

# EXHAUST FANS FOR A COLD CLIMATE

by Jon Eakes

WHEN BATHROOMS or kitchens are built or remodeled, it is standard practice today to install an exhaust fan or some sort. In the U.S., the Uniform Building Code recommends installing fans. Often there is very little detailing or specification relating to exhaust fans other than the number of cubic feet of air they move per minute (cfm), so the fan is simply installed in the “standard way,” whatever that means. This works fine in a warm climate, and even works fairly well in a poorly insulated house, but in a well-insulated or reinsulated house in a northern climate, “standard” means something very different.

First of all, a builder should be sensitive to the fact that an exhaust ventilation system will do no good if the homeowner will not use it. There are three basic reasons why most systems are simply not turned on.

First, the fan may be plugged full of rags or the outside damper taped shut in an effort to stop the constant cold drafts. Many northerners seem to think fans are expendable energy-wasting devices, and most traditional installation techniques are not adequate for our well-insulated, cold-climate houses. Details on that in a minute.

Second, most fans are so noisy that they are used only when there is no alternative, such as when the kitchen is full of smoke. Rarely will a cook endure the whine, if not the rattle, of the range hood simply to remove a bit of steam. Specification sheets on fans include noise factors and this should be an item of prime, not passing, interest. Very quiet fans exist, but they do cost more. In general, squirrel cage fans are quieter and more efficient than blade-type fans. (Squirrel cage fans consist of a cylinder with fins along the sides and cost about \$80, whereas the blade fans are in the \$20 to \$30 range.) Some manufacturers have separated the fan from the range hood or the bathroom grill, allowing the fan to be placed near the exhaust port, perhaps even in the basement. This helps immensely to eliminate the noise problem.

Third, people forget the fan, especially when doing ordinary cooking or when taking showers. Tying the bathroom fan to the light switch often creates noise when there is no need and does not assure removal of steam after someone leaves the room. A time-delayed off switch helps, but the best solution is to operate the fan on a humidistat switch with a manual override. If the occupants think about it, they can turn the fan on to remove odors or other forms of pollution but, whether they think of it or not, water vapor will automatically turn the fan on whenever the room is too humid, and leave it on until the condition is corrected. An exhaust fan with this kind of switch will also turn on of its own accord whenever

the general household humidity becomes too high from whatever source, such as laundry drying or run shampooing. This control procedure is now standard for northern installations of air-to-air heat exchangers, but is equally valid for any other household ventilation system.

A quick look at the historical development of the installation of exhaust fans in dwellings on the Canadian prairies will help show why traditional installations cause drafts and other problems today.

It used to be standard practice to run a fan up through the ceiling, through the attic, and out any place on the roof. That worked, and worked well, as long as the attic was so poorly insulated that freezing temperatures in the attic were rare or at least not continuous for long periods of time. With the energy crises, we suddenly started to fill these attics with lots of insulation. This provided significant space heating savings but also had the important side effect of radically reducing the temperature of the attic air. This meant that the attic would now freeze almost every winter night, and often would stay frozen for weeks at a time. We immediately found bathroom fans dripping water.

There were actually two sources of this unexpected condensation. First, the fan was loosely installed through the ceiling vapor barrier, the fan box was full of holes, and the ducting was often full of holes. Water vapor escaped from the bathroom and the fan system into the attic, forming frost; on a warmer afternoon this frost would melt and drip into the insulation and eventually back into the bathroom. Also, we found that when the fan was turned off, the hot air would not longer heat the ducting that went through the freezing attic, and the water left in the duct, as well as the vapor that would diffuse up through the fan box during the night, would all freeze to the inside of the duct. The next morning when the fan was turned on, the frozen vapor would melt and flow back into the bathroom, dripping down the back of the neck of someone trying to shave.

The first efforts to solve these new problems consisted of carefully sealing the ceiling penetration and the entire exhaust system to keep the moisture in, and then wrapping the exhaust duct with R-20 insulation to try to keep it warm and avoid internal condensation. These efforts were somewhat successful, except that now even more vapor tended to freeze to the uninsulated portion of the ducting exposed on the roof—helping to freeze the damper open and creating a constant draft of cold air into the bathroom (or kitchen) while not eliminating all the dripping (Fig. 1).

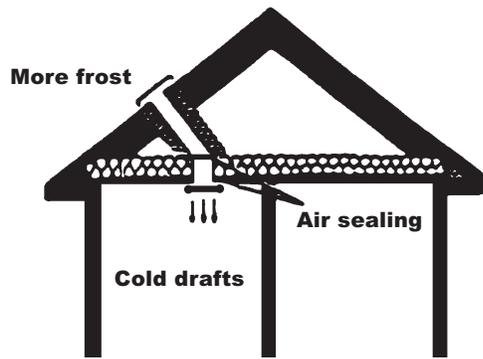


Figure 1. Attempts to insulate the exhaust duct for fans vented through a cold attic and the roof resulted in more frost forming on the exterior portion of the ducting.

Then a scheme was devised to run the ducting into the attic, slope it downward and out the side of the house, seal it tight and insulate it. This worked better, as the condensation drip now went down the outside wall (making a nice black line all the way down the wall) and cold air was less likely to creep back into the vented room. But the dampers still froze open and, if the exhaust port was poorly placed, exhausted vapor would rise up into the eave vents of the house and back into the attic (Fig. 2).

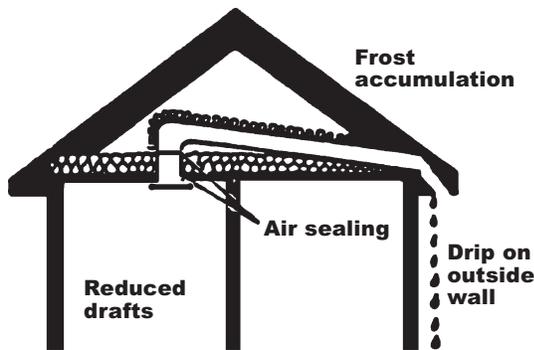


Figure 2. Exhaust fan vented ducting routed through a cold attic to the eaves allowed the condensation to drip down the outside of the building, rather than into the vented room.

Efforts to vent directly through a side wall were quickly dropped, as the lack of insulation led to immediate frost buildup and direct wind entry (Fig. 3). However, the side wall installation had the advantage of eliminating most of the complicated sealing requirements of ceiling penetrations.

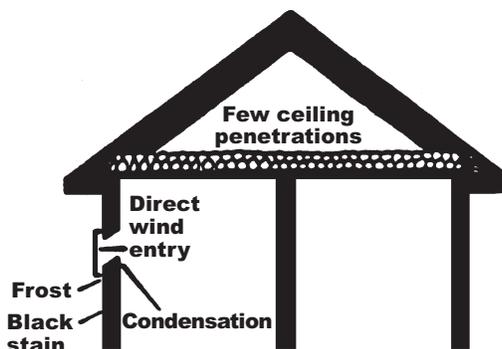


Figure 3. Exhaust fans vented through walls are easier to install, but frosting, condensation and cold air entry are still problems.

The trouble-free solution for the Canadian climate was finally found by routing the exhaust duct into or through an interior partition wall, down to the basement, out through a basement window (or a header penetration) on a downward-draining slope (Fig. 4). There is still frost buildup at the exhaust port outside the wall, the damper still freezes open most of the winter, and it still makes a black drip mark down the wall. But the frost doesn't drip back into the house, the wind doesn't blow up one or two stories of ducting (cold air does not "fall" up vertical ducting), and the black mark can be hidden behind the flowers. The entire ducting run is warm and condensation free and if the fan is placed near the exhaust port in the basement, the ducting is under suction, not pressure, which prevents smoke, vapor, and odors from escaping through unsealed joints. Not only is the noise of the motor distant from the living quarters of the house, but if someday the homeowner wants to upgrade from an exhaust-only system to a balanced air-change system, or an air-to-air heat exchanger, the exhaust ducting is already installed and in the right place.

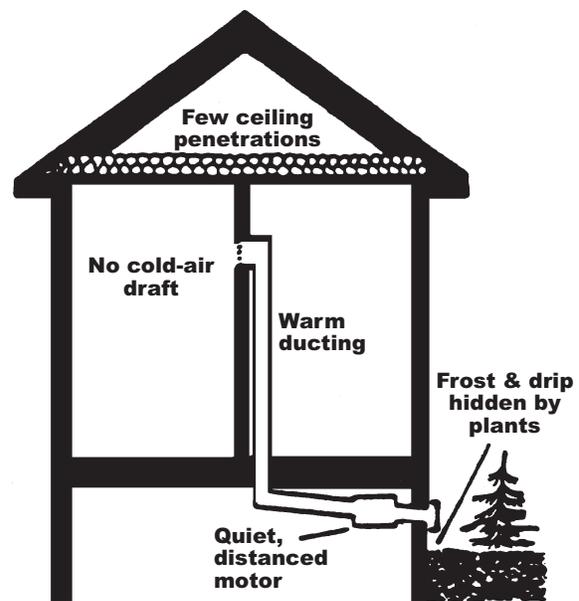


Figure 4. The best solution for venting humid air is to direct the ducting down through the warm interior of the house and out through a wall near ground level.

Even in renovations, we can usually sneak the ducting through kitchen cupboards or through a closet backed up to a bathroom. To go down and out does not occur to most people, but precisely because this direction is the opposite of the predominant thermal forces in a cold climate, it brings an exhaust fan into complete control.