Heat Recovery Ventilation

Indoor Air Quality and Ventilation

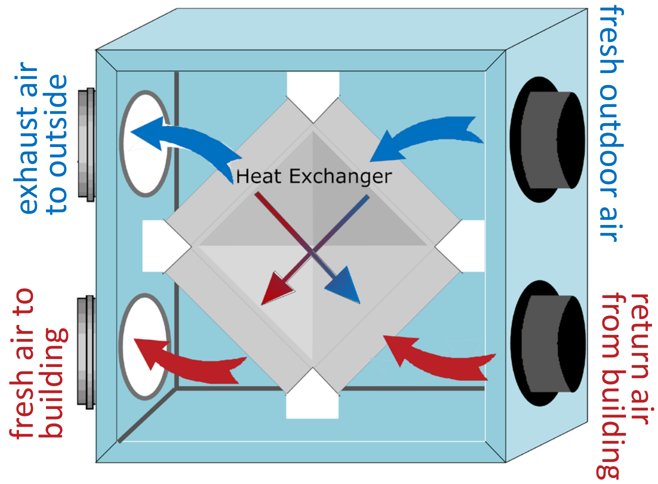
Indoor Air Quality, or IAQ, refers to the quality of the atmosphere in a building based on temperature, humidity, and the amount of pollutants such as carbon dioxide, radon, volatile organic compounds, and particulate matter. IAQ in homes receives more attention these days because houses are more airtight and better insulated than ever before. While this means homes are more energy efficient, it also means that passive air leakage through the building envelope will not provide sufficient ventilation to moderate humidity and airborne pollutants.

Controlling indoor humidity can be a challenge in a cold climate. Sources of water vapor include breathing, cooking, showering, laundry, and plants. Some humidity (30-40%) is desirable because it keeps skin and sinuses from becoming too dry, stops static build-up, and has respiratory benefits. Humidity levels above 40%, however, can cause condensation within the building envelope, leading problems with mold, mildew, and rot. Humidity above 60% any time of the year provides growing conditions for bacteria, viruses and fungi.

There are several ways to manage IAQ, and one of the most important is through ventilation. Heat Recovery Ventilators (or HRVs) are the best way to provide balanced, continuous ventilation to the entire house while conserving energy in a cold climate. This article provides an overview of the purpose of HRVs as well as the different types, modes, efficiencies, and cost.

What's an HRV and how does it work?

HRV systems are becoming increasingly common in cold climate construction and are almost indispensible in today's super-insulated, airtight homes. As older homes are getting retrofit and becoming tighter and more insulated, they are also facing indoor air quality issues. HRVs improve the indoor air quality of your home and save more energy than other types of ventilation.



The main job of the HRV is to supply fresh outdoor air to the house while expelling stale indoor air laden with moisture, animal dander, and gases from combustion appliances and carpets. At the heart of the HRV is a heat exchanger (called a "core") where heat is transferred from outgoing stale air to incoming fresh air without the airstreams mixing. Most HRVs recover between 70-90% of the heat from exhaust air, depending on the unit and controls, far more efficient than a standard exhaust fan that blows warm air directly outside.

The ducting of an HRV system typically supplies fresh air to bedrooms and living areas while exhausting humid air from bathrooms, kitchens, laundry rooms and crawlspaces. Many systems also include a boost mode in the bathroom to get rid of excess moisture. The HRV does not eliminate the need for a cooking fan, so a range hood should still be the main outlet for greases and smoke above the cook stove.

Balancing the HRV

The HRV is designed to be balanced, meaning it takes in as much air as it exhausts, maintaining close to neutral pressure inside the home. It should not create a negative pressure in the home, like an unregulated exhaust fan might. Negative pressure can cause combustion appliances, such as oil-fired furnaces or wood stoves, to backdraft, which means dangerous exhaust gases are pulled from the flue back into a home. It's also important to remember that HRVs are not meant to supply air to combustion appliances.

Energy Use & Maintenance

Residential-sized HRVs use about as much power as a 60-watt light bulb when running, and are getting more and more efficient. As with any appliance, an HRV should be checked and cleaned regularly. Filters can be washed or cleaned with a vaccuum.

Other Uses

You can install an in-line filter system on the warm-side supply air that will filter particles and odors from the incoming air. For example, in the winter this can help keep particulate pollution (from wood-burning and other sources) out of your home.

Installation and operating costs

The cost of an HRV depends on the size of the building and the amount of ductwork needed. For an average home, it may run from $6,000 to $8,000 for the ventilator, ductwork, control system, and labor. Larger homes will require larger HRVs and more ductwork. On the other hand, homes with existing ductwork for a furnace will have lower costs if it can be used for the HRV as well. While the upfront cost may sound high, the energy savings for homes in cold climates are also significant.

Operating costs include the electricity to run the fan and any frost protection devices. To get an idea of the cost of running an HRV system, consider a few models available in Alaska. The table below shows the electrical use—at low and high speed—of three different HRVs.

As the electrical use and fan speed will depend on external static pressure (available from individual product spec sheets) this table should not be used to compare the efficiency of the three models. Instead, it gives some examples of the electrical use of some HRVs.

HRV model	Low speed operation (cubic feet per min.)	High speed operation (cubic feet per min.)
Venmar EKO	Electricity: 24 watts Air flow: 49 cfm	Electricity: 54 watts Air flow: 122 cfm
Zhender 350	Electricity: 17 watts Air flow: 59 cfm	Electricity: 70 watts Air flow: 132 cfm
Lifebreath 100 ECM	Electricity: 40 watts Air flow: 78 cfm	Electricity: 115 watts Air flow: 161 cfm

The operating cost of the HRV depends on how often it runs in each speed. The table below lists the approximate operating costs in three Alaska cities if the HRV runs 22 hours a day on low speed and 2 hours a day on high speed.

HRV model	Fairbanks ($0.20/kWh)	Anchorage ($0.14/kWh)	Juneau ($0.10/kWh)
Venmar EKO	daily: $0.13 monthly: $3.18	daily: $0.09 monthly: $2.67	daily: $0.06 monthly: $1.91
Zhender 350	daily: $0.10 monthly: $3.08	daily: $0.07 monthly: $2.16	daily: $0.05 monthly: $1.54
Lifebreath 100 ECM	daily: $0.22 monthly: $6.66	daily: $0.16 monthly: $4.66	daily: $0.11 monthly: $3.33

In all cases, it costs less than $100 a year to operate the HRV and continually provide fresh, warm air to a home.

To calculate your specific cost, find the electrical usage for your unit in the online product sheet here:

Venmar http://www.venmar-usa.com
Zehnder http://zehnderamerica.com
Lifebreath http://www.lifebreath.com

In Alaska, HRVs require a defrost mechanism to prevent the heat exchange core from freezing on cold days. Some models, such as the Venmar EKO and the Lifebreath 100 ECM, are programmed to switch to recirculation mode and recirculate warm indoor air through the core for a portion of each hour to prevent freeze-up. The Zehnder 350, on the other hand, uses either a 1,000 watt electric resistance heater to preheat incoming air or a ground loop, which transfers heat from the outside ground into a heat exchanger. A 7-watt circulating fan routes incoming cold air to the heat exchanger to capture this heat. Both the electric heater and the ground loop are controlled by temperature sensors and turn on when the appliance is approaching freezing.

These defrost mechanisms will add some operating cost to the system during winter months. For instance, running the ground loop circulator of the Zehnder on cold days will add less than a nickel a day of operating costs in Fairbanks. The electric preheater will add more, around $1.50 a day, depending on outdoor temperature. It would be cheaper in Juneau and Anchorage, because of lower electric rates in those regions.

Besides electricity for fans and any defrost systems, there are no additional maintenance costs. Filters should be checked and cleaned once a year but can be vacuumed and re-used. To lower operating costs with any ventilation system, look for features like variable speed, electrically efficient fans and high heat recovery efficiency. Also, an HRV with programmable controls can turn down ventilation when buildings are unoccupied and save money.

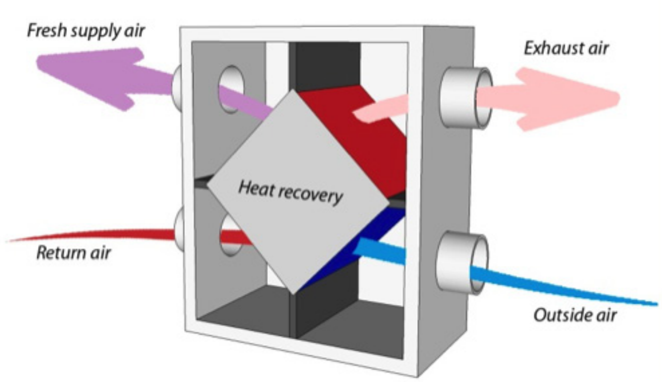
Recirculation Mode

One often-debated feature of HRVs is recirculation mode, where the unit closes the connection to the outside and brings exhaust air back into the rooms. This uses less energy than ventilation mode, since there is no cold air coming in from outside.

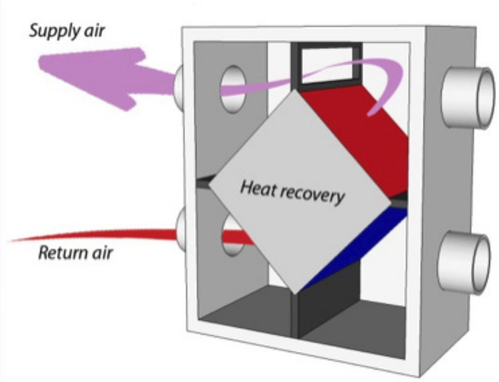
As no ventilation occurs when the HRV operates in recirculation, this mode should not be used continuously. Recirculating indoor air means moisture and indoor pollutants are no longer being flushed out of the home, and the concentration will continue to rise and can eventually reach harmful levels. Recirculation can also spread unwanted smells from more to less polluted areas, such as from the bathroom to the living room.

In order to maintain sufficient air exchange, some HRVs offer modes where these two strategies can be combined. For example, 20/40, 30/30, or Smart Mode. In 20/40, the HRV will bring in fresh air for 20 minutes and then recirculate for 40 minutes (likewise for 30/30). Smart modes usually require some kind of sensor (humidity, carbon dioxide, or temperature) to dictate when to ventilate and when to recirculate.

Air Exchange Mode



Recirculation Mode



While recirculation is appropriate for some situations, relying on it too much can undermine the benefit of having an HRV—to maintain indoor air quality that is healthy for both humans and buildings.

How Efficient is your HRV?

The efficiency of an HRV can range widely. More efficient HRVs can recover more heat from the exhaust air. To get a true comparison of HRV models, it's important to understand the different efficiency measures and how they're calculated. The efficiencies also vary depending on the difference between indoor and outdoor temperature and amount of airflow through the HRV.

The **Sensible Recovery Efficiency (SRE)** quantifies the amount of heat recovered from the exhaust air at a given air flow and temperature. It is reported as a percentage of the total heat available for recovery. For instance, if an HRV has an SRE of 55%, the HRV core transfers 55% of the heat available in the outgoing air to the incoming airstream. The SRE corrects for a number of factors that add heat to the incoming air in a realistic situation, such as heat that might enter the airstream through the HRV case, airflow imbalances between the supply and exhaust airstreams, heat gains from circulating fans, and energy used to defrost the HRV core. The SRE is often used to compare the heating season performances of HRVs because it calculates the efficiency of an HRV without regard to differing circumstances in installed locations.

The **Apparent Sensible Effectiveness (ASE)** is another efficiency measure often listed by HRV manufacturers. Unlike the SRE, the ASE accounts for the incidental heat transfer from fans to the airflow, heat leaking in or out of the HRV case, and any leaks between the airstreams through the HRV core. Typically, it will be higher than the SRE for a given HRV, air flow, and temperature difference because it includes heat gained by incoming air from sources other than the exhaust air. The ASE is typically used to calculate the final delivered supply air temperature at a given flow rate for an HRV.

Other Types of Ventilation

Exhaust-only systems consist of fans and vents in the bathrooms and a range hood over the stove.

Supply-only systems use a fan to bring fresh air into a home and employ the existing ductwork to distribute the fresh air (in a home with a forced air heating appliance). They are not recommended in Alaska because they create positive pressure indoors, which can force moisture from inside the home into the building envelope.

Balanced systems employ a heat recovery ventilator (HRV) or energy recovery ventilator that both supplies and exhausts air. Balanced systems have the benefit of transferring heat from the exhaust air stream to the supply air stream, lessening the amount of energy needed to heat the fresh air to room temperature. Typically these systems pull exhaust air from bathrooms, the laundry room, and the kitchen, and supply fresh air to the bedrooms and living area.

When comparing different HRVs, first ensure that reported efficiencies were measured in an independent lab. Second, make sure you're comparing apples to apples. For instance, the SRE of one HRV at a given air flow and temperature should be compared to the SRE of another HRV at the same air flow and outdoor temperature, not to the ASE. To compare a wide variety of HRVs, visit the Home Ventilating Institute at www.hvi.org, a non-profit that provides performance certification of residential ventilation products and contains a directory of efficiency ratings.

Conclusion

While it may seem expensive up front, you should look at an HRV system as an investment in a healthy home. In this climate, indoor moisture can cause problems not only for the structure but also for your health. An HRV will protect the occupants as well as the home by removing excess moisture and pollutants before they have a harmful effect. If you're thinking about purchasing a system, make sure you learn about the specifics and find an installer who is willing to educate you and stand behind their work.