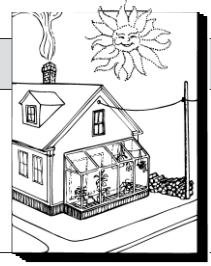

Ventilating Heat Pumps

by Bruce Sullivan

As more home buyers come to accept whole-house ventilation as a necessity rather than an option, the question of heat recovery becomes an important consideration. Anytime you exhaust stale air and bring in fresh air, you are blowing out heat and replacing it with cold air that must be heated. This obviously increases a home's heating load. However, if some of the heat from the exhaust air can be recovered, the additional heat load is reduced.

There are two ways to recover this heat — with air-to-air heat exchangers, or with ventilating heat pumps. This month, I want to talk about the ventilating heat pump. This technology is little talked about, but is a bit simpler to install than air-to-air heat exchangers.

The Swedes developed a heat pump that extracts energy from the air exhausted by a ventilation system. This ventilating heat pump (VHP) transfers heat from the outgoing stale air to a tank of water. The suction created by the exhaust fan draws outside air through vents in the walls or window sash.. The fan alone can ventilate anytime, but heat recovery occurs only when the compressor heats water. This means ventilation occurs when the water heater kicks on to heat water.

This control "logic" takes some getting used to. Showers, baths, and laundry all generate water vapor *and* use hot water, so at first you might be persuaded that a VHP automatically supplies spot ventilation when you need it. However, these VHPs are typically set to turn on after a hot water draw of about 10 to 15 gallons. If the shower has a low-flow shower head, as it should, that's more than one shower's worth.

Even though ventilation is a bit out of sync, it takes six to eight hours a day to heat a tank of water, so over the course of the day the house's overall humidity is kept in line. Also, ventilation is ensured; it's not dependent on the whims of the occupants. Nevertheless, if an occupant wants the option of ventilating during showers (to clear the mirror, for example), the system can be wired with switches or crank timers at each pick-up point for ventilation without heat recovery.

Two Models

Currently, the only U.S. manufacturer of a VHP is Therma-Stor Products (P.O. Box 8050, Madison, WI 53708; 800/533-7533). They make two models: the *Therma-Vent* and the *Envirovent*. Both can produce all the hot water needed by a typical family of four while providing ample ventilation.

Therma-Vent. The Therma-Vent is essentially a heat pump water heater with a powerful exhaust fan and an 80-gallon tank. Heated, moist exhaust air is picked up from one or more locations in the house. The heat is transferred to the water tank, and a single duct carries cool, stale air from the unit to the outside. A thermostat in the water tank operates the heat pump and ventilates the house whenever the tank temperature drops below the set point.

Envirovent. The more sophisticated Envirovent offers water heating plus limited forced-air space heating and cooling. The 7,000 Btus of heating and cooling capacity is comparable to two or three electric baseboard heaters or a mid-size window air conditioner. This amount of space conditioning might go a long way in a tight, well-insulated house, but only in mild weather.

Costs And Savings

Contractors pay about $1,700 plus shipping for the simpler Therma-Vent. Contractor cost for an Envirovent with the 80-gallon tank is $2,150 plus shipping. Ducts and accessories range between $200 and $400. Then there's the little bit of extra labor to install a VHP compared to a normal water heater. On the other hand, the VHP replaces the water heater and bath fans, which saves several hundred dollars.

Over time, energy savings from water heating help make up for the higher cost. The typical family of four uses about 5,000 kilowatt-hours (kwh) to heat water for a year. At an electric rate of 5¢ per kwh, that family would spend $250 per year. With a VHP operating at its typical 250% efficiency, that family would spend only $110 — saving $140 per year. At 10¢ per kwh, the savings are about $300 per year. Since these estimates assume "average" hot water use, a family that uses more hot water would save more.

Keep in mind that any heat recovery system will recover only some of the exhausted heat. In cold weather, ventilation will still add to the house heating load. Ventilation is necessary for a healthy house, and of course, this costs.

Installation

The major work of installing a VHP falls into five categories: planning, ducts, plumbing, electrical, and "supervision." The plumber and electrician usually take care of hooking up the unit, while the general contractor does the rest. So the keys to a successful installation are planning and communication. The manufacturer provides detailed instructions and checklists for subs to help this process along.

The Therma-Vent is a single piece of equipment with a fan and compressor mounted on top of an 80-gallon tank. It installs just like an electric water heater. The only additional work is plumbing a drain line for condensate and running the ducts.

In existing homes your only option may be to install one exhaust pickup for the whole house.

Therma-Stor's basic whole-house ventilator is essentially a heat-pump water heater with a powerful exhaust fan and an 80-gallon storage tank. This model heats domestic hot water with the heat extracted from exhaust ventilation. The water tank is larger than most because the water heats slowly.

In new construction and major remodels, you can run ducts to each bathroom, the laundry, or other high-moisture areas. These pickups replace spot ventilation fans.

If possible, locate the VHP near the center of the house, so duct runs can be as short as possible. As with all hvac equipment, keep ducts inside the conditioned space if possible, and don't restrict air flow with a twisting, turning run or by cramming flexible ducts through small openings.

Ventilation experts generally call for a fresh air supply rate of 0.3 to 0.5 air changes per hour (ach) or 15 cubic feet per minute (cfm) per occupant. On these VHPs, air flow is adjusted with a slide damper on the fan unit or with adjustable grilles on the pick-up points. One nice thing about "exhaust only" schemes such as VHPs is that you have to adjust only the exhaust air stream.

If a certain amount of air is blown out of the house, then a similar amount must be coming in somewhere. Tight construction and fresh air inlets give you some control over the location of incoming air.

Installation of the Envirovent is a bit more complicated than for the Therma-Vent. It has a water tank and a separate air handler/compressor unit (called the Space Conditioning Module). A field-connected, pre-charged refrigerant line runs between the two units. In addition to the exhaust ducts, the Envirovent needs a return and supply for space conditioning, as shown in the illustration. It also comes with a standard heating/cooling thermostat.

It's worth making a floor plan sketch showing the locations of the VHP, ducts, inlets, and controls, and sending it to the manufacturer for review. They may point out changes to make installation easier and improve performance. Therma-Stor Products also offers a toll-free telephone line for assistance. The people there have always been prompt and helpful, in my experience.

Personal Observations

I've been living with an Envirovent for almost five months — not enough time to make any definitive statements. Nevertheless, here are a few preliminary thoughts.

Overall I'm pleased, but the control strategy takes getting used to. I'm having trouble letting go of the idea that heat recovery should occur whenever ventilation does. Again, ventilation occurs only whenever water heating or space heating is needed.

Nevertheless, the ventilation is better than anything I've experienced. We've been able to keep the house at around 50% relative humidity, which is a major accomplishment in this mild, wet climate (about 4,500 heating degree days). The air flow is adjusted to exhaust about 120 cfm from the house. Two main bathrooms get 35 cfm each, the guest bath gets 20 cfm, and the kitchen gets 25 cfm. The remaining 5 cfm is duct and cabinet leakage. The bathrooms get less air flow than recommended for spot ventilation, so the mirror fogs. However, there is no sign of mustiness, odor, or mildew. I think the long run-time makes up for the lower air flow rate. If anything, the unit may ventilate too much. Occasionally, an evening bath or late load of laundry has triggered several hours of ventilation while the family slept.

The unit heats water very well, but the space heating is strictly supplemental. The delivery temperature of 90°F seems too much like a draft. Luckily the registers are located in hallways, so it's not annoying. Since space heating also ventilates, I run the unit as a space heater only when the outdoor temperature is above 42°F.

So far, my experience is based on our coldest weather. In about a year, I'll give a more complete report on performance. I'm looking forward to milder weather, when I expect the Envirovent to shine. ■

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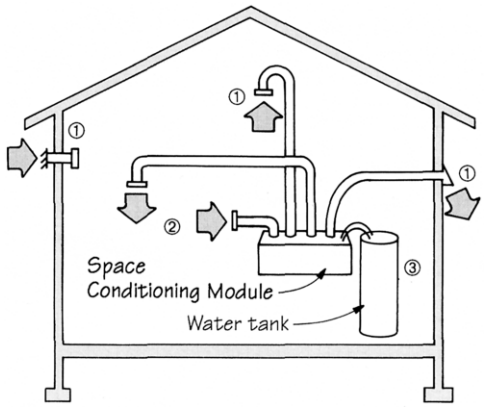
VHP With Space Heating



*The more sophisticated Envirovent has a water tank and a separate air handler/compressor unit called the Space Conditioning Module. The Envirovent has three functions: **(1) Whole-house ventilation** exhausts stale air from pickups in the bathrooms, laundry, and kitchen. Through-the-wall inlets bring fresh air into bedrooms. **(2) Supplemental space heating and cooling** requires both return and supply ducts. **(3) Water heating** is performed with a heat pump compressor. The unit includes a backup electric element.*

Sizing Up Ventilator Heat Pumps

Advantages

- VHPs eliminate the risk of cross-contamination inside the unit.
- Energy savings occur year-round, not just during the heating and cooling months.
- VHPs operate at very high efficiency.
- Occupants are guaranteed ventilation, because they cannot turn off ventilation without shutting down water heating.
- VHPs offer a high-efficiency alternative for shady sites where solar water heaters wouldn't work.

Compromises

- If you install a VHP as a replacement for all the bath fans, the unit ventilates the whole house when it runs.
- VHPs operate when the thermostat in the water tank calls for heat. That may not be when you need spot ventilation to clear humidity or odors.
- VHPs use the refrigerant HCFC-22, which is commonly used in refrigerators. Although this is about 90% less harmful than ozone-killing CFC-11 and CFC-12, it does degrade ozone. HCFC-22 is currently scheduled to be phased out over the next 20 to 30 years.

Disadvantages

- The installation and maintenance cost of these units is higher than air-to-air heat exchangers or other central ventilators.
- Incoming air is not tempered. Poorly placed inlet vents would cause a cold draft when the outdoor temperature drops.