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Working with natural draft equipment

To ensure the safe venting of natural draft chimneys, be reminded that significant combustion safety research has demonstrated that most natural draft appliances, such as wood stoves, fireplaces, mid-efficiency furnaces and natural draft water heaters, can reliably overcome negative pressures of 5 Pascals (-0.02" H_2O) during start-up and shut down. If, however, house pressures relative to outside are lower than -5 Pascals, then these appliances may not vent reliably or safely.

Under Pressure

I was recently asked to help sort out some comfort issues in a new four-level, 1,200 sq. ft. townhouse. Not too surprisingly they were having issues with even distribution of heat throughout this tall but thin trendy downtown home.

In an addition to the obvious warm air rising, cold first floor scenario, the owner mentioned that whenever they were entertaining the problem seemed much worse – everywhere got very chilly.

It was then that we noted the 800 cfm range hood over the six-burner, gas range. Upon further investigation we found it only exhausted 600 cfm, but still, compare this to the 500 cfm that the hot water air handler heating system was delivering for the entire dwelling to understand the comfort issue.

Many readers will recognize that this is no longer an isolated case. I have diagnosed issues in a 30-storey, high-rise condominium where all 300 suites had special grease capturing range hoods with a reported capacity of 600 cfm installed, and again in a large custom home with a 3,800 cfm commercial exhaust hood over an indoor barbecue. I've even seen it in production housing where more and more builders are offering deluxe kitchen options.

In many cases, large capacity range hoods, more effective bathroom fans and higher air flow clothes dryers are being installed in ever tighter building enclosures.

The question is: Should we be worried?

As a contractor, I prefer to look at what we can do to address situations such as these.

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DEPRESSURIZATION RISK

There are three primary issues or risks and a few inconveniences associated with the depressurization of buildings by exhaust appliances. The first and most serious is the risk of back-drafting of combustion appliances. The second is the potential impact on other exhaust appliances, or even the proper performance of the offending appliance due to the back pressure. Third is the comfort issue of drafts, and the heat loss or gain of the infiltrating air.

There are diagnostic tests and solutions to each of these issues.

In assessing the potential for a backdraft due to exhaust appliances, one should consider the combination of kitchen fans, clothes dryers and other large exhaust appliances that may be running at any particular time – that is, look for the "worst case" scenario.

In commercial buildings there may be a wide variety of exhaust devices that affect building pressures, and careful documentation and or control of processes may be required to ensure combustion safety.

HVAC contractors should use a digital pressure gauge that is capable of accurate measurements down to two-to-five Pascals to measure the pressure across building envelopes at various operating conditions if there are natural draft combustion appliances (including mid-efficiency B-vented furnaces) in the building.

A pressure gauge with wind averaging or dampening is very useful to allow reliable testing on days where winds average or gust above 15 km/h.

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HANDLING BACK PRESSURE

Large exhaust appliances in small buildings can result in a back pressure on the entire system.

Recall the condominium suites with the 600 cfm exhaust fans. When any of those fans operated, the pressure across the relatively small suites was in the order of 75 Pascals (0.3" of W.C.). Since the range hoods themselves had a very shallow fan curve, their air flow capacity at 0.3" W.C. dropped to just under 250 cfm.

There were two important results. First, the 250 cfm was no longer enough to meet the exhaust flow specifications of the installed natural gas ranges needed to ensure safe exhaust vent duct temperatures. Second, the bath fans were unable to overcome the 0.3" static pressure and actually ran backwards whenever the range hoods were turned on.

The bath fans were an amusing oddity, but the safe venting over the gas cook top is a clear safety issue that would need to be resolved by ensuring adequate make-up air to ensure proper exhaust flows. This is a very common issue in restaurants where inadequate make-up air may lead to insufficient smoke and heat control in the kitchen.

A practical pressure limit in these situations should be below -25 Pascals (-0.1" W.C.).

WHAT ABOUT COMFORT?

Maintaining comfortable conditions during the operation of large exhaust appliances is the third practical concern. On a cold winter's day, 600 cfm of exhaust flow results in a heat loss of approximately 40,000 BTUH. Given that the original heat loss for the townhouse mentioned earlier was just 22,000 BTUH, and the hot water air handler had an installed capacity of just 32,000 BTUH, it is not hard to imagine that Christmas dinner with the family might be a chilly affair.

The same concern would apply on a hot, muggy summer evening for a large restaurant when the added latent load of infiltrating air combined with the latent load from patrons would be difficult to compensate for with traditional cooling equipment.

Make-up air provided anywhere into the space will relieve the pressure and help control the drafts. Tempering the make-up air reduces the draft affect and adds heating and cooling capacity when it is needed.

WHAT TO DO AT -5

If the pressure in the building falls lower than -5 Pascals with respect to outside when exhaust appliances are operating, then the safe operation of natural draft appliances will be compromised. There are three possible remedies:

1. Switch to all direct vent or power vented combustion appliances.
2. Eliminate large exhaust appliances.
3. Provide make-up air whenever the exhaust appliances are operating.

The amount of make-up air can be determined by simply matching the exhaust capacity of the exhaust appliances or during the actual depressurization test use the opening of doors and windows and/or fresh air intakes to show the amount of make-up air needed to reduce the negative pressure to less than -5 Pascals.

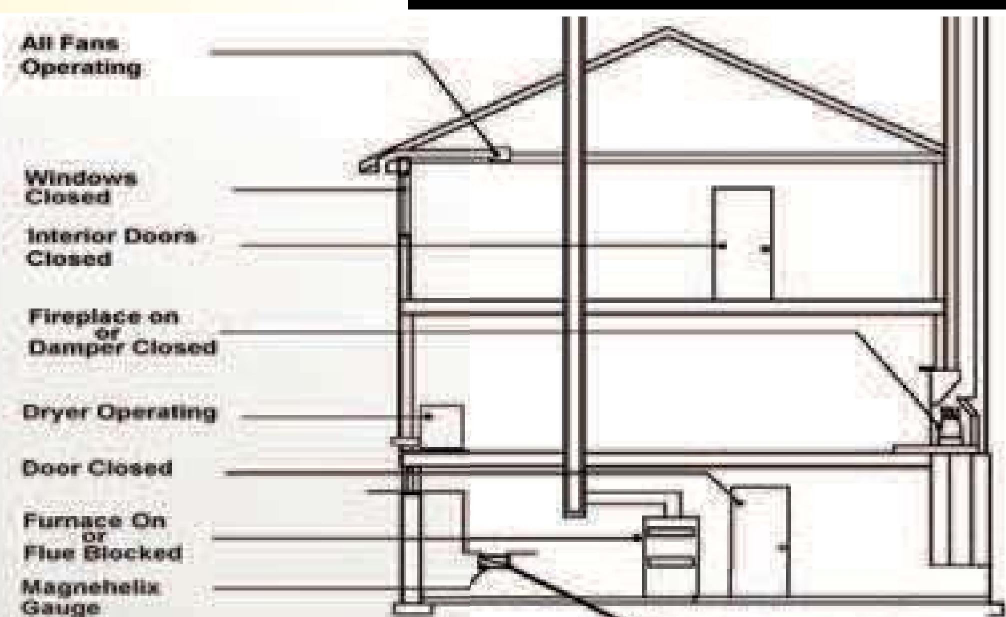
This procedure uses the inherent natural leakage of the building to reduce the amount of mechanical make-up air required.

The make-up air can be provided to anywhere within the conditioned volume of the building, wherever it is convenient and avoids drafts.

MEASUREMENT TECHNIQUES

Training provided by the Heating, Refrigeration and Air Conditioning Institute (HRAI) describes a specific, straightforward protocol and reporting form for conducting a Depressurization Test.

- Close all exterior doors and windows.
- Open all interior doors.
- Temporarily block off chimney flues.
- From the digital pressure gauge, extend one tube to the outside. Find a suitable spot under a doorway, or open a window slightly. Run the tube and tape off the remaining gap so you don't pinch the tube.
- Turn on exhaust appliances and watch the change in pressure.



- The test is affected by wind, so it can only be done on calm days (below 15 kph winds) or use gauges that have wind averaging capabilities.