-related fatality cases show that workplaces with temperatures above 70°F may have a heat hazard present when work activities are at or above a moderate workload.²

Excess humidity increases equipment and facility wear and can impact products and raw materials. Facilities can experience the effects of high humidity in a number of different ways. Excess humidity can result in a buildup of condensation or mold, saturation or corrosion of electrical products, increased drying times, or quality issues with paper products.¹² Warehouses built atop a concrete slab are susceptible to "sweating slab syndrome," where warm, moist air comes into contact with a cool concrete floor and forms condensation puddles. This causes additional stress on the facility and increases the potential for employee falls and forklift accidents.

Hot and humid air decreases employee productivity. A 2007 study found that thermal stressors have a substantial negative impact on performance, particularly for those tasks that require controlled body movements.³ The Berkeley National Lab estimated a 1.2 percent reduction in work performance per 1°F temperature rise when the temperature is above 80° F.⁴ These productivity effects may be compounded if employees are affected by increased equipment wear, like rust or condensation, and facilities challenges like slippery floors or mold.

Solution: Installing HVLS Fans: High-volume low-speed air circulation

What are HVLS Fans?

High-volume, low-speed (HVLS) fans are an effective way to improve air circulation in large buildings and warehouses. These fans are designed to move a large volume of air at a low speed, creating a slow and steady airflow that helps to keep people cool and comfortable.

HVLS fans use large, specially designed blades in a ceiling-mounted hub configuration that typically spans 8 feet or more in diameter. The blades are engineered to rotate slowly, typically between 50 and 100 revolutions per minute, depending on the size and design of the fan.

The airflow created by an HVLS fan is different from that created by a traditional high-speed fan. Rather than blowing air directly at people, an HVLS fan creates a large, slow-moving column of air that circulates throughout the room. This gentle, constant airflow helps to create a more consistent temperature and humidity level throughout the space.

How do HVLS Fans improve air circulation?

Horizontal floor jets. The blades of an HVLS fan are specially designed to create a large column of air that moves in a circular pattern. This column of air moves from the fan's blades to the floor and then back up again, creating a horizontal floor jet that moves in all directions. This floor jet helps to distribute air evenly throughout the space, preventing stagnant air pockets from forming. The large size of HVLS fan blades allows for a large volume of air to be moved with relatively low energy input. The blades are designed to create a significant amount of momentum in the air, which allows the air to continue to move even after the blades have stopped pushing it.

Engineered precision blades. The shape of the fan blade, or “foil”, combined with its angle of attack, or “pitch”, are key factors in determining the amount of air moved and the energy required for the effort. Conventional HVLS fan blades are based on the principles of aerodynamics and use an unsymmetrical foil to push air down. Newer blade designs rely on fluid dynamics to leverage a symmetrical foil and reduce frictional resistance and drag while allowing for reversibility in winter months.

Evaporative cooling. The fan's low speed operation creates a gentle breeze, which provides a cooling effect on people by evaporating the perspiration present on their skin. This evaporate cooling effect makes workers feel cooler without changing the temperature of the air.

Destratification. In winter months, heated air gets trapped near the ceiling and cool air settles near the warehouse floor, creating an uncomfortable environment for employees. HVLS fans can mix the stratified air to evenly distribute heat from ceiling to floor and decrease winter energy use.

What are the benefits of HVLS Fans?

Greater employee comfort. HVLS fans create a gentle, constant airflow that maintains a consistent temperature and humidity level throughout the space. According to the Manual of Naval Preventive Medicine, air movement of as little as 2 mph will provide a cooling effect of approximately 5°F (the air feels 5 degrees cooler) and at 4 mph will offer a chilling effect of 10°F.

Better energy efficiency. HVLS fans are more energy efficient than traditional industrial fans and air conditioning systems. A 20-foot HVLS fan can move approximately 125,000 cubic feet per minute (cfm) of air – equivalent to six or more standard fans – with a 1 to 2 horsepower motor. HVLS fans can also be used in conjunction with an AC system for additional energy savings, allowing for a higher set temperature than normal with a decreased cost to operate, decreased load, decreased maintenance, and longer system life for the AC system.

Low operating costs. The typical operating cost of an HVLS fan is \$0.17 per hour (at \$0.10 per kWhr electricity rate). HVLS fans are a cost-effective way to keep warehouses cool in summer.

Fewer stagnant air pockets. Stagnant air can lead to a buildup of pollutants, dust, and other harmful particles in the air, which can be damaging to employee health. HVLS fans move large volumes of air with a powerful horizontal floor jet that reduces “dead” zones across the facility. This virtually noiseless operation prevents stagnant air pockets from forming.

Reduced condensation. Where warehouses experience condensation buildup due to high humidity conditions, HVLS fans can help to reduce condensation by moving more air at a slower rate. This movement raises the evaporation rate of moisture in the air as the warm air mixes with cooler air. Less condensation prevents rust, corrosion, mold and mildew from forming on your equipment and inventory.

Year round benefits. In the winter, some HVLS fans can reverse to provide effective destratification without producing a breeze that chills employees. A 2014 study by the Nicor Gas company found that a facility utilizing HVLS fans cycled their heating system less frequently, resulting in a 21.4% reduction in energy use.¹³

What are the disadvantages of HVLS Fans?

Large space requirements. HVLS fans are large, and require a lot of space to operate effectively. If a warehouse has limited ceiling space, clearance heights, or obstacles that would interfere with the fan's operation, it may not be feasible to use an HVLS fan.

Extreme climate effectiveness. HVLS fans are most effective in moderate climates where the temperature and humidity levels are not extreme. In very hot or humid climates, HVLS fans may not be able to provide enough cooling to keep workers comfortable.

Moderate initial cost. HVLS fans can be more expensive than traditional fans, which may make them less attractive to warehouse owners who are on a tight budget.

Required maintenance. HVLS fans require regular maintenance to keep them operating effectively. If the maintenance schedule is not followed, the fans may not operate properly, which can reduce their effectiveness and lead to higher energy costs.

Solution: Optimizing HVAC Systems: Warehouse Air Conditioning

How does Warehouse Air Conditioning improve air circulation?

Actively cools and dehumidifies air. Warehouse air conditioning systems improve air circulation by providing a steady flow of cool and dehumidified air throughout the space. The system takes in warm air and passes it over a refrigerant-cooled evaporator coil, which lowers the air temperature and dehumidifies the air. The cool and dry air is then distributed throughout the warehouse through a network of air ducts and vents.

Filters contaminants. Warehouse air conditioning systems can be equipped with air filters that remove contaminants such as dust, dirt, and allergens from the air. This can further improve indoor air quality and create a healthier and more comfortable environment for workers.

What are the benefits of Warehouse Air Conditioning?

Lower air temperature. The HVAC cooling system actively lowers the ambient temperature in industrial spaces. With a unit that is properly sized for the space, a temperature decrease of 10 to 20 degrees is possible.

Less humidity. Lower moisture levels in the air can prevent a buildup of condensation or mold, and better protect electrical and mechanical equipment from saturation or corrosion. Air conditioning helps to maintain a stable low humidity environment and can extend the life of machinery and other equipment.

Greater employee comfort. Lower humidity levels can feel more comfortable, especially in warm or hot environments. When humidity levels are high, the air can feel heavy and sticky, which can make it harder for sweat to evaporate from the skin. When humidity levels are lower, the air feels drier, and sweat can evaporate more easily, which can make people feel cooler and more comfortable.

Better indoor air quality. Warehouse air conditioning systems can help to filter out pollutants, dust, and other airborne particles, creating a healthier work environment for employees. This can reduce the risk of respiratory problems and other employee health issues.

What are the disadvantages of Warehouse Air Conditioning?

Initial costs are high. Installing a warehouse air conditioning system can be expensive, especially for large facilities. A commercial HVAC installation is an extensive project involving ductwork, piping, and heating and cooling elements mounted throughout your commercial building.

Maintenance costs are high. Regular maintenance of HVAC systems includes changing filters, cleaning coils, and ensuring that all components are in good working order. The complex installation that is often required for large buildings can contribute to higher than expected maintenance and repair costs.

Operating costs are high. For commercial buildings with high ceilings or constant open doors, AC warehouse cooling systems may be running continuously. A large amount of electricity is used to attempt to maintain a constant low temperature across the height of the facility, which can lead to high summer energy bills.

Cools unevenly. Conditioned air is forced through a series of ducts to its final destination. Once there, cold air tends to fall toward the ground unless it is moved by an external force, like a fan or other source of air movement. This can allow for uneven cooling across a large commercial space.

Solution: Utilizing Factory Cooling Fans: Pedestal Fans and Floor Fans

How do floor fans improve air circulation?

Floor fans work by pulling air in from the surrounding environment and pushing it out in a specific direction. This creates a steady stream of moving air, which can help to cool or warm a room, depending on the direction of the fan blades and the speed of the fan.

What are the benefits of using floor fans to cool warehouses?

Improved worker comfort and autonomy. Floor fans can help to circulate air and create a steady airflow in a targeted space, which can improve worker comfort and reduce the risk of heat-related illnesses. Small fans can be placed strategically to adapt to the needs of specific employees, offering some autonomy in creating a comfortable workspace.

Low initial costs. Compared to other cooling solutions, floor fans are typically more affordable to purchase and operate. They can be an effective way to provide cooling in a large space without breaking the budget.

Easy to install and maintain. Floor fans are relatively easy to install and maintain, with most capable of plug and play operation. Components that require maintenance are typically easily accessible and user-friendly.

Increased energy efficiency. Using floor fans in combination with other cooling solutions can improve their efficiency. When used with commercial air conditioning, floor fans can help to direct cool air to targeted locations or employees.

Better indoor air quality. Floor fans can help to improve indoor air quality by circulating air and reducing the concentration of pollutants and other airborne particles in targeted spaces.

What are the disadvantages of using floor fans to cool warehouses?

Provides limited cooling capacity. While floor fans can provide a significant amount of cooling in small areas, they may not be able to cool large warehouses or spaces with high heat loads on their own. In such cases, additional cooling solutions may be needed.

Creates trip and fall hazards. Long fan cords and extension cords can present tripping or fall hazards when not properly managed. When multiple floor fans are placed in high-traffic areas, the risk of employee injury can increase. Fall protection has ranked first on OSHA's violation list for the last 12 years running.¹⁴

Increases ambient noise. Floor fans can be noisy, which can be disruptive in certain work environments. This is particularly true if multiple fans are used in close proximity to one another, which can create a significant amount of ambient noise.

Monopolizes electrical outlets. Multiple small, high-speed fans can monopolize available electrical outlets and prevent their more efficient use. A lack of available permanent outlets could encourage unsafe practices by employees looking for power.

Creates facility safety hazards. Fire Marshalls may not allow permanent extension cords due to fire hazard risks. Extensive floor clutter created by multiple floor fans can create safety issues for forklifts.

Solution: Increasing Outside Air: Opening Windows and Doors

How does opening windows and doors improve air circulation?

When windows and doors are open, air from outside enters the space and mixes with the indoor air. As the temperature and pressure inside the room changes, air flows in and out of the space. This creates a natural ventilation effect that helps to move air through the room.

Opening windows and doors on opposite sides of a room can create a cross-breeze that helps to cool the space down. This can be particularly effective in the evening or early morning when the outside air is cooler.

What are the benefits of opening windows and doors to cool warehouses?

Natural cooling. By opening windows and doors, you can take advantage of natural cooling methods such as cross-ventilation and the stack effect. Cross-ventilation occurs when air is drawn in through one side of the building and out through the other side, while the stack effect occurs when warm air rises and escapes through higher openings, creating a vacuum that pulls in cooler air from lower openings.

Energy savings. By relying on natural cooling methods, you can reduce your energy consumption and save on cooling costs. This can be particularly beneficial in areas with mild climates or during cooler times of the year.

Improved indoor air quality. Opening windows and doors can also help to improve indoor air quality by increasing the circulation of fresh air and reducing the buildup of pollutants, moisture, and odors.

What are the disadvantages of opening doors and windows to cool warehouses?

Increased security risks. Leaving doors and windows open can make a commercial space more vulnerable to theft, vandalism, and other security risks. This is especially true for warehouses located in areas with high crime rates or that store valuable inventory. Corporate closed door policies may prevent having open dock doors at any time other than when unloading.

Dust, debris and insects. Opening doors and windows can allow dust, debris, insects, and pollutants to enter the warehouse, which can impact indoor air quality and potentially damage sensitive equipment or inventory.

Variable humidity levels. In areas with high humidity or during hot and humid weather conditions, external ventilation may not be effective at cooling a warehouse and could actually increase indoor temperature and humidity levels.

Weather-related damage. Open doors and windows can leave a warehouse exposed to the elements, including rain, wind, and extreme temperatures. This can damage inventory, equipment, and infrastructure.

Solution: Installing Exhaust Fans

How does installing exhaust fans improve air circulation?

Removes stale air. Exhaust fans are designed to remove stale, humid air from an enclosed space. This can be particularly effective in warehouse areas with poor ventilation, where stale air can become trapped and lead to indoor air quality issues.

Increases air exchange. By removing stale air, exhaust fans create a negative pressure environment within a warehouse, which draws in fresh air from outside. This increases the rate of air exchange, which better regulates temperature, humidity, and air quality.

Removes pollutants. Exhaust fans can remove pollutants, such as dust, fumes, and odors, from a warehouse. This can help to improve indoor air quality and create a more comfortable and healthy environment for employees.

What are the benefits of installing exhaust fans?

Improved indoor air quality. Exhaust fans remove pollutants, fumes, and odors from the air, which can help to improve the overall indoor air quality of a warehouse. This can be particularly beneficial for warehouses that store or handle chemicals, solvents, or other potentially hazardous materials and do not have an extensive ventilation system.

Reduced humidity levels. High humidity levels can create a range of problems, including mold growth, corrosion, and damage to inventory and equipment. Exhaust fans can help to reduce humidity levels by removing moist air from the warehouse and promoting the circulation of drier, fresher air.

Improved employee health. Poor indoor air quality can lead to a range of health problems for employees, including respiratory issues, headaches, and fatigue. By reducing indoor pollutants and increasing external ventilation, exhaust fans can create a more comfortable and healthy work environment.

Conclusion

Large commercial buildings face significant challenges in maintaining employee comfort and productivity during the warm and humid summer months. To address these issues, facility managers may utilize a range of strategies to improve air circulation, such as high-volume low-speed fans, high-efficiency HVAC

systems, or factory cooling fans. Proper air management can lower air temperatures, decrease humidity, and improve employee morale and productivity while reducing the risks of warm, stagnant air. Despite the difficulties of cooling large spaces, it is possible to achieve a consistent warehouse temperature and reduce energy bills and environmental impact through the use of effective cooling techniques.

Contact VividAir

VividAir is a high performance commercial HVLS fan manufacturer dedicated to the science of better air. Our patented designs include the Z-Tech™ blade, a stepped symmetrical fan blade that dramatically reduces frictional resistance and drag while greatly increasing air displacement and thrust. The Z-Tech blade design provides an industry leading coverage area that's 30% greater than the competition.

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