RESEARCH HIGHLIGHTS

Technical Series 00-144

RETROFITTING VENTILATION INTO LOW-RISE HOUSING

Introduction

Poor indoor air quality is a growing concern for homeowners. Research shows that inadequate ventilation can be one of the causes. Effective and inexpensive ways to add ventilation to existing buildings are being explored.

A research project was undertaken to find, test and verify methods of retrofitting ventilation into low-rise housing. The purpose of this project was to identify effective and economical retrofit ventilation systems and evaluate their performance. Ten example systems were investigated. The results of this project will provide industry with retrofit ventilation ideas.

The ten case studies examine the effectiveness and costs of different retrofit ventilation options for existing housing. A variety of indoor air quality problems were addressed and a variety of approaches were employed to resolve them. The table on pages 2 and 3 provides a summary of the case studies. Single-page summaries are provided in the Appendix. For full-length individual write-ups, contact the project manager at CMHC.

Research Program

For this project, ten single-family homes where homeowners had indoor air quality concerns were identified. In each case, a contractor or ventilation system supplier assessed the problem and installed a solution. Temperature, humidity, and CO_2 were measured to assess levels of ventilation within houses in their pre-retrofit condition. The measurements were taken over a two- to three-day period with normal occupancy. Short-term monitoring was also used to measure the change in ventilation with the house operating in post-retrofit condition. In one case, radon contamination was measured directly before and after the retrofit.

The retrofit costs were obtained from the contractors during the retrofit. In some cases, the retrofit was completed before the project was undertaken. The ventilation system was sealed for pre-retrofit testing when the retrofit was done earlier. Current costs were obtained either by updating the original costs or from contractor estimates in those cases.

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Canada

No.	Address	Problem	Solution	Results	Installation Costs	Annual Operating Costs
1	Eden Mills, ON	• High concentrations of radon gas infiltrating from crawlspace	• Draw soil gases into collection trench with fan and exhaust outdoors • Seal soil surface with continuous membrane • Seal sump lid and crawlspace hatch with airtight gaskets	• Radon gas concentrations reduced almost 95% from 15.8 pCi/L down to 1 pCi/L • Surface sealing alone did not provide significant radon concentration reduction	$2,450	$79
2	Waterloo, ON	• Poor indoor air quality and moisture in basement apartment • Odour infiltrating to main floor	• Exhaust-only fan with multiple pick-up point and timer • Exhausting from basement draws air from main floor	• Overnight CO_2 reduced by 45% in basement apartment • Tenants report fresher, less humid air • Less odours to main floor	$750	$171
3	Cayuga, ON	• Owner concerned symptoms including colds, dryness and static	• Install heat-activated damper in outdoor air duct connected to furnace return • Exhaust duct without damper connected to furnace supply	• Air change rates increased especially on mild calm days • Adding mechanical ventilation increases fresh air supplied	$326	$66
4	Brantford-1, ON	• Excess condensation and mold growth in second floor bathrooms	• Install "Mixing Box" ventilator in second floor attic • Humidity control activates ventilation mode providing fresh air on demand • Recirculation only when humidity low	• CO_2 concentration reduced 50% • Drafts could be a concern in cold weather • Serviceability and duct leakage a concern with attic mounted equipment	$1,745	$430
5	New Dundee, ON	• Homeowners concerned noticeable staleness indicative of poor IAQ • Excessive moisture causing condensation on windows	• HRV retrofit to provide balanced ventilation with heat recovery • Furnace system used to distribute ventilation air	• 15 L/s increase in overall ventilation flow • CO_2 reduced 14% • Condensation on windows eliminated	$1,750	$60

No.	Address	Problem	Solution	Results	Installation Costs	Annual Operating Costs
6	Conestogo, ON	• Poor air quality, stuffiness in basement • Possible mold growth in basement bedrooms	• Fresh air from first floor mixed into basement by operating furnace fan intermittently • Furnace cycling control activates fan at set intervals	• Overnight build-up of CO_2 reduced by 25% • Humidity and odours significantly reduced	$275	$27
7	Toronto, ON	• Older house had energy-efficient retrofit • Adequate supply of fresh air was to be ensured	• Install HRV to exhaust from high moisture areas • Supply fresh air to second floor bedrooms	• Overnight CO_2 reduced by 50% in bedrooms • Installation of equipment in attic makes servicing difficult	$2,825	$80
8	Brantford-2, ON	• Contaminants from home office equipment compromising IAQ • Fresh air not distributed well throughout house	• Exhaust-only ventilation system with pick-up at pollutant source • Depressurization provides fresh air via infiltration throughout house	• CO_2 reduced by 30% • Mechanical ventilation provides 0.48 ACH • Air quality in basement and remainder of house improved	$602	$260
9	Elmira, ON	• Stuffy air in bedrooms • Condensation on windows • Mold growth on bathroom ceiling	• Install HRV in unfinished basement • Modified HRV installation to eliminate continuous furnace fan operation • Stale air drawn from furnace return, fresh ducted to supply	• Overnight CO_2 peaks reduced from 1,000 ppm to 500 ppm • Overnight RH peaks reduced from 45% to 35% • Owners report noticeable improvement in freshness of air in house	$1,345	$117
10	Wilsonville, ON	• Owner wanted to control ventilation to reduce humidity on demand • Concerned that wood stove was causing furnace to back draft	• Install motorized damper in fresh air supply duct to furnace return • Cycle control runs furnace fan on regular, periodic basis • Damper opens when fan operating inducing fresh air	• Peak CO_2 reduced by 50%	$945	$62

Implications For Renovators and Renovation Contractors

The ten case studies show that a wide range of technically-effective and cost-efficient retrofit systems for improving indoor air quality are available. These case studies in themselves, however, do not provide the whole picture. The assumption implicit in any of these studies is that the situation was reviewed in sufficient detail to accurately diagnose the problem and prescribe an appropriate solution.

The contractor needs to consider a number of issues before choosing the retrofit ventilation system to be installed in an existing house. These issues include:

1. Determine that the problem is one that additional ventilation will resolve. For example, condensation on double pane windows and mold growth may be indicative of high humidity levels that need to be dealt with before adding ventilation. Lingering odours, stuffy rooms, may be indicative of a need for additional ventilation.
2. Decide how much ventilation is required to overcome the indoor air quality (IAQ) problem. This is usually difficult to determine, though sources such as F326 will certainly provide good guidance.
3. Determine how leaky the existing house is and whether the ventilation concern is one of poor distribution or inadequate ventilation quantities, or a combination of the two.
4. Based on the contaminants of concern, the leakiness of the house and the amount of air needed will determine a strategy to be implemented. Here the case studies may be helpful in providing some options to consider. In houses with spillage-susceptible combustion appliances, consideration needs to be given to ensuring the house is not placed under a negative pressure.
5. Leaky houses may need improved air distribution more than additional ventilation air. Operating the furnace fan can move air around the house. Using a fan cycle timer can provide the distribution required while limiting the fan operating time and cost.
6. In tighter houses, some form of supply air may be required. Using an intermittent furnace cycling control in conjunction with a fresh air supply duct and motorized damper can provide an inexpensive means of supplying fresh ventilation air. A heat recovery ventilator (HRV) on the other hand, provides heat recovery but is somewhat more expensive to install. Using only the HRV fans for distribution through the supply side of the furnace ducting can further reduce operating costs.
7. Be careful of locating equipment in inappropriate locations, such as attics or poorly accessible crawl spaces. In two case studies equipment was installed in the attic. It is unlikely that the equipment will be serviced adequately, due to difficulties in access. Attic installations are also more problematic because of air leakage, high temperatures in summer, and freezing in winter.
8. Installation costs for the different options were found to range from about $300 to about $3,000. Operating costs range from about $30/yr to over $400 annually.

SUMMARY #6—CONESTOGO

Problem

Homeowners are concerned with possible poor indoor air quality in basement bedrooms based on mold odours and stuffiness.

Solution

The leaky house had abundant levels of fresh air on main floor. Turning on the furnace fan mixed the house air, introducing fresh air from the main floor into the poorly ventilated basement. This was done by intermittently activating the furnace fan using a furnace fan cycling control.

Furnace Fan Cycling Control

Methodology

A commercially available special-purpose controller is retrofit to the furnace. The controller operates the furnace fan intermittently. The house air is mixed and turned over. Fresh air from the main floor is introduced to the basement. To avoid excessive fan operation, the controller turns the fan on only if the thermostat has not activated heating or cooling during the previous OFF period.

Fan on and off times are independently adjustable. The initial setting chosen was 10 minutes ON and 50 minutes OFF.

Results / Comments

Efficacy was quite good with overnight build-up of CO_2 concentrations reduced by 25%. The homeowners believe that other airborne contaminants such as humidity and odours have also been reduced significantly. Basement contaminant levels are reduced as air throughout the house is mixed. Contaminants are then carried out of the house with air exfiltrating from the main floor.

Higher efficacy could be achieved through longer fan run times. Increasing fan operating time would have an impact on the annual operating costs proportional to the increase in annual operating hours.

Costs

Installation and Operating Costs

Item	Customer Cost
Total Installation Costs	$275
Total Annual Operating Costs	$ 27

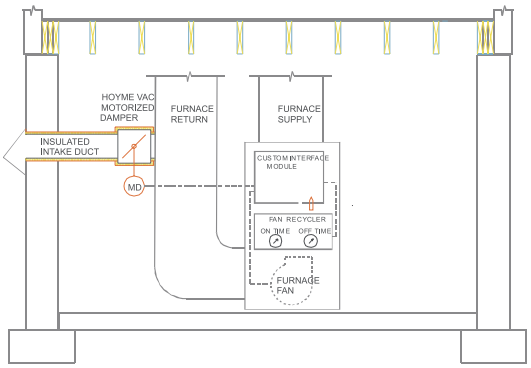
SUMMARY #10—WILSONVILLE

Problem

Homeowners were concerned with occasional backdrafting due to depressurization when the wood stove was started. They also wanted to add controllable ventilation to provide humidity control.

Solution

An outside air intake duct with a "Hoyme-VAC" motorized damper was connected to the furnace return air duct. A "Fan Recycler" timer was installed to operate the furnace fan and motorized damper, providing ventilation air on a regular, periodic basis.



Motorized Damper and Furnace Fan

Methodology

A 150-mm (6") diameter insulated duct and in-line motorized damper were connected from an outdoor intake hood to the furnace return. The furnace fan operates at low speed and the Fan-Recycler ensures the fan operates on high speed and opens the damper for a minimum 15 minutes of every 30 minutes. A custom interface constructed to adapt the Fan Recycler to the oil furnace allows the homeowner to choose between three modes of damper operation as listed below.

Mode	Description
Open	Damper always open. Provides manual override for use during wood stove operation
Heating	Damper opens on furnace burner operation, not on fan changing to high-speed
Auto	Damper opens on furnace fan high-speed operation (heating or cooling), including fan "on" override at thermostat, and furnace fan high-speed operation by Fan Recycler

"Auto" was default for field test with the Fan Recycler operating

Results / Comments

Peak CO_2 concentrations were approximately 50% lower than those recorded before the system was installed. This potentially represents a significant decrease in the concentration of indoor air contaminants.

Costs

Installation and Operating Costs

Item	Customer Cost
Total Installation	$945
Total Annual Operating Cost	$ 62

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Research Consultants: Enermodal Engineering Limited

Housing Research at CMHC

Under Part IX of the *National Housing Act*, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.

This fact sheet is one of a series intended to inform you of the nature and scope of CMHC's research.

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