

# Ventilation

## Strategies for small commercial buildings

Creating a tight building envelope is critically important to reducing air leakage and cutting energy consumption in a commercial building. Without proper ventilation a building can concentrate pollutants leading to unhealthy indoor air conditions. Common indoor pollutants can include:

- Particulate matter (dust, debris)
- Microbial contaminants (mold, bacteria)
- Plant pollen
- Gases, including radon, formaldehyde and carbon monoxide
- Volatile organic compounds (VOCs)
- Secondhand smoke

Achieving good indoor air quality (IAQ) means understanding the hierarchy of how to deal with pollutants. In order of importance, pollutants can be controlled by:

- Elimination
- Separation
- Dilution (through ventilation)
- Filtration

The best way to deal with a pollutant is to not have it in the building. The next best way is to keep it away from the occupants. Third on the list is flushing it out with “fresh” outdoor air, and finally, some pollutants can be captured in a filter (thicker, pleated filters are generally preferred).

A healthy indoor environment needs controlled ventilation, meaning pollutants removed from areas of high concentration while at the same time fresh air, in the right amount at the right time, is delivered throughout occupied areas of the building to maintain health and comfort. While certain ventilation strategies can improve energy efficiency, the majority are implemented strictly for improving odors and health and thus will have a negligible payback. Ventilation is required by both the International Mechanical Code as well as the ASHRAE 62.1 standard.

### REMOVING POLLUTANTS WITH EXHAUST VENTILATION

Many commercial buildings have locations in which pollutants are generated or concentrated: restrooms, shower areas, locker rooms, kitchenettes, janitor closets, photo copier areas and specialty applications such as kilns or chemical storage areas. For these spaces, exhaust fans are an excellent strategy for removing pollutants at the source.

Make sure your exhaust ventilation is working properly by:

1. Creating a log and inspecting and assessing all existing fans – note control capabilities.
2. Performing a “toilet paper test” to ensure that exhaust fans actually pull air to the grill.
3. Cleaning exhaust fans and grills and confirm proper damper operation.

4. Making sure exhaust fans are properly ducted to outside. Large diameter, straight round-metal ducting offers the lowest flow resistance and highest delivered airflow. If flex duct is used, it should be tight and straight with gradual turns where needed.
5. Specifying quiet, efficient ENERGY STAR® fans for upgrades.

For commercial kitchen ventilation strategies refer to the following design guideline: [www.sustainablefoodservice.com/files/HVAC-Handbook-Commercial-Kitchen-Ventilation-Best-Practice.pdf](http://www.sustainablefoodservice.com/files/HVAC-Handbook-Commercial-Kitchen-Ventilation-Best-Practice.pdf)

## Whole building ventilation strategies

In addition to functioning local exhaust systems for spot ventilation, every commercial building needs a whole building ventilation system to bring in fresh outdoor air (OA) and distribute it to the occupants’ breathing zones (usually about 3 to 6 feet above the finished floor). Common ventilation strategies encountered in small commercial buildings include:

### No Ventilation System Currently Installed

- Relying on uncontrolled infiltration to randomly provide air changes has not been acceptable by code for many years. And although natural ventilation strategies have been utilized, this approach generally only works in dry, mild climates and with limitations.

### Outdoor Air Ducted into Return (Central Fan Integrated System, CFIS)

- Central Fan Integrated Supply (CFIS) ventilation is the most commonly installed system in small commercial buildings. Consisting of an OA duct connected to the return air side of a typical split system, this approach relies on the air handling unit (AHU) to pull OA as well as return air from the building; after passing through a filter, the mixed air is conditioned and the supply ducts then distribute the air throughout the building (Figure 1).

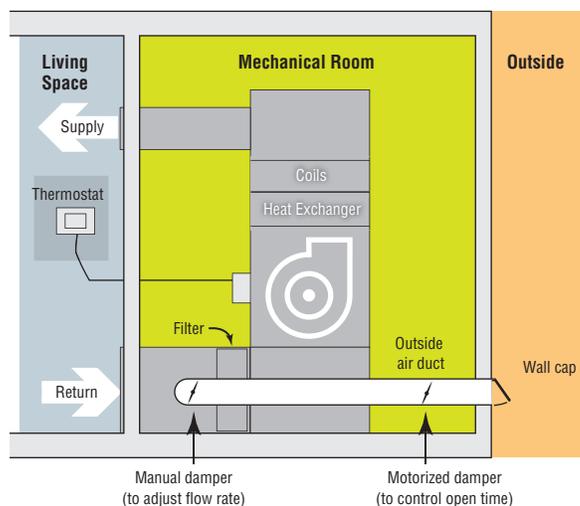


Figure 1. Central Fan Integrated System

- This approach is fairly inexpensive from a first cost standpoint and theoretically puts the building under a desirable positive pressure but has no energy recovery.
- Key components include a barometric or motorized damper that shuts the system off when the AHU is not running or when controls indicate ventilation can be reduced.
- This strategy is also common with packaged HVAC units (often located on the roof) – note that a “set-and-forget” slide damper does not offer automatic closure when the unit is off.
- Economizers are controls that, when the outdoor conditions are favorable (i.e., cool, dry weather), flush the building with maximum OA instead of running the compressor. While this strategy of using “free cooling” can provide significant savings, economizers are not appropriate for all climates and have a poor track record regarding their installation and maintenance. Consult with an HVAC technician to confirm proper operation.

### Dedicated Outdoor Air System (DOAS)

- Dedicated Outdoor Air Systems (DOAS) offer an improved approach to commercial ventilation – these systems de-couple and pre-treat ventilation air independently from interior air and can be optimized for that purpose. After leaving the DOAS, the now conditioned air is often distributed throughout the building via the main HVAC ductwork or may be independently ducted (Figure 2).
- DOAS are designed specifically to handle the moisture (latent load) in the OA. Some DOAS systems include mechanical dehumidification, while others rely on a heat (and moisture) exchanger core and still others rely on a desiccant wheel (Figure 3) to remove OA moisture with the dryness of the exhaust air leaving the building.

- Heat Recovery Ventilators (HRV) include a heat exchanger core and pre-heat or pre-cool the OA with the energy of the air leaving the building. Energy recovery ventilators (ERV) are similar, except that they can transfer both heat and moisture from the OA into the exhaust air. (Figures 4, 5)
- These systems cost more up front but, particularly in spaces with higher OA ventilation needs, generally offer reasonable paybacks due to their energy recovery as well as significantly better moisture control. Consult with an experienced mechanical designer to assess your needs.

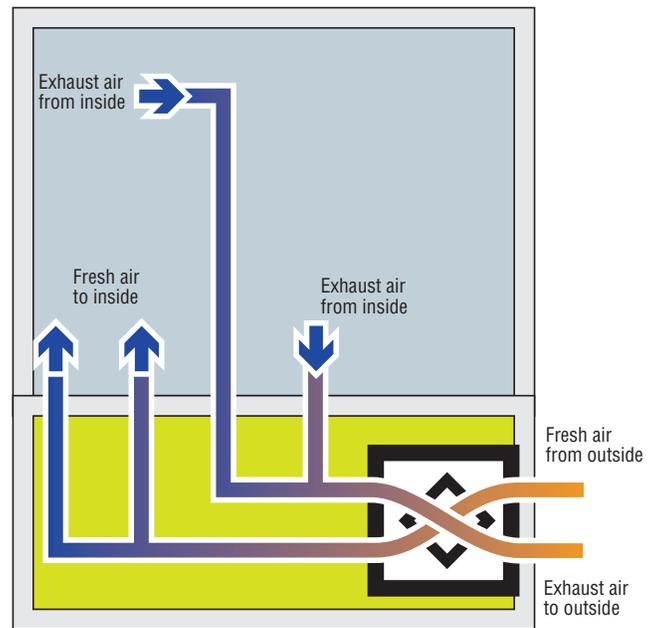


Figure 4. Outside air is pre-conditioned (cooled and dried in summer, heated in winter) with energy from the exhausted air in an ERV

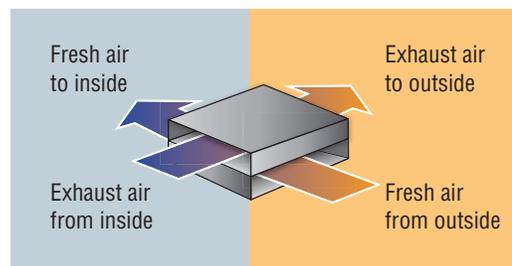


Figure 5. An ERV's core prevents the inlet and exhaust air stream from mixing, but allows heat and moisture to be transferred.

When assessing your building's ventilation strategy make sure to:

1. Note the control capabilities.
2. Confirm OA is pulled inwards (towards the grill) and examine the ducting, if accessible.
3. Note any filters and dampers in the OA ventilation duct.

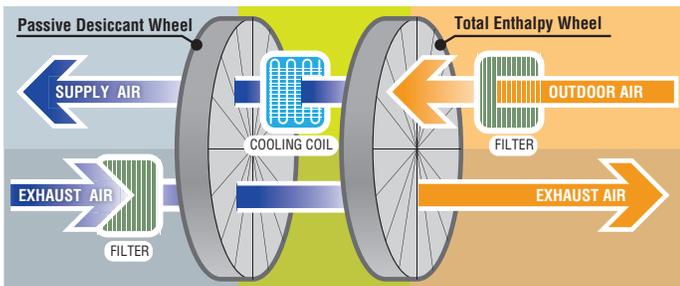


Figure 2. Dedicated Outside Air System with mechanical refrigeration and desiccant-based energy recovery

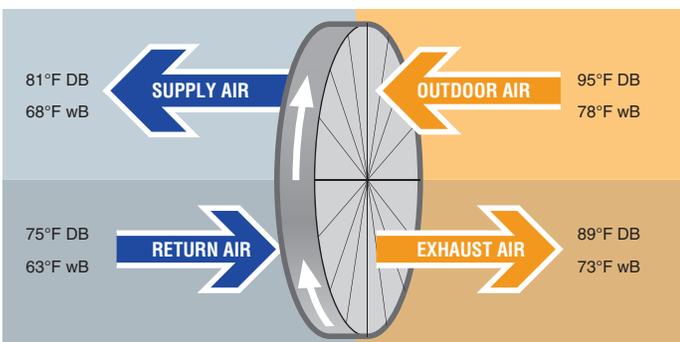


Figure 3. Desiccant wheel dries the incoming OA with the exhaust stream

## IMPORTANT OPERATION DETAILS

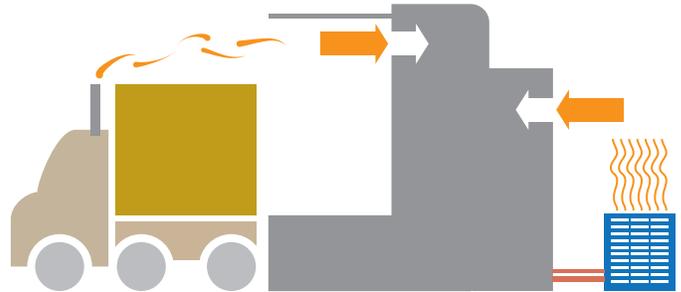
### Only Ventilate When Necessary

- Many buildings waste energy by simply not shutting their ventilation system “OFF” during non-occupied periods. Building occupancy can be adjusted with programmable time-clock controls.
- Ventilation systems are usually designed to handle the peak conditions, and usually a building is not operated in this manner. Significant savings can be obtained by employing Demand Control Ventilation (DCV), essentially adjusting the amount of OA needed based on the actual people load at that moment.
- DCV works particularly well in larger spaces (>500 sq. ft.) that often experience a variable amount of people in them. Examples include classrooms, conference rooms, cafeterias, auditoriums and other places of assembly.
- DCV requires sensors to make adjustments to the OA delivered to a space.
  - » *Occupancy Sensors* – similar to lighting controls, occupancy sensors use ultrasonic and/or infrared to detect the presence of people and will timeout upon their departure. According to the 2016 version of ASHRAE 62.1, this type of control can now reduce the ventilation down to zero in certain areas (classrooms, multiuse spaces, breakrooms, corridors, etc.), even though other parts of the building are still occupied.
  - » *People Counter* – particularly in spaces with one or two main entryways, a people counter can accurately estimate the number of occupants and adjust the ventilation rate accordingly.
  - » *CO<sub>2</sub> Sensors* – As humans inhale air, oxygen is removed and carbon dioxide (CO<sub>2</sub>) is exhaled. Outdoor ventilation air typically contains approximately 400 parts per million (ppm) of CO<sub>2</sub> and CO<sub>2</sub> sensors in a space can detect rises in indoor CO<sub>2</sub> levels (often at 800 to 1,000 ppm) and can increase the OA ventilation to accommodate the increase in people. Once occupants depart and the CO<sub>2</sub> levels drop, the system can throttle back to lower levels. CO<sub>2</sub> sensors can go out of calibration, so have them checked periodically to ensure proper operation.

When assessing your building’s ventilation controls, make sure to:

1. Refer to the programmable controls to make sure ventilation does not occur when the building is unoccupied.
2. Confirm the proper operation of DCV controls.
3. Confirm OA intakes are not too close to sources of contamination.

### Outdoor Air Intakes



- It may seem obvious, but one of the most common challenges for commercial building ventilation systems is finding a good location from which to pull the outdoor air. Numerous buildings have OA intakes located too close (generally < 15 to 25 feet) to sources of contamination, including:
  - » loading docks / other idling vehicles
  - » smoking areas
  - » plumbing stacks
  - » combustion flue pipes
  - » exhaust vents
  - » back-up fuel-fired generators
  - » garbage dumpsters
  - » cooling towers
  - » off-gassing roof shingles
  - » thermal pollution from outdoor condensing units or excessively hot locations
  - » locations with poor drainage that pool water and promote microbial growth
- Generally the best location to pull in outdoor air is from up high but avoid pulling air too close to the roofing surface.
- Be sure a half-inch mesh bird screen covers the OA inlet and periodically check for debris.