Ventilation Strategies

INTRODUCTION

The need to supply a home's occupants with fresh air should be considered a top priority in any new build or energy retrofit project. However, the majority of homes in the US have limited or no mechanical ventilation systems. Often, we rely on the holes, gaps and cracks in the building's shell to allow some amount of air to leak into and out of the living space. This approach can create a variety of problems that may include poor indoor air quality, structural degradation, and decreased energy efficiency. The solution is to build homes as air tight as possible and install a mechanical ventilation system that is capable of delivering a constant amount of fresh filtered outdoor air from a controlled location.

THREE DIFFERENT APPROACHES

There are a variety of ways to supply a home with mechanical ventilation, but only three main strategies: exhaust, supply and balanced. Each of these has their own variety of installation scenarios, efficacies, installation costs, operating costs, etc. A builder or HVAC contractor will need to be cognizant of the pros and cons associated with each and should design, install, and commission a system that is appropriate for each situation.

EXHAUST STRATEGY

The first approach for introducing mechanical ventilation is an exhaust strategy. Exhaust strategies depend on air being mechanically removed while inducing outdoor air to infiltrate passively through holes in the building envelope. The exhaust method is typically the easiest and lowest cost to implement. However, these systems incur somewhat higher operating costs as conditioned air is dumped outside and unconditioned air is drawn in from outside. The most common example of an exhaust ventilation system is the installation of a bathroom fan with integrated timer to control an operation schedule that exhausts a prescribed amount of air. A more elaborate approach is to install a single, remotely located and continuously operating fan that is independently ducted to extract air from multiple rooms.

Exhaust ventilation strategies do potentially cause other issues that should be addressed. Continuously exhausting air from a building potentially creates a negatively pressurized building envelope. This depressurization can cause air to infiltrate from unwanted areas, such as crawlspaces, attics, or garages. Special attention should be given to air sealing the garage common wall, ceiling plane, and floor plane to keep potential pollutants in these spaces from being able to enter the home. The use of natural draft combustion appliances should also be limited when utilizing an exhaust ventilation strategy. A tight building envelope combined with continuously operating exhaust fans can potentially cause natural draft appliances to back draft, spilling combustion by-products into the living space. An easy solution is to always specify more energy efficient direct vent or power vented sealed combustion furnaces and water heaters.

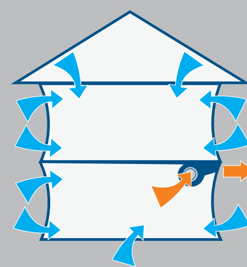
SUPPLY STRATEGY

The supply ventilation approach works by mechanically bringing outside air directly into the living space while passively inducing indoor air to leave the house. The most common example of this scenario is outside air ducted directly into the return side of the HVAC distribution system. This strategy will slightly pressurize the house, reducing the opportunity for combustion appliances to backdraft and mitigating the infiltration of pollutants from attached garages, crawlspaces, etc. Other benefits include the ability to pre-condition the air, controlling the point of entry, and filtering the air stream. This approach is inexpensive and can typically be retrofitted to an existing duct system. However, supply ventilation strategies that make use of existing ductwork only provide ventilation during the heating and cooling seasons when the air handling equipment is in use and will need to incorporate alternative strategies for the shoulder months. Control systems, such as an Air Cycler, are available that couple a mechanical damper with the air handler fan to utilize the air handler and ductwork to provide ventilation without conditioning the air in these shoulder months.

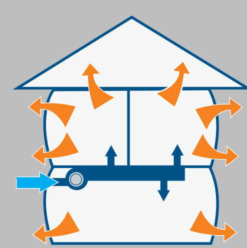
BALANCED STRATEGY

The most effective solution for providing ventilation is a balanced system in which the amount of exhaust air is equal to the amount of incoming air, creating no net pressure imbalance on the

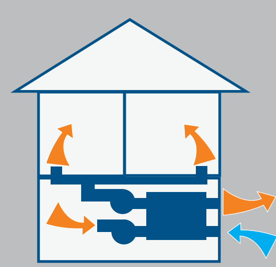
THREE MAIN VENTILATION STRATEGIES



1. Exhaust strategies induce negative pressures on the house and draw in air through the holes in the envelope.



2. Supply strategies provide positive pressures on the house that force air out through the holes in the envelope.



3. Balanced strategies supply and exhaust equal amounts of air, creating no net air pressure effect on the house.

STRATEGIES AT A GLANCE

Ventilation Strategy Evaluation Table

Ventilation Option	Installation Costs	Operating Costs	Distribution Effectiveness	Design Complexity
Exhaust	$	$$	moderate	simple
Supply	$	$$	good	simple
Balanced	$$	$$$	better	moderate-complex
Balanced (ERV/HRV)	$$$	$	best	moderate-complex

house. There are a variety of ways to produce balanced ventilation, and it is an appropriate strategy for any climate. The most basic systems are modifications of the two methods described earlier that allow for the introduction of make-up air at a controlled location. This could be something such as bathroom exhaust fans with integrated timers tied synchronously to an Air Cycler (an Air Cycler is an air handler fan control timer that uses the existing equipment and ductwork to introduce just ventilation air when there is not a call for heating or cooling).
The most sophisticated and effective technique is the installation of a fully ducted ventilation system independent of a forced air heating/cooling distribution system. Coupling a heat recovery ventilator (HRV) or energy recovery ventilator (ERV) to this setup provides for greater energy efficiency and lower operating costs. HRVs and ERVs temper incoming fresh outdoor air with outgoing indoor air by crossing the two in a heat exchanger. (ERVs also exchange water vapor across the core). This heat exchange recovers the majority of the energy that has already been spent to heat or cool the air before it is exhausted outside. HRVs and ERVs can be installed in a variety of set-ups, but the most effective is part of an independently ducted system. In this case, polluted indoor air from kitchens, baths, etc. can be exhausted while fresh air is provided to the living spaces and bedrooms. This is by far the most cost prohibitive (upfront) and labor intensive installation, but gives the greatest distribution of fresh air and is the most energy efficient.

ASHRAE 62.2-2010

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) are an international organization promoting "a sustainable world through research, standards writing, publishing and continuing education." Standard 62.2 was developed specifically for low-rise residential buildings to address ventilation and indoor air quality. Although the standard addresses local ventilation for source control (e.g. kitchen range hoods to exhaust moisture and odors), the parts concerning whole-house ventilation are the primary concern of this paper. The latest iteration 62.2-2010 is the most comprehensive version to date and provides an easy to use formula or table for determining minimum required ventilation rates. These rates are in cubic feet per minute (cfm) and assume 24 hour operation.

CONCLUSION

The need for ventilation is apparent; fresh air is essential to the health of building occupants. Ben Franklin wrote "I am persuaded that no common air from without, is so unwholesome as the air within a close[d] room that has been often breathed and not changed." He understood over 200 years ago the importance of providing fresh air to the occupants of a building. As technology has progressed, we now have the tools and understanding to provide that air in a comfortable, energy efficient and affordable manner.

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Ventilation Requirements

$Q_{fan} = 0.01A_{floor} + 7.5(N_{br} + 1)$

where

Q_{fan} = ventilation flow rate, cfm

A_{floor} = floor area, ft^2

N_{br} = number of bedrooms; not to be less than one

OR

Floor Area (ft^2)	Bedrooms 0-1	2-3	4-5	6-7	>7
< 1500	30	45	60	75	90
1501-3000	45	60	75	90	105
3001-4500	60	75	90	105	120
4501-6000	75	90	105	120	135
6001-7500	90	105	120	135	150
> 7500	105	120	135	150	165

ANSI/ASHRAE Standard 62.2-2010 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings