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Effectiveness of Dehumidifiers in Controlling Moisture in Houses

INTRODUCTION

Houses are exposed to numerous moisture sources including precipitation, surface water, moisture in the ground around the foundation and moisture in the air from both indoor and outdoor sources. To prevent moisture from accumulating to the point where condensation, water damage and mold growth can occur, a variety of strategies can be used to deflect, drain and dry outdoor moisture and to control indoor moisture sources.

One method to control indoor moisture conditions involves the use of dehumidifiers. Dehumidifiers are often used as temporary solutions to high indoor humidity conditions that may occur throughout the year. However, year round operation of dehumidifiers may offer improved moisture control but the extent to which this is the case had not been fully explored.

In 2004, a CMHC pilot study examined the effectiveness of a typical residential dehumidifier in reducing moisture levels in basements of new houses. The results of the three-month study indicated that the relative humidity (RH) and moisture content of wood in the dehumidified basements were reduced compared to control houses with similar conditions. This *Research Highlight* reports on a subsequent field study that measured the effectiveness of dehumidifiers in controlling general moisture conditions in houses of varying ages in different regions of Canada. The purpose of this study was to determine if year round operation of dehumidifiers could improve moisture conditions and reduce opportunities for moisture related problems.

RESEARCH OBJECTIVES

The objectives were

1. To develop a practical and cost-effective method for assessing the effectiveness of dehumidifiers in the control of moisture in houses.
2. To determine the usefulness of dehumidifiers to control general moisture conditions in houses in different regions of Canada.

METHODOLOGY

The study examined moisture conditions within houses across Canada with and without dehumidifiers installed. The study was designed to monitor a group of houses over a period of two years. Baseline characteristics (moisture conditions) of each house without dehumidifiers were monitored the first year. Dehumidifiers were installed in the houses and moisture conditions were monitored for another year.

Thirty houses—10 from Ontario and Quebec, 10 from B.C. and the Atlantic and 10 from the Prairies were located for the study. To be eligible to participate in the study, the houses:

- did not have dehumidifiers or air conditioning systems
- had not experienced previous flooding in the year before; and
- no home renovations or move were anticipated in the next two years.

Temperature and RH measurements were automatically recorded with two data loggers placed by the participants in the basement and the main floor. The data loggers were pre-calibrated and set to take measurements every hour. Participants were asked to return the data loggers periodically to the project coordinator throughout the study so that data could be downloaded and to ensure the devices were working properly.

Wood moisture content was measured by the participants with a moisture meter at five pre-determined locations in the basements and two locations on the upper floors. An infrared thermometer was used to measure surface temperatures in five basement and seven main and upper floor locations. Participants were provided log sheets for recording the measurements on a monthly basis.

During year two, when the dehumidifiers were operating, the participants also measured and recorded the volume of water extracted by the dehumidifier. The dehumidifier chosen for the study was a heavy duty model with a moisture-removal capacity of 31L (8.19 gal.) per day and a 10 L (2.64 gal.) reservoir for the removed water. It had an RH sensor that automatically stopped operation when the ambient air reached a pre-set RH of 50 per cent and started again when the RH of the air exceeded 50 per cent. The dehumidifier stopped operating when the reservoir was full. Calibration marks on the reservoir helped participants determine how much water had been extracted by the dehumidifier when they emptied the reservoir.

RESULTS

At the end of year one, 22 of the original 30 participants agreed to continue with the study and installed dehumidifiers. Useful results were obtained from 21 households. Eighteen participants—seven from Quebec and Ontario, four from Alberta and Saskatchewan, five from B.C. and two from the Atlantic—returned reasonably complete data that could be displayed graphically.

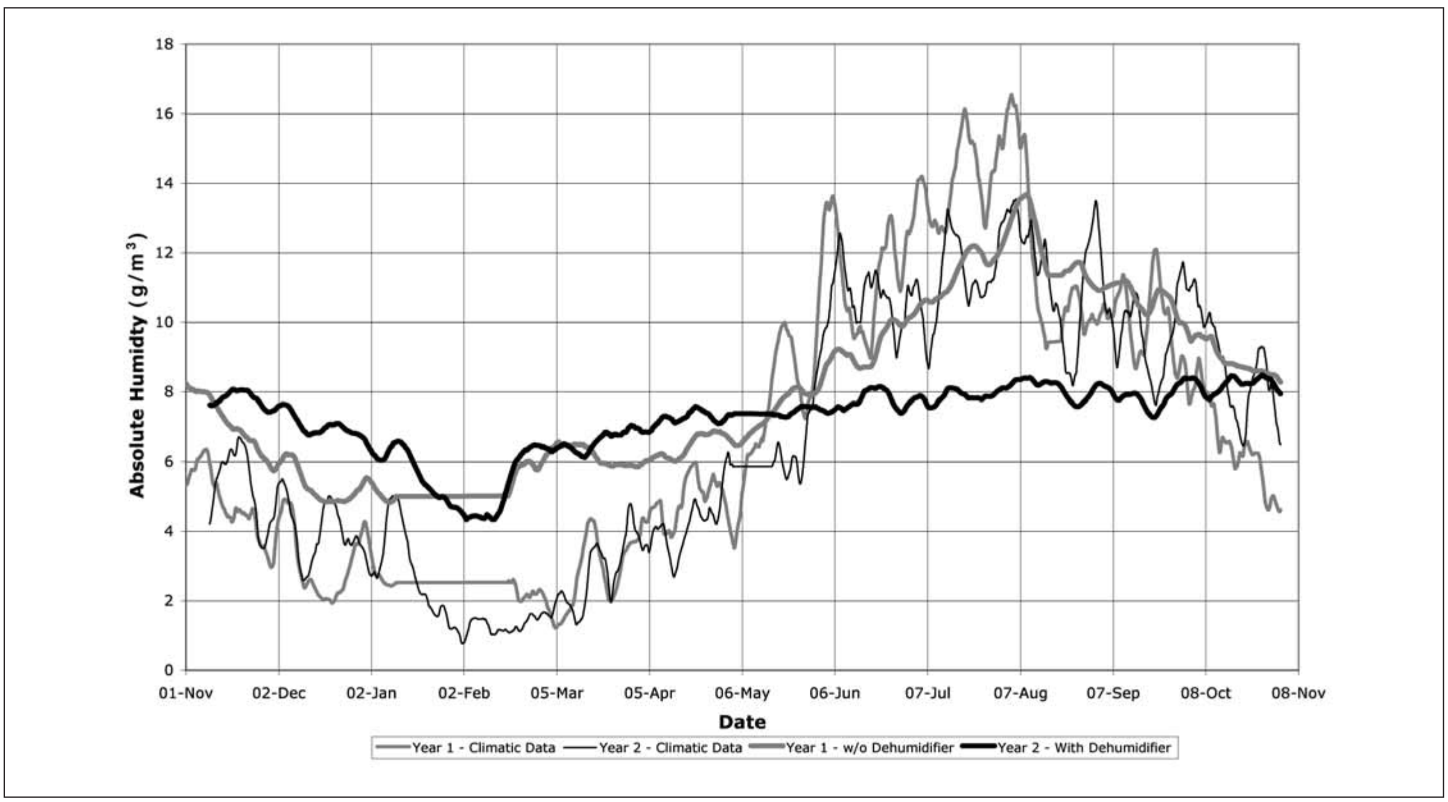

Figure 1 Comparison of Year 1 and Year 2 indoor basement and outdoor absolute humidity

Although there were gaps in moisture meter measurements and volume of water reported due to reporting lapses on the part of the occupants or absences, the overall quality of the data from the 18 houses was sufficient for analysis. A few individuals gave meticulously recorded data with very few gaps. In particular, data from House 22 was consistent throughout the study and the results will be used as an example to illustrate the type of information that was obtained. Figure 1 (House 22) presents a comparison of the absolute humidity (moisture content) of the basement air in Year 1 (without a dehumidifier) and Year 2 (with a dehumidifier) together with climatic data retrieved from Environment Canada for the location of the house for both years. In year 1, the indoor absolute humidity during the winter months was higher than that for outdoor air. During warm months of year 1, from May to the beginning of October, indoor absolute humidity resembled that of outside air, with a peak in early August. In Year 2, when the dehumidifier was running, indoor absolute humidity remained nearly constant and lower than the outdoor absolute humidity during the warm months from May to October.

On the main floor, which is typically open to the outdoors during the warm months, there was no reduction of indoor air moisture levels during the second year when the dehumidifier was operating. Generally, moisture levels in basement air were less than moisture levels in outdoor air during the spring, summer and fall months when the dehumidifier was operating.

Figure 2 shows the moisture removal rate vs. time graph for Year 2 for House 22. The moisture removal rate was calculated from the volume of water collected by the dehumidifier over time. Water was extracted from the air for a month in November (start of year 2) and from May until the end of October. No water was collected during the winter months. Figure 2 demonstrates how closely the moisture removal rate tracked the changes in outdoor absolute humidity.

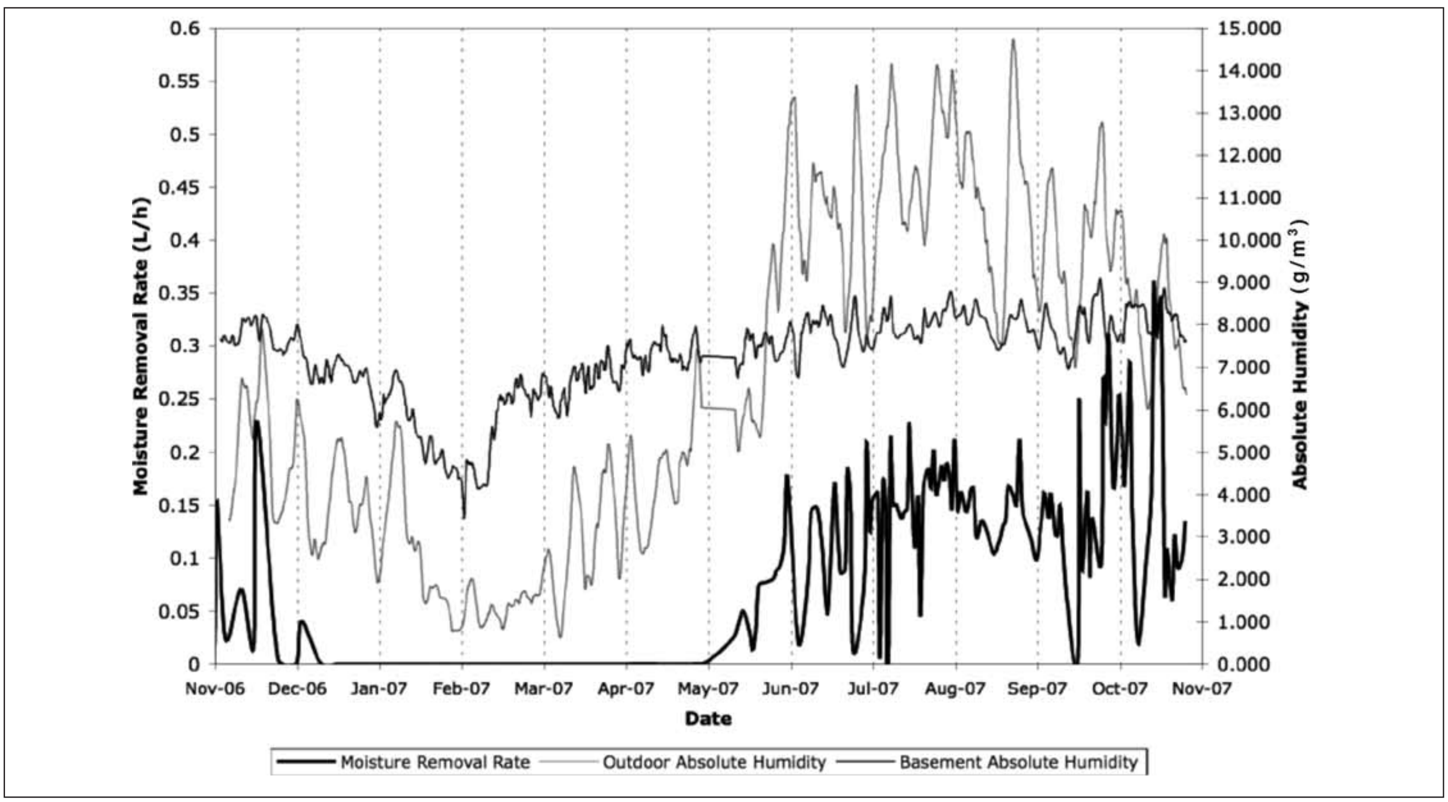

Figure 2 Moisture removal rate vs. time graph for Year 2

Figure 3 shows the moisture content of wood at various locations versus time over the two years for House 22. During Year 1, without dehumidification, the wood moisture content peaked at 10 per cent between June and October, while in Year 2, with dehumidification, the wood moisture content stayed around 7 to 8 per cent. There was no difference in moisture content of wood between the first and second year on the upper floor which is somewhat consistent with the previous observation concerning the limited impact of dehumidifier operation on main floor indoor air moisture levels. Dehumidification of the basement lowers the absolute indoor humidity and this is reflected in the wood moisture content in the basement.

Two houses gave results inconsistent with the above observations. House 13 had a higher indoor absolute humidity than the outdoors in winter and summer months even with dehumidification. The wood moisture content of this house was unchanged by the dehumidifier, which was removing an average of 0.60 L (0.16 gal.)/hr compared to 0.20 to 0.25 L (0.05 to 0.07 gal.)/hr in other houses. In House 9, absolute humidity was lower with dehumidification but wood moisture content was high, with 7 to 12 per cent moisture content in the summer and up to 24 per cent in the winter of both years. The moisture removal rate was as high as 0.75 L (0.20 gal.)/hr.

These anomalies can be explained by higher moisture sources in both houses. House 13 had an attached crawl space with a dirt floor next to the basement. House 9 had a preserved wood foundation. Dehumidifiers could not make a difference to the moisture loading through the dirt floor of House 13 and moisture may be diffusing through the wood foundation of House 9.

Overall, more than half of the houses showed a reduction in indoor humidity levels when dehumidifiers were installed relative to the corresponding climatic conditions of the regions where these houses were located. Seven houses showed some reduction in the wood moisture content while the rest did not show any reduction. All houses returning sufficient data showed at least some level of moisture removal, with 10 of 18 houses showing good levels of moisture removal.

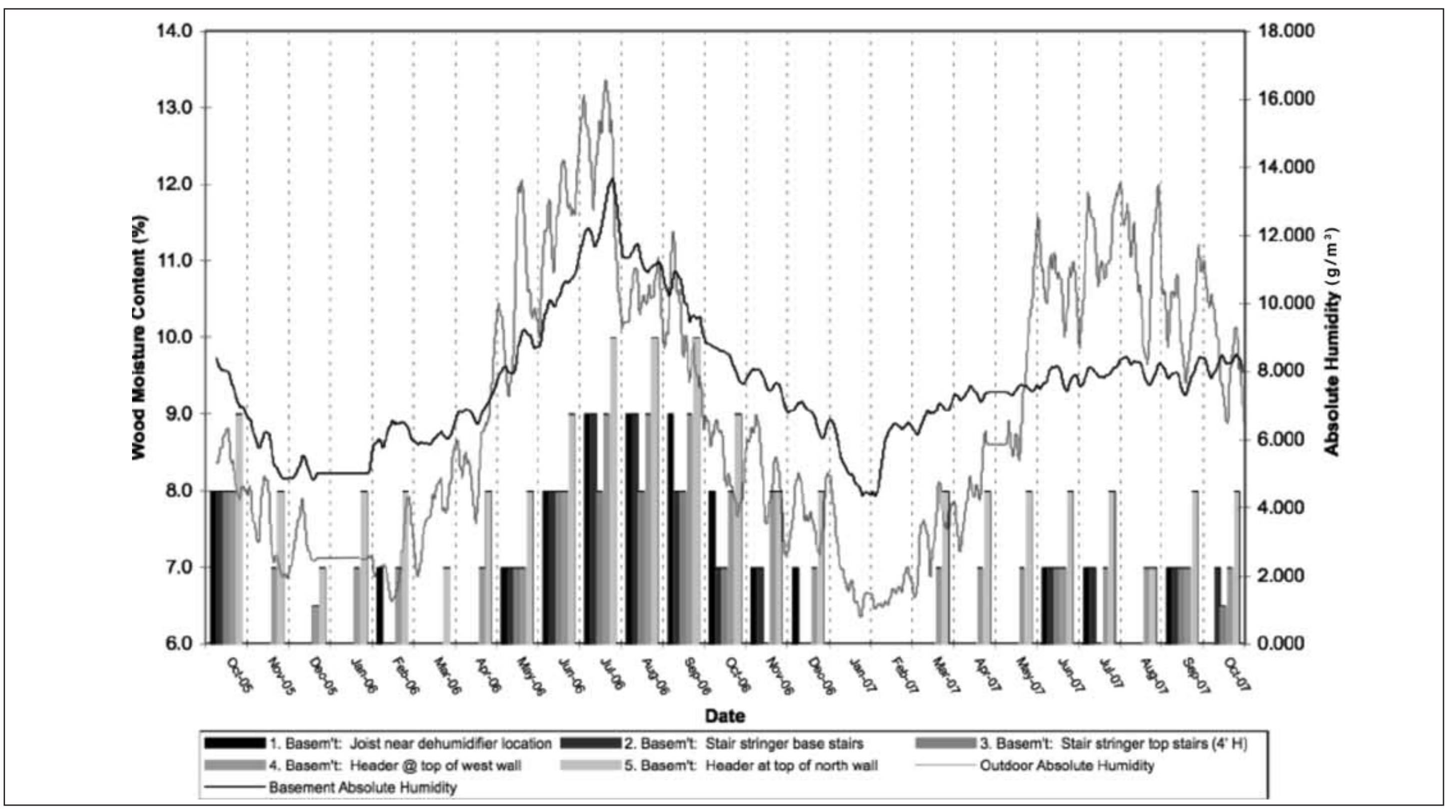

Figure 3 Basement wood moisture content for House 22 in Year 1 and Year 2

The highest moisture removal rates were in Atlantic Canada. The Prairies (considered 'dry' in the winter, not needing dehumidification) had high moisture removal rates during the summer. In central Canada, moisture removal rates were low to medium in the summer. In B.C., the moisture removal rate was low to medium year round.

CONCLUSION

This study confirmed that in the houses tested, dehumidifiers were effective in reducing indoor humidity during the warm months—May to November in most regions of Canada. Moisture levels in basement air were less than moisture levels in outdoor air when the dehumidifiers were operating. For the study, the dehumdifiers were placed in the basements of the homes and, in most cases, the benefit of the dehumidifier was primarily observed in the basement. Typically, the main floor humidity levels fluctuated with the outdoor levels during the second summer of dehumidification while the basement levels remained at a more constant level.

IMPLICATIONS FOR THE HOUSING INDUSTRY

The study demonstrates the benefits of dehumidifiers to control indoor moisture conditions in houses. In most regions of Canada, dehumidification is beneficial during the non-heating season while year round operation can be beneficial for houses located in milder coastal climates. Basements of newly constructed homes can be dehumidified, even before occupancy, to help remove moisture from construction materials. While this study demonstrates the benefits of mechanical dehumidification, moisture source control should be considered first where it is practical, and cost-effective, given the energy costs associated with the operation of dehumidification equipment.

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