

The following e-mail exchange summarizes some of the current science and the current Canadian building code status of outside combustion air.

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From: John Viner <JohnV@weccusa.org>
To: Norbert Senf <mheat@mha-net.org>
Subject: Masonry Heaters
Date: Fri, 7 Jul 2000 09:10:34 -0500

Norbert

I work with Joe Nagan and the WI Energy Star Homes Program. I read your 94' report on [Air Requirements for Masonry Heating Systems](#) and have a couple of questions.

On page 4 you made reference to a study in 1989 that stated all fireplaces would spill, during diedown, roughly at 10 pascals. I am curious what fireplaces were tested. So called gasketed air tight doors? Machined fit doors?

I am also curious, is there not a thing as a truly air tight firebox? The question keeps being raised how tight is tight?

Thank you for your time

John Viner

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From: Norbert Senf
To: John Viner

Hello John:

Please find a [chart attached](#) detailing the 5 fireplaces that were tested.

So called gasketed air tight doors? Machined fit doors?

Commercially available doors at the time (1989)

I am also curious, is there not a thing as a truly air tight firebox? The question keeps being raised how tight is tight?

The airtightness of the firebox is determined by the tightness of the loading doors, plus any other similar hardware in the system such as cleanouts, dampers, etc. Also, with metal chimneys there are the joints between the chimney sections.

Spillage rate is a function of the pressure difference between the room and the firebox, and the size of leakage area. Obviously, with smaller cracks, there will be less leakage.

An important distinction to make is spillage RATE and spillage SUSCEPTIBILITY. Tighter doors will reduce spillage rate, but not spillage susceptibility. Outside air can also be shown to not reduce spillage susceptibility, since it does not lower firebox pressure, relative to the room - this is the function of the chimney (if outside air lowered firebox pressure it would, in fact, be a chimney - not a good thing.)

With wood smoke, even a few molecules are detectable by the human nose, since humans evolved this as a survival function. Therefore, during startup, when there is smoke, you could have a very tight door, and still detect smoke with your nose if the house pressure is negative relative to the firebox. The actual smoke concentration could be minimal. Note that this would be more of a nuisance factor than any real health or safety issue. The best method to prevent poor startup draft is to avoid having the chimney on an outside wall. Also, in my opinion, powered exhaust appliances in the house should be held responsible for their own makeup air to avoid house depressurization.

From a safety viewpoint, the issue is spillage during the tailout phase, when there is high CO and no smoke that can be easily smelled. This is more of an issue in systems with rapid dilution air cooling such as open fireplaces, chimneys on outside walls, and systems with low thermal mass, such as metal prefabs. Here, tight doors would reduce the potential for CO concentration in the room tremendously.

Best Norbert Senf

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Reply from John Gulland, who is one of the recognized authorities in this area:

Norbert, John,

I never miss an opportunity to help people (especially people who talk to the public or develop regulations) get a better understanding of how natural draft systems function

in modern houses. The issue of outdoor air supplies and alternative approaches has become something of a specialty of mine. Further comments below.

The five fireplaces tested were:

Security BIS (gasketed doors, advanced combustion, outdoor air to circulation chamber)

RSF Opel (gasketed doors, advanced combustion, outdoor air direct to firebox)

Oliver-McLeod (builder's box with bi-fold doors, outdoor air to circulation chamber)

Oliver-McLeod (same unit modified to supply outdoor air to firebox)

Pressurizer (gasketed door, fan powered outdoor air/circulation air, discontinued, but somewhat similar to the Travis Industries Fireplace Extrodinaire)

The fireplaces ranged from loose (Oliver-McLeod) to extremely tight (Opel). These differences made no difference in spillage performance: all five were fine at -5Pa and all spilled during diedown at -10Pa.

> >*I am also curious, is there not a thing as a truly air tight
> >firebox? The question keeps being raised how tight is tight?*

John, you seem to be asking about the way fireplaces behave in a depressurized environment. Norbert has given a good answer. In short, for batch fed woodburning equipment, tightness only makes a difference in spillage volume, not spillage susceptibility -- there is no such thing as a hermetically sealed woodburning device. Following is an explanation of how Canadian code authorities responded to the new information about outdoor combustion air supplies and natural draft combustion in tight construction.

The 1990 National Building Code (NBC) of Canada had mandatory requirements for outdoor air supplies for fireplaces, but, when the findings of Canada Mortgage and Housing Corporation (CMHC) research on outdoor air supplies were tabled during the revision cycle leading to the 1995 edition, the requirements were removed.

Here is some background on the evolution of outdoor air supplies in the NBC:

The 1990 NBC contained the following Article (clause): "9.22.1.4 Combustion Air. Fireplaces, including factory-built fireplaces, shall have a supply of combustion air. (See Appendix A)"

Appendix A-9.22.1.4. read in part: "The intent of this Article is to allow the fireplace to be operated without affecting, or being affected by, other appliances or exhaust equipment. For this to occur, the fireplace must be provided with a supply of combustion air dedicated to the fireplace only; an opening to the exterior should be provided at or near the fireplace opening."

The Article went on to require outdoor air for factory-built fireplaces in accordance with the manufacturer's instructions and gave a series of prescriptive requirements for outdoor air supplies for site-built masonry fireplaces.

In the proposed revisions sent out for public comment in August 1993, it was proposed to delete Appendix note A-9.22.1.4. with the following reason given: "Combustion air supplies as currently prescribed are generally ineffective. The requirement to provide combustion air is being deleted from CAN/CSA A-405, Design and Construction of Masonry Chimneys and Fireplaces and from the Code."

The '95 NBC contains the following: "9.22.1.4. Combustion Air. Where a supply of combustion air is provided directly to the fire chamber of a fireplace, including a factory-built fireplace, the installation shall comply with the "Outdoor Air Supply" requirements provided by CAN/CSA A-405, Design and Construction of Masonry Chimneys and Fireplaces." This is the only reference to combustion air for fireplaces.

The supply of outdoor air was made non-mandatory and this wording was included because the CMHC research that showed outdoor air supplies to be ineffective, also showed that direct-to-combustion chamber supplies could be hazardous because of the potential for wind-induced reverse flow of combustion gases through the supply duct. The A-405 requirements proposed ways to provide outdoor air safely if you choose to supply it.

Like most building codes in North America, the NBC had included outdoor combustion air requirements for combustion equipment on the assumption that it was a good strategy to reduce spillage susceptibility. Unfortunately the assumption was acted upon before any research had been done to explore how outdoor air supplies actually behave.

The research reports that influenced the Standing Committee of Part 9 of the NBC are:

1) [Fireplace Air Requirements, ORTECH for Canada Mortgage and Housing Corporation, 1989](#)

2) The Effects of Glass Doors on Masonry Fireplace Spillage and Surface Temperatures, Dennis Jaasma, Virginia Polytechnic Institute for Canada Mortgage and Housing Corporation, 1994

They are available from the CMHC information centre at (613) 748-2367.

Although the two studies were conducted by two labs with different set-ups, different protocols and different appliance types (1. factory-built, 2. masonry), they arrived at the same conclusion: The susceptibility to combustion spillage due to room depressurization is not affected in a predictable way by the presence or absence of air supplied from outdoors, whether supplied to the combustion chamber or indirectly through a supply duct terminating near the fireplace.

In both studies the reference room depressurization at which spillage was induced was 10 Pa. In 'Fireplace Air Requirements', none of the five tested fireplaces spilled at 5 Pa depressurization despite the fact that all were very different in their configurations and features, although all did have glass doors. The tests at the two depressurization levels were done with and without outdoor combustion air supplies.

Once the research findings were in and analyzed, the underlying physical process became clear: That is, air flows to a zone of lower pressure through any available opening, regardless of our wishful thinking. In retrospect, this principle appears rather obvious, although for most of us it was not, until revealed in the lab.

As a result of the findings of these two studies, and against the backdrop of dozens of other CMHC studies of combustion venting and building aerodynamics, it was recognized that managing the indoor pressure environment was the only viable option for preventing health- and life-threatening combustion spillage from chimney-vented atmospheric appliances. This is particularly the case with automatic oil and gas equipment of this type because they have dilution devices downstream of the combustion chamber: barometric draft controls in the case of oil appliances and draft hoods in the case of gas appliances. Dilution air cools the exhaust, weakens draft and offers a ready path for combustion spillage, roughly equal to the spillage susceptibility of open fireplaces. Automatic operation of gas and oil systems takes place independently of householder knowledge and participation and may continue for long periods undetected and that is why this type of spillage is considered potentially life-threatening.

But it was also recognized that hand-fed controlled combustion woodburning equipment do not use dilution devices and have high spillage resistance during most operational periods except for the tail out of the coalbed phase of the fire as system temperatures cool. This type of spillage cannot continue for long without householder intervention (reloading), and this implies awareness of any malfunction.

Therefore, the '95 NBC at 9.32.3.8. Protection Against Depressurization requires make up air for exhausts exceeding 150 cfm where chimney vented oil and gas systems are installed in the building. Where the only spillage-susceptible equipment present is woodburning, the section requires only the installation of a carbon monoxide detector to provide warning of spillage should it occur. A performance alternative to the prescriptive approach of 9.32.3.8. is offered in the form of a reference to the CSA ventilation code F326.

Hope this is useful. Let me know if you have any questions.

Regards,
John Gulland
The Wood Heat Organization Inc.

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