Cold Climate Housing NEWS

Cold Climate Housing Center, Minnesota Extension Service
Minnesota Cold Climate Building Research Center, University of Minnesota

MnBRC Volume 2, Issue 4

WORKSHOPS SCHEDULED

During February and March of 1990, the CCHC staff will be conducting educational programs for building professionals. This years workshops will emphasize two key areas of cold climate housing: ventilation and foundations. The **tentative** dates and locations of these workshops are:

Mankato	**February 13**
Rochester	**February 16**
Granite Falls	**February 20**
Worthington	**February 21**
Detroit Lakes	**February 26**
Bemidji	**February 27**
Duluth	**March 1**
Eveleth	**March 2**
Alexandria	**March 6**
Brainerd	**March 7**
St. Paul	**March 9**

For more information, contact: Cold Climate Housing Center, 203 Kaufert Laboratory, 2004 Folwell Avenue, St. Paul, MN 55108; (612) 624-9219.

INSIDE THIS ISSUE

Coping With Moisture In The Home

Timothy D. Larson, Forest Products

During the late fall, winter and early spring months, information centers, builders, window manufacturers, siding manufacturers, insulating contractors, neighbors, and other housing specialists hear a lot about homeowner moisture problems. Window condensation, mold and mildew growth in corners, moist basement walls, attic frost and "stuffy" indoor air are common signs of residential moisture problems. In many instances these moisture problems can be solved with simple moisture management practices and/or minimization of moisture input into building materials during the construction process.

Where Does the Moisture Come From?

It's very important to understand that as air cools its capacity to hold water also decreases. This has been observed by everyone during the summer when a glass full of a cold drink begins to 'sweat.' This means that the air cooled by the glass has reduced its capacity to hold water to the point that condensation occurs. This also means that the warm air we have in our homes in the winter has the capacity to hold more moisture than the cold air that is outside. In fact, air at 70°F and 100% relative humidity (RH) holds over seven times more moisture per pound of dry air than air at 20°F and 100% RH. Therefore, inside air may "condense out" some of its moisture when it contacts surfaces that cool it too much. A good example of this is the condensation that builds up on window glass. The second part of the answer to the above question is the identification of moisture sources in the home that contribute to moisture in the air. These sources of moisture include bathing, cooking, breathing, humidifiers, plants, floor mopping, saunas, steambaths, whirlpools, gas ranges, refrigerator defrost, indoor firewood storage, dishwashing, combustion of unvented space heaters and others. Unvented clothes dryers, for example, can contribute 0.59 to 0.77 gallons of moisture per load to house air. A cord of unseasoned firewood stored indoors could contribute 50 to 100 gallons of moisture to the house over the heating season. A five-minute shower puts about 0.065 gallons of moisture into household air. It has been estimated that a family of four generates 1.9 to 3.2 gallons of water on an average day. If a house is tight with little or no ventilation it is easy to see how the relative humidity will rise to levels that may cause moisture problems.

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Coping With Moisture In The Home

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On top of the household-produced moisture there is also the nonhousehold-produced moisture. These sources include spillage of combustion devices, seasonal drying out of materials, drying out of new construction materials, ground moisture, plumbing leaks, rain, snow, and others. Ground moisture migration through the basement can add up to 13.1 gallons per day to the house. A new concrete foundation may have 625 gallons or more of water to give up as it drys out.

When dealing with moisture problems one needs to find the sources of the moisture and reduce or eliminate them whenever possible. It is also important to use kitchen and bathroom exhaust systems when activities in those areas are adding to an excessive moisture level in the home. In a tight home it will be necessary to address the need for a ventilation system to control humidity in the house as well as take care of other pollutants.

Generally speaking one needs to maintain a relative humidity in the house between 30 to 45% in order to keep the occupants and building healthy. During the colder parts of the winter it is advisable to stay at the lower end of this range. Quality humidity gauges should be bought to accurately determine the levels of humidity in a home.

Moisture Problems

The most common moisture problem in Minnesota is condensation on the interior surface of window glass. If the temperature should drop to -10°F or below, some frosting on the window is not too unusual. But if there is water running off the window at say 10°F, then some action needs to be taken to reduce relative humidity in the house. The windows in a house can be a type of humidity gauge because they are generally the coldest surfaces and can warn the occupant when the relative humidity in a house is too high.

Another common moisture problem is thermal dusting and/or mold growth at the corner where the exterior wall and ceiling meet or at the corner where exterior walls meet. Closets, bathrooms and kitchens are where one generally finds this problem. Again the reason for this occurring is that there is a surface cold enough for condensation to develop, given the relative humidity maintained in the house. When this happens it is a sign that this portion of the house is thermally weak or that there is excessive heat loss in the area. One common cause is that the air providing attic ventilation is penetrating the insulation at this location and degrading its thermal performance. In addition, the double top and top plate in the exterior wall makes this area thermally weak. It is important that attic ventilation must not penetrate ceiling insulation. This can be accomplished by installing an insulation block and a vent chute as shown in Figure 1. The insulation block could also be used to reduce heat flow through the top and double top plate region.

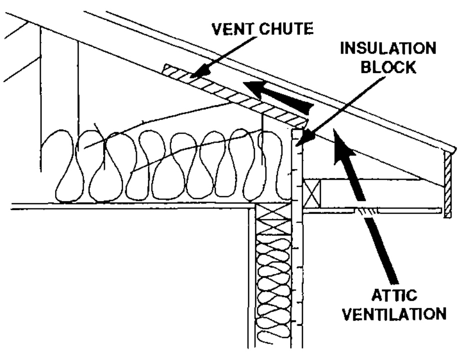

Figure 1. Detail to prevent degrading of ceiling insulation by air flow for attic ventilation.

Frost in the attic is upsetting to most homeowners and can result in the deterioration of the roof sheathing, ceiling insulation, interior ceiling finish, and soffit and exterior siding just under the overhang. The development of frost in the attic is primarily due to the presence of attic bypasses which are openings/cracks in the ceiling that allow warm, moist air from the house to escape into the attic. These bypasses need to be sealed up. Generally the most glaring attic bypasses are the ceiling penetrations of the soil stack, electrical fixtures, and the chimney (see Figure 2). Additional bypasses include dropped kitchen or bath soffits, recessed lights, stairways, and places where interior partitions inter-sect the ceiling. Story-and-one half houses present unique problems in the area of bypasses particularly where the short vertical upstairs wall meets the ceiling of the first story. An excellent pamphlet entitled "Attic Bypasses" which details attic bypass problems and solutions can be obtained by calling the Minnesota Energy Division at 612/296-5175 or 800-652-9747 for greater Minnesota.

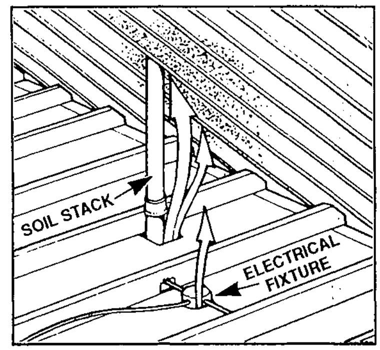

Figure 2. Attic bypasses associated with a soil stack and an electrical fixture.

Siding problems can arise from moisture vapor flowing through cracks in the walls during the winter. This flow from the inside to the outside of warm, moist air will eventually reach a point in the wall where condensation will take place. This may be at the inside surface of the wall sheathing or at the sheathing/siding interface. In either case this moisture may freeze and accumulate over the winter only to thaw in the spring and expose the siding to high moisture conditions. Peeling paint, water stains, cracked or warped siding and decay are signs

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Building For IAQ: Particulates

Sylvia Fuoss, Research Assistant, Indoor Air Quality

Formaldehyde and mold are well known pollutants that can cause problems in new construction. Builders know that in order to protect their reputations and avoid expensive call-backs or even litigation from their customers, they need to control these contaminants. In addition, however, there are other pollutants that can cause problems. Builders also need to know how to control these in a cost-effective manner.

What Are These Pollutants?

Particulates are some of the most common, and most neglected, building pollutants. The word *particulate* refers to any very small portion of a material. Ordinary house dust is an example of a particulate. Aerosols, which are solid or liquid particles suspended in air or gas, are also examples of particulates.

Why Should Builders Worry About Dust?

There are two major reasons why builders need to care about particulates. (1) Particulates look dirty and cause the occupant extra cleaning work. Customers will be sure to pass any complaints about this on to their builders. (2) Some particulates can produce adverse health effects. These health effects can be caused both by the size of the particulate, and by the material itself. The smaller particulates, which are called *respirable suspended particulates* (RSP), can be drawn deeply into the lungs during breathing. The area of the lung that receives the particulates cannot easily sift the small particles out. Damage can result to lung tissue.

Particulates are usually too small to be separated out and identified without elaborate methods, so researchers have often measured them together and named them *total suspended particulates* (TSP). Inside the lungs, the materials themselves vary in their ability to irritate or even alter or destroy the lung tissue. The effect may be immediate or it may surface later in a person's life. For example, a bit of formaldehyde-based adhesive attached to a tiny bit of paper may cause a small, but immediate, irritation. While an asbestos fiber, on the other hand, may lay in the lung for 20 years, and eventually cause cancer.

What Other Kinds of Materials Are Found in Particulates?

Other materials found in particulates include segments of mold or their spores, house dust, mites, tiny globules of cooking fat, water droplets (which may contain suspended minerals, detergents, pesticides, metals, etc.), metal fragments, portions of skin, hair, dried urine and feces from humans and other animals or insects, and inert materials with chemicals adsorbed onto their surfaces. Cockroach feces, for example, have been identified as a strong cause of asthma attacks. Builders cannot be expected to prevent cockroach infestations, but they can make design choices that will make it easier for the occupant to maintain more control over some of these problems.

How Can The Builder Help Control Particulates?

The builder can influence generation and control of particulates beginning with the site selection.

Choosing a site away from heavy traffic routes will keep down dust drawn in from outside. The house's placement on the site can also influence the amount of mold-producing moisture that occurs inside the basement and house.

Equipment choices between types and installation inside the house are critical. Exhaust fans in the kitchen, for example, are standard equipment, but the design and placement of the fan and exhaust duct, and the supply of make-up air will affect the efficiency of the fan's operation. Installing an oversized fan might increase its effectiveness in removing aerosols, but it may also depressurize the house, allowing radon to infiltrate. And finally, the noise level the fan generates may determine whether or not it is even turned on. Builders, as well as kitchen designers, need to be informed of the newest research in the design of exhaust appliances.

Finishes can affect more than just physical appearances. The use of hard-surfaced floors instead of wall-to-wall carpeting is a trend that has great benefits for controlling particulates. Hardwoods, ceramic tile, and marble are examples of classic quality building finishes. Many vinyls have similar benefits but with a lower cost. Underfloor heating devices can be used to add warmth to a surface. A variety of area rugs can provide color accents. All these treatments allow for complete cleaning of the floor surfaces, while carpets allow particles to settle and are re-suspended when people walk across them. Wet cleaning of carpets accelerates mold growth without completely removing the material it feeds upon.

Total ventilation installation can reduce excess humidity and other related problems, such as mold and insect infestations. The builder can also include air-cleaning appliances, such as electronic types which control particulates very effectively.

The system's approach to building promoted by the Cold Climate Housing Center benefits the occupant and builder in many ways.

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Measured Performance of Kitchen and Bathroom Exhaust Fans

When considering house ventilation for controlling moisture and other indoor air constituents, researchers as well as builders often express doubt that installed standard bathroom and kitchen exhaust fans actually provide the amount of ventilation indicated in manufacturers' data sheets. A recent field and laboratory testing program performed by Canada Mortgage and Housing Corporation (CMHC) supports that suspicion and in fact indicates that some of those exhaust fans are only supplying a small fraction of their rated amounts of ventilation. An analysis of the findings, presented by Donald Fugler at the January meeting of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) suggests that improper installation is at least partially responsible for the poor performance.

Airflow and sound level measurements were performed on 26 bathroom fans and 17 kitchen exhaust fans in newly constructed houses in four regions of Canada. The measured airflow was compared to the rated airflow for each fan. The results are shown in Figures 1 and 2.

Notice that in literally every case, the measured airflow is considerably less than the rated flow, with some fans supplying only one-fifth of their rated capacity. Only three kitchen fans showed measured airflows above 50% of their rating.

Installation methods are partly at fault.

As part of this study, Fugler looked at the effect of ducting type on measured flow rate. Although most manufacturers recommend using 3.25"x10" rectangular duct, many installations had 4-inch round duct. Comparison testing in the laboratory showed that using the 4-inch duct instead of the larger rectangular duct could reduce overall airflow by up to 40%.

Source: Energy Design Update, Feb. 1989 (617) 648-8700.

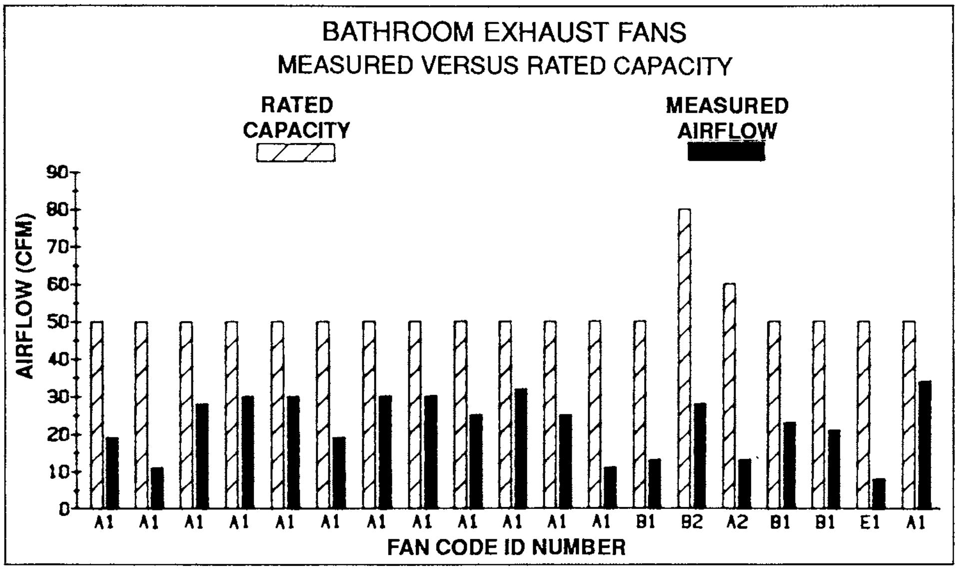

Figure 1 - Rated versus measured airflow of bath fans. Source: CMHC.

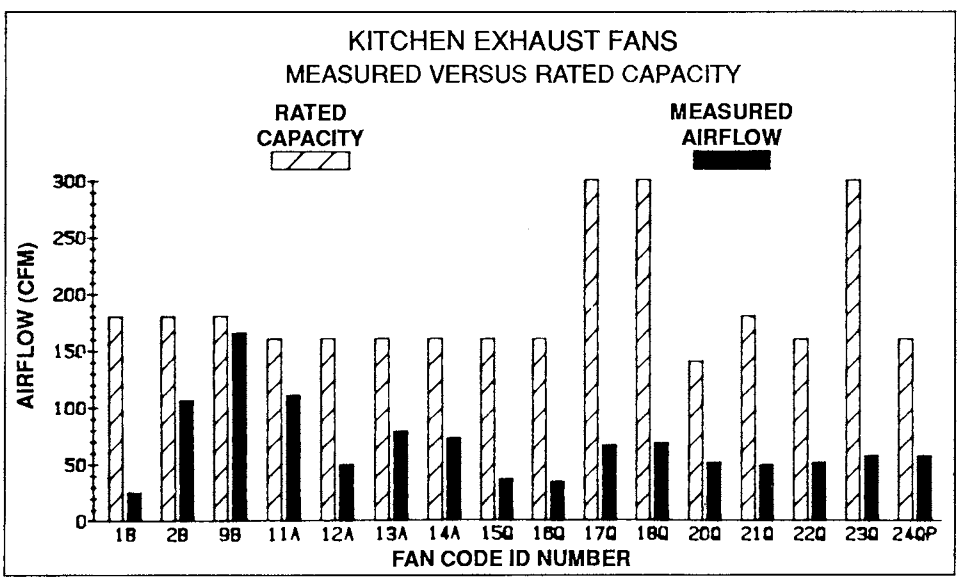

Figure 2 - Rated versus measured airflow of kitchen fans. Source: CMHC.

Coping With Moisture In The Home

Continued from page 2.

of this type of moisture problem. The interior surfaces of the walls need to be airtight so moist air does not travel across the wall during the winter. Also the house should not be pressurized (i.e., the pressure in the house should not be greater than the pressure outside), as this forces air flow through openings or cracks in the walls of the house.

Guidelines for Reducing Moisture In New Homes Due to Construction

Moisture from new construction can cause moisture problems for the new homeowner and consequently for the builder. It has been shown and is demonstrated by the graph in Figure 3 that moisture contribution from building materials to new homes in the first year of their existence can be more than double what is generated by its occupants. Because of this the builder is advised to observe the following guidelines during construction to minimize this moisture source found in new homes:

* Use the minimum amount of water in all concrete.
* Protect all construction materials from rain and snow.
* Minimize the use of unvented heating devices as they can contribute moisture to building materials and delay drying of concrete, etc.
* Delay finishing the basement as long as possible to allow for drying of block or concrete walls.
* Educate the homeowner on new construction moisture. If the house is finished before cold weather sets in the homeowner should be told to take deliberate steps to air (dry) the house out.

Summary

Most moisture problems are caused by relative humidities that are too high for the building in question. Moisture sources need to be identified and dealt with appropriately. If relative humidity is not too high, then interior surfaces need to be warmed by improving or protecting the insulation in walls and ceilings. In tight houses it will be necessary to provide some type of ventilation system to control moisture and other pollutant levels.

If you would like further information on a moisture problem, please write to the Cold Climate Housing Center, 203 Kaufert Laboratory, 2004 Folwell Avenue, St. Paul, MN 55108; or call 612/624-9219.

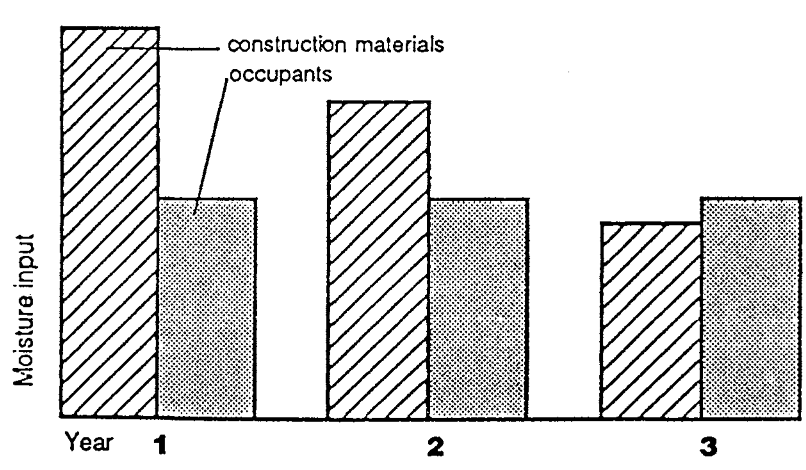

Figure 3. Moisture Release from drying construction materials compared to moisture release due to occupant activities in the first three years of a new house.

(Source: Canada Mortgage and Housing Corporation. 1987. "Moisture Problems.")

References

Angell, William J. and Wanda W. Olson. 1988. "Moisture Sources Associated with Potential Damage in Cold Climate Housing." Cold Climate Housing Center. CD-FO-3405. Minnesota Extension Service, University of Minnesota, St. Paul, Minnesota 55108.

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The House Doctor

The intent of this column is to discuss issues or problems currently being encountered by contractors, builders and consumers in building and maintaining homes in cold climate regions.

Backdrafting Prevention

John Fick, Agricultural Engineering

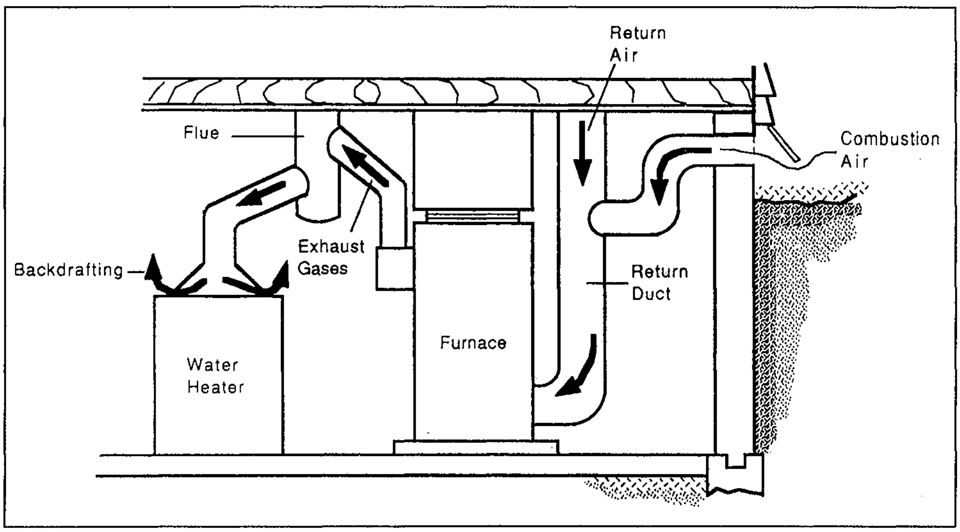
Did you ever wonder why the prevention of backdrafting (the situation when exhaust fumes are not released to the outside due to a reverse in the flow of gases in the chimney or flue) is so often talked about by housing specialists? They talk about it so much because backdrafting can cause a serious health risk. "Tightening up" a home without considering its effect on indoor air requirements may cause condensation problems on windows, paint to peel, and furnace backdrafting. While peeling paint and condensation problems can be costly, backdrafting can make people sick or even threaten lives.

The following "abbreviated" case study illustrates a rather typical example of where a combination of home "system" changes caused backdrafting.

Facts About the Home

* The home, a one story rambler, was built in the early 1960's.
* As a true do-it-yourselfer, the owner had been steadily working on "tightening up" the home over the past few years.
* The home had a forced-air heating system retrofitted with a new medium high efficiency furnace (80% Annual Fuel Utilization Efficiency).
* A combustion air duct was added as part of the new furnace installation. This was to provide the air required by fuel-burning appliances for complete combustion. The furnace and the water heater were vented through a common flue (see diagram).
* The furnace installation was inspected and met all codes.
* The other exhaust appliances included the gas clothes dryer, an approximately 300 cubic feet per minute (cfm) kitchen exhaust fan, and a 50 cfm bathroom exhaust fan.

This furnace backdrafted through the vent hood of the water heater when any two of the other exhaust appliances were running in tandem (see Figure 1).



Why did the new and more efficient furnace backdraft while the old furnace did not?

In this case the answer is fairly simple. The homeowner, by tightening up his home, was reducing infiltration, which for this home was the only accommodation for make-up air (the air brought into a building from outside to replace air that is exhausted by vented appliances). Each time an exhausting appliance was used, it depressurized or reduced the air pressure inside the home. This depressurization occurred because more air was being exhausted by appliances than was provided by make-up air. The old, less efficient furnace, which produced hot exhaust gases, created enough natural draft to overcome this depressurization. The new higher efficiency furnace, which produced cooler exhaust gases, could not overcome this depressurization, thus backdrafting occurred. The combustion air duct was not sufficient enough to act as (nor should it ever be considered) a supply air duct for other exhaust appliances ("supply air" is simply the air supplied to a desired space through ducts).

Situations like this where make-up air is required can be corrected in a number of ways ranging from cracking a window to putting in a balanced mechanical ventilation system.

This example points out the following four important points about backdrafting:

1. Combustion air is not the only factor to consider when backdrafting occurs.

2. Simply meeting code does not dismiss the possibility of backdrafting.

3. The home must be viewed as an integrated system and the effects of all changes should be considered.

4. Backdrafting should be tested for whenever the changes made could allow for backdrafting to occur.

A simple test for backdrafting is as follows: hold a smoking item (for example, an extinguished match) under the vent hood. If the smoke is drawn up the flue, there is no backdrafting. If it's blown into the room, backdrafting is present. Perform this test with all depressurizing appliances in the home in operation.

Appliance selection can also help eliminate or greatly reduce the possibility of backdrafting. Sealed combustion appliances will provide air directly to the combustion chamber (with no mixing with indoor air). The gases are then vented directly outside in a sealed pipe, eliminating the possibility of backdrafting.

Forced-draft and induced-draft furnaces greatly reduce the possibility of backdrafting, although they require make-up air to operate.

For more information concerning backdrafting and make-up air, the following publications are available: Combustion Air. March 1988. Dept. of Public Service, 900 American Center, 115 E. Kellogg Blvd., St. Paul, MN 55101. Residential Kitchen Ventilation. August 1989. Minnesota Extension Service/Cold Climate Housing Center, University of Minnesota, 203 Kaufert Laboratory, 2004 Folwell Avenue, St. Paul, MN 55108. Refer to item number, HE-FO-3725.

SERI Develops Vacuum Insulating Applications for Windows and Home Appliances

SERI, the Solar Energy Research Institute located in Golden, Colorado, announced that it has applied vacuum insulating to windows and home appliances.

The vacuum window glazing involves evacuating the space between two glass panes and permanently sealing the perimeter by laser welding the glass together. The predicted thermal resistance is R-16, significantly better than typical double pane windows with R-values of 2 to 4. The vacuum window glazing is much thinner and lighter than other insulating windows.

SERI's concept depends on a welded steel envelope to maintain a vacuum of the sort used in vacuum bottles. The process for hermetic sealing and vacuum maintenance is being developed. R-values over 100 per inch are predicted.

The most likely use in appliances involves a compact single layer panel providing an insulation rating of R-15 in a thickness just over one tenth of an inch. Applied to refrigerators, this would allow a doubling of sidewall insulating values with negligible changes in the production process.

SERI's novel concept in compact insulation for refrigerators and freezers may provide an attractive alternative to expanded foam insulation made with chlorofluorocarbons (CFCs). CFCs have drawn international attention because of their apparent link to depletion of the ozone layer and to global warming. Manufacturers faced with federal requirements to design more energy efficient appliances also have been cautioned that insulating foams made with CFCs may be less available and more expensive.

SERI's vacuum insulation concepts have attracted considerable interest from potential industry partners. Discussions are underway toward establishing collaborative efforts. For further information on these or other SERI technologies available for license, contact Dana Moran, manager, Research and Technology Applications, SERI, 1617 Cole Boulevard, Golden, Colorado 80401-3393; 303/231-7115.

Excerpted from Minnesota Energy Alternatives, Winter 1989.

Changes at the Cold Climate Housing Center

Dr. Lewis Hendricks is now the director of the Cold Climate Housing Center. Lew has served as the coordinator of the CCHC since it began in 1987. In his new role, Lew will be responsible for program direction, budget management, and long-range planning. Patrick Huelman will assume the role of coordinator. Pat has been a specialist with the Center since October of 1988 and prior to that served as the program coordinator for the Iowa State University Energy Extension group. Pat will oversee day to day operations and coordinate the various educational programs offered through the Center.

Stan Wrzeski has recently joined the CCHC team in the indoor air quality area. Stan, a consultant from Milwaukee, brings to the Center both expertise and experience in residential ventilation. He will be focusing on indoor air quality concerns and ventilation system design and installation.

Building For IAQ: Particulates

Continued from page 3.

This approach includes good design and quality control of all construction details, with special attention paid to careful installation of air barriers and vapor retarders, adequate insulation, informed choices in finishes and well-designed mechanical ventilation equipment. Also included in a systems approach is the ability to prevent and control particulate indoor air pollutants. Without a clear understanding of how this system operates, the occupant may not use it effectively.

Can A Builder Help The Occupant Manage The House?

To help the occupant learn how the building should perform, clear written instructions for its operation should be provided by the builder. These instructions should be written in non-technical language. This should include not only the equipment warranties and instructions for individual appliances, but any specific suggestions for system management.

These builder actions aimed at managing particulates in the home can help produce a satisfied customer--the most profitable recommendation the builder can achieve.

Questions? Comments?
For more information:

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(612) 624-9219

Are you moving? If so, please send your name and new address to CCHC. Thank you.

Cold Climate Housing Publications

"Home Moisture Sources," Fact Sheet CD-FS-3396.

"Mold and Mildew in the Home," Folder CD-FO-3397.

"Home Indoor Air Quality Assessment," Folder CD-FO-3398.

"Residential Heat Loss," Folder CD-FO-3399.

"Insulation Basics," Folder CD-FO-3400.

"Moisture Sources Associated with Potential Damage in Cold Climate Housing," Folder CD-FO-3405.

"Home Indoor Winter Relative Humidity: What is Acceptable?" Folder HE-FO-3415.

"Radon Issues in House Buying and Selling," Folder HE-FO-3532.

"Radon Facts for House Sellers and Buyers," Fact Sheet HE-FS-3533.

"A Systems Approach to Cold Climate Housing," Folder CD-FO-3566.

"Humidity and Condensation Control in Cold Climate Housing," Folder CD-FO-3567.

"Ceiling Airtightness and the Role of Air Barriers and Vapor Retarders," Folder CD-FO-3568.

"Exterior Wall Airtightness and the Role of Air Barriers and Vapor Retarders," Folder CD-FO-3569.

"Performance of Downdraft Kitchen Range Exhaust Systems," Folder HE-FO-3722.

"Performance of Kitchen Range Exhaust Hoods," Folder HE-FO-3713.

Two video tapes on range exhaust systems are available through the Extension Distribution Center, 3 Coffey Hall, 1420 Eckles Avenue, St. Paul, MN 55108. They are "Performance of Kitchen Range Exhaust Systems" (HE-VH-3593) and "Kitchen Range Exhaust System" (HE-VH-3594).

Several other Cold Climate publications are currently being prepared, reviewed or planned. By writing or calling the Cold Climate Housing Center, you can obtain single copies of the publications listed above. Additional copies of the listed publications can be purchased from the Extension Distribution Center on the St. Paul Campus. Fact sheets are priced at 10¢ wholesale, 20¢ retail, while Extension folders are priced at 25¢ wholesale, 50¢ retail.

During the coming year, CCHC staff will be conducting educational programs in many subject areas related to cold climate housing. A Cold Climate "Central" telephone number--612-624-9219--has been set up in Kaufert Laboratory (Forest Products) on the St. Paul Campus. Incoming calls regarding the program and information requests may be directed to this number or to specialists serving particular subject matter areas.

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