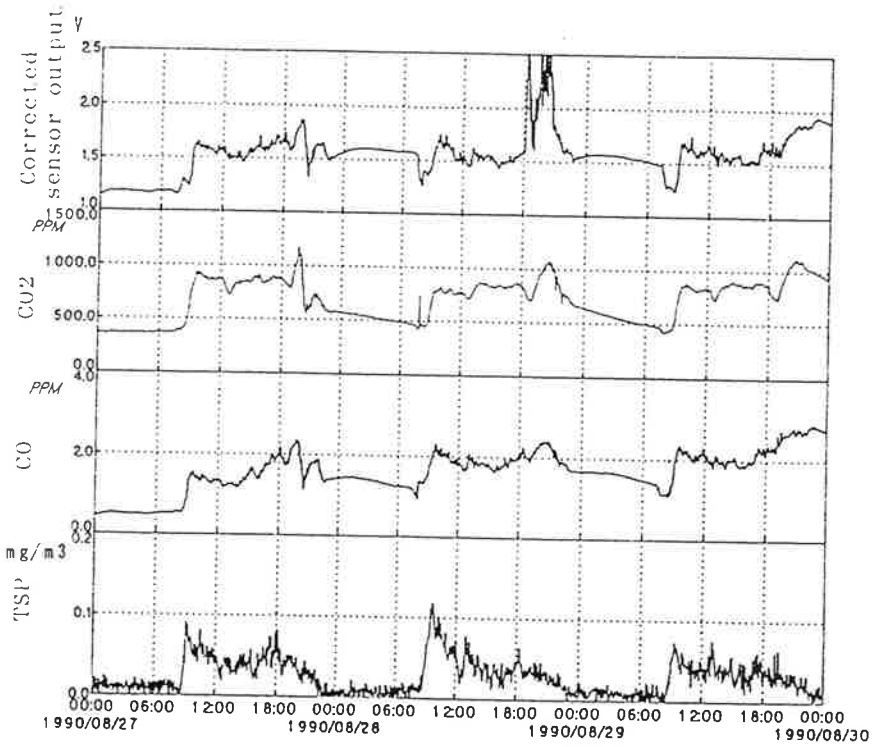

Fig.4 Examples of time-course of concentration of CO2 and CO and TSP measured parallel to the sensors

OCCUPANT USE OF VENTILATION CONTROLS AND HUMIDIFIERS DURING COLD SEASONS

Kevin M. Kelly, Monica Brien and Robert W. Stemp

Jay-K Independent Lumber Co. Inc., New Hartford, New York, USA

ABSTRACT

During the past two decades the desire to save energy has created tight houses with chronic moisture problems. This situation prompted us to mail a questionnaire to 3000 Jay-K Home Center customers in December 1991 to determine heating season fresh air sources, occupants' use of air change devices, (i.e., actual ventilation), humidifier use, and humidifier cleaning. Occupants' disregard for fresh (outdoor) air and replacement air sources when exhausting air with furnaces, exhaust fans, and clothes dryers indicates that occupants are not taking steps to ensure good indoor air quality. The presence of uncleaned home humidifiers adds to the problem. Based on the data obtained, a review of building ventilation standards and humidifier use may be advisable.

INTRODUCTION

We find that the need to conserve energy by reducing convection air change in dwellings and the introduction of gas/vapor barriers which eliminate diffusive air change have precipitated moisture problems and possibly indoor air quality problems during cold seasons (1). Energy conserving measures tend to increase the inhabitants' indoor exposures to pollutants and hence augment the risk of adverse health effects (2). Counseling customers about moisture problems in homes leads us to believe that many occupants do not want to let cold outdoor air into their homes. A commonly advised solution for a moisture problem is the use of kitchen and bath exhaust fans and/or opening windows to supply outdoor air. However, removing heated air with fans or by opening windows appears to be a waste of money to home owners. The noise caused by fans that change air is bothersome and drafts from fans are uncomfortable in any season (3,4). In the present state of the art, residential ventilation must depend upon cooperation from the occupants (5). The objective of our study was to determine if occupants opened windows in cold seasons vs. warm seasons and to determine if occupants supplied replacement air for furnaces, exhaust fans and dryers during cold seasons. In addition, we wanted to see if humidifiers were cleaned as often as recommended in the literature (6).

Therefore we designed a questionnaire to determine whether occupants open windows in warm and cold seasons, whether they use fans and other air exhausting devices, their possible sources for replacement air for exhausted air, and their use and cleaning of humidifiers.

METHOD

The questionnaire used in this study was derived from a series of pretesting sessions. Initially, 47 items relating to aspects of indoor air quality were evaluated by groups of employees and customers of a Home Center located in central New York State. Phase II testing consisted of a shorter questionnaire submitted for evaluation to other employees, customers, and to a local environmental health group.

The resulting 12-item questionnaire was mailed to 3000 of the Home Center charge account customers. The questionnaire was mailed December 2, 1991 because we wanted occupant responses during a cold season. Reponses were received throughout the first 15 days of December. During this time the area average high and low temperatures were +5° c and -2° c.

RESULTS

One hundred forty-one completed questionnaires were returned (4.7%). Because our sample was self-selected, our ability to generalize the results to other populations is limited. The issues raised in the survey are, nevertheless, important concerns. The overall results are presented in Table 1. Descriptive statistics provide the data analysis. Most of the sample (81%) reported living in homes at least 11 years old, i.e. built before 1980. Enforcement of energy-saving building code restrictions increased about 1980 in New York State as a consequence of the 1973 Arab oil embargo. Seventy percent (70%) believed their homes to be well insulated, and slightly fewer (59%) felt their homes were well weather-stripped. Overall, 70% of the respondents did not supply outdoor air to the indoors by opening windows in cold weather. Occupants who perceived their homes to be poorly weather-stripped were more likely to keep windows closed (83% vs. 68%), as were those believing their homes to have inadequate insulation (75% vs. 67%). In contrast to this cold weather behavior, 78% of all respondents reported always opening windows in warm weather.

Sixty seven percent (67%) of our sample reported having kitchen fans while 74% said they had vented bath fans. Fully 97% reported owning clothes dryers. While exhaust fans in kitchens and bathrooms were used by some to remove source-generated pollutants, none were used for continuous air exchange. Of those owning fans, 17% never used kitchen or bath fans, while 75% used bath fans less than half-an-hour daily and kitchen fans only sometimes when cooking (69%). Two-thirds of the respondents who used exhaust fans and had vented clothes dryers never opened windows to supply replacement air for exhausted air.

Approximately half (47%) of our survey reported owning humidifiers. Of these, 82% reported using them. Some reports have linked humidifiers to disease transmission including Legionnaires' disease (7,8). The National Jewish Center for Immunology and Respiratory Medicine in Denver recommends weekly and sometimes daily cleaning of humidifiers (6). Only 15% of our sample using humidifiers reported cleaning them as recommended (weekly) while 45% cleaned them yearly and 27% cleaned monthly. Twelve percent (12%) reported never cleaning their humidifiers.

Table 1. Response percentage to questionnaire label items.

Age of home?		Have bath fan?		Have dehumidifier?	
0-2 years	8%	Y	74%	Y	45%
3-10	3%	N	26%	N	55%
11+	81%				
Don't know	8%	Use bath fan?		Have humidifier?	
		Never	17%	Y	47%
Is home well insulated?		1/2 hour	75%	N	53%
Y	70%	1 Hour+	8%		
N	21%			Use humidifier?	
Don't know	9%	Open windows in cold weather?		Y	82%
		Never	71%	N	18%
Is home well weather-stripped?		1-7 hours	24%		
Y	58%	8+	5%	Clean humidifier?	
N	24%			Yearly	45%
Maybe	16%	Have chimney?		Monthly	27%
Don't know	2%	Y	89%	Weekly	15%
		N	11%	Daily	1%
Have kitchen exhaust fan?		Have cellar drain?		Never	12%
Y	67%	Y	61%		
N	33%	N	39%	Open windows in warm weather?	
Use kitchen exhaust fan?				Always	78%
Never	17%	Have clothes dryer?		Seldom	16%
Sometimes	69%	Y	97%	Never	6%
Always	14%	N	3%		

DISCUSSION

Weather-stripping, insulating, limited use of exhaust fans, closed windows, etc., may increase the energy efficiency of buildings. However, adopting these energy-saving measures may compromise the indoor air quality. Few of our respondents opened windows or used exhaust fans, but over 70% had cellar drains and chimneys. Are these drains and chimneys the prime source of replacement air in cold weather (9)? Using fans, (although commonly advised), maintaining humidifiers and opening windows are some of the mechanical aspects of air quality maintenance which are not a high priority for occupants during cold weather (10). Air-to-air heat exchangers have been suggested as a mechanism to facilitate air change during cold weather. However, they are not widely used here in central New York State; there is a high initial cost, they are fairly complex systems which require flow balancing, filter changing, blower lubrication, and annual cleaning of the heat exchanger core. In addition, most successful systems make use of fans and other mechanical devices that may eventually fail and require periodic inspection to insure their continued operation (11).

Based upon our survey results, it appears that supplying ventilation air and replacement air has a low priority for our respondents. There is little perceived reward for using either passive or forced ventilation in cold weather.

Perhaps "healthier" buildings could be built by targeting both building respiration and replacement air. Use of air change by diffusion through building components without intervention by the occupants may improve indoor air quality. Research done at National Institute of Standards & Technology has found that even with a 35% interior relative humidity, ventilated side walls of buildings remove water vapor without condensation (12). Research done in Denmark has found that "Outer walls open (porous) for water vapor could be a contributing factor to an improved indoor air quality as the pollutants which are adsorbed on the inner surface of the outer walls rarely will be emitted to the room again. On the contrary, the pollutants will be transported through the wall and finally emitted to the outdoor air" (13). In addition, replacement air could be passively supplied by specific design to prevent random infiltration through unknown or unclean passages.

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EVALUATION OF RESIDENTIAL VENTILATION CONTROLLER TECHNOLOGY

John P. Kesselring[1], Michael D. Koontz[2], Donald R. Cade[2], Niren L. Nagda[3]

[1]Electric Power Research Institute, Palo Alto, CA, USA
[2]GEOMET Technologies, Inc., Germantown, MD, USA
[3]ICF Incorporated, Fairfax, VA, USA

ABSTRACT

A low-cost, CO_2-based controller connected to an energy recovery ventilator (ERV) was evaluated over a 5-day period in an energy-efficient demonstration house located in Florida. Parameters monitored included temperature, humidity, air exchange rate, energy consumption, ERV on-time, and CO_2 and radon levels. CO_2 production from a four-person family was simulated to yield indoor CO_2 levels above 1,000 μL/L (ppm) in the absence of mechanical ventilation. During periods of ERV operation, the air exchange rate increased from 0.1 to 0.4 ACH, CO_2 levels were kept below 1,000 μL/L throughout the house, radon concentrations were reduced by about 50 percent, and HVAC/ERV energy consumption increased by 15 to 20 percent.

INTRODUCTION

The air quality in a building, when expressed in terms of indoor pollutant concentrations, can be affected by factors such as indoor sources of pollution (e.g., products, materials, furnishings, and the occupants themselves), outdoor concentrations, air exchange rates, and the air-cleaning capabilities of heating, ventilating and air conditioning (HVAC) systems. In many cases problems attributable to indoor sources may be detected, but the changes in furnishings, cleaning devices, or occupant activity patterns to improve the situation could be difficult to implement. In such situations, the rate of air exchange can be altered through natural or mechanical ventilation. Mechanical ventilation may be preferable, particularly if tied in with an energy-recovery system, because natural ventilation does not readily enable precise control of the air exchange rate and can also carry a substantial energy penalty.

A rationale for increased ventilation is provided by guidelines or standards such as ASHRAE 62-1989 (1), which specifies indoor levels that are acceptable for pollutants such as carbon monoxide, total suspended particles, carbon dioxide (CO_2) and ozone. Further, the standard indicates ventilation rates for specific types of occupied spaces [e.g., 0.35 air changes per hour (ACH) or 15 cfm of fresh air per person, whichever is greater, for residential living areas] to achieve acceptable indoor air quality by controlling contaminants common to these spaces, assuming that prevailing outdoor levels of such contaminants are acceptable.