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Residential Ventilation

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A number of factors contribute to the high levels of energy efficiency that are now possible in new and existing homes. Airtightening measures – those that prevent air infiltration through the building shell – are among the most critical of these. In new construction and in the improvement of an existing home, low air infiltration rates are achieved through an attention to the details of both construction materials and practices. And as air leakage has decreased in homes, ventilation has become a residential design issue because of problems that arise from excess moisture and other indoor air pollutants.

Before airtightening measures were as widespread as they now are, ventilation of homes was achieved naturally, as air leaked in and out of cracks in the building shell – around windows and doors, where dissimilar building materials meet, and other places. Natural ventilation is undesirable because it can never be controlled. Its rate depends on wind speed, vegetation around a house, site topography, and other variables. And natural ventilation imposes large energy costs on a home because the incoming infiltration air must be heated in the winter. But in the absence of natural ventilation, mechanical ventilation is necessary for removing moisture and other pollutants as well as bringing fresh air into a home.

A basic mechanical ventilation system consists of exhaust fans, which are ducted to the outdoors, in kitchens and bathrooms. Clothes dryers should always be ducted to the outdoors. An issue that arises in airtight homes is the provision of make-up air for these systems. As exhaust fans pull air out of a house, that air must be replaced. In a leaky house, that air is supplied through infiltration. This happens because the fans place negative pressure on a house and, if no windows are open, pull in air from cracks that exist in the building envelope or from a chimney, which can be dangerous if the chimney is connected to an operating combustion appliance. Other ventilation systems exist that not only pull air out of a house but also provide make-up air.

Approaches to residential ventilation can be categorized as **exhaust**, **supply**, and **balanced** systems. Fans that pull air out of a space, such as a bathroom exhaust fan or a kitchen range ventilation hood comprise basic exhaust ventilation systems that most people are familiar with. As noted above, however, these fans can place an airtight house under negative pressure. Variations of exhaust systems provide make-up air to the house in some manner. The simplest way to do this is to install passive vents, which are small screened openings in exterior walls. These admit air by opening when the home comes under negative pressure, such as when an exhaust fan is turned on. A study by Roberson, Brown, Koomey, and Greenberg (1998) concluded that passive vents are only recommended for use in very small, airtight homes in which depressurization is safe. Home depressurization is only safe if all combustion appliances receive combustion air from outside the home; there are no fireplaces in the home; the home has no attached garage; and the home is not located in a high radon area.

More commonly used than exhaust fans with passive vents is a central exhaust system that pulls air out of a house combined with a fan that pulls fresh air into the house and delivers it through ducts to several rooms, usually each bedroom and living area. Whole-house fans are effective in this type of supply system. A variation of this system, if the house has a forced air furnace, is to deliver outdoor air to the return duct, so that it can be mixed with indoor air and heated before it is delivered to the rooms.

A **heat recovery ventilator (HRV) —** also referred to as an **air-to-air heat exchanger —** is a balanced system that consists of a device which pulls fresh air into a home at the same time that it is exhausting air out of the home. The two airstreams are separated but pass over a core, or heat exchanger, that transfers heat from the warmer airstream to the colder one. A heat recovery ventilator also dehumidifies the home, because the warmer airstream contains moisture that condenses during the exchange process. The resulting water is delivered to a drain through a tube. HRVs can be stand-alone units with ducts or they can be integrated with the ducts of a forced air furnace. In addition to the basic systems described above, other variations exist, including central exhaust/supply systems with dehumidification and systems with air filtration options. Several studies have analyzed the cost effectiveness of various ventilation systems by examining purchase and installation costs, annual operating costs, and additional imposed heating costs (to heat incoming air). In addition to costs, benefits that are difficult to quantify include increased human comfort and the prevention of moisture problems and house depressurization. The study by Roberson *et al.* (1998) concluded that in cold climates, the most cost-effective system is a central exhaust fan that also supplies fresh air. This system was followed closely by a heat recovery ventilator, which has the added benefit of increased human comfort. While the purchase cost is higher than non-heat recovery systems, unit price decreases as volume increases, which means that production builders may realize volume discounts, depending on the number of homes they build, and could pass these savings along to buyers.

A comparison by the National Association of Home Builders Research Center (2002) also showed that ventilation without heat recovery, while having a lower purchase cost, has substantially high operating costs if the cost of heating incoming fresh air is considered. A report by Matson and Feustel (1998) concluded that a central exhaust system, with supply air provided through ducts or passive vents, is the most cost-effective for cold climates. This study included a survey of equipment distributors and found that while builders have had experience with various ventilation systems, common bathroom exhaust fans are most frequently installed in new homes.

As builders become more familiar with advanced ventilation systems, and as more ENERGY STAR homes are built, buyers will become aware of advantages and disadvantages of various residential ventilation systems. More widespread familiarity and awareness are factors that will eventually facilitate routine installation of better ventilation systems in homes.

References:

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