CHIMNEY WARS

Prevent backdrafts. Don't make fireplaces, furnaces clothes dryers, and kitchen fans all fight for the same air

by Jon Eakes

A fireplace has trouble getting started. A furnace puffs occasionally into the basement, home owners complain of odors, and some members of the family seem to have the flu all winter...

These are common occurrences-so common that, until recently, no one paid them much attention. It wasn't until researchers demonstrated that a number of carbon-monoxide deaths each year were caused by chimney spillage (the Hatch Report, 1983) that the Canada Mortgage and Housing Corporation got into gear. They:

1. scientifically studied the draft mechanisms of chimneys;
2. developed testing procedures for contractors and home owners to evaluate the situation in a given dwelling; and
3. developed a computer program to study how chimney flues and exhaust fans compete for air in a house.

The research is not formally completed, and the Canadian government is keeping tight-lipped. But the findings so far are startling. Here's an unofficial preview of what will eventually appear in glossy government pamphlets, and may get blown up into the biggest housing scandal since urea formaldehyde.

The Problems

We have always had flue-gas spillage in our houses. Only now it is occurring more frequently and the gases collect in more dangerous concentrations in our modern, tighter houses. The greatest cause of spillage and backdrafting is the naturally drafting fireplace. It is the most dangerous polluter in the house.

Furnaces with inadequate draft—usually caused by poor flue-pipe design and construction—also cause problems. Complicating the situation is the fact that current practices for supplying make-up air to houses are inadequate. And ways to test draft reliability are just being developed.

Nobody knows exactly what contractors should do about it all. (Comforting, isn't it?)

How to Detect Backdrafts

There are two approaches to finding out how a given house performs: testing and monitoring.

Testing

A series of tests have been developed and verified in the field. No tests, however, are foolproof, and changes in the weather could change their outcomes.

The tests create worst-case scenarios, and then look for chimney spillage or draft reversal. If the worst-case conditions cause a backdraft, then a home owner can take steps to avoid those conditions (for instance, don't turn on all the fans at once), or find ways to supply more air into the house.

Here is an example of a test and some possible remedies:

- Test on a cool day with hardly any wind and 40- to 60-degree temperatures.
- Close up the house and turn off the furnace.
- Turn on all exhaust fans, the smallest first. Wait a few minutes between each fan, and then test for a backdraft at the dilution-air inlet of the furnace. Use a smoke pencil or a lit cigarette.

Downdraft kitchen fans and outside-exhausting central vacuums will usually cause a backdraft. If the furnace backdrafts *only* when these large fans are on, one option is to open a window or shut down the furnace whenever these fans run. If the other fans together cause a backdraft, open a basement window about a thumb's width. If that stops the backdraft, a four-inch fresh-air duct that goes into the basement or into the cold-air return of the furnace could be all that is needed. If you install it, test again and see if it works.

- Next, with the fans on (except the vacuum and barbecue fans, if you have determined that they are a special problem), turn on the furnace. If it won't draw within 30 seconds, open a window. If it still can't establish a draft within a few seconds, turn off the furnace before you gas yourself out. (If it does work, turn off the furnace quickly to keep the chimney cold for the next test.) If the chimney fails to draw with the window open, you probably have a furnace, flue pipe, or chimney problem rather than an air-supply problem.

You may have a poorly tuned furnace, a ridiculously long and elbowed flue pipe, or a blocked chimney. If opening the window does the trick, then you should supply air to the house. A four-inch fresh-air duct going into the return-air plenum of the furnace may be sufficient, or you may need an eight-inch duct that goes directly into the basement.

Some gas codes require such air supplies, and call them combustion-air supplies—although the air doesn't know if it is going to the furnace or the kitchen fan. Its purpose is just to decrease the negative pressure inside the house. One interlock damper device (ACA-PAC) that is approved by the Canadian Gas Code won't allow the furnace to come on unless the air duct is open, but closes it when the furnace is off to keep the basement warm. It's good but expensive.

- Now, shut the furnace off but leave the fans on (except the vacuum, barbecue, and other "problem" fans). Try to light a fire in the fireplace. It probably won't draft up the chimney. Open a window long enough to get a hot fire going. Close the window and test for backdraft at the dilution entry of the furnace again. If it is backdrafting, open a window again. If the window must be opened very wide, you should condemn the fireplace or provide it with a fresh-air intake.

The fresh-air intake should be as large as the throat of the chimney, and located close to the fire and in *front* of it. If an air intake is under or behind the fire, burning embers can be thrown into the room. The air intake should have a good damper or plug that can be tightly closed when the fireplace is not being used. In very cold regions, the fresh air must be pre-tempered, or it will form frost where it enters the living room and meets the indoor humidity.

The fireplace should also have tight-fitting doors so it can be sealed off from the house and shut down at night. Unfortunately, no fireplace doors tested so far are adequate.

One solution, if you must put in a fireplace to sell a house, is to use a steel insert with gasketed doors, or an airtight stove. They need much less air for draft, and can be closed off when you go to bed—so no backdrafting of carbon monoxide at 3 a.m.

Are you starting to realize that an open fireplace is not only a heat loser but an outdated, dangerous device?

Monitoring

The first type of monitoring is to look for signs of frequent chimney spillage. Typical signs are soot on the mantel, or rust around the flue pipe or the draft-air intake (gas exhaust contains great quantities of water). Look for melted plastic gaskets around the water pipes coming out of the top of the hot-water tank. The water temperature won't do that: hot gas coming down the draft hood will.

Carbon-monoxide sensors that operate much like smoke alarms are on the market. Others that can measure a wider variety of pollutants are coming.

Inexpensive chimney-backdraft sensors are available in Canada. They are temperature-sensitive dots that are suspended in the draft-air supply. If exposed to prolonged high temperatures—caused by backdrafting exhaust gases—they will turn black. The advantage of such sensors over the tests is that they watch continuously under all conditions. ■ —*Jon Eakes*

The Chimney Tug-of-War

Sit back and try to visualize the following series of events.

Start with a typical old, drafty house. Turn on the kitchen fan, bathroom fan, and the clothes dryer. As they exhaust air from the house, they increase cold-air drafts *into* the house. Then the furnace goes on, but the gap at the sill plate and other leaks provide enough air for the furnace. If you want to light the fireplace, you may have to open the window a crack. But, in general, there is plenty of air for all the gadgets in the house. Of course, the heating bills are high and the house is uncomfortably drafty.

Next, let's look at a moderately well-sealed house. Turn on the fans and dryer. If you check, you may find that the exhaust fans are drawing air down the furnace flue. That poses no problem—until the water heater goes on. It may have trouble establishing a draft, and spill some of its exhaust into the basement. More likely, the water heater cannot overcome the momentum of the cold air coming down the chimney, and will completely backdraft. The gases will be drawn upstairs toward the fans. When the furnace goes on, its hotter gases may be able to establish a draft, but often cannot.

It's 7 p.m. in the same house. One or more exhaust fans are on. Someone lights a fire in the fireplace, which always spills smoke into the house until you open a window. Once a hot fire is established, you can close the window. But where is the air coming from? From the furnace flue, perhaps.

It's 8 p.m. The living room is comfortable with its fire, but the rest of the house has cooled off. The furnace turns on. It will probably backdraft into the basement. The gases will head up to the living room to feed the fireplace. A fireplace can draw 50 times as much air as a furnace.

It's now 3 a.m. You survived the furnace gases, although you did feel drowsy in front of the fire. (A poorly tuned furnace can produce large quantities of carbon monoxide, and one symptom of carbon-monoxide poisoning is sleepiness.) Now, the fire in the fireplace has died down and its draft is weak. The furnace now wins the tug-of-war for the available air, and draws air *down* the fireplace chimney. Glass doors don't stop the backdrafting. The smoldering wood gives off carbon monoxide, smoke particles (some carcinogenic), formaldehyde, nitrogen dioxide...Sleep tight.

How Chimneys Fail

Many houses have three chimneys: the furnace chimney, the fireplace chimney, and the house itself. All houses function as "chimneys" in that cold air comes in at the bottom, gets heated, and goes out the top. The problem is that all three chimneys compete for draft air. Many furnace chimneys function so poorly that they frequently lose the tug-of-war to the stack effect of

the house itself.

Most furnaces have long flue pipes with many elbows, unsealed joints, and no insulation. The flue pipe ends up heating the basement, while the gases are cooled so much that they start their trip up the chimney with a handicap. To make matters worse, the masonry chimney is usually uninsulated and often located on a cold outer wall. Under these conditions, the furnace may take several minutes to establish a draft. Until then, exhaust gases are spilling into the house. Finally, the furnace manages to warm up the chimney, but then it cycles off and the chimney cools rapidly back down.

Chimneys work worst in mild, windless weather and in tight houses. Cold-climate houses in the spring and fall fit this description.

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Research indicates that we can significantly increase the power of the draft and decrease the start-up spillage by sealing the flue pipe (e.g., with muffler-repair tape) and wrapping it in fiberglass insulation of at least R-5.

Techniques are also being perfected to retrofit smaller flue liners in the chimney to keep flue temperatures up. This is often done in oil-to-gas conversions since gas flue temperatures run lower. Pouring insulation around the flue liner will give it even better thermal resistance, and allow it to heat up more rapidly when the furnace goes on. These steps can double and triple the drafting force of a chimney.

You can further reduce the likelihood of backdrafts by providing a large warm-air supply register to the furnace room or basement. This will tend to pressurize the space. Also, seal all the joints in the return-air ductwork in the basement. Leaks in the return ductwork depressurize the space. You can add a small, half-size return grille.

You can see why Canada is so interested in the new generation of sealed-combustion furnaces—closed systems that bring in their own outside air and expel it with a fan. They don't compete with other fans and appliances in the house.

With a sealed-combustion furnace, you can even add a fireplace as long as it has an adequate air source. Exhaust fans would then do no more harm than cause cold-air drafts. If you replace the exhaust fans with a balanced air exchanger, the uncomfortable drafts can be eliminated as well.

We may not make many houses that way today, but at least we know the ideal solution to chimney competition. For now, the challenge is to provide enough air to prevent backdrafts without causing high heating costs or uncomfortable drafts. ■

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