Research & Development Highlights

The Effects of Glass Doors on Masonry Fireplace Spillage and Surface Temperatures

Introduction

Current trends in housing technology favour a “tighter’ house to minimize energy losses. Without adequate ventilation, this can lead to increased depressurization of the building envelope, which in turn can cause spillage of combustion appliances.

A previous CMHC study was conducted to determine the effect of fireplace doors on manufactured fireplaces; see the report *Fireplace Air Requirements* (1989). This subsequent project was initiated to examine the impact of glass doors on masonry fireplace safety in terms of both spillage and elevated firebox temperatures.

Research Program

Both spillage and fire safety tests were performed on a single masonry fireplace built inside a laboratory. A chamber surrounding the fireplace was designed to maintain depressurization at 10 Pa during spillage testing as well as contain/exhaust spillage emitted. A dilution tunnel was fitted above the chimney to capture effluent.

Fuel loads for all tests were constructed of cribs of dimensional Douglas fir. “Initial” loads were constructed of main logs and kindling while “reloads” were made up of 2 main logs only. Spillage testing used only a single initial fuel load. This represented a worst case as the masonry temperatures would not be very high. Conversely, the fire safety testing worst case would be after a long, hot fire. The testing for fire safety required four hours of sustained fire at a moderately high burn rate.

The laboratory instrumentation included CO and CO_2 concentrations in the flue, dilution tunnel and ambient air; spillage by infrared and CO concentration of the spillage chamber; and the pressure difference across the spillage chamber. Thermocouples were placed at various locations on the masonry for temperature monitoring. Some thermocouples were located between the masonry and wood members which represented the framing attached to the fireplace. These were called “buried member” temperatures.

Six calibration tests were performed to establish protocols and calibrate instruments for spillage and fire safety tests.

Spillage testing was generally conducted at a chamber depressurization of 10 Pa. Smoke spillage would occur only as the fire died down, not when it was in full burn. The size of the combustion air intake to the fireplace was varied as was the air leakiness of the fireplace doors. The door leakage range was from open doors to sealed doors, with two intermediate openings of 3 **mm** and 9 mm around the door perimeter.

The time, relative spillage level, and duration

The time, relative spillage level, and duration of spillage event were noted for all tests. A zero or ambient reading for spillage exhaust CO and CO_2 signaled the end of the test.

The first three fire safety tests looked at the effects of closing glass doors of varying tightness upon a fire which had been burning for four hours. The second series of tests took place with the glass doors closed for the entire test period. A third set of tests changed the leakage location of the doors. Instead of having leakage around and through the glass doors, as in the first two series of fire safety testing, leakage was restricted to the top, bottom, or sides of the door. This would show if door leak location could affect temperatures in the firebox.

Findings

Spillage

Compared to tests with no doors, the use of glass doors significantly reduced the CO spillage by a range of 63 - 99%.

No correlation was seen between the amount of spillage and leakiness of glass doors. The difference in fire duration is likely a key factor. The fires did not behave consistently during the testing and some premature collapse of fuel loads occurred.

Differences in air supply openings had no significant impact on spillage in this small sample. Tests with the 9 mm gap showed that spillage decreased with an increasing air supply. However, tests with a 3 mm gap resulted in high spillage levels for open and closed air supplies and low spillage levels for the intermediate air supply.

Fire Safety

For all fire safety testing, the buried member temperatures were higher on the chimney then at the fire box. Typically, the tighter the door, the higher the firebox temperatures. See Table 1. (Note: contrary to most laboratory testing, the temperatures below are actual temperatures and not the temperature rise above ambient).

Table 1.Fire Safety Testing Results Buried Member Temperatures

Test Conditions		**Temperatures (C)**	
Door Closure	**Door Air Leakiness**	**Average**	**Absolute Maximum**
Open-then-closed	**Sealed**	**51**	**99**
Open-then-closed	**3 mm Gap**	**48**	**85**
Open-then-closed	**9 mm Gap**	**47**	**82**
Closed	**3mmGap**	**55**	**101**
Closed	**6mm Gap**	***53***	***95***
Closed	**9 mm Gap**	**46**	**89**
Closed	**Top**	**63**	**126**
Closed	**Sided**	**56**	**108**
Closed	**Bottom**	**47**	**84**

Door leakiness localized to the top gave the highest buried member temperatures while door leakiness at the side resulted in the highest glass door temperatures. Both buried member and glass door temperatures were lowest with leakiness localized at the bottom of the firebox. This was likely due to air entering the firebox in an upward direction causing a low burn rate.

The maximum rate of increase in temperature for the glass door was 20°C/min in the open-then-closed door test. As expected, glass door temperatures for closed door testing were much higher than for open-then-closed testing.

While fuel reloads were discontinued at the 4 hour mark, temperature monitoring was not completed until the firebox temperature reached ambient levels, in this case around the 10 hour mark. Figure 1 shows that higher temperatures were actually achieved roughly *2.5* hours after the last reload.

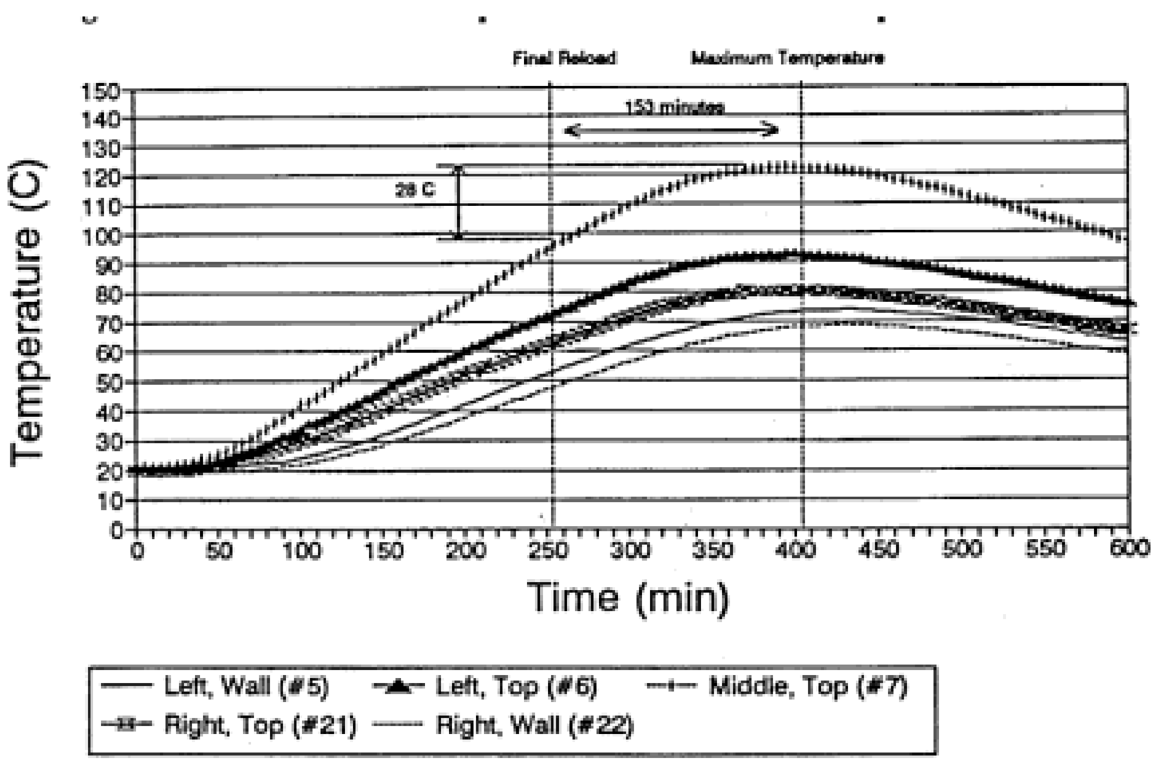
Impact on the Housing Industry

Fresh air intakes have not prevented spillage in lab testing and should not be depended on to do so in housing renovations or new construction.

Fireplace doors are useful in minimizing spillage but are not fail safe.

Retrofitting of fireplaces with glass doors will moderately raise firebox temperatures.

Consideration should be given to the quality of glass doors used for retrofitting fireplaces due to the sharp rate of temperature increase on glass doors when doors are closed upon an operating fire.



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Research Report. The Effects of Glass Doors on Masonry Fireplace Spillage and Surface Temperatures (1995)
Research Consultant: Department of Mechanical Engineering, Virginia Polytechnic Institute and State University.

A full report on this research project is available from the Canadian Housing Information Centre at the address below.

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Figure 1. Buried Member Temperatures for Closed-Door Top Leakiness Test